WATER GLOBAL PRACTICE

The Cost of Irrigation Water in the Jordan Valley

CAROLINE VAN DEN BERG AND SANA KH. H. AGHA AL NIMER
with support from Turi Fileccia, Luz Maria Gonzalez, and Suhail Wahseh

WORLD BANK GROUP

WATER PARTNERSHIP PROGRAM

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Abbreviations

FOB	free-on-board
GTZ	Gesellschaft für Technische Zusammenarbeit (Germany)
ha	hectare
JD	Jordanian dinar
JRV	Jordan River Valley
JVA	Jordan Valley Authority
NEPCO	National Electricity Power Company
O&M	operation and maintenance
WAJ	Water Authority of Jordan
WUA	water user association

Executive Summary

Jordan is one of the most water-stressed countries in the world. Its annual renewable resources of 145 cubic meters per capita are far below the threshold of severe water scarcity of 500 cubic meters. The competition among water needs for irrigation, industrial and domestic uses, wetland protection, and in-stream habitat needs continues to pose serious challenges in Jordan. As a result of this competition, the available fresh water for farmers in Jordan, and more specifically farmers in the Jordan Valley, has declined. The five-year moving average dropped from 155 million cubic meters in 2003 to 131 million cubic meters in 2009. The drop in fresh water has been accompanied by an increase in treated wastewater, which although assisting in maintaining access to water for agriculture, has had an impact on the quality of the available water. Nevertheless, the total crop area has increased from 28,000 hectares in 1994 to 34,300 hectares in 2012.

In the past 20 years, agricultural productivity in the Jordan Valley has increased despite the sector's major water resource constraints. The increased reliance on new farming and irrigation technologies (most notably the introduction of greenhouses and drip irrigation technologies) and the expansion of the area planted have resulted in higher agricultural output. However, the forces driving these changes are weakening, and in 2012 and 2013 the country registered negative growth rates in the sector. In the Jordan Valley, this lack of growth also translated for the first time into a decline in crop productivity per dunum.[1] Despite the modernization of agriculture in the Jordan Valley, cropping patterns have barely changed over the last 20 years. In 1994, the five major crops (tomato, cucumber, eggplant, squash, and potato) constituted 62 percent of the total cropped vegetable, whereas the share of these five crops increased to 70 percent in 2012. Banana has shown an expansion due to the crop's artificially high prices resulting from import restrictions.

In the Jordan Valley, the public irrigation infrastructure assets are managed by the Jordan Valley Authority (JVA), the government organization responsible for the socioeconomic development of the Jordan Valley. Ensuring that the Jordan Valley can thrive will depend on the capacity of the JVA to provide the needed water quantity and quality. Currently, the JVA's capacity is hampered by its lack of financial viability. Although the JVA has strived in recent years to improve its revenue base, more effort is needed to secure its financial sustainability. Although the JVA has increased industrial tariffs, it has left irrigation tariffs untouched (which are extremely low at JD 0.011 per cubic meter and have not been adjusted since 1994).

The large operating deficits within the context of an increasingly aging infrastructure have already resulted in depreciation and maintenance payments increasingly being squeezed out, jeopardizing the medium-to-long-term viability of the existing water infrastructure. With the increase in energy prices (and the dismantling of energy subsidies), the JVA's financial results will be highly compromised in the short term. The postponement of investments during the last decade, and increasing energy costs coupled with new responsibilities regarding the pumping of water to Amman, have contributed to large operating losses which, in 2012, were equivalent to about 40 percent of total recurrent expenditures. In view of the many uncertainties, including changes in energy subsidies currently extended to the water sector, the upward risk for further operation and maintenance cost increases seem higher than the downward risks. Yet, it also shows that the JVA will have to lay out a roadmap for irrigation water tariff increases that are accompanied by efficiency improvements and other measures to help farmers make the transition to higher tariffs.

The purpose of this study is to determine the cost of irrigation water in the Jordan Valley, compare this cost with the revenues generated by the JVA, and to estimate the impact of increasing irrigation water prices—based on different levels of cost recovery—on farming.

The study undertook a financial analysis of the JVA combining data from the JVA's administration and the JVA's budget books, while collecting more disaggregated data on the JVA's revenues and expenditure from its financial and operational departments. It supplemented this analysis with farmer surveys in the Jordan Valley and an assessment of the agricultural sector using data from from the Jordanian Department of Statistics and an expert team of the Food and Agriculture Organization.

The cost of irrigation water in the Jordan Valley. The analysis shows that the JVA needs significant tariff increases to strengthen its financial sustainability. Depending on the level of cost recovery, the minimum required tariff increases for irrigation water could be very large. If the JVA wanted to at least cover its operation and maintenance costs in 2013, it would have required an irrigation water tariff of JD 0.108 per cubic meter—assuming that the current cross-subsidies and current inefficiency levels remain unchanged. Yet, if the JVA were able to reduce its billing and collection inefficiencies, the required irrigation water tariff would drop to JD 0.066 per cubic meter. If the government wanted to pursue its objective as stated in the Government of Jordan's Water Strategy (2009) that depreciation should also be covered, the irrigation water tariff would have to increase to between JD 0.132 and JD 0.215 per cubic meter, depending on whether billing and collection inefficiencies improve.

The tariff increases necessary to ensure JVA's financial viability are rather large, especially compared to current tariffs, and will require time to be implemented. The more efficient JVA becomes in providing irrigation water services, the more able it will be to reduce the size of the required tariff increases. The JVA has several routes to improving its efficiency, which include changing billing and collection practices, changing revenue policies, and efficiency improvements in the delivery of JVA services.

Change in billing and collection practices. The farmer survey that was undertaken by the JVA in 2011–12 for this study found that billing efficiency was only 82 percent and collection efficiency only 75 percent. Hence, JVA is obtaining less than 62 percent of its potential revenues. Improving billing and collection efficiency would go a long way toward lessening the need for irrigation water tariff increases, while also ensuring fairness in water tariffs. In addition, the current practice of billing farmers on the basis of quota allocations, when actual water volumes provided are often significantly lower, will need to be reviewed, because farmers may not be willing to pay for water that has not been received. Since the JVA is increasingly transferring the distribution responsibility to water user associations (WUAs), it should consider putting WUAs in charge of billing and collecting irrigation water tariffs from farmers.

Change in JVA's and WUA's capability to retain revenues. Currently, the JVA is a ministerial department that collects revenues, but which then transfers these revenues to the Treasury, a policy that does not provide many incentives to increase billing and collection efficiencies. This report, therefore, recommends ensuring that billed and collected revenues are retained by the JVA or WUAs (if responsibility has been transferred), and allowing the WUAs to keep their share needed for the operation and maintenance of the distribution networks, while handing the rest over to the JVA. This would also dovetail with the government's vision of transforming the JVA into a bulk water supplier.

Efficiency improvements in the delivery of JVA services. Although the JVA has cut costs significantly over the years, especially with regard to maintenance and investments, there is still ample scope for efficiency gains. These gains are especially evident in energy cost savings, including a more explicit agreement with the Water Authority of Jordan on water pumping to Amman, improvement in staff productivity and maintenance policies and implementation. Energy makes up an increasing part of the total operating costs of JVA (due to the increase in electricity prices and reduction of subsidies). In addition, JVA's mandate was expanded to include pumping water to Amman, without explicit agreements on the costs and revenues linked to that pumping. An explicit agreement with the Water Authority of Jordan on water pumping, and a policy to improve energy efficiency, would be first steps in improving energy efficiency in the JVA. At the same time, staff productivity as measured by staff per farmer served is very low, and hence there is ample scope to improve staff productivity in the JVA. Finally, although maintenance has been neglected in recent years, and the required irrigation water tariffs assume a much higher maintenance provision, the JVA could develop and implement an asset management plan to extend asset life; rationalize rehabilitation, repair, and replacement investment decisions; and rationalizing maintenance.

The impact of increasing irrigation water tariffs on farmers. The proposed irrigation water tariffs are much higher than the rates currently in place. A comparison with other countries shows that the proposed tariff scenarios are comparable to irrigation water tariffs in countries for which data are available. The impact of tariff increases on farmers' incomes is in general moderate, because water costs make up only a small part of the total cost of farming. Yet, as can be expected, certain cropping patterns will be much more affected by the tariff increases than others. It is especially crops that tend to consume large volumes of water (especially citrus) that will feel the impact of the irrigation water tariffs. In the case of another water-intensive crop as banana, which benefits from import restrictions, only very large tariff increases will make this crop unprofitable.

Because the agricultural sector in Jordan is under stress, having registered negative growth in 2012 and 2013, any government policy to rationalize irrigation water subsidies should, where possible, try to increase the resilience of farmers in a comprehensive manner. The farming sector in the Jordan Valley will have to address issues related to, among others, the marketing of crops, and provide support to introduce new technologies that reduce the risks for farmers to change cropping patterns. These are not under the purview of the JVA, but will help improve the productivity in the sector. In addition, the government should assess the impact of the irrigation water tariffs on poor farmers. The farmer survey found that 17 percent of the survey respondents could be classified as poor. Propoor farm policies can come in different forms, ranging from cross-subsidies in the irrigation tariff structure to direct income support to poor farmers. Because the number of poor farmers is very small, it is relatively easy for government to provide income support to poor farmers in the Jordan Valley.

Note

1. One dunum is equivalent to 1,000 square meters, or 0.1 hectare.

Chapter 1

Introduction

Background

Jordan is one of the most water-stressed countries in the world. Its annual renewable resources of 145 cubic meters per capita are far below the threshold of severe water scarcity of 500 cubic meters (Aquastat 2008; Northcliff et al. 2008). The competition among water needs for irrigation, industrial and domestic uses, wetland protection, and in-stream habitat needs continues to pose serious challenges to the country. These challenges are further exacerbated by the deterioration of water quality. The competition for increasingly scarce water resources is reflected in the use of water sources. In 2007, (the latest year for which data are available), agriculture withdrew about 64 percent of the renewable water resources compared to 74 percent in 1992. The share of agriculture decreased during the same period from close to 8 percent to less than 3 percent of gross domestic product in 2007.

However, compared to many other countries in the region, Jordan has made progress in water sector reform. For example, the Government of Jordan is paying attention to sector policies and is trying to address water scarcity. The government has a system of quotas and tariffs in place for irrigation water. Favorable institutional arrangements exist, with a regulatory authority, the Ministry of Water and Irrigation, and two providers for irrigation and water supply and sanitation services, the Jordan Valley Authority (JVA) and the Water Authority of Jordan. Further, the government has embarked on the establishment of water user associations (WUAs) to deliver retail irrigation services to farmers. Farmers in about 40 percent of the Jordan Valley are in various stages of establishing WUAs. These WUAs interface with the JVA at the level of the head units along the King Abdullah Canal and in the irrigation systems in the Southern Ghors. Finally, recent major investments have both increased the supply of bulk water and enhanced wastewater treatment capacity (making reuse of wastewater possible).

The production of agricultural produce in the Jordan Valley could not be achieved without irrigation. In the Jordan Valley, the total crop area increased from 28,000 hectares (ha) in 1994 to 34,300 hectares in 2012, with virtually all of that area being irrigated. Water is delivered to farms through pressurized closed conduits. The challenge is to allocate the limited supply of water available to the approximately 10,000 Jordan Valley farms[1] in a transparent and equitable way and to apply it to crops so as to maximize output per unit water, prevent the accumulation of salts and other soil contaminants, and avoid deep percolation losses of water below crop root zones.

The Government's 2009 Water Strategy lays out the future challenges for irrigation in Jordan, and focuses on reducing the annual water allocation for irrigation (in favor of domestic and industrial demand) by improving efficiency through appropriate water tariffs, the use of new technologies, and incentives for farmers to improve the efficiency of on-farm irrigation. The Water Strategy is supplemented by the Irrigation Water Policy (GoJ n.d.) and the Irrigation Water Allocation and Use Policy (GoJ n.d.). These policies consolidate and elaborate elements of that policy relating to on-farm water management, management and administration, water tariffs, and irrigation efficiency, whereas the Irrigation Equipment and System Design Policy (GoJ n.d.) provides a policy on defining and updating irrigation equipment and system design standards.

Objectives

Given the general scarcity of water in Jordan, the government is aiming to sustain or even increase agricultural production while at the same time promoting more efficient use of water. The government expects water demand management and water conservation to play an important role in achieving sustainable use of freshwater resources in Jordan. Water demand management in irrigated agriculture is expected to generate significant savings in the water sector. The JVA—through the Ministry of Water and Irrigation—is expected to undertake all necessary water demand management measures (economic, technical, and regulatory) to support more efficient use of water, and in turn, help sustain or increase agricultural production.

According to the 2009 Water Strategy, irrigation water tariffs will play a key role in the process of efficiency improvements. Irrigation tariffs aim to cover actual operation and maintenance expenses,[2] and increasingly also fund part of the capital costs of the services. The cost recovery issue has been discussed in the sector for many years. Differential prices shall be applied to irrigation water to account for water quantity and quality, taking into consideration the socioeconomic aspects. Pricing instruments are to be supplemented by incentive programs and reform of systems so as to promote water use efficiency by farmers. Such programs might include the establishment of sustainable funding mechanisms to provide low-interest long-term loans, tax incentives, grants, and fee waivers for efficient water use equipment. At the same time, the government will develop and implement incentives to encourage low-water-consuming, high-value crops so as to increase the highest economic return per cubic meter of water used and the sustainability and efficiency of the existing irrigation systems.

The objectives of this study are to (a) determine the financial cost of irrigation water in the Jordan Valley and the levels of cost recovery for irrigation water that can be achieved by comparing the costs of irrigation water (using different cost scenarios) and the revenues generated by the JVA in the Jordan Valley, and (b) estimate the impact of increasing irrigation water prices (based on different levels of cost recovery) on farm incomes and water productivity and use in the Jordan Valley.

A study on the cost of irrigation in the Jordan Valley and its estimated financial impact on farm income was conducted in 1993 by the Ministry of Planning and the Ministry of Water and Irrigation, and provided important input in determining irrigation water policies. The current study will be an update of the 1993 study but will also expand its scope to (a) examine how irrigation tariffs and water quotas have affected water use in the irrigation water sector in the Jordan Valley between 1997 and 2010; (b) look into the poverty impacts of increasing irrigation tariffs, using the methodology developed in the Venot, Molle, and Hassan (2007) study to determine how different prices will affect different farmer groups, including poor farmers; and (c) determine any indirect effects that might occur because of the policies implemented since 1993.

Methodology

The study team used, as a starting point, the methodology presented in the 1993 report by the Gesellschaft für Internationale Zusammenarbeit (GIZ), which mainly focused on determining the financial cost of providing irrigation water in the Jordan Valley, especially operation and maintenance costs. It included an analysis on how to improve efficiency in operation and maintenance, how to generate cost savings, and how the different tariffs would affect farmers' incomes using various cropping patterns. This part of the study was later reproduced and detailed in the work of Venot, Molle, and Hassan (2007) and Molle, Venot, and Hassan (2008) to determine the trends in land tenure, irrigation water pricing, cropping patterns (production/yields by crop), farm gate prices, production costs, water costs, and socioeconomic characteristics of landholdings (size of farm, type of farms, type of landholding, and so on).

The current study focused on assessing the financial costs of providing operation and maintenance. It supplemented this methodology with a farm budget survey in which about 230 farms[3] were surveyed about their cropping patterns, revenue and cost flows, water availability, and consumption to determine how farmers would react to changes in irrigation water prices.

Most of the financial cost analysis is based on a public expenditure review of the JVA to determine its minimum financial needs—under improved levels of efficiency—to keep on providing water to farmers in the Jordan Valley (Sommaripa 2011). Budget estimates and disaggregated actual expenditures are recorded for the period covering 2004 to 2012, with specific focus on 2008 and beyond. Although data before 2008 are available, the format in which these data are available makes them difficult to compare with data after 2008, when the JVA accounting systems were upgraded.

The data collection process raised a number of methodological issues that were dealt with as carefully as possible. First, data availability and quality dictate the type of analysis of budget allocation and expenditure to be conducted. Second, special attention was given to ensuring that expenses were analyzed and classified according to their economic use either as capital or current expenditure (box 1.1).

The budget lines were individually examined and assigned to the correct capital or current expenditure category. As a result, it is possible to quantify the extent to which misclassification of spending across budget categories has

BOX 1.1 Evidence of Misclassification of Expenditures across Budget Types

Jordan has a dual budget system aimed at separating capital expenses, recorded in the development budget, and current expenses, recorded in the recurrent budget. The data collection process examined whether individual budget lines were correctly classified according to their economic nature into capital versus current spending, regardless of whether the budget line belonged originally to either budget.

A line-by-line review of the budget reveals that recurrent expenditures constitute a significant part of the development expenditure. This misclassification is a result of the sector responding to incentives created by less flexible criteria for allocating discretionary shares of the recurrent budget than for shares of the development budget.

Incremental budgeting did not allow for significant changes in the cost structure of the JVA to be reflected in the budget, which especially became a problem after 2008, when the accounting systems were upgraded. In the JVA budget, recurrent expenditure amounting to about JD 8.8 million was misclassified in the 2011 budget expenditure as development expenditure against a total expenditure of JD 21.9 million. Since then, the misclassification of recurrent expenditure has decreased, as has development expenditure.

been taking place (see box 1.1). It has become evident that nowadays, development budgets are not always a good proxy for investment, and the functional separation between current and capital spending is increasingly fuzzy. This reinforces the temptation to postpone maintenance of existing assets and to delay allocation of resources of ongoing projects, a situation that makes monitoring of the quality of spending difficult.

Notes

1. The average size of the estimated 10,000 landholdings in the Jordan Valley is relatively small, at about 3.5 ha (Venot, Molle, and Hassan 2007).
2. For more details on cost recovery in irrigation, see Easter and Liu (2007); Johansson et al. (2002); and Molle and Berkoff (2007).
3. According to the typology undertaken by Venot, Molle, and Hassan (2007).

Chapter 2

Institutional Framework of the Irrigation Water Sector in the Jordan Valley

The Jordan Valley Authority (JVA) was established in 1973 as the Jordan Valley Commission, but was given its current name in 1977. The area of the JVA's responsibilities extends from the Yarmouk River in the North to the Red Sea in the South. The eastern extension of the area is limited by a 300-meter contour line north of the Dead Sea and a 500-meter contour line south of the Dead Sea. The King Abdullah Canal serves as the backbone of the JVA water distribution system north of the Dead Sea irrigating farm units.

The JVA is a governmental organization responsible for the social and economic development of the Jordan River Valley, including the development, use, protection, and conservation of water resources, and supports the infrastructure in the Jordan Valley. Its core activities are in land and water resources development.

The JVA's obligations are established in the Jordan Valley Development Law of 1988 and the 2001 amendments. Article 3 of the law includes responsibilities,[1] which focus on the development of water resources in the Jordan Valley, and on their use for farm irrigation; domestic, municipal, and industry use; generation of hydroelectric power; and other beneficial uses. Also included is the protection and conservation of these resources and the implementation of all works related to the development, use, protection, and conservation thereof, including among others:

- Planning, design, construction, and the operation and maintenance of irrigation projects and related structures, conveyance and distribution networks, surface and subsurface drainage works, flood protection works, and roads and buildings for;
- Soil surveys and classification, identification, and reclamation of lands for use in irrigated agriculture, and land division into farm units;
- Development and improvement of environmental and living conditions in the Jordan Valley;
- Implementation of related works, including:
    - Setting rules and regulations for land on which construction of buildings is permitted, setback lines, rights of way, outside towns, and villages borders;
    - Land development for residential, industrial, agricultural, and other uses;
    - Planning, design, and construction of farm roads;

- Social development of the Jordan Valley, which includes the involvement of private agencies to help achieve development objectives; and
- Additional development activities as requested by the Jordanian Cabinet.

Jordan's 2009 strategy, "Water for Life," proposed a new structure for the delivery of irrigation water. Delivery of bulk water irrigation would be managed by one organization, whereas the retail distribution of agricultural water would be managed by water user associations (WUAs). In the long term, the proposed bulk water provider in the Jordan Valley would focus on the regulation and supervision of bulk irrigation water services. Involvement of stakeholders and the private sector in irrigation management would be introduced and gradually promoted. It is foreseen that with these changes in the institutional structure, appropriate water tariffs and incentives would be introduced to promote water efficiency in irrigation, and ensure higher economic returns for irrigated agricultural products. Yet, progress towards moving to a bulk supplier has been very modest. By 2013, there were 20 registered water user associations (compared to 18 in 2009). By that same year, the JVA had transferred the distribution of irrigation water to 16 of these registered WUAs, covering 44 percent of the irrigated area in the Jordan Valley.

Note

1. Jordan Valley Development Law of 1988, amended in 2001 by Law No. 30.

Chapter 3

Water Balance in the Jordan Valley

Introduction

The Jordan River Valley (JRV) drains an area of about 18,300 square kilometers on both sides of the Jordan River. Within Jordan, it drains an area of about 7,627 square kilometers. The JRV basin is divided into five major subbasins: Upper Jordan, Yarmouk River, Lower Jordan, East Dead Sea, and the South Dead Sea. The available resources in the Valley are ground and surface water resources in addition to treated effluent from the treatment plants to the Valley or discharging to wadis.

Upper Jordan River Subbasin. The Hasbani, Banyas, and Lidan Rivers are the main tributaries of this subbasin, which drains into Lake Tiberias. Other sources are minor springs and seasonal flow. The total contribution of this subbasin is 660 million cubic meters per year. The evaporation rate from the lake is about 270 million cubic meters per year.

Yarmouk River Subbasin. This subbasin is the biggest contributor to the Jordan River flow. Historically, the annual discharge to the Jordan River was about 600 million cubic meters per year. Measurements show that the flow of the river has declined over the last decade. The annual discharge of the Yarmouk River (base and winter flow) to the Jordan River is about 200 million cubic meters. The flow diverted to the King Abdullah Canal and Unity Dam has declined over the last decade from 108 million cubic meters in 1995 to about 25 million cubic meters in 2011.

Lower Jordan Subbasin. The main tributaries to the Lower Jordan River Subbasin are the Zarqa River (the largest tributary) and the Wadis Al Arab, Ziglab, Jurum, Yabis, Kufranja, Rajib, Shuieb, Kafreen, and Hisban. The volume of water from this subbasin amounted to 116 million cubic meters per year in 2010. This includes the base flows and runoffs and treated effluent from the As Samra and Irbid treatment plants.

East Dead Sea Subbasin. Several wadis contribute to the flow in this subbasin; the major wadis are Wadi Mujib and Wadi Wala, but their overall contribution is very small.

Total available water resources in the Jordan Valley have declined in the last decades due to the construction of dams and other diversions mainly for agricultural use. The available resources in the Jordan Valley are shown in table 3.1. The contribution from surface water (Yarmouk River) varies from year to year due to infrastructure development in Syria. Currently, water volumes from surface water sources are between 25 percent and 40 percent of the 1992 contribution. The contribution of side wadis varies based on rainfall intensity and storage capacity of the dams. The use of treated effluent has increased significantly in recent years.

TABLE 3.1 Water Inflows into the Jordan Valley

million m³ per year

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Yamouk	54.616	30.414	22.953	54.748	68.610	42.550	14.249	31.765	23.496	28.500	26.203	26.407
Mukhaibah Wells	17.865	19.871	30.880	24.410	28.753	32.121	34.665	31.830	30.199	28.529	27.698	25.557
Ziqlab	5.111	4.393	4.150	8.158	8.235	7.284	6.429	5.136	3.896	3.752	2.384	2.374
Jarem	4.518	2.771	2.502	3.662	4.041	3.225	3.304	3.278	2.672	2.406	2.249	1.877
Kufranja	5.043	2.727	3.657	17.320	4.180	6.518	4.147	4.280	2.204	2.694	2.371	2.460
Rajib	3.535	1.712	2.639	11.775	2.792	3.124	2.337	2.596	1.596	1.629	0.106	0.022
Zarqa River	77.287	72.774	87.514	117.477	82.466	89.098	76.293	82.110	79.341	98.171	104.228	95.414
Shieb	4.674	4.398	7.812	13.911	4.468	4.698	3.933	6.142	3.071	6.155	5.549	4.006
Kafreen	8.028	6.558	14.592	23.137	8.518	11.615	7.393	10.855	6.938	8.435	11.257	6.746
Hesban	1.498	1.375	3.296	4.074	2.782	3.186	2.173	0.909	1.031	3.031	3.091	3.080
N. Conveyor	54.485	45.360	51.138	53.392	50.206	46.989	53.121	43.480	42.137	42.219	45.525	43.628
Small wadis	1.000	0.319	0.337	15.308	2.329	4.811	2.527	1.762	1.653	1.578	0.046	0.050
Total	237.760	192.672	231.470	347.372	267.380	255.220	210.571	224.144	198.234	227.407	230.706	211.622

Source: JVA Control Center.
Note: KAC = King Abdullah Canal.

Table 3.2 reflects how water inflows are used. The water available for irrigation purposes is affected by the diversion of scarce water resources for drinking water purposes. An increasing part of the water inflows is used for drinking and irrigation.

In addition to these inflows, wastewater is also being reused. In 2011, this treated wastewater flow amounted to 110 million cubic meters, of which JVA estimated 75 percent was being used by farmers in the Jordan Valley (equivalent to 83 million cubic meters per year).

Hence, with an average freshwater flow of 124 million cubic meters in 2011 and an average flow of reused wastewater of about 83 million cubic meters, the available flow for irrigation is estimated at 207 million cubic meters. The flow of reused wastewater becoming available to Jordan Valley farmers is increasing as part of the policy of the government to extend wastewater collection and treatment, while planning to reuse these wastewater flows in agriculture and industry.

Water Scarcity in the Jordan Valley

The farmer survey conducted between December 2011 and January 2012 looked into farmers' perspectives regarding water scarcity. Farmers facing water scarcity have been defined as those who stated that "access to water for crops" was the most important problem that the government should solve. This amounts to 100 farmers (42 percent of the sample of 236 farmers interviewed). Almost all the farmers facing water scarcity conditions are located in the

TABLE 3.2 Water Inflows and Water Used into the Jordan Valley

Year	Estimated inflow (MCM)	Discharged for irrigation (MCM)	Drinking water (MCM)	Total water for all uses (MCM)	Water for all uses as a percentage of total water inflows	Three-year trend average of water uses as a percentage of total water inflows	Drinking water as a percentage of of total water uses
2001	192.67	102.07	39.94	142.01	74%	n.a.	28%
2002	231.47	158.39	36.75	195.13	84%	73%	19%
2003	343.37	169.53	38.50	208.02	60%	77%	19%
2004	267.38	183.75	50.60	234.35	88%	77%	22%
2005	255.22	162.49	53.53	216.02	85%	86%	25%
2006	210.57	128.83	52.68	181.51	86%	83%	29%
2007	214.14	136.92	40.61	177.52	79%	84%	23%
2008	198.23	125.10	43.79	168.89	85%	81%	26%
2009	227.41	132.33	49.43	181.76	80%	83%	27%
2010	230.71	138.21	53.00	191.21	83%	82%	28%
2011	211.62	123.72	53.54	177.26	84%	83%	30%
Average	236.87	133.36	46.48	179.85	76	76%	26%

Source: JVA Control Center.
Note: MCM = million cubic meters; n.a. = not available.

Northern Ghors (71 percent), Karamah (47 percent), or Middle Ghors (38 percent). Farmers from the Southern Ghors did not perceive water scarcity as the most important issue to tackle. Seventy-one percent of the surveyed farmers living in the Northern Ghors face an acute problem of water scarcity, unlike the majority of surveyed farmers in the other three regions (table 3.3).

Among those farmers facing water scarcity, 48 percent are family farms and 52 percent are entrepreneurial farms (the proportions in the full sample were 41 percent and 59 percent, respectively). Table 3.4 shows that 82 percent of the surveyed farmers growing banana and 76 percent of the surveyed farmers growing citrus crops face major water shortages. Yet, less than one-third of the surveyed farmers growing vegetables confirmed facing major water scarcity issues.

In general, farmers relying on wells do not face major water shortages. Farmers facing water scarcity issues often combine sources, while 36 percent of the surveyed farmers who rely solely on the King Abdullah Canal face water scarcity (table 3.5).

Half of the surveyed farmers using open field techniques reported facing major water scarcity, which is consistent with the previous finding that farmers growing citrus and banana suffer the most from water shortages. A large majority of the surveyed farmers using plastic houses or plastic tunnels confirmed not facing acute water scarcity (table 3.6).

TABLE 3.3 Profile of Farmers Facing Water Scarcity, by Location

Region	Total number of farmers	Farmers facing major water scarcity problems (%)	Farmers not facing major water scarcity problems (%)	Total (%)
Northern Ghors	49	71	29	100
Middle Ghors	77	38	62	100
Karamah	74	47	53	100
Southern Ghors	36	3	97	100

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.

TABLE 3.4 Profile of Farmers Facing Water Scarcity, by Cropping Pattern

Main activity (Q2.6)	Total number of farmers	Farmers facing major water scarcity conditions (%)	Farmers not facing major water scarcity conditions (%)	Total (%)
Citrus crops	34	76	24	100
Palm dates	8	50	50	100
Vegetables	155	29	71	100
Banana	17	82	18	100
Mixed farming	5	60	40	100
Other	9	44	56	100

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.
Note: (Q2.6) = survey question Q2.6.

TABLE 3.5 Profile of Farmers Facing Water Scarcity, by Source of Water

Main source of irrigation water	Full sample	Farmers facing major water scarcity (%)	Farmers not facing major water scarcity (%)	Total (%)
King Abdullah Canal	47	36	64	100
Water reuse	34	56	44	100
Wells	38	3	97	100
Springs	79	42	58	100
Dams	7	86	14	100
Combination of resources	31	77	23	100
Total	236	42	58	100

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.

TABLE 3.6 Profile of Farmers Facing Water Scarcity, by Farming Method

Farming method	Full sample	Farmers facing major water scarcity problems (%)	Farmers not facing major water scarcity problem (%)	Total (%)
Open field	165	50	50	100
Plastic house	29	28	72	100
Plastic tunnel	6	17	83	100
Other	2	0	100	100
Combination of methods	34	26	74	100
Total	236	42	58	100

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.

The majority of farmers using surface irrigation or localized tubes (as their main irrigation method) reported water scarcity as an issue, while only one-third of surveyed farmers using drip irrigation technologies did so (table 3.7).

Farms facing major water scarcity problems are, on average, smaller (46 dunum) than farms that do not (74 dunum). Farmers with major water scarcity issues irrigate a larger proportion of their land (91 percent), on average, than the farmers who do not (81 percent). Farmers dealing with water scarcity problems are more likely to use open field methods (either exclusively or in combination with other methods) and are less likely to use drip irrigation (either exclusively or in combination with other irrigation techniques). Finally, farmers facing acute water shortages are more likely to grow citrus and banana and less likely to grow vegetables (table 3.8). As a result, farmers who complain about water scarcity issues tend to use less water per dunum than those who do not. Interestingly, even though they have access to less water per dunum, their net crop revenue per dunum is not statistically significant different from other farmers.

TABLE 3.7 Profile of Farmers Facing Water Scarcity, by Irrigation Method

Irrigation method	Full sample	Farmers facing major water scarcity problems (%)	Farmers not facing major water scarcity problem (%)	Total (%)
Surface irrigation	20	80	20	100
Localized tubes	8	75	25	100
Drip	192	34	66	100
Micro-sprinkler	2	100	0	100
Subsurface irrigation	1	100	0	100

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.

TABLE 3.8 Profile of Farmers Facing Water Scarcity, Regression Analysis

Indicator	Farmers facing major water scarcity problems Mean (median)	Farmers not facing major water scarcity problems Mean (median)	Mean test (significance)[a]
Number of farmers	100	136	—
Farm size (dunum)	46 (*34*)	74 (*36*)	(**)
Irrigated area (dunum)	37 (*30*)	39 (*30*)	n.s.
Share of irrigated area (%)	91 (*100*)	81 (*98*)	(***)
Distance to the water source (m)[b]	104 (*50*)	168 (*50*)	n.s.
Estimated water use (m^3/year)	12,012 (*11,513*)	17,705 (*14,836*)	(***)
Estimated per dunum water use (m^3/year)[c]	346 (*347*)	559 (*450*)	(***)
Income category	2.1 (*2*)	2.5 (*2*)	(*)
Expenditures (JD/year)	8,753 (*5,000*)	19,492 (*11,500*)	(***)
Per dunum expenditures (JD/year/dunum)	236 (*115*)	464 (*279*)	(***)
Crop revenues (JD/year)	21,250 (*15,000*)	33,094 (*17,140*)	(**)
Per dunum crop revenues (JD/year/dunum)	588 (*417*)	666 (*397*)	n.s.
Crop net revenues (JD/year)	10,074 (*7,666*)	16,459 (*7,000*)	n.s.
Per dunum crop net revenues (JD/year/dunum)	280 (*177*)	283 (*121*)	n.s.
Open field method exclusively (%)	82	61	(***)
Open field method in combination (%)	91	79	(**)
Drip irrigation exclusively (%)	65	93	(***)
Drip irrigation in combination (%)	72	95	(***)
Vegetables as main crop[d] (%)	45	82	(***)
Banana as main crop[d] (%)	14	2	(***)
Citrus as main crop[d] (%)	30	7	(***)
Farm value (JD/m^2)	376 (*200*)	287 (*200*)	(*)

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.
Note: — = not applicable. a. n.s., *, **, *** = not significant, significant at the 10% level, 5% level, and 1% level, respectively.
b. The average distance to the water source is calculated from answers to question Q3.2. We take the middle point of each interval and the lower bound for the last interval ("more than 4 km"). A number of farmers did not answer this question.
c. Calculated from answers to questions Q3.7. d. Obtained from answers to question Q4.1.
JD = Jordanian dinar; m = meter; m^2 = square meter; m^3 = cubic meter.

Farmers facing water quality issues have been defined as those who stated that "water quality" was the most important environmental problem that the government should solve. This amounts to 26 farmers overall (equivalent to 11 percent of the sample). Among the farmers reporting water quality issues, 73 percent live in the Middle Ghors region, 23 percent live in Karamah, and only 1 percent lives in the Southern Ghors. None of the farmers living in the Northern Ghors experience major water quality problems. Among those farmers reporting water quality problems, 81 percent are entrepreneurial farms. They tend to grow vegetables. Among the 26 farmers facing water quality issues, 73 percent rely on springs as their main source of irrigation water and about 19 percent rely on recycled water. Among the farmers facing major water quality issues, 50 percent use open field as the main farming method and 38 percent use plastic houses, whereas almost all of these farmers use drip irrigation technologies. Farmers who complain about water quality have lower per dunum crop revenues than farmers who do not.

Table 3.9 shows some average (and median) characteristics for farmers facing major water quality problems and farmers not facing major water quality problems, along with the significance of the corresponding mean test. Farmers facing major water quality problems are wealthier, on average, and have higher expenditure and gross and net revenues (in total and on a per dunum basis). These farmers are also less likely to use open field methods.

TABLE 3.9 Profile of Farmers Facing Water Quality Problems, Regression Analysis

Indicator	Farmers facing major water quality problems Mean (*median*)	Farmers not facing major water quality problems Mean (*median*)	Mean test (significance)[a]
Number of farmers	26	210	—
Farm size (dunum)	48 (*35*)	64 (*35*)	n.s.
Irrigated area (dunum)	41 (*34*)	37 (*30*)	n.s.
Share of irrigated area (%)	96 (*100*)	84 (*100*)	(**)
Distance to the water source (m)[b]	138 (*50*)	138 (*50*)	n.s.
Estimated water use (m^3/year)	16,215 (*14,461*)	15,082 (*13,478*)	n.s.
Estimated per dunum water use (m^3/year)	375 (*345*)	480 (*374*)	n.s.
Income category	3.12 (*2*)	2.21 (*2*)	(***)
Expenditures (JD/year)	28,032 (*20,000*)	13,318 (*8,000*)	(***)
Per dunum expenditures (JD/year/dunum)	673 (*452*)	330 (*206*)	(***)
Crop revenues (JD/year)	46,031 (*30,000*)	25,431 (*15,200*)	(**)
Per dunum crop revenues (JD/year/dunum)	1,108 (*827*)	567 (*385*)	(***)
Crop net revenues (JD/year)	18,782 (*11,000*)	12,917 (*6,350*)	n.s.
Per dunum crop net revenues (JD/year/dunum)	430 (*189*)	261 (*154*)	n.s.
Open field method exclusively (%)	50	72	(**)
Open field method in combination (%)	54	88	(***)
Drip irrigation exclusively (%)	88	80	n.s.

table continues next page

TABLE 3.9 *continued*

Indicator	Farmers facing major water quality problems Mean (median)	Farmers not facing major water quality problems Mean (median)	Mean test (significance)[a]
Drip irrigation in combination (%)	88	85	n.s.
Vegetables as main crop[c] (%)	73	65	n.s.
Banana as main crop[c] (%)	12	7	n.s.
Citrus as main crop[c] (%)	8	18	n.s.
Farm value (JD/m^2)	317 (*240*)	331 (*200*)	n.s.

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.
Note: — = not applicable. a. n.s., *, **, *** = not significant, significant at the 10% level, 5% level, and 1% level, respectively.
b. The average distance to the water source is calculated from answers to Q3.2. We take the middle point of each interval and the lower bound for the last interval ("more than 4 km"). A number of farmers did not answer this question. c. Obtained from answers to question Q4.1.
JD = Jordanian dinar; m = meter; m^2 = square meter; m^3 = cubic meter.

Conclusions

The profiles of farmers who face water scarcity are distinct. Farmers who complain about lack of access to water tend to be located in the northern part of the Jordan Valley. Their cropping pattern is more likely to be dominated by the production of citrus and banana, which are be water-intensive crops. Farmers who face water scarcity also tend to be more dependent on open field farming methods and less likely to use drip irrigation methods. Water quality issues are less prominent in the responses of the surveyed farmers and were mostly brought up by farmers in the Middle Ghors. Farmers facing water quality issues are more likely to grow vegetables that are usually farmed under greenhouse conditions. They also have invested in drip irrigation methods to use water more efficiently.

Chapter 4

Irrigated Agriculture in the Jordan Valley

Introduction

Development of irrigated agriculture started toward the end of the 1950s around the side wadis of the Jordan Valley. With the construction of the East Ghor Canal, later named the King Abdullah Canal, which diverted water from the Yarmouk River to the Jordan Valley, intensive irrigation became possible. The King Abdullah Canal, running along the East Bank of the Jordan Valley, constitutes the backbone of the Jordan Valley hydraulic scheme. The canal was extended three times to over 110 kilometers. In the past five decades, 10 dams have been constructed with a combined storage capacity of around 322 million cubic meters. The main reservoir is the King Talal Dam on the Zarqa River, with a total capacity of 80 million cubic meters.[1] Irrigation schemes in the Jordan Valley have been constructed, rehabilitated, operated, and maintained by the government.

Agriculture is the main water user in the Jordan Valley, with an average design consumption of 220 million cubic meters per year. A series of irrigation projects have been implemented over the years (see table 4.1) to serve a command area of about 360,000 dunum,[2] organized around 10,000 farm units (of 35 to 40 dunum each).

In 2010, agricultural land in the Jordan Valley made up about 13 percent of the total agricultural land in use in the country. Yet, unlike the rest of Jordan, the Jordan Valley almost exclusively depends on irrigated water to grow its crops. Its cropping pattern is quite distinct from that of the Highlands, with vegetables being the most important crop (table 4.2).

Since the 1990s, surface irrigation channels have been converted into pressurized piped systems to raise irrigation efficiency. At present, surface irrigation in the Jordan Valley is virtually nonexistent, although capital-poor farmers practice a hybrid form of surface and localized irrigation.

Despite major investment efforts, overall system efficiency is still a major challenge because of increasing water scarcity and competing uses of water resources. Actual water consumption is only 45 percent of design consumption. Water is allocated through a crop-based water quota system. Five crop planting categories are acknowledged by the JVA: vegetables, citrus trees, banana, cereals and grains, and others (fruit trees). However, only three planting categories (vegetables, citrus trees, and banana) are used for allocating farm water quotas. From the 1960s and throughout the 1980s, quotas (see table 4.3 for the quota schedule) were related to actual crop water requirements. With the emergence of water scarcity, the JVA

TABLE 4.1 Irrigation Projects in the Jordan Valley (from North to South)

Irrigation Project	Size (in dunum)
Wadi Arab (1985)	12,530
North East Ghor (1978)	27,600
North Ghor Conversion (1996)	73,000
Zarqa Triangle (1978)	16,500
Middle Ghor (1992)	64,544
King Abdullah Canal Extension (1978)	36,915
King Abdullah Canal Extension (1988)	60,000
Hisban Kafrein (1978)	16,590
South Ghor I (1985)	47,000
South Ghor II (2004, to be completed)	9,700
Total	364,379

Source: JVA.

TABLE 4.2 Total Cultivated and Irrigated Area in Jordan in 2011

Crops	Jordan			Jordan Valley		
	Total area (dunum)	Irrigated area (dunum)	Nonirrigated area (dunum)	Total area (dunum)	Irrigated area (dunum)	Nonirrigated area (dunum)
Tree crops	850,049	469,751	380,298	109,052	107,672	1,380
Field crops	1,129,038	87,549	11,041,489	21,315	20,283	1,033
Vegetables	428,628	407,195	21,432	183,672	183,627	45
Total	2,407,714	964,495	1,443,219	314,039	311,581	2,457

Sources: JVA. See also IWMI/IRD "Research Report," 18, 2007.

TABLE 4.3 Quota System by Jordan Valley Authority (2004 Onward)

<table>
<tr><th rowspan="2"></th><th colspan="3">Quotas (m^3/ha/day)</th></tr>
<tr><th>Vegetables</th><th>Citrus</th><th>Banana</th></tr>
<tr><td>March 16–31</td><td>15</td><td colspan="2">On demand but < 20</td></tr>
<tr><td>April 1–15</td><td>15</td><td rowspan="2">20</td><td rowspan="2">30</td></tr>
<tr><td>April 16–30</td><td rowspan="2">20</td></tr>
<tr><td>May 1–June 15</td><td>30</td><td>50</td></tr>
<tr><td>June 15–August 15</td><td>On demand but < 10</td><td rowspan="2">40</td><td rowspan="2">70</td></tr>
<tr><td>August 16–September 15</td><td>10</td></tr>
<tr><td>September 16–October 15</td><td>15</td><td rowspan="2">30</td><td rowspan="2">50</td></tr>
<tr><td>October 16–31</td><td rowspan="2">20</td></tr>
<tr><td>November 1–December 15</td><td colspan="2" rowspan="2">On demand but < 20</td></tr>
<tr><td>December 16–March 15</td><td>10</td></tr>
</table>

Sources: JVA. See also IWMI/IRD "Research Report," 18, 2007.

froze the existing cropping patterns in the Jordan Valley and decided to grant "vegetable allowances" to all areas not covered by orchards at the time. The aim was to avoid further area expansion of citrus and banana, since they are crops with high water requirements.[3] Before 1999, the annual values of official water allocations (November to April) totaled 4,800, 9,500, and 17,200 cubic meters per hectare for vegetables, citrus trees, and banana, respectively. Prolonged drought years have imposed adjustments to quotas that are still valid today: 3,600, 7,500, and 12,550 cubic meters per hectare for the same crops, respectively.

Agricultural Transformation in the Jordan Valley

In the last 15 years, major changes have occurred in the Valley. Water scarcity, as discussed in Chapter 4, resulted in smaller water quota allocations. Farmers have reacted to this by expanding their cropping area and increasing crop productivity.

Between 1994 and 2010, the area under cultivation in the Jordan Valley grew significantly, at 22 percent. The expansion was especially pronounced for tree and vegetable crops. During the same period, the area under cultivation for field crops declined significantly, as can be seen in table 4.4. Concurrently, the sector has become more productive as measured by increases in average yield per dunum. The production volume per dunum almost doubled, driven by increases in productivity in field and vegetable crops. Tree crop productivity declined over the same period.

Vegetables. The most important crops planted in the Jordan Valley are tomato, eggplant, cucumber, potato, and squash. The area planted increased by 29 percent over the last 15 years. At the same time, average yields increased by 145 percent over the same period, from 1.86 metric tons per dunum to 4.75 metric tons in 2010. Expansion beyond 200,000 dunum appears unlikely and would be achievable only to a limited extent and only if market or policy shocks occur to other crops (for example, removal of banana import tariffs).

The expansion of vegetable production is mainly the result of large on-farm investments and the commercialization of agriculture in the

TABLE 4.4 Total Crop Area and Production in the Jordan Valley, 1994–2010
percent

Indicator	Vegetables	Cereals	Fruit trees			
			Citrus	Banana	Traditional crops	Total
Area planted	129	70	126	115	276	138
Production (in metric ton)	316	197	82	182	299	105
Average yield (in kilogram)	245	282	65	158	109	76

Source: Fileccia and Punda 2012.

TABLE 4.5 Total Vegetable Crop Area and Production in the Jordan Valley, 1994–2010
percent

Indicator	Increase between 1994 and 2010	Increase between 1994 and 2000	Increase between 2000 and 2010
Area planted	129	114	113
Production (in metric tons)	316	201	157
Average yield (in kilograms)	245	176	139

Source: Fileccia and Punda 2012.

TABLE 4.6 Total Field Crop Area and Production in the Jordan Valley, 1994–2010
percent

Indicator	Increase between 1994 and 2010	Increase between 1994 and 2000	Increase between 2000 and 2010
Area planted	70	92	76
Production (in metric tons)	197	149	133
Average yield (in kilograms)	282	161	175

Source: Fileccia and Punda 2012.

Jordan Valley. Most of the productivity increases occurred before 2000 (table 4.5). The sector has become increasingly less diversified. The five main crops constituted 62 percent of the cropped area in 1994. In 2010, the contribution of these major crops increased to 68 percent. In total production volumes, this specialization is even more striking. The five major crops made up 70 percent of vegetable crop production in 1994, but no less than 80 percent in 2010.

Field crops. The most important field crops are maize, wheat, barley, and clover. Although the crop area declined between 1994 and 2010, productivity increased from 0.42 metric tons per dunum in 1994 to 1.39 metric tons in 2010. In 1994, wheat and barley constituted 83 percent of the total cereal crop area in the Jordan Valley, but in 2010, the share of these two crops declined to 43 percent, with increasing importance of maize and clover. Productivity for barley and wheat hardly changed between 1994 and 2010, but that of maize and clover did (table 4.6).

Fruit tree crops. The development of fruit tree crops presents a complex picture. Despite the government's efforts to freeze the existing cropping patterns in the Jordan Valley, further area expansion of citrus and banana—crops that have higher water requirements[4]—occurred between 1994 and 2010 (table 4.7). Most of the increase in area expansion took place before 2000. This expansion is linked to a waiver that was introduced in 2004 to legalize citrus orchards that were planted between 1991 and 2001. Trends of citrus production reflect farmers' coping strategies through changes in orchard specialization (that is, species conversion from clementine and mandarin cultivars to lemon and oranges).

TABLE 4.7 Total Tree Crop Area and Production in the Jordan Valley, 1994–2010

Indicator	Increase between 1994 and 2010	Increase between 1994 and 2000	Increase between 2000 and 2010
Area planted	138	143	97
Production (in metric tons)	105	90	117
Average yield (in kilograms)	76	63	121

Source: Fileccia and Punda 2012.

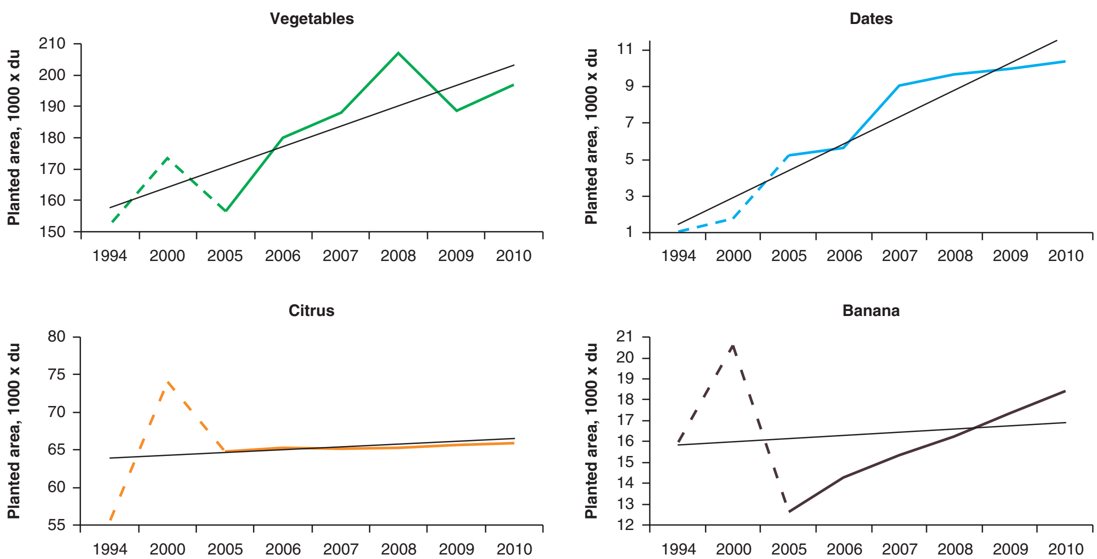
The area planted with banana crops expanded rapidly between 1994 and 2000, declined during 2000–07, and expanded after 2007. At the same time, the areas used for more traditional tree crops, such as grapes, olives, dates, and figs, increased (see figure 4.4).

Productivity increases vary widely among types of crops. Citrus production, despite the increase in area planted with citrus trees, declined rapidly between 1994 and 2010, with average yields in 2010 only about 65 percent of those in 1994. Farmers responded to stem the production losses by intensifying production through increasing the number of trees per dunum. Banana crops show a different pattern. Crop area increased, but so did production and average yield, with almost all the crop area expansion taking place between 1994 and 2000 and all productivity growth after 2000. As for traditional crops, like dates, most of the growth in production has been linked to area expansion, with limited increases in average yields.

Major on-farm investments have been made in the past to cope with reduced irrigation water availability and reliability, while maintaining or increasing production. To date, almost all farms have adopted some sort of localized irrigation technology. Even those farmers who are considering using surface irrigation (on citrus orchards) have in reality adopted a piped system to irrigate individual trees. The majority of farmers have constructed standby ponds to collect and store water when it is distributed by the JVA at farm turnouts to better regulate farm irrigation scheduling. A number of farmers use groundwater to expand their water quotas. Yet, few farmers have been able to improve water quality where this has become a major issue (particularly in the middle and southern part of the Jordan Valley, which receives water from the King Talal Dam).

Another development that has had an impact on the Jordan Valley are land market transactions. Venot, Molle, and Hassan (2007) cite an estimated land rent of US$570 per hectare per year. In discussions with farmers in 2012, land rental values of about JD 143 per dunum per year (which translates to JD 1,430 per hectare per year, equivalent to US$2,043 per hectare per year) were registered. A 2012 farmer survey even registered values approaching JD 4,000 per hectare per year (equivalent to more than US$5,700). The increase in rental values has resulted in an increase in land transactions—especially in farms classified as entrepreneurial farms—with 20 percent of the surveyed farmers mentioning a change in ownership or

FIGURE 4.1 Historical Area and Cropping Pattern Trends for Major Crops in the Jordan Valley



Source: Fileccia and Punda 2012.

rental status in the five years before the survey. These transactions have also resulted in a consolidation of farms. Although 80 percent of the farms surveyed mentioned they consisted of one farm unit of 35 to 40 dunum, 20 percent of the farms consist of more than one farm unit, while the average farm size increased to slightly over 60 dunum, suggesting that the agricultural sector in the Jordan Valley is consolidating, with fewer but larger farms.

According to Venot, Molle, and Hassan (2007), 87 percent of farm managers farmed 51 percent of the total area in the Jordan Valley. In the 2012 farmer survey, non-owners made up 53 percent of the farm managers farming 45 percent of the total farm area. This suggests that agriculture in the Jordan Valley is becoming increasingly entrepreneurial. Facing increased water scarcity and country-specific market problems, only farmers with sufficient investment capacity are able to stay profitable in the Jordan Valley.

Current Production Systems and Cropping Patterns in the Jordan Valley

Eight broad farm-type systems prevail in the Jordan Valley. Based on ongoing research and survey data[5] and as compared to actual cropping pattern information (Department of Statistics), their distribution is shown in table 4.8.

As shown in table 4.9, 4.10 and figure 4.2, about 342,000 dunum were cultivated in the Jordan Valley in 2012, with an irrigation intensity of 99 percent.

TABLE 4.8 Major Production Systems in the Jordan Valley

percent

Type of production system	Share
Citrus farms – surface irrigation (partially localized)	9
Citrus farms – drip irrigation	9
Vegetables – open field	31
Vegetables – greenhouses	11
Vegetables – open field and greenhouses	11
Banana	7
Dates	3
Mixed	19

Source: Fileccia and Punda 2012.

TABLE 4.9 Cropping Patterns in the Jordan Valley

dunum

Crop	1994	2005	2008	2010	2011	2012
Vegetables	152,552	156,420	207,141	196,946	183,672	200,313
Field crops	43,550	36,395	33,451	33,337	21,315	30,416
Fruit trees	80,525	93,825	102,386	106,592	109,052	111,625
of which:						
Citrus	*55,605*	*64,838*	*65,274*	*65,849*	*65,989*	*6,137*
Banana	*15,979*	*12,637*	*16,242*	*18,434*	*19,617*	*20,811*
Dates	*753*	*4,949*	*9,395*	*10,101*	*10,712*	*11,418*
Others	*8,188*	*11,401*	*11,476*	*12,208*	*12,734*	*13,259*
Planted area	276,627	286,640	342,978	336,875	314,038	342,429
Irrigated area	275,102	282,827	338,533	333,630	311,581	340,904
Nonirrigated	1,525	2,900	4,444	3,245	2,457	1,525

Source: Fileccia and Punda 2012.

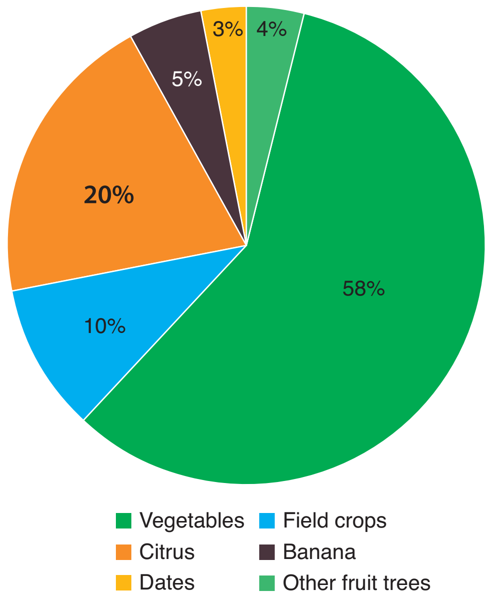
TABLE 4.10 Crop Production in the Jordan Valley

metric tons

Crop	1994	2005	2008	2010	2011	2012
Vegetables	252,591	640,124	743,774	798,274	876,140	915,756
Field crops	18,078	58,197	38,944	43,572	30,686	23,289
Fruit trees	179,482	177,391	150,274	182,067	171,546	166,871
of which:						
Citrus	*148,480*	*134,148*	*89,526*	*116,415*	*104,894*	*107,892*
Banana	*23,970*	*31,820*	*41,422*	*43,625*	*48,105*	*38,669*
Dates	*227*	*2,514*	*5,665*	*7,511*	*7,583*	*6,548*
Others	*6,805*	*8,909*	*13,661*	*14,516*	*10,964*	*13,762*
Total	450,151	875,712	932,992	1,024,463	1,078,372	1,105,916
Productivity per dunum in kilograms	1,627	3,055	2,720	3,041	3,434	3,230

Source: Fileccia and Punda 2012.

FIGURE 4.2 **Share of Crops in the Jordan Valley, 2010**



Source: Fileccia and Punda 2012.

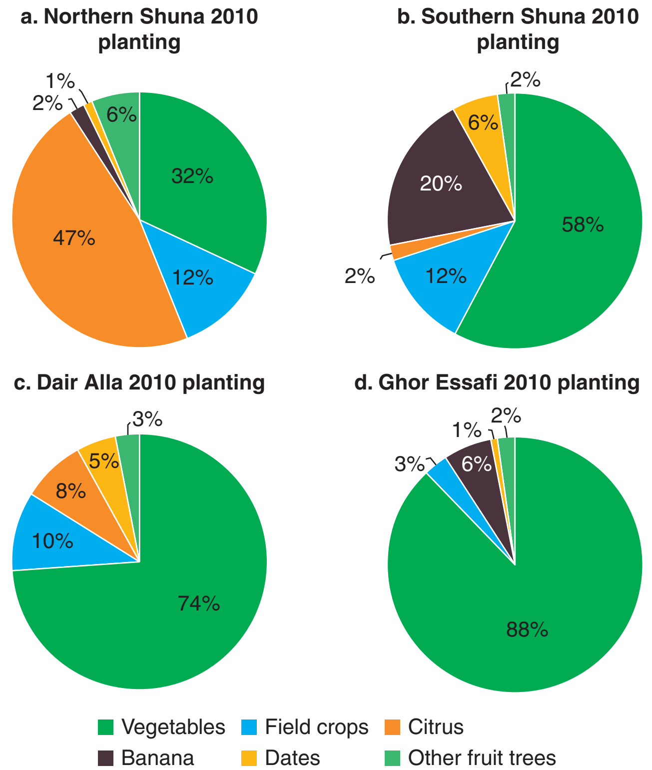
The geographic distribution of the Jordan Valley cropping pattern is depicted in figure 4.3. North Shuna (Northern Directorate) covers about 117,000 dunum of planted area. In this area, citrus is the main crop. The Dair Alla (Middle Directorate) crop area stands at about 76,000 dunum. The crop area in Southern Shuna (Karamah) is 66,000 dunum and in Ghor Essafi (Southern Ghors) 48,000 dunum. In Dair Alla (Middle Directorate), the Southern Shuna (Karamah), and Ghor Essafi (Southern Ghors), vegetables are the most important crops. Southern Shuna accounts for 70 percent of the banana cropping area.

Crop and Farm Economics in the Jordan Valley

Crop and farm budgets have been analyzed by computing elements of the most representative crops and production systems in the Jordan Valley. With regard to production costs, the following main assumptions have been used: (a) Land rental cost has been generalized (as an opportunity cost) to all production systems, given that it prevails everywhere in the Valley. (b) Permanent labor is overwhelming compared to seasonal work, and it has been universalized in most cases. (c) Management input by owner or tenant is significant and is computed everywhere. (d) Investment cost depreciation is calculated on actual wear and tear, as discussed with farmers (and not by using technical proxies). (e) No taxes are applicable.

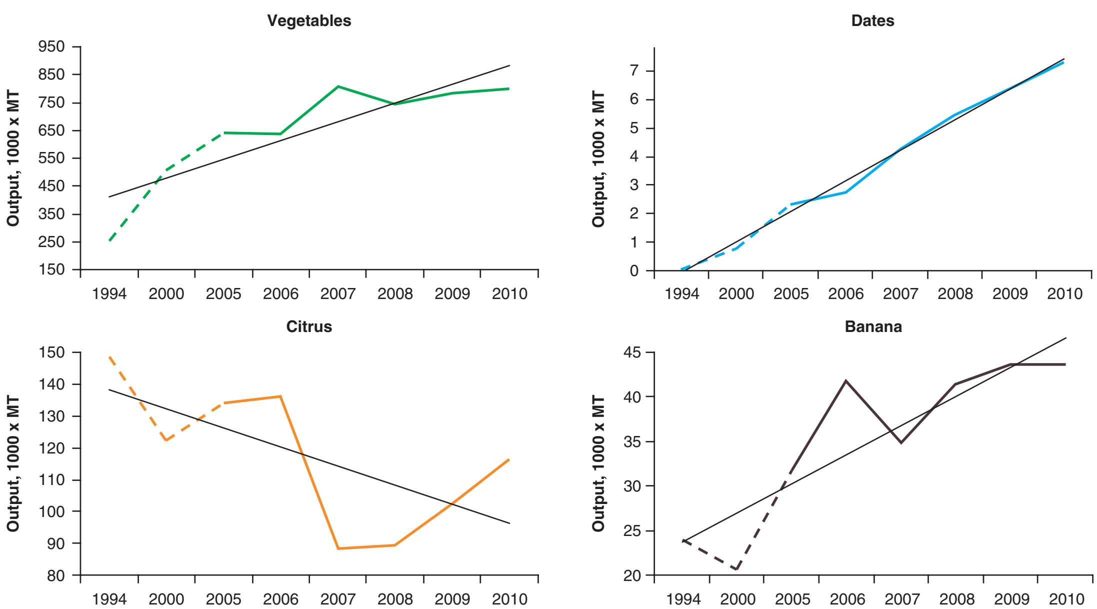
Yield outputs are derived using surveys based on discussions with primary informants and were cross-checked with relevant secondary and other professional sources (such as the Ministry of Agriculture, the National Center for

FIGURE 4.3 Geographic Distribution of Cropping Patterns in the Jordan Valley



Source: Fileccia and Punda 2012.

FIGURE 4.4 Historical Production Trends in the Jordan Valley



Source: Fileccia and Punda 2012.
Note: MT = metric tons

Agricultural Research and Extension, the Agriculture Credit Corporation, and the private sector). Output farm gate prices are also derived from surveys of multiple primary informants. Sensitivity simulations have been attempted by using the Department of Statistics' average 2010 prices and by referring to free-on-board (FOB) prices,[6] deducting marketing costs,[7] or by considering whichever best price is obtainable by the producers.

At current prevailing price levels, few production systems generate positive net returns. Only banana, melon grown under greenhouse conditions, and dates produce net benefits (see table 4.11). Open field potatoes and drip irrigated citrus also provide positive benefits.

To determine returns to investment and farmland, Jordan Valley producers need to pursue best possible farm gate prices, which are achievable only by trading either in export conditions (for instance, to European markets) or in special cases, even in the Amman fresh fruit market (for example, melon), or else by targeting high-value produce (for example, Medjool dates).

Main Issues Farmers in the Jordan Valley Are Facing

Based on discussions with farmers and private sector farm representatives in the Jordan Valley, four outstanding issues have emerged, which may rank differently depending on the location and the farming category.

Irrigation water. About 42 percent of the farmers interviewed reported access to water for crops as the most important issue to tackle.

In the northern part of the Valley, it is mainly a question of water quantity and reliability. Water quality is acknowledged as good, at least for the time being.[8] As evident from JVA consumption data, water is distributed to farmers below quota allocations. Even farmers who have made major investments to improve their irrigation system efficiency (drip irrigation and farm reservoirs) confirmed that they were unable to satisfy the crops' water requirements. Farmers with higher capital resources use groundwater to integrate irrigation scheduling. However, groundwater is in most cases brackish, requiring further investment for desalinization purposes.

In the middle of the Valley and in Southern Shuna (Karamah Directorate), which is served by the King Talal Dam water, farmers not only mention water quantity as an issue, but also water quality. Insufficient water quantity and poor water quality are reported to be affecting cropping pattern choices and yields. They also impose higher maintenance costs to the irrigation systems.

In the Southern Ghors, distributed water quality is not considered an issue; yet, because of insufficient quantity, farmers now increasingly integrate their irrigation requirements with groundwater, depending on availability of resources, which is often of lower quality. Where farmers experience salinity problems, these have been compounded in recent years as a result of reduced water availability and consequent insufficient (or lack of) leaching irrigation.

TABLE 4.11 Crop Production Systems Revenues and Costs in the Jordan Valley, Full Cost

Jordanian dinar

Type of crop	Returns in current situation				Returns with average (2010) department of statistics price			Returns with best market/ FOB price (2010–11)		
	Gross revenue JD/unit	Total cost JD/unit	Net return JD/unit	Net return (%)	Gross revenue JD/unit	Net return JD/unit	Net return (%)	Gross revenue JD/unit	Net return JD/unit	Net return (%)
Banana (years 2–5)	2,138	1,316	822	62	—	—	—	2,138	822	62
Citrus after (8 years), drip irrigation	920	859	61	7	992	133	0	2,326	1,467	171
Citrus after (8 years), surface irrigation	540	657	(117)	–18	496	(161)	–25	1,163	506	77
Cucumber, greenhouse	1,500	1,745	(245)	–14	1,181	(563)	–32	2,985	1,241	71
Dates (after 8 years)	3,567	3,196	371	12	—	—	—	8,750	5,554	174
Melon, greenhouse	3,500	2,739	761	28	274	(2,192)	–89	3,500	761	28
Potato, open field	2,800	2,559	241	9	739	(1,820)	–71	2,800	241	9
Tomato, greenhouse	2,940	3,107	(167)	–5	1,663	130	0	3,648	2,094	135
Tomato, open field	588	1,263	(675)	–53	673	(590)	–47	1,459	196	16

Source: Field interviews, March 2012, as recorded in Fileccia and Punda (2012).
Note: These calculations assume that for tree crops, the initial start-up costs before trees are mature are not included in the calculations.
— = not available.

Farmers in the Jordan Valley generally do not complain about water prices, which are perceived as the least of their production costs. The majority of interviewed farmers stated a willingness to pay higher prices, provided that adequate and reliable water quantity and quality are guaranteed.

Labor and management. Less than 10 percent of the labor requirements are provided by the Jordanian workforce. Trustworthy functions are delegated to Jordanian workers (for example, supervision, mechanical operations, plant protection, seedlings production, and asset maintenance), including females (for example, produce grading, handling, and packaging). Migrant labor is very important in the Jordan Valley. There are no major wage differentials between Jordanian and migrant workers, but recently, migrant workers have been increasingly moving to other sectors (civil works) that offer better salaries. The situation is perceived as critical by almost all farmers, and the labor crunch is a reality in many areas of the Valley. As a result, at the time of the survey in 2012, the cost of labor was reported to be rising significantly.[9] During the past three or four decades, a number of migrant workers, attracted by labor opportunities, have settled in these areas. Over time, many have evolved into farm tenants, who use family labor.[10] Some have also engaged in related efficient agribusinesses and service provision activities. These farmers have become an important economic segment in the Jordan Valley.

Finally, farm management has a differentiated pattern in the Jordan Valley. Broadly speaking, the current pattern appears to be evolving as follows: management through professional but aging executives in the northern part of the Valley, foreigner operated in the middle part of the Valley, and qualified younger operators in the southern part of the Valley. A matter for concern is the perspective in the north that market and economic prospects might not attract a rapid generational shift there. Sustained negative trends may also persuade other operators to gradually withdraw from the Valley and eventually also extinguish the enthusiasm of the young professionals in the south.

Country-specific market problems. Marketing-related issues are mentioned by 38 percent of farmers as their most pressing problem (see also Nachbaur 2004). Farmers mention issues with access to marketing (25 percent of the farmers), sale price of agricultural products (11 percent), and export regulations (2 percent) as impediments, while availability of labor, access to credit, and cost of agricultural inputs are also mentioned. The Jordan Valley is considered the main agribusiness hub of the country. The domestic market undoubtedly has its own importance and relevance. However, due to the natural agroecological comparative advantages posed by this "natural greenhouse" to produce off-season or time-of-year anticipated fruit and vegetable produce for the European market, export trade constitutes the prime opportunity for the Valley's output.

This opportunity is constrained by the geopolitical shocks to which the country and the region are regularly subjected. Border transit restrictions, which occasionally occur[11] at the time when markets are more advantageous, have dramatic consequences on the produce, which is perishable, subject to significantly higher transportation costs, or otherwise subject to lower prices by traders and domestic markets. Alternative routes to Europe and Russia or the Commonwealth of Independent States markets could be sought, which are, however, not always in the reach and capacity of all producers and traders operating in the Valley.

Finance for technology. Farmers in the Valley have made important progress in adopting technology, particularly during the last decade. This has resulted in conversion from gravity or surface irrigation to localized or drip irrigation, improved irrigation scheduling by including on-farm water reservoirs, increased cropped area under plastic houses, adoption of quality seeds and seedlings of higher-yielding varieties, cultivar changes based on actual market demand, and improved plant nutrient management. The farmer survey revealed that 81 percent of the respondents use drip irrigation, another 5 percent use some other form of localized tube irrigation, and another 8 percent use surface irrigation. In the Middle and South of the Jordan Valley and the Southern Ghors, drip irrigation is almost universal. Yet, in the Northern Ghors only 51 percent of farmers use drip irrigation, 31 percent depend on sprinkler irrigation, and another 14 percent use some form of localized tubes to irrigate their plots.

About 70 percent of the farmer respondents practice open field farming methods. However, the importance of greenhouses (plastic tunnels and plastic houses) has increased rapidly. Currently, 15 percent of survey respondents reported growing their crops in greenhouses, and another 14 percent use a combination of open field farming and greenhouses. Greenhouses are mostly concentrated in the Middle Directorate to grow vegetables.

Growing vegetable and fruit crops on a large scale is a major undertaking that requires continuous upgrading and innovation. The producers who have a profitable economic future in the Jordan Valley are only those who have the investment capacity to fully upgrade the efficiency of on-farm irrigation systems by extending production under high-tech greenhouse conditions, adopting climate-smart and sustainable agriculture technologies and methodologies, producing crops of high market value, and increasing the marketing value of their produce. Yet, to be able to make the necessary investments, farmers will need to have access to convenient terms of credit so they will be able to achieve the needed investment upgrades.

Crop Water Productivity

Water productivity is defined in different ways. We have used a simple and relatively rough definition that measures crop production (in monetary terms) against the gross inflow of water. Water productivity as measured in table 4.12 is only an approximation, since water use is based on water quota allocation in the Jordan Valley. Since it is known that the water available is less than that of the quota allocation, actual water crop productivity is higher than presented in table 4.12. However, since insufficient disaggregated data relate

TABLE 4.12 Crop Water Productivity
Jordanian dinar per m³

Crop	Gross revenues per cubic meter of irrigation water required	
	Current survey prices	Best market prices
Tomato (greenhouse)	8.17	20.27
Tomato (open field)	1.60	4.10
Cucumber (greenhouse)	8.33	16.59
Potato (open field)	7.77	7.78
Melon (greenhouse)	9.72	9.72
Dates: non-Medjool	8.22	8.22
Medjool	20.16	20.16
Banana	1.61	1.61
Citrus surface	0.47	1.20
Citrus drip	0.96	2.43

Source: Fileccia and Punda 2012.

crop production volumes and values with water consumption, it is difficult to achieve a higher level of precision than the level reflected in the table.

As shown in table 4.12, crop water productivity (in monetary terms) is highly dependent on crop prices. The expected relationships have been confirmed for the Jordan Valley. Drip irrigation tends to be associated with higher crop water productivity than surface water irrigation. In addition, the use of greenhouses tends to also be associated with higher crop water productivity than the use of open field farming techniques. The table also shows that crop prices have a big influence on water crop productivity.

Conclusions

To ensure a sustainable economic future for the Jordan Valley, a number of actions need to be taken, including the following:

- Ensuring the long-term certainty of the availability and good quality of irrigation water
- Pursuing high productivity through precision agronomic technologies
- Maximizing production of export vegetables grown under high-tech greenhouses (computerized with temperature or humidity control systems over 25 percent of the current vegetable area, or about 50,000 dunum)
- Optimizing citrus orchards (in the north) by gradually diversifying (over 50 percent of the current citrus area, or about 30,000 dunum) with other high-value fruit trees, including table grapes
- Expanding date palm area (with Medjool dates variety) to the extent possible (doubling the current date palm area to 20,000 dunum), and reducing the banana area
- Improving overall marketing and value-adding capacity.

If the Jordan Valley Authority does not succeed in ensuring the long-term quantity and quality or water, it will have to rely more on quota allocation and reduce overall crop area based on actual water availability, and/or reduce the length of the cropping season (until April) to enhance market opportunities for off-season produce.

These proposed actions would require considerable investment in the Jordan Valley. The Food and Agriculture Organization estimated the investment requirement to be about US$1.5 billion (excluding the investment related to the off-farm irrigation system). Special policy attention to agriculture of the Valley is needed, with an immediate focus on labor and migration matters, ad-hoc intergovernmental trade agreements, and area-specific engagements with donors and international financial institutions to source required funding, and toward the concrete facilitation of credit opportunities to farmers. Eventually, the government should consider removing any residual trade barriers. Furthermore, public sector responsibilities and a related investment in improved irrigation water management and distribution to guarantee farmers long-term security on a set amount of good quality water.

Finally, sector service providers (for example, the National Center for Agricultural Research and Extension) would need to concentrate their research and development efforts on effectively addressing the major issues producers are concerned about. The establishment of a modern and efficient market information system (through, for example, an empowered Jordan Exporters and Producers Association for Fruits and Vegetables) to guide producers' planting and marketing strategies may also be warranted.

Notes

1. The King Talal Dam provides water through the King Abdullah Canal to irrigate the middle and south of the Jordan Valley. This water is a mixture of fresh water and treated wastewater from the As Samra wastewater treatment plant, which serves Amman and Zarqa.
2. One dunum is equivalent to 0.1 hectare, or 1,000 square meters.
3. A waiver was introduced in 2004 when the JVA legalized citrus orchards planted between 1991 and 2001.
4. A waiver was introduced in 2004 when the JVA legalized citrus orchards planted between 1991 and 2001.
5. The World Bank commissioned a farmer survey under the "The Cost of Irrigation Water in the Jordan Valley" study, which was conducted in early 2012.
6. *Source:* 2012 Global Trade Information Services, Inc.
7. *Source:* Department of Statistics.
8. The northern part of the Jordan Valley is the main area for citrus orchards, where water quality is crucial to ensure sustainability of this asset. Should the King Talal Dam water be extended to any portion of this area to address irrigation deficiencies, the survival of the citrus orchards could be endangered.
9. An entrepreneur reported that daily wages at peak demand time range widely from JD 10 to JD 30.

10. Most migrant workers are located between Al-Ramil and Karamah. Some of them arrived in Jordan during the 1970s and work now, with their families, on farms that are larger than average (6 to 12 ha); others arrived during the 1990s and tend to have smaller farms (*Source:* IWMI 2007). Migrant labor is paid half the current daily wage rate (JD 4 to JD 5 per day).
11. For example, in 2012, at the optimal market time, Jordanian container trucks were unable to reach Turkey (and thereafter the European markets) through Syria or Iraq.

Chapter 5

Jordan Valley Authority's Current Revenues

Introduction

The Jordan Valley Authority (JVA) derives revenues from four different sources: land and housing revenues, water charges, other operating revenues, and non-operating revenues. Land and housing revenues consist mainly of rent and sales of land that has been developed, recovered, or improved by the JVA. The revenues consist of user charges for land plots for domestic, industrial, commercial, or agricultural uses. The rental and lease revenues come from farm units, housing units, and leases to investors

Farm units. The JVA divides the irrigable lands into farm units of between 30 and 40 dunum[1] (that is, 3 to 4 hectare). When renting these units, the contract stipulates that they must be used for agricultural purposes only. The lease value ranges from JD 30 to JD 40 JD per hectare per year. A total of 360,000 dunum (about 36,000 ha) has been developed and distributed to farmers, to irrigate around 10,000 farm units.

Housing units. The JVA allocates, develops, and improves some land for housing purposes when such lands are not allocated for faming units. The allocation follows the land use plans approved by the board of the JVA.

Lease to investors. Investors lease the land where a project is implemented. The investor is entitled to purchase the land, and the value of the lease is deducted from the price of such land.

Water Revenues

Water revenues consist of the sale of raw water for irrigation and industrial use in the Jordan Valley. Along the Valley, the JVA has four management centers in the Northern, Middle, Karamah, and Southern Ghors Directorates. Each center is in charge of billing and collecting user charges. The water business consists of distributing raw water for irrigation in all directorates and for irrigation and industrial use in the Southern Ghors.

The data on revenues from the different sources in the JVA vary significantly. The major sources of data are the Finance Department and the Control Center in Deir Allah. The data from the two sources differ widely, with the Finance Department data being consistently higher than the data reported by the Control Center since 2004.

The different sources of revenues are as follows as summarized in figure 5.1:

Irrigation water tariff. The tariff was established in 1994 and has remained constant since. It is based on an increasing block rate where consumption varies from 8 to 35 fils (cents) per cubic meter (table 5.1). The inflation rate

FIGURE 5.1 **Irrigation Revenues, 2005–12**

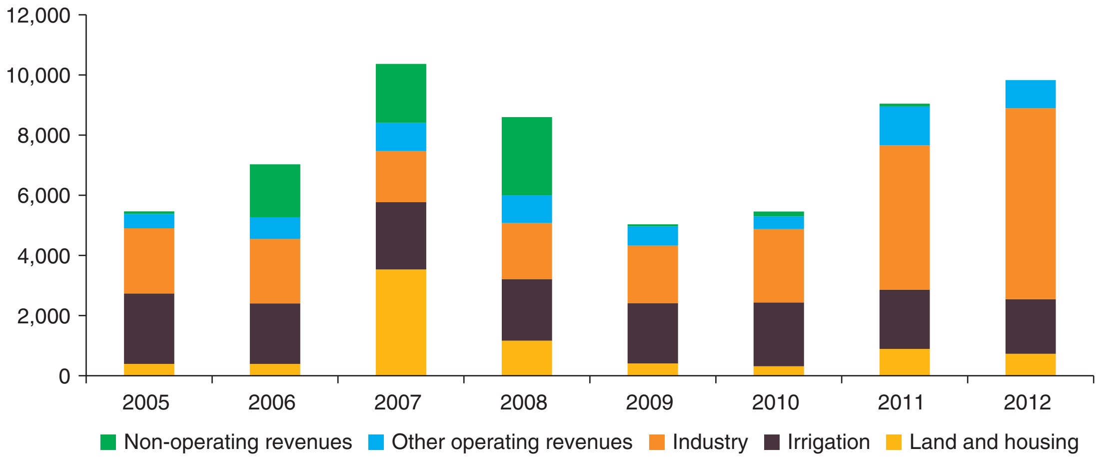


TABLE 5.1 **Irrigation Water Tariffs**

Volume of water consumed (m^3/month)	Current unit price (JD/m^3)	2011 prices if tariffs were adjusted for inflation (JD/m^3)
0–2,500	0.008	0.014
2,501–3,500	0.015	0.027
3,501–4,500	0.020	0.036
More than 4,500	0.035	0.063

Source: JVA Financial Department.

from 1994 to 2011 was 81 percent,[2] which means that today's tariffs are about half the 1994 price.

Water charges for industrial use. The JVA charge for industrial use is JD 1.25 per cubic meter since 2011.

Energy cost of pumping water from the North Conveyor. In January 2011, the JVA started to charge the Water Authority of Jordan a cost equivalent to the energy cost of pumping water from the North Conveyor. The water is elevated 1,000 meters to the water treatment plant of Zei, which is operated by Miyahuna. About 50 million cubic meters of water is pumped per year. This cost is refunded by the Water Authority of Jordan to the JVA, and started to enter the books in 2011.

In addition to the above-mentioned main categories, the JVA also generates revenues from other operating and non-operating revenues.

Other operating revenues. This consists of bids, which result from the works to be awarded to private investors, and stamps, for all legal documents signed with the JVA, such as leases, registrations, water titles, land titles, and licenses.

Non-operating revenues. This category consists mainly of fines and penalties for late payments. It also includes the sales of land, which are one-time payments. Revenues increased from 2005 to 2007,[3] after which they started to decline. Most of the revenues associated with the Land and Housing Department followed a downward trend. Table 5.2 shows that water revenues make up the majority of the JVA revenues.

Water Revenues from Irrigation

Water revenues are based on the water allocation made by the JVA on the basis of crop-based quotas. The quotas are set according to water availability and demand patterns. Given that competition for water has increased, the quota system is reviewed on a regular basis, according to water availability. In 2004, the JVA established new quotas to better match supply of water and crop water requirements. The current annual quotas correspond to 3,600 cubic meters per hectare for vegetables, 7,650 cubic meters per hectare for citrus, and 12,550 cubic meters per hectare for banana (as discussed in Chapter 4).

Water volume supplied and billed. The information on the volume of water supplied by the JVA is not consistent across the different data sources. The information at the pumping stations of the JVA differs from the information registered by the directorates, and also from the information obtained in Deir Allah (where the control center of the Jordan Valley network is located). The data suggest that water production has been declining since 2005. This is to be expected, since a larger share of the water supplied by the JVA is being used for municipal water supply in Amman.

It is also not clear what portion of the volume of water is actually used by the farmers. The JVA bills the farmers according to the quota system, which does not necessarily correspond to the volume of water used because of differences in water availability, type of crop cultivated, irrigation system, type of farm, and degree of intensification of farming, among other reasons. Water volume billed is registered by the JVA Control Center as 144 million cubic meters per year in 2010 compared to 129 million cubic meters of water supplied (table 5.3). This suggests that most JVA customers are charged on the basis of quota allocations instead of actual consumption levels.

Billing Efficiency. The JVA does not supply bills for its customers, but rather provides receipts when customers pay their bills. The farmer survey data show that 18 percent of the farmers interviewed did not respond to this question, which could suggest that they do not pay for water from the JVA (either because they do not use the water or because they use it without paying), or that the respondent does not know the answer (if the respondent is not the one paying the water bill).

Collection Efficiency. Ten percent of farmers responded that they did not receive a receipt from the JVA, which may indicate that they do not pay for their water, or that the JVA did not provide them with a receipt. Therefore, it is likely that up to 28 percent of JVA customers do not pay for the water they consume. The farmers who do not receive receipts are almost solely concentrated in the Karamah Directorate, whereas all the respondents in the Northern and Southern Ghors receive receipts.

TABLE 5.2 Jordan Valley Authority Revenues, 2000–12

REVENUES JVA (JD, thousands)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012p
Land and housing												
Housing for JVA employees	20	22	28	26	25	20	16	13	24	31	65	23
Rented land	519	503	377	372	395	397	3,535	1,165	411	315	400	248
Housing units	8	7	54	59	140	168	165	192	370	571	356	418
Agricultural units and services	—	—	—	—	—	—	—	—	57	77	73	48
Total	547	532	459	457	560	585	3,716	1,370	862	994	894	732
Water												
Irrigation – Jordan Valley	239	281	474	86	2,342	2,010	2,235	2,049	2,007	2,120	1,967	1,815
Water for industry	—	—	—	—	2,168	2,143	1,703	1,865	1,906	2,440	4,798	6,343
Total	239	281	474	86	4,510	4,153	3,938	3,914	3,913	4,560	6,775	8,198
Other operating revenues												
Stamps	28	134	546	35	61	33	133	70	202	19	166	20
University	6	23	86	17	10	7	30	23	43	12	5	
Bids	—	—	6	5	—	—	—	8	21	9	8	6
Electricity	26	27	—	—	370	654	760	329	315	287	299	285
Other income	20	16	57	245	32	29	14	491	61	96	802	617
Total	80	200	694	302	474	723	937	921	642	423	1,291	938
OPERATIONAL REVENUES	866	1,013	1,627	845	5,544	5,461	8,591	6,205	5,417	5,977	8,952	9.826
Non-operating revenues												
Land sold	2,097	903	602	1,134	70	1,753	1,912	2,567	45	162	83	0
Fines	0	0	31	25	18	5	47	31	24	1	9	1
Total	2,097	903	633	1,159	88	1,758	1,959	2,598	69	163	92	1
TOTAL REVENUES	2,962	1,917	2,259	2,005	5,632	7,219	10,551	8,803	5,487	6,140	9,045	9,827

Source: JVA.
Note: — = not available.

TABLE 5.3 Water Volume Supplied and Billed

thousand m³ per year

	2004	2005	2006	2007	2008	2009	2010
Southern Ghors	34,219	36,747	35,294	34,937	36,546	38,118	37,191
Northern Directorate	46,948	46,185	35,996	35,910	31,704	30,170	33,175
Middle Directorate	37,767	53,482	45,751	44,867	43,180	40,826	44,972
Karamah Directorate	26,183	27,709	23,593	24,925	24,959	23,913	25,616
Total irrigation	145,118	164,123	140,634	140,640	136,389	133,026	140,953
Industry in Southern Ghors	1,572	339	121	369	860	975	3,747
Total volume water billed	146,690	164,462	140,755	141,009	137,249	134,001	144,700
Total volume water supplied	165,592	179,512	161,714	152,038	131,334	129,718	129,247

Source: JVA Control Center.

TABLE 5.4 Collection Efficiency of Irrigation Water Tariffs

percent

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Southern Ghors	73	82	87	112	130	110	140	109	117	105
Northern Directorate	—	65	67	76	76	73	70	73	72	69
Middle Directorate	65	68	76	76	79	79	78	76	74	64
Karamah Directorate	54	52	52	62	65	58	61	64	63	67
Total irrigation	—	69	73	82	87	81	87	81	83	75

Source: JVA Control Center.
Note: — = not available.

Based on data from the Finance Department, in 2010, the JVA billed, on average, 11 fils per cubic meter for irrigation water. In 2010, the JVA was only able to collect about 75 percent of the revenues despite the very low tariffs. Collection efficiency has declined in recent years, which may reflect the difficult financial conditions many farmers face.

The low efficiency in collecting revenues (table 5.4) may be linked to the fact that JVA revenues are collected and then transferred to the Treasury. This practice is likely to provide few incentives to the JVA to collect revenues. The low tariffs also do not provide many incentives to bill and collect from farmers, since the costs of collecting revenues is high relative to the amount collected.

One area for further investigation is the water consumption pattern in the Southern Ghors. Even though the JVA Control Center confirms a large amount of water being supplied and billed to the Southern Ghors, almost all farmers in the directorate who were interviewed in the survey reported using groundwater as their main source of water. When farmers pay for the water they actually use instead of the water they are allocated (on the basis of their quota), it is likely that JVA revenues will decline due to both volume and tariff effects. Based on the JVA's data presented in table 5.3, actual water volume

TABLE 5.5 Estimated Irrigation Revenues Based on Quota Allocations, 2011

	Crop (dunum)	Crop (ha)	Quota allocation (m^3/ha/year)	Allocation (m^3)	Tariff (in JD)	Calculated revenues (in JD)
Vegetables	228,433	22,843	3,600	82,234,800	0.008	657,878
Citrus	65,989	6,599	7,500	49,491,750	0.015	742,388
Banana	19,617	1,962	12,550	246,193,350	0.035	861,809

billed was about 141 million cubic meters in 2010, whereas an estimate based on quota allocation results in 2010 would result in a billed volume of 156 million cubic meters (see Table 5.5). Hence, billing inefficiencies were 10 percent in 2010 compared to the results of the farmer survey (discussed above) that registered billing inefficiencies of 18 percent in 2012.

Water Revenues from Industry

The JVA currently charges a tariff of JD 1.25 per cubic meter for raw water to be used by industry. In 2010, the JVA billed industries for 3.8 million cubic meters, generating a total revenue from industry of JD 2.4 million. With the introduction of the new tariff in 2011, revenues from industry increased significantly to more than JD 6.3 million in 2012. This sharp increase has resulted in the share of industrial revenues increasing from 45 percent in 2010 to 65 percent in 2012.

Since 2011, the JVA has charged the Water Authority of Jordan the electricity cost for pumping water to Amman. This issue will be discussed in more detail in Chapter 6 on operation and maintenance costs.

Conclusions

The large differences in revenue information generated by the different departments in the JVA (the Finance Department, the JVA Control Center, and the four directorates) make it difficult to accurately determine the revenue-generating capacity of the JVA. As a result, management has to take decisions on the basis of inadequate and unreliable information.

Nevertheless, in view of the above analysis, it is clear that the JVA can significantly improve its revenue flows. The rapid increase in industrial tariffs shows that the revenue base can be increased. This increase in revenues will also require a change in accountability regarding the revenues. Currently, all revenues are transferred to the Treasury and do not return to JVA. As such, the incentive for the JVA to bill and collect efficiently and effectively to expand its revenue base is small.

The revenues flows can be characterized as follows.

Industrial water revenues. If one assumes no additional fixed charges to industry, it is likely that the increase in water tariffs has so far not affected the consumption of water from the industry, suggesting that water was a critical input into business expansion and that more efficient use of water (recycling) and/or substitution is not easy to implement in the short term.

Irrigation water revenues. In 2010, the JVA collected only about 75 percent of irrigation revenues. The farmer surveys held in 2012 put the collection efficiency even lower, at 72 percent. Reducing billing and collection efficiencies could result in a significant increase in revenues.

Water pumping to Amman. If the JVA provides additional services such as the pumping of water to Amman, the costs associated with this service should be charged to those benefiting from the service. By not doing so, the JVA is essentially cross-subsidizing groups of water users outside the Jordan Valley. If it is assumed that the costs of pumping water to Amman only requires electricity (and does not require any other input from the JVA), then by not charging these costs to the beneficiaries of this pumping, the JVA lost at least JD 2.0 million in revenues in 2010.

JVA's practice of charging customers against quota allocations resulted in higher revenues than if farmers were charged for their effective use of water. If the JVA reverted over time to an effective scheme where users pay on the basis of their meter readings, this would need to be taken into consideration when designing tariffs, since calculating tariffs that cover operation and maintenance costs on the basis of quota allocations instead of effective use will result in different tariff requirements.

Notes

1. One dunum is equivalent to 1,000 m^2, or 0.1 ha; thus, 1 ha equals 10 dunum.
2. *Source:* The Central Bank of Jordan.
3. Data before 2005 depend on a different accounting system, and hence are not directly comparable to data after 2005.

Chapter 6

Jordan Valley Authority's Operation and Maintenance Costs

Introduction

The information available on operation and maintenance (O&M) costs is for 2004 to 2012 (table 6.1). There is, however, a significant difference between data originating before and after 2008, when a new accounting system was introduced. The large increases in O&M costs since 2007 are likely the result of more complete recordkeeping. The period 2007 and 2008 also coincided with a spike in food and energy prices that may have adversely affected the O&M costs through significant increases in staff and energy costs.

Total operating costs in 2008 were more than double the total operating costs in 2007. Different cost categories show different trends. Personnel costs increased by 25 percent. Energy was either completely subsidized before 2008 or was not registered at all, since energy costs increased from only JD 57,000 in 2007 to JD 5.7 million in 2008. The JVA has always required sizable amounts of energy, given the need to pump water to distribute for irrigation and industrial purposes. Finally, there was a fivefold increase in social security, contributions, and third-party services.

As a result, the share by cost component has changed significantly over time. Personnel costs were about 90 percent of total costs before 2008, then decreased to 53 percent in 2008, and have since crept up to 62 percent in 2012. Energy cost has increased rapidly since 2007 (figure 6.1).

Data on staff numbers vary widely according to source—actual staff working in the JVA in 2010 varies from 1,400 to 1,800 depending on the source of information used.[1] For this report, we have used the estimate presented in table 6.2. The number of employees decreased from about 2,000 in 2009 to 1,591 in 2011, which corresponds to a 19 percent reduction in staff. Staff numbers in the daily wages category declined by 86 percent between 2009 and 2011. The share of JVA employees with a high school degree increased from 52 percent to 70 percent between 2009 and 2011. The outflow of highly qualified staff (defined as those with a college degree) continues; between 2009 and 2011, about 8 percent of college-educated employees left the JVA.

The budget books of the Ministry of Finance show that escalating O&M costs are a big issue. The actual current costs (O&M costs) increased from JD 5 million in 2004 to JD 13 million in 2010, with almost all of the increase occurring after 2008.

A part of the current costs are ending up in the JVA's capital cost budgets. In 2004, 10 percent of the total current costs were hidden in the capital budget. By 2011, this share had increased to 40 percent. As a result, the share of capital

TABLE 6.1 JVA Operation and Maintenance Costs
Jordanian dinar, thousands

Expense category	2004	2005	2006	2007	2008	2009	2010	2011	2012*
Salaries and allowances	4,812	5,580	5,893	5,911	7,408	7,622	7,399	7,623	8,568
Social security, contributions, third-party services	295	264	311	338	1,679	1,618	1,657	1,382	1,460
Total staff costs	*5,107*	*5,844*	*6,204*	*6,249*	*9,087*	*9,240*	*9,056*	*9,005*	*10,028*
Consulting fees and studies					220	883	178	14	16
Utility bills	—	—	—	—	129	159	173	142	166
Supplies (office and cleaning)	100	111	108	138	225	437	256	11	13
Maintenance of assets not related to irrigation	48	48	2	425	946	1,431	648	71	165
Insurance, transportation, subscriptions, publicity, taxes, and training expenses	151	169	207	172	558	624	660	117	137
Electricity	27	7	35	57	3,717	2,984	2,187	2,396	2,098
Pumping water					1,270	2,546	2,033	4,426	2,700
Fuel	—	—	—	—	710	758	680	686	735
Total energy cost	*27*	*7*	*35*	*57*	*5,696*	*6,288*	*4,900*	*77,508*	*5,533*
Monitoring water quality	—	—	—	—	150	166	166	0	0
Maintenance of irrigation equipment	—	—	—	—	145	567	283	51	44
Financial expenses	—	—	—	—	14	136	1	0	0
Total operating expenses	*5,434*	*6,179*	*6,556*	*7,041*	*17,170*	*19,932*	*16,322*	*16,919*	*16,102*

Source: JVA Financial Department.
Note: *2012 are preliminary figures.
— = not available.

FIGURE 6.1 Composition of Jordan Valley Authority Operation and Maintenance Costs

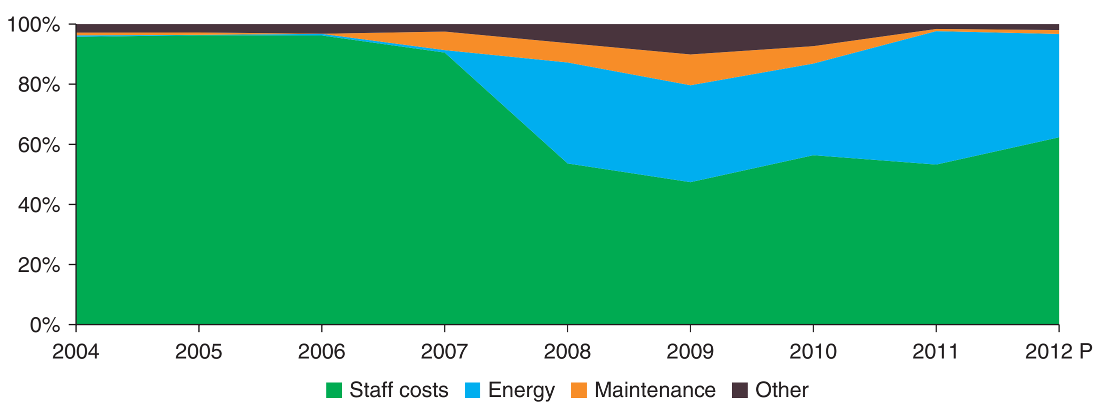


TABLE 6.2 JVA Employment

Year	Level 1 – college degree	Level 2 – 2 years college	Level 3 – high school	Contracts – highly educated	Daily wages	Total
2009	238	160	1,031	12	525	1,966
2010	225	161	1,131	12	160	1,689
2011	220	160	1,121	18	72	1,591

Source: JVA's Human Resources Department.

TABLE 6.3 JVA Actual Expenditure in Government Budget

Category	2004	2005	2006	2007	2008	2009	2010	2011	2012 Prelim.
Current costs	4,873	4,936	5,311	5,198	6,034	6,839	7,626	8,145	9,164
Current portion in capital costs	561	1,243	1,245	1,500	6,671	7,160	5,801	8,794	6,938
Total current costs	5,434	6,179	6,556	6,698	12,705	13,400	13,427	16,938	16,102
Current cost in capital budget as % of current costs	10	20	19	22	53	51	43	52	43
Total capital costs excluding current costs	48,176	33,493	38,660	25,887	16,511	26,663	16,089	13,166	8,712
Total capital and current costs	53,610	39,672	45,216	32,580	29,216	40,663	29,516	30,105	24,814
Capital costs (excluding current costs) as % of total costs	90	84	86	79	57	66	55	44	35
Current cost (JVA Finance Department)	*5,434*	*6,179*	*6,556*	*7,041*	*17,170*	*19,932*	*16,322*	*16,919*	*16,102*
Difference in current costs between Ministry of Finance and JVA data (%)	*0*	*0*	*0*	*5*	*35*	*49*	*22*	*0*	*0*

Sources: Ministry of Finance, Budget Department, and JVA Finance Department.

investment in the total JVA budget has decreased from 90 percent of total expenditure in 2004 to only 43 percent in 2012 (table 6.3). This expenditure pattern is not commonly seen in the water sector elsewhere in the world, which in general tends to be heavily skewed to capital costs because of the capital-intensive character of the sector.

Water Operation and Maintenance Costs

To estimate the costs associated with water activities, the operating costs of the JVA, available from 2004, were broken down in two categories: costs directly associated with the water business and other costs. The first category consisted of electricity costs related to operation (excluding pumping costs), costs from pumping stations, costs related to monitoring the quality of water, maintenance of irrigation equipment, and personnel costs related to employees in the directorates and Southern Ghors. The second category of "other costs" consists of all other costs (such as staff costs, administrative costs, and maintenance of equipment other than irrigation). These costs have been allocated to the provision of irrigation water services based on the share of irrigation costs as measured by employment in the total JVA costs.

Staff Costs

Because of the widespread difference in actual staff numbers in the JVA, we assume that the number of staff was 1,591 in 2011 (according to table 6.2), with 1,501 permanent staff and 90 temporary contracts.[2] The data for 2010 show the following:

- The Water Section of the JVA makes up 79 percent of the total workforce in the JVA.
- Most of the workforce is linked to the four directorates (North, Middle, Karamah, and Southern Valley) and the Dams Directorate. These five directorates make up 65 percent of the JVA staff.
- Highly qualified staff (that is, staff with at least a college degree), make up only 15 percent of the total JVA workforce.
- The shortage of professional staff in the JVA is still an issue; 20 years after the 1993 GTZ study, only 11 percent of the employees in the JVA Water Section have a college degree. The Dams Directorate is the directorate with the highest share of staff with a college degree, at 19 percent, which is much lower than in 1993.

In 2012, staff costs made up about 62 percent of total O&M costs. If salaries and wages are linked to employment numbers, the average monthly salary of a JVA employee is about JD 387 per month, compared to a minimum wage in 2012 of JD 190 per month. The relatively low level of these base salaries may explain the rapid increases in allowances. In 2010, allowances made up 15 percent of total staff costs and are likely a tool to supplement salaries and wages in the JVA.[3]

Energy Costs

Pumping costs. Given that energy costs are so important to running the water business at the JVA, special attention was paid to understanding consumption patterns and energy tariffs charged to the JVA. Information was obtained for 2005–07 and 2009–10. The information was provided by the Finance Department but only for Northern, Middle, and Karamah Directorates.

The available information for the directorates contains energy consumption and the respective cost for each pumping station in each directorate. These pumping costs make up 78 percent of the total energy costs in the JVA. The energy use for pumping in the Valley is about 0.39 kilowatt hours per cubic meters of water supplied, which is much higher than the energy use provided in the 1993 GTZ study. It is not clear whether the large difference is the result of information deficiencies, the result of delayed maintenance, or a combination of these factors.

The cost per kilowatt hour of energy differs among the directorates and varies from JD 0.038 per kilowatt hour in the Northern Directorate to JD 0.061 in the Middle Directorate, with an electricity rate for pumping of about JD 0.041 per kilowatt hour (see tables 6.4, 6.5, and 6.6).

Pumping costs to Amman. In recent years, an increasing part of the water that the JVA supplied is used to supply water to Amman. In 2010, this flow of water was estimated at 53 million cubic meters. In return, the JVA receives treated wastewater that is blended and reused, especially in the Middle Directorate. The costs associated with this water pumping are significant because the water has to be lifted more than 1,000 m. The JVA values these pumping costs at the electricity rate of JD 0.041 per cubic meter of water pumped, similar to the cost of electricity. However, this is only a nominal cost. If the true energy requirement[4] (assuming 100 percent pump efficiency) is

TABLE 6.4 Energy Use at Pumping Stations in Each Directorate
Megawatt hours per year

Directorate	2005	2006	2007	2009	2010
Northern Directorate	15,100	13,757	15,312	5,890	8,080
Middle Directorate (mostly gravity based)	1,152	865	1,919	639	883
Karamah (South) Directorate	7,795	12,282	27,504	25,369	30,222
Southern Ghors	n.a.	n.a.	n.a.	n.a.	n.a.
Total Energy Usage	24,047	26,904	44,734	31,897	39,185

Source: JVA Control Center.
Note: n.a. = not applicable.

TABLE 6.5 Energy Costs at Pumping Stations in Each Directorate
Jordanian dinar, thousands

Directorate	2005	2006	2007	2009	2010
Northern Directorate	482	523	414	292	309
Middle Directorate	47	46	45	36	54
Karamah (South) Directorate	258	551	1,215	1,213	1,350
Southern Ghors	n.a.	n.a.	n.a.	n.a.	n.a.
Total Energy Costs	787	1,121	1,675	1,541	1,714

Source: Finance Department.
Note: n.a. = not applicable.

TABLE 6.6 Energy Tariff at Pumping Stations in Each Directorate
Jordanian dinar per m³

Tariff	2005	2006	2007	2009	2010
Northern Directorate	0.03	0.04	0.03	0.05	0.04
Middle Directorate	0.04	0.05	0.02	0.06	0.06
Karamah (South) Directorate	0.03	0.04	0.04	0.05	0.04
Southern Ghors	n.a.	n.a.	n.a.	n.a.	n.a.
Total energy tariff per kWh	0.03	0.04	0.04	0.05	0.04

Source: Calculations based on information from Finance Department and Control Center.
Note: n.a. = not applicable.

2.8 watts per hour to lift 1 cubic meter of water 1 meter, the actual volume of energy needed to pump water to Amman was about 150 million kilowatt hour in 2010. If the JVA pumps the water in stages through pumping stations, the cost of pumping will be lower; but if pumping efficiency is below 100 percent, the overall energy requirements will increase.

To better understand the true cost of pumping water to Amman and hence be better able to price this service, the JVA should collect information on the volume of energy consumed to pump water to Amman, and the overhead cost of pumping water to Amman.

Maintenance Costs

The maintenance costs are highly volatile, suggesting that maintenance acts as a balancing item in the JVA budget. As a result, maintenance costs vary significantly over time (table 6.7). In addition, maintenance costs are low. The total asset base of the JVA in historical prices amounts to JD 356 million.[5] The average total maintenance costs alone are about JD 1 million (equivalent to 0.3 percent of the asset base), which further reflects that maintenance is seriously underfunded. A rapid assessment of the JVA budget shows that maintenance often ends up in the capital budget and as such is crowding out the capital investment program of the JVA. The current portion of the capital expenditures amounted to 26 percent in 2010 (equivalent to close to JD 6 million). This translates to a total maintenance cost that is equivalent to about JD 7 million—equivalent to about 2 percent of the asset value in historical prices. Ward (2010) noted that where the opportunity costs of irrigation water are high (as is the case in the Jordan Valley), investments in irrigation infrastructure maintenance will perform weakly.

Summary of Operation and Maintenance Costs

Based on staff numbers (including overhead), 92 percent of the staff costs, utility costs, and maintenance of assets not associated directly with irrigation are associated with the water business. Energy costs and maintenance costs of irrigation are fully connected to the water business.

TABLE 6.7 JVA Operation and Maintenance of Water Services
Jordanian dinar, thousands

Expense category	2005	2006	2007	2008	2009	2010	2011	2012 prelim.
Salaries and allowances	5,162	5,451	5,468	6,852	7,050	6,844	7,013	7,883
Social security, contributions, third-party services	244	288	313	1,533	1,497	1,533	1,271	1,343
Total staff costs	*5,406*	*5,739*	*5,780*	*8,405*	*8,547*	*8,377*	*8,284*	*9,226*
Consulting fees and studies	—	—	—	204	817	165	13	15
Utility bills	—	—	—	119	147	160	131	153
Supplies (office and cleaning)	103	100	128	208	404	237	10	12
Maintenance of assets not related to irrigation	44	2	393	875	1,324	599	65	152
Insurance, transportation taxes on sales, training expenses	156	191	159	516	577	611	108	126
Electricity	7	35	57	3,717	2,984	2,187	2,396	2,098
Pumping water				1,270	2,546	2,033	4,426	2,700
Fuel	—	—	—	710	758	680	686	735
Total energy cost	*7*	*35*	*57*	*5,696*	*6,288*	*4,900*	*7,508*	*5,533*
Monitoring water quality	—	—	—	150	166	166	0	0
Maintenance of irrigation equipment	—	—	—	145	567	283	51	44
Total Operating Expenses JVA	*5,716*	*6,067*	*6,517*	*16,319*	*18,837*	*15,497*	*16,170*	*15,260*
Total billed water volume (million m^3)	164	141	141	137	134	145	137	155

Note: — = not available

Table 6.8 shows that the JVA is not able to cover its basic operating costs; its revenues fall far short despite a large increase in industrial revenues after the price increase in 2011.

The lack of cost recovery ensures that the JVA's dependence on taxpayers is increasing. The taxpayers' share in covering the JVA's operating deficit increased from 23 percent in 2004 to 76 percent in 2009. Since then, due to the tariff increases for industrial water users and further cost savings (mainly due to declines in maintenance costs), the operating deficit declined to 60 percent of O&M costs in 2012. Future taxpayers will also be paying for JVA's low levels of cost recovery. Shortfalls in basic maintenance will require additional replacement and rehabilitation of existing infrastructure in the near future.

The JVA currently provides three types of services: water for irrigation, water for industry, and pumping. Pumping services are not explicitly acknowledged, but they are an important service, with the ensuing costs but no explicit revenue base. Table 6.9 presents the costs associated with providing all three services. Yet, as noted, the costs of the JVA are mainly driven by the availability of budget funds. In recent years—most notably in 2011 and 2012—certain cost categories have been reduced significantly (energy costs, maintenance costs, and other costs). Hence, when presenting the cost allocation, we will

TABLE 6.8 JVA Financial Performance Indicators
Jordanian dinar, thousands

Indicator	2005	2006	2007	2008	2009	2010	2011	2012
Operating revenues	*4,984*	*4,876*	*4,875*	*4,835*	*4,555*	*4,983*	*8,057*	*9,093*
Irrigation water	2,342	2,010	2,235	2,049	2,007	2,120	1,967	1,815
Water for industries	2,168	2,143	1,703	1,865	1,906	2,440	4,798	6,343
Other operating revenues (excluding land and housing)	474	723	937	921	642	423	1,292	935
Operating costs from water	*5,716*	*6,067*	*6,517*	*16,319*	*18,837*	*15,497*	*16,170*	*15,260*
Total operating income	–732	–1,191	–1,642	–11,484	–14,282	–10,514	–8,113	–6,117
O&M cost recovery (%)	*87*	*81*	*75*	*30*	*24*	*32*	*50*	*60*

Source: Calculations based on information from the JVA Finance Department.

TABLE 6.9 Summary of Current Costs for Irrigation Water, 2012, Three-Year Average
Jordanian dinar, thousands

Expense category	O&M cost TOTAL	O&M cost INDUSTRY	O&M cost IRRIGATION	O&M cost PUMPING
Total staff costs	8,614	198	5,289	3,136
Electricity	700	25	675	—
Pumping costs	3,053	—	—	3,053
Fuel	2,227	80	2,147	—
Total energy cost	—	*105*	*2,822*	*3,053*
Maintenance of assets not related to irrigation	271	6	166	99
Maintenance of irrigation equipment	181	—	181	—
Total maintenance costs	*452*	*6*	*347*	*99*
Other expenditure	577	13	354	210
Total operating expenses of JVA before depreciation	*15,624*	*323*	*8,813*	*6,497*
Total water volume (million m^3)	231	5	141	86
O&M costs in JD per m^3 of water	0.067	0.062	0.063	0.078

Source: Calculations based on information from the Finance Department and Control Center.
Note: — = not available.

use data for the period between 2008 and 2012. The cost allocation between the different users is based on current billed volume of water.

According to the farmer survey, water use as reported by the JVA is about 30 percent higher than water users' estimations (as measured by meters and flows). If the actual consumed volume is the measure at which rates are being calculated, then the irrigation tariff would be 30 percent higher.

Income Statement of Water Business, Jordan Valley Authority

The income statement reflects all revenues and costs (including depreciation and interest payments). The most important cost item apart from the operating costs and revenues is depreciation, because the JVA has a large asset base.

Depreciation. Depreciation enables the JVA to replace existing assets in the future. To estimate the value of assets used for water activities, assets were classified in two categories: assets exclusively related to water activities, and assets shared with other activities. The first category of assets refers to dam and irrigation equipment, and their total value was included. Those assets correspond to 84 percent of JVA's total assets. This percentage was used to allocate the second category of assets as water related. The results are presented in table 6.10.

Table 6.10 shows that the JVA had total assets valued at JD 357 million at historical prices in 2010. Most of the water infrastructure of the JVA dates back from the 1960s to 1980s. Hence, it is likely that the actual replacement value of these assets is significantly higher than the historical price valuation.

In addition, the asset value base may be higher than is registered in table 6.10, since the increase in assets as registered in the JVA's budget books does not correspond to the investment flows that the Ministry of Finance registers in its budget books. The JVA's capital budget (excluding the current portion in its capital budget) assumes that the asset base should have been increasing more between 2008 and 2010. Adjusted for the current portion in the capital expenditure, the JVA's capital expenditure reached JD 16 million in 2010. However, this capital expenditure is only partially reflected in the asset register of the JVA, which registered new capital assets of only JD 3 million. It is unclear why only JD 3 million of the invested JD 16 million in 2010 entered the JVA books; it is likely that the transfer of assets is incomplete.

Currently, depreciation is set at about JD 5.6 million, which is an underestimation of the real depreciation requirements because of the undervaluation of

TABLE 6.10 Asset Inventory of the JVA
Jordanian dinar, thousands

Category	2008	2009	2010
Assets related exclusively to water activities			
Dams	268,913	270,825	274,049
Irrigation systems	35,361	35,682	35,682
Subtotal	304,274	306,506	309,731
Assets shared with other JVA activities			
% Assigned to water activities	84	85	85
Construction and buildings	13,630	13,602	13,627
Furniture – office equipment	26	29	26
Tools and equipment	32,212	32,035	31,994
Information systems	298	309	335
Vehicles	3,386	1,005	1,007
Assets assigned to water activities	49,552	46,980	46,990
Total assets (water related)	*353,826*	*353,487*	*356,720*

Source: JVA Finance Department.

the asset base (as explained above). A further element of the undervaluation is the JVA's use of very long depreciation periods, which is not in line with best practice. As table 6.11 shows, assets such as furniture, tools, and, to a lesser extent, vehicles, have very long depreciation periods. The large fluctuations in depreciation from year to year, moreover, suggest that depreciation is not systematically charged.

The decline in the capital budget is worrying because with a total historical cost asset base of JD 357 million, and an annual capital investment program of about JD 13 million to JD 16 million in most recent years, total annual depreciation costs (based on good practice and at historical prices) should amount to at least JD 14 million. This would mean that virtually the total current investment budget is needed to cover the replacement of existing assets (on a historical cost basis). Hence, the JVA is currently not able to maintain its current asset base.

TABLE 6.11 Depreciation as a Percentage of Current Assets and Implicit Lifetime of Assets

Category	2009 (%)	2010 (%)	Lifetime of assets in years	Good practice lifetime of assets in years
Dams	2.0	2.1	49	50
Irrigation systems	4.0	4.0	25	25
Construction and buildings	2.3	3.1	32	25
Furniture – office equipment	8.7	1.6	61	5
Tools and equipment	4.9	5.9	17	5
Information systems	3.7	19.9	5	5
Vehicles	–247.7	12.5	8	5
Total	1.8	2.7	37	25

Source: JVA Finance Department.

TABLE 6.12 JVA Financial Performance Indicators with Depreciation Included

Jordanian dinar, thousands

Indicator	2008	2009	2010	2011	2012 prelim.
Operating revenues	***4,835***	***4,555***	***4,983***	***8,057***	***9,093***
Irrigation water	2,049	2,007	2,120	1,967	1,815
Water for industries	1,865	1,906	2,440	4,798	6,343
Other operating revenues (excl. land and housing)	921	642	423	1,292	935
Operating costs from water (incl. depreciation)	***21,836***	***24,354***	***21,126***	***21,854***	***20,944***
Total operating income	–17,001	–19,799	–16,143	–13,797	–11,851
Cost recovery (%)	*22%*	*19%*	*24%*	*37%*	*43%*

Source: Calculations based on information from the JVA Finance Department (estimates for 2011 and 2012 depreciation).

Interest payments. These payments in the JVA are minimal and according to practice, interest payments are made by government and are not included in the financial statements of the JVA.

Adjusted income statement. An adjusted income statement for the JVA water operations is presented in table 6.12, with total depreciation costs of JD 5.6 million per year, increasing the actual net operating loss to JD 16 million in 2010 when no pumping revenues were collected by the JVA, which assumes a level of cost recovery of only 24 percent.

Conclusions

JVA's capacity to track its operating and maintenance costs needs to be significantly improved, an observation already made in the previous chapter on operating revenues. The JVA's inability to cover a part of its O&M costs through its revenues has resulted in pressure on the JVA to curb costs. The agency has tried to reduce its energy costs. At the same time, depreciation and maintenance payments have been squeezed, which means that the medium-to-long-term viability of the existing infrastructure is in jeopardy. The delays in maintenance have resulted in an increasingly large part of the investments being used for ad-hoc maintenance and rehabilitation, whereas the lack of current revenues severely affects the capacity of the JVA to attract higher-qualified staff.

Energy costs are currently highly subsidized in Jordan, with the JVA paying highly subsidized rates for water pumping. The increase in energy prices and the expected further electricity rate increases will affect the JVA, since energy makes up about 30 percent of its total O&M costs. The data on actual electricity consumption—both for pumping irrigation water and for pumping water through Amman—are not very consistent, but suggest that there is room for improvement.

Compared to the 1993 GTZ study, energy needs for irrigation pumping have increased significantly since 1993, from about 0.10 kilowatt hour per cubic meter to about 0.39 kilowatt hour per cubic meter in 2010. The additional services provided by the JVA by pumping water to Amman (a relatively new service for the JVA) explains (part of) this difference. Nonetheless, it is likely that information deficiencies and years of delayed maintenance have also contributed to this increase in energy intensity. Any investment planning program for the JVA should make investments for energy efficiency improvement a high priority, since they can reduce energy volumes significantly and, hence, will help the JVA better cope with increasing electricity and energy prices.

Finally, the JVA uses a nominal rate for pumping water to Amman. The JVA should know precisely how much this service costs in terms of energy, but also in any ancillary costs in the form of staff requirements and basic overhead. This would enable the JVA to value and better price the service it provides, since the price of bulk water for the Water Authority of Jordan is now implicitly set at JD 0.045 per cubic meter.[6]

Notes

1. Data in the 2012 budget indicate 1,800 people working at the JVA in 2010. Data from the Human Resources Department vary between 1,400 and 1,591 in 2011.
2. Data from JVA's Human Resources Department show that in 2011, the JVA Water Section included 1,189 direct employees and 172 indirect employees (allocating the administration staff to the different directorates based on staff numbers). Hence, in 2011, there were 1,361 permanent employees in the Water Section. Yet, details on staff in the budget books of the government refer to much higher staff numbers.
3. The Ministry of Finance budget books show a different picture, with a much lower contribution of wages and salaries and a much larger share of allowances in the JVA budget. Interestingly, a significant part of the wage and salary component of the JVA staff (including allowances) is put in the capital budget of the agency instead of the current budget.
4. The true energy requirements for lifting 1 ton of water 1 meter are 1,000 kg * 1 m = 10,000 Nm = 10,000 J = 2.7778×10^{-7} * 10,000 kWh = 2.78 * 10^{-3} kWh = 2.8 Wh (where kg = kilogram, m = meter, Nm = Newton meter for, J = joule, kWh = kilowatt hour, and Wh = watt hour).
5. Because much of the infrastructure was put in place decades ago, historical cost assessments are likely to underestimate current maintenance requirements.
6. This price also gives an indication of the price the JVA implicitly pays for treated wastewater.

Chapter 7

Jordan Valley Authority's Operation and Maintenance Cost Requirements

Introduction

The assessment of the Jordan Valley Authority's (JVA's) finances as depicted in Chapter 6 shows that the its financial viability is severely compromised. The escalation of operation and maintenance (O&M) costs is the result of inflation, fuel price increases, and explicit acknowledgment of the assignment of new tasks (that is, increasing flows of water being pumped to Amman to supplement the public water supply). In the absence of an increase in the JVA's revenue, these escalating costs are resulting in increasingly large financing gaps. The JVA has dealt with the increasing operating losses by crowding out its investment programs and increasingly diverting capital funding toward paying for operational losses and postponing maintenance. The long-term effects of this behavior is that the quality of the assets and, hence, the quality of the service, is and will be adversely affected. The limits to continuing this behavior are becoming evident, since government budgets are likely to decline in the immediate future.

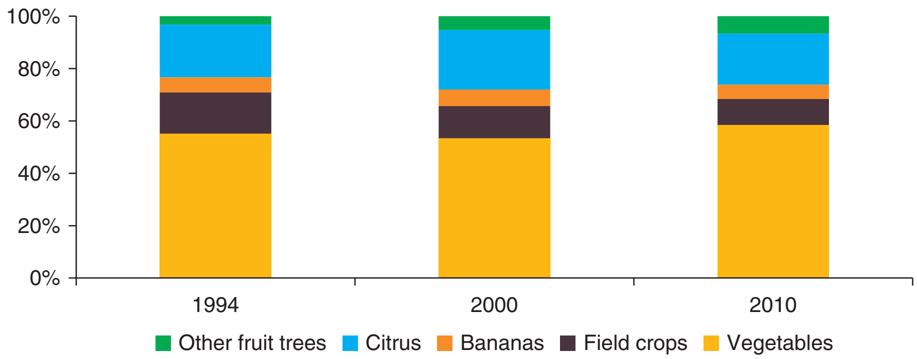
The lack of adjustments to the irrigation tariffs has resulted in a real decline in irrigation tariffs, which provides farmers with few incentives to use irrigation water more efficiently. Although water availability limits the increase in irrigation water demand, the effects are shown in irrigation consumption patterns. The Jordan Valley has seen few changes in cropping patterns over the last two decades (see figure 7.1) due to the combination of low tariffs (that are declining in real terms), and a quota allocation that favors banana and fruit tree crops (both crops with high water requirements).

In this section, we will calculate the O&M requirements of the JVA to ensure that the agency can provide services of better quality without compromising its long-term future.

Requirements for Operation and Maintenance Staff Costs

According to the JVA's Financial Department, there were 1,501 permanent employees working in the JVA in 2011 (estimates from the budget books show a total of 1,658, which increases to 1,756 in 2012). If those in the administrative offices were distributed proportionally to revenues, 1,361 employees were in the Water Division and the remaining staff in the Land Division.

FIGURE 7.1 Cropping Patterns in the Jordan Valley in 1994, 2000 (Before Legalization of Fruit Crops), and 2010



Source: Department of Statistics.

TABLE 7.1 Current and Required Number of Employees for Water Activities, Jordan Valley Authority

Employee category	Working in JVA in 2011	Efficiency scenario	Difference
Level 1 (college degree)	152	66	86
Level 2 (2 years college)	108	148	–40
Level 3 (high school or less)	1,130	1,007	123
TOTAL	1,389	1,220	169

Sources: GTZ 1993; JVA Financial Department.

The 1993 GTZ study calculated that about 1,220 employees would be needed to carry out improved JVA operations in water activities, assuming that the task of the JVA is to operate and maintain the existing water irrigation infrastructure (table 7.1). This number is lower than the staff currently working in the JVA, and hence, efficiency improvements can be made.

Salaries have increased significantly since 1994, with monthly salaries increasing from JD 184 per month per employee to JD 379 per month in 2012. Overall, real salary increases have been averaging 1.7 percent per year. Despite these increases, salaries of JVA employees are still significantly lower than the salary of their peers in the private sector, making it difficult for the JVA to attract well-qualified staff. Even though there could be gains in reducing staff numbers, it is likely that the qualifications of the staff need to improve, and an active human resources policy is required in combination with a revision of salary levels and structures. We will assume that the effects of reducing staff numbers and higher staff costs will balance each other out.

Energy Costs

Energy costs are divided in three categories: electricity cost from the pumping stations along the distribution system, fuel, and electricity paid for pumping water in the Northern Conveyor.

Electricity cost from the pumping stations along the distribution system. In 2010, the energy required for irrigation water pumping was estimated at 0.39 kilowatt hour per cubic meter. Benchmarks elsewhere show that there is room for improvement in the actual consumption per cubic meter of irrigation water. Energy costs are heavily influenced by the price of electricity. A 2012 paper, "Options for Immediate Fiscal Adjustment and Longer Term Consolidation" (World Bank 2012) shows that electricity is heavily subsidized in Jordan. The electricity tariff for the JVA has been cross-subsidized by other consumer groups. Since a realignment of energy subsidies is taking place, energy tariffs are likely to increase significantly. Tariffs increased in 2012 to JD 0.066 per kilowatt hour. However, the actual cost-recovery-based tariff needed to ensure that the National Electricity Power Company's (NEPCO)'s tariffs do not fall below its buying tariff is likely to be around JD 0.133 per kilowatt hour. Hence, in the short term, electricity prices for water pumping will have to increase from, on average, JD 0.04 per kilowatt hour in 2010 to JD 0.066 per kilowatt hour in 2012. In 2013, the government announced another 15 percent tariff increase, which would bring the rate to JD 0.0759. In the longer run, electricity prices are likely to further increase to a cost-recovery-based tariff of JD 0.133 per kilowatt hour by 2017 (table 7.2).

Fuel. Between 2008 and end 2010, the Government of Jordan phased out cash subsidies on petroleum products, causing a sharp drop in oil subsidies. However, early in December 2010, oil retail prices (except for heavy fuel oil for industrial consumption, power generation, and aviation fuels) were again frozen. Furthermore, petroleum subsidies were reintroduced. We assume that the fuel prices follow the same price developments as that of electricity (table 7.3).

Pumping water from the Northern Conveyor. In 2010, the volume of water the JVA provided to Amman was estimated at 53 million cubic meters. Since then, according to recent JVA data, the volume of water pumped increased to more than 100 million cubic meters in 2012. This is

TABLE 7.2 Current and Required Electricity Costs for Irrigation Water Pumping

Electricity indicator	2010	2012	2013	With electricity cost recovery rate
Volume of water produced (thousand m^3)	129,247	129,247	129,247	129,247
Cost per kWh (JD)	0.04	0.066	0.0759	0.133
Electricity used per m^3 of water produced (kWh)	0.39	0.39	0.39	0.39
Base case scenario of current volume energy consumption savings:				
Scenario I: efficiency gain of 10 percent	n.a.	0.35	0.35	0.35
Scenario II: efficiency gain of 25 percent	n.a.	0.29	0.29	0.29
Total electricity costs (JD, thousands) in 2010 and 2012	2,033	2,700	—	—
Base case scenario electricity costs (JD, thousands)	n.a.	3,327	3,826	6,704
Scenario I: electricity costs (JD, thousands)	n.a.	2,994	3,433	6,016
Scenario II: electricity costs (JD, thousands)	n.a.	2,661	2,845	4,985

Source: JVA.
Note: — = not applicable; n.a. = not available.

TABLE 7.3 Current and Required Fuel Costs

Fuel indicators	2010	2012	2013 (average of 3 years)	With electricity cost recovery rate
Volume of water produced (thousand m^3)	129,247	129,247	129,247	129,247
Cost per m^3 (JD)	0.005	0.009	0.010	0.0175
Total fuel costs (JD, thousands) in 2010 and 2012	680	735		
Base case fuel costs in (JD, thousands)	n.a.	1,122	1,226	2,261
Scenario I: fuel cost (JD, thousands)	n.a.	1,010	1,103	2,036
Scenario II: fuel cost (JD, thousands)	n.a.	842	920	1,696

Source: JVA.
Note: n.a. = not applicable.

TABLE 7.4 Current and Required Pumping Water Costs to Amman

Pumping indicator	2010	2012	2013 (3-year average)	With electricity cost recovery rate
Volume of water produced (thousand m^3)	53,936	105,700	86,000	86,000
Cost per m^3 (JD)	0.038	0.066	0.0759	0.133
Electricity consumption per m^3	1.00	1.00	1.00	1.00
Total fuel costs (JD, thousands) in 2010 and 2012	2,033	2,700	—	—
Base case pumping costs in (JD, thousands)	n.a.	6,976	6,527	11,483
Scenario I: pumping cost (JD, thousands)	n.a.	6,278	5,874	10,294
Scenario II: pumping costs (JD, thousands)	n.a.	5,232	4,896	8,578

Source: JVA.
Note: — = not available; n.a. = not applicable.

a rapid increase since 2010, and it is not clear whether this increase is a permanent feature of the JVA's business. In return, the JVA receives treated wastewater that is blended and reused, especially in the Middle Directorate.[1] The costs associated with this water pumping are significant, especially since the water must be lifted more than 1,000 m. The JVA values these pumping costs at the electricity rate of JD 0.041 per cubic meter of water pumped.[2] However, this is a nominal cost only, because energy prices have been increasing, it implicitly assumes that each cubic meter of water pumped requires 1 kilowatt hour of energy, and it assumes that pumping this water requires only electricity but not staff or any other input from the JVA (table 7.4).

Maintenance Costs

Because maintenance is currently on an ad-hoc basis, an improved maintenance program would include routine maintenance taking place to reduce rehabilitation requirements. GTZ, in its 1993 study, included a maintenance plan that would undertake routine maintenance, which it valued at JD

1.7 million at 1993 prices. However, since 1993, the JVA has increased its asset base by about JD 149 million. It is likely that productivity increases have also taken place in the corresponding period, which can partially offset the increase in maintenance costs. We have assumed a net increase of maintenance costs of about 1.5 percent of total historical asset value, compared with an actual maintenance cost in 2010 of less than 0.8 percent of total historical asset value (table 7.5).

Depreciation

Currently, depreciation is set at about JD 5.6 million, which is likely to significantly underestimate the real depreciation requirements because of the undervaluation of assets and the fact that depreciation periods are not in line with best practice (table 7.6). Depreciating against replacement value would require much higher depreciation payments and has not been included here.

TABLE 7.5 Current and Required Maintenance Costs
Jordanian dinar, thousands

Indicator	2010	2012	GTZ study 1993 prices	GTZ study adjusted for 2012
Maintenance for irrigation infrastructure	283	44	1,406	2,410
Maintenance for equipment	615	596	277	763
Maintenance for assets not directly linked to irrigation water infrastructure	n.a.	n.a.	n.a.	n.a.
Maintenance in capital budget of JVA	4,201	5,490	n.a.	n.a.
Total	5,099	6,130	n.a.	3,821

Source: JVA.
Note: n.a. = not available.

TABLE 7.6 Depreciation of JVA in 2010 Prices
Jordanian dinar, thousands

Indicator	Asset base	Depreciation	Depreciation period (years)
Assets related exclusively to water activities			
Dams	274,049	5,481	50
Irrigation systems	35,682	1,427	25
Assets related shared with other JVA activities			
Construction and buildings	13,627	545	25
Furniture – office equipment	26	5	5
Tools and equipment	31,994	6,399	5
Information systems	335	67	5
Vehicles	1,007	201	5
Total	356,720	14,126	

Source: JVA.

Summary of Operation and Maintenance Requirements

Table 7.7 shows that the actual cost requirements are significantly higher than the current costs the JVA registers today. In the table, we assume that the steep increase in salary costs in the JVA in 2012 is structural and that staff costs will increase by 3 percent in 2013. We assume for the remaining costs—electricity and fuel—that they will increase due to electricity price increases. In addition, we assume that maintenance costs will need to increase to a level that allows for a more sustainable use of resources. The cost allocation between the different users is based on current billed volume of water of the last three years.

Conclusions

The analysis shows that O&M requirements are significantly higher than what is currently set aside for the sector through the government's budget and the revenue flow from the JVA (by charging farmers and industry for

TABLE 7.7 Summary of Required Operation and Maintenance Costs for Irrigation Water, 2013 (2013 Electricity Price Rates)
Jordanian dinar, thousands

Expense category	O&M cost TOTAL	O&M cost INDUSTRY	O&M cost IRRIGATION	O&M cost PUMPING
Total staff costs	9,225	148	6,098	2,980
Electricity	3,826	134	3,692	
Pumping costs	6,527			6,527
Fuel	1,226	43	1,183	
Total energy cost	*12,581*	*177*	*4,875*	*6,527*
Maintenance of assets not related to irrigation	1,411	22	932	453
Maintenance of irrigation equipment	2,410		2,410	
Total maintenance costs	*3,821*	*22*	*3,574*	*453*
Other expenditure	1,500	24	992	485
Total operating expenses of JVA before depreciation	***26,125***	***371***	***15,307***	***10,445***
Depreciation	*14,126*	*226*	*9,377*	*4,520*
Total operating expenses of JVA after depreciation	***40,251***	***597***	***24,604***	***14,965***
Total billed water volume (million m^3)	145	5	141	86
Total required O&M costs *without industrial cross-subsidies* on current billed volume	0.179	0.071	0.109	0.121
Total required O&M costs *with industrial cross-subsidies* on current billed volume	0.135	1.25	0.066	0.121
Total required O&M costs plus depreciation cost (on historical asset cost base) *without industrial cross-subsidies*	0.28	0.11	0.17	0.17
Total required O&M costs plus depreciation cost (on historical asset cost base) *with industrial cross-subsidies*	0.23	1.25	0.13	0.17

Source: Calculations based on information from the Finance Department and Control Center.
Note: Cross-subsidies are assumed to move from industry water users to irrigation water users.

water provided). The postponement of investments in the last decade and increasing energy costs, in combination with new responsibilities regarding the pumping of water to Amman, are resulting in a minimum required O&M cost of JD 26 million (compared to an actual amount in 2012 that was less than JD 16 million [both figures excluding depreciation]).

Improvements in billing and collection are likely to generate more revenues for the JVA, but these will not be sufficient to cover the O&M cost shortfall without resorting to either tariff increases, increases in government subsidies, or both. This is especially true since the JVA currently bills on the basis of quota allocations, whereas actual water supplied is lower. Hence, unless the government decides to pay for these increasing operating losses in full, tariff increases will be necessary to ensure JVA's financial sustainability.

Notes

1. It is estimated that the volume of wastewater the JVA receives is about 89 million cubic meters per year.
2. This assumes that each cubic meter of water pumped requires 1 kWh of energy. With the altitude differences that must be covered, it is likely that the real cost to the JVA is higher.

Chapter 8

Proposed Tariff and Cost Recovery

Concepts of Cost Recovery

The costs associated with the construction of water supply and wastewater infrastructure and its operation and maintenance (O&M) can include both financial and economic costs.

Financial costs are directly associated with the provision of water services by the agency, in this case the Jordan Valley Authority (JVA), and include O&M costs to fund the daily operations of the infrastructure; capital costs, which cover the capital for the renewal of existing infrastructure (depreciation); and the capital needed for expansion of the service.

Economic costs are the financial costs of the service and any externalities related to the environment or the resource costs and benefits of water,[1] whereas the financial costs for service provision are adjusted for price distortions and transfer payments. The economic costs of the service reflect the costs of providing the service for society.

What constitutes full cost recovery can vary widely. When financial sustainability is the major concern, the recovery of the financial cost is important. However, full cost recovery can also include the economic costs of services, including the pricing of externalities. Paying for the full cost of irrigation water services is difficult regardless of the objective being pursued. This is because the value that users attach to water services is not necessarily equal to the cost of these services. The results of this mismatch between private benefits and social costs is chronic underinvestment in the water sector and inadequate maintenance, which together result in the provision of low-quality services, resulting in users not willing to pay for these services. This results in a downward cycle of low collection efficiencies that result in agencies not generating sufficient funds to undertake adequate maintenance, let alone expansion.

Achieving full cost recovery solely through water tariffs has proved to be elusive even in many developed countries. In many countries, water tariffs are low. Increasing these rates to full cost recovery levels will require huge tariff increases that are often politically difficult to attain because there is a general concern that full cost recovery rates will clash with the need for affordability of services, and will therefore not enable the poor to access these basic services. Nonetheless, evidence has shown that subsidies are often not well targeted and hence not effective in reaching the poor.

To achieve financial sustainability, the tariff should be fixed at such a level that all cash flow needs can be met, which in the case of the JVA is likely to require at least coverage of direct O&M costs and depreciation funds and, where possible, a contribution to future capital requirements by collected revenues.

Yet, because the current tariff levels are so low, it is likely that moving to a tariff system that covers basic cash flow needs will require a phased approach before that goal can be attained.

Scenario Analysis

Currently, there are three different tariffs: for irrigation water, for industrial water, and for water for pumping. We make the following assumptions in our analysis: (a) water for pumping is priced against cost price, with the total O&M costs for water pumping consisting of staff costs, energy costs, and maintenance costs allocated on the basis of water volume consumed or pumped; (b) water for pumping will be fully paid for by either the government or water consumers in the cities served by the JVA's raw water; (c) industrial water is priced against the current rate of JD 1.25 per cubic meters[2]; and (d) cross-subsidies are in place, with industrial water users cross-subsidizing water for irrigation.

The following scenarios will be tested. In all scenarios, it is assumed that the costs of water pumping will be fully paid for by the service providers benefiting from these services. All three scenarios are measured in constant 2013 prices.

Base Case Scenario: Actual O&M Cost Scenario. This includes the current O&M cost based on actual cost in 2013 prices allocated between industrial and irrigation water use.

Scenario I: Optimized O&M Cost Scenario. This is based on the funds required to operate the JVA in such a manner that all assets are operated and maintained according to good practice. This scenario assumes that (a) the electricity prices are at actual cost in 2013; (b) the costs are allocated among three user categories: industry, irrigation, and water pumping; and (c) a cross-subsidy policy is in place for the industry that subsidizes farmers' water use.

Scenario II: Sustainable O&M Cost Scenario based on billed quota allocations. In this scenario, we include the optimized O&M cost plus depreciation, and (a) depreciation is based on full historical costs; (b) the electricity prices are at actual cost in 2013; (c) the costs are allocated among three user categories: industry, irrigation, and water pumping; (d) the practice of billing on quota allocations remains in place; and (e) a cross-subsidy policy is in place for the industry that subsidizes farmers' water use.

Scenario III: Sustainable O&M Cost Scenario based on billed volumes on effective use. In this scenario, we include the optimized O&M cost plus depreciation, and (a) depreciation is based on full historical costs; (b) the costs are allocated among three user categories: industry, irrigation, and water pumping; (c) electricity prices are expected to increase to JD 0.133 per kilowatt hour by 2017; (d) the practice of billing on quota allocations is changed in favor of a tariff system, where actual consumption volumes are charged; and (e) a cross-subsidy policy is in place for the industry that subsidizes farmers' water use.

Table 8.1 provides details on the three scenarios.

The costs of providing irrigation water (depending on the scenario) under the three scenarios range from JD 0.033 to JD 0.343 per m^3 in 2013, assuming that the electricity rates will be significantly increased, cross-subsidies from industry will help alleviate the impact on farmers, pumping costs are paid for by those who benefit from them (Amman water users), and the JVA will continue to charge on billed volume (not actual volume).

Currently, the most important source of revenues for the JVA is industrial water revenues, which generated more revenues in 2012 than it received for irrigation water, while industrial water use is just a fraction of total water use. In 2012, industrial water revenues constituted 71 percent of total revenues while supplying only 2 to 3 percent of the total water volume consumed. In view of the high price of industrial water and the normally observed high price elasticity of industrial water users, the scope for the JVA to charge industrial water users significantly more in the future may be limited.

Table 8.1 shows that the costs of providing irrigation water are significantly higher than what is currently charged (an estimated average of JD 0.011 per cubic meter). If the JVA were to charge farmers against water consumed instead of the quota allocations, irrigation water rates would have to be increased even more. In fact, actual irrigation water tariffs should be significantly higher, since currently (as shown in Chapter 5), billing and collection efficiencies are at 82 percent and 75 percent, respectively. If these efficiencies do not improve, then the actual required tariffs will be significantly higher and would increase to JD 0.343 per cubic meter.

TABLE 8.1 Required Irrigation Tariff Increases under Different Scenarios with Current Billed Volume

Expense category	Current O&M cost (3-year average 2010–12)	Scenario I: O&M and 2013 electricity prices	Scenario II: O&M plus depreciation and 2013 electricity prices	Scenario III: O&M plus depreciation against 2017 electricity price	Scenario III: O&M plus depreciation against 2017 electricity price
Total staff costs	6,098	6,098	6,098	6,098	6,098
Electricity	2,025	3,692	3,692	6,470	6,470
Fuel	709	1,183	1,183	2,182	2,182
Total energy cost	*2,734*	*4,875*	*4,875*	*8,652*	*8,652*
Maintenance of assets not related to irrigation	100	932	932	932	932
Maintenance of irrigation equipment	44	2,410	2,410	2,410	2,410
Total maintenance costs	*144*	*3,342*	*3,342*	*3,342*	*3,342*
Other expenditure	202	992	992	992	992
Total operating expenses JVA before depreciation	*9,178*	*15,307*	*15,307*	*19,083*	*19,083*
Depreciation	n.a.	n.a.	*9,337*	*9,337*	*9,337*
Total operating expenses JVA after depreciation	n.a.	n.a.	*24,644*	*28,905*	*28,905*

table continues next page

TABLE 8.1 *continued*

Expense category	Current O&M cost (3-year average 2010–12)	Scenario I: O&M and 2013 electricity prices	Scenario II: O&M plus depreciation and 2013 electricity prices	Scenario III: O&M plus depreciation against 2017 electricity price	Scenario III: O&M plus depreciation against 2017 electricity price
Total billed water volume (million m^3) based on quota allocation	141	141	141	141	n.a.
Total billed water volume (million m^3) based on actual water supplied	n.a.	n.a.	n.a.	n.a.	108
Total cost (in JD per m^3) on basis of quota (or actual) volume (with cross-subsidies)					
100% billing and collection efficiency	0.033	0.066	0.132	0.162	0.211
Current billing and collection efficiency	0.054	0.108	0.215	0.263	0.343

Source: Calculations based on information from the JVA Finance Department.
Note: Industrial water revenues have been assumed to be constant over the period. The reason behind this assumption is that industrial water consumption fluctuates heavily over the years, as do revenues. Since industrial water use tends to be more price elastic than that of irrigation water or water supply, we have assumed most increases in prices will be offset by declines in consumption.
n.a. = not applicable.

Sensitivity and Risk Analysis

The results obtained so far assume that all variables are at current levels of efficiency. We see different inefficiencies such as energy inefficiency, maintenance inefficiency, staff productivity challenges, low billing efficiency, and low collection efficiency.

Results of the analysis, presented in table 8.2, show that the required tariff increases are sensitive to efficiency improvements, most notably changes in billing and collection efficiency. If all farmers who use JVA water paid for it, the O&M costs per unit of water billed would decrease significantly. Other efficiency improvements can reduce energy, maintenance, and staff costs, but the effect is less significant. However, the analysis shows that efficiency improvements alone will not be sufficient to put the JVA on a path of financial viability. Therefore, tariff increases will be needed.

This is even more pertinent since there are more downward than upward risks to consider. There is considerable room to improve efficiencies in the JVA, especially regarding billing and collection efficiencies, and to a lesser extent, energy efficiency. A combination of different efficiency improvements will enable JVA to dampen the effect of irrigation tariffs significantly.

Figures 8.1 and 8.2 show the most likely tariff required if the JVA were able to improve its efficiency while maintaining the use of quota allocations. When we run a risk analysis, assuming cross-subsidies, the effect of efficiency improvements is significant. Without efficiency improvements, the required

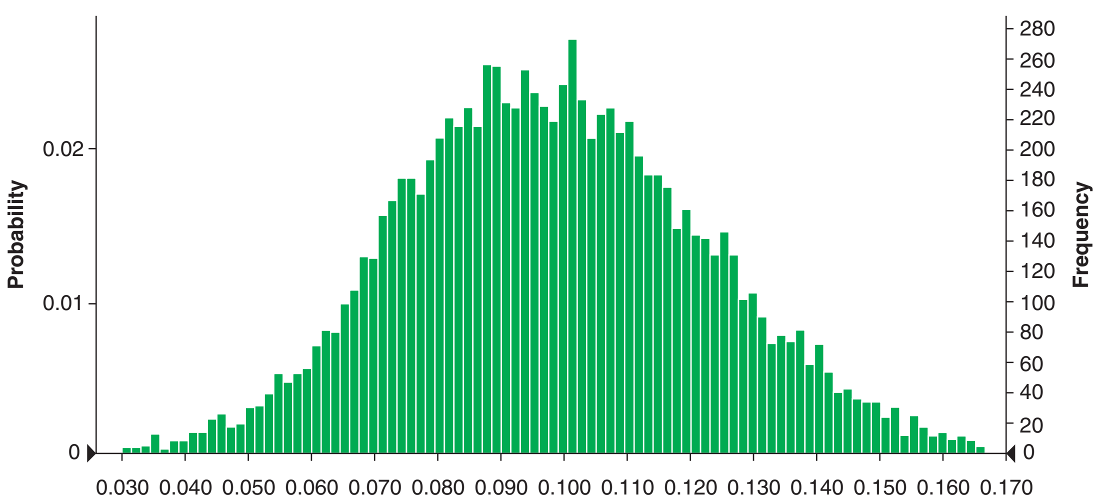
TABLE 8.2 Sensitivity Analysis of Irrigation Costs to Be Covered with Full Electricity Rate Increase (in 2013 Prices)

Expense category	Scenario I: Required O&M cost	Scenario II: Required sustainability cost based on quota allocations at 2013 electricity prices	Scenario III: Required sustainability cost based on quota allocations at 2017 electricity prices
Base case with current inefficiencies and no cross-subsidies	0.108	0.215	0.343
Energy efficiency improvement with 25%	0.093	0.201	0.318
Maintenance efficiency with 25%	0.098	0.206	0.321
Staff productivity improvements with 25%	0.090	0.197	0.32
Improvements in billing efficiency to 100%	0.088	0.177	0.282
Improvements in collection efficiency to 100%	0.071	0.161	0.258
Improvements in billing and collection efficiency to 100%	0.066	0.132	0.211

Source: Calculations based on information from the JVA Finance Department.

FIGURE 8.1 Risk Analysis of Irrigation Operation and Maintenance Cost Based on Quota Allocations with 2013 Electricity Price

Jordanian dinar per m³



tariff to cover O&M costs, at 2017 electricity prices, would be JD 0.203 per cubic meter. Yet, when we include a combination of different efficiency improvements, the median required O&M tariff increase could drop to JD 0.09 per cubic meter, and the tariff to cover O&M and depreciation could drop from JD 0.343 to JD 0.196 per cubic meter if these efficiencies were implemented.

FIGURE 8.2 Risk Analysis of Irrigation and Operation and Maintenance and Depreciation Cost Based on Quota Allocations with 2017 Electricity Price

Jordanian dinar per m³

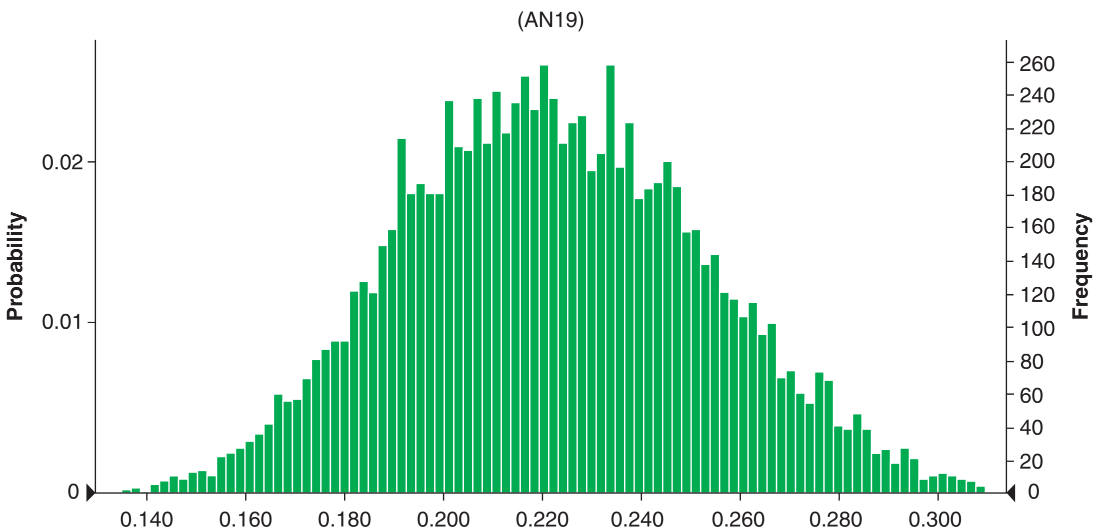


TABLE 8.3 Irrigation Water Prices, Jordan Compared with Selected Countries

Country	Tariff system	Year
Jordan (2013 energy price increase, with cross-subsidies,100% billing and collection efficiency)	Current irrigation tariff: US$0.011 Tariff under Scenario I: US$0.066 (O&M cost) Tariff under Scenario II: US$0.132 (full cost)	2013
Jordan (2017 energy price increase, with cross-subsidies, 100% billing and collection efficiency)	Current irrigation tariff: US$0.011 Tariff under Scenario III: US$0.211 (full cost)	2017 in 2013 prices
France	Average irrigation water prices in Province US$0.14 –US$0.36 per cubic meter	2012
Israel	Average irrigation water tariffs US$0.55–US$0.78 (agricultural water tariff) US$0.27 (for saline and treated wastewater used in agriculture)	2013
Italy	Average irrigation water tariff (made up of a fixed charge per hectare and a charge per cubic meter) Average fixed charge; US$88–US$230 per hectare Average charge per cubic meter: US$0.15–US$2.03	2012
Spain	Average charge per cubic meter: Segura basin – US$0.04 (surface water or treated wastewater) – US$0.58 (desalinated water) Castilla-Mancha – US$0.19	2012

Source: Dinar, Pochat, and Albiac-Murillo 2015.

Benchmarking Jordanian Irrigation Tariffs

Table 8.3 compares the tariff scenarios in Jordan, discussed above, with those in selected countries. Despite much effort to collect data on irrigation water tariffs, very little updated information is available. The Food and Agriculture Organization published an assessment in 2002, but this information has not been updated. We rely mainly on Dinar, Pochat, and Albiac-Murillo (2015) for some data on irrigation water tariffs, although even in that publication, there are far fewer data on irrigation prices than on drinking water and wastewater tariffs. In addition, the data in that publication are mostly limited to developed countries.

Conclusions

The analysis above shows that the JVA needs significant tariff increases (and/or government subsidies) to achieve financial sustainability. Depending on the level of cost recovery, the minimum required tariff increases are going to be very large, assuming that the cross-subsidy policy of today is continued, and government subsidies are not going to be increased. However, the rates that would be charged would not be very high compared to available international benchmarks.

The most important measures the JVA could take to limit the increase in tariffs would be to increase billing and collection efficiency and ensure that all farmers who use JVA water pay for the service. Other measures, such as improved energy efficiency and cost efficiency, would also offer opportunities to reduce tariff requirements, but would have less impact than improving billing and collection efficiency.

In view of the many uncertainties, including changes in energy subsidies currently extended to the water sector, the upward risk for further O&M cost increases seem higher than the downward risks. Although the tariffs are much higher than the current irrigation water tariffs, a quick comparison with other countries shows that the proposed tariff scenarios are not completely out of line with those in countries that have pursued a more efficient allocation of water resources. Still, it also shows that the JVA will have to lay out a roadmap for tariff increases that is accompanied by efficiency improvements and other measures to make farmers aware of the required tariff increases and, where possible, provide assistance to help them make the transition to higher tariffs.

Notes

1. Some argue that the cost of regulation and other forms of administration should also be included in the full cost of water services.
2. It is assumed that industry in the area served by the JVA will pay the JVA's water rates unless the cost of self-provisioning is lower than the rates that the JVA charges.

Chapter 9

Impact of Cost Recovery on Farm Incomes

To assess the effects of changes in tariffs on farmers' incomes in the Jordan Valley, farm models were constructed based on observed cropping patterns. The impact of the different cost recovery tariffs on crop production costs and farmers' net revenues will be calculated.

Farm Models

Eight broad farm-type systems prevail in the Jordan Valley. Their distribution, as discussed in Chapter 5, is as follows: citrus farms with surface irrigation, citrus farms with drip irrigation, vegetables – open field, vegetables – greenhouses, vegetables combining open field and greenhouses, banana farms, dates, and mixed farming. For more details on the farm models, see appendix C.

Apart from the production systems listed above, field crops and other fruit trees constitute additional cropping patterns practiced in the Jordan Valley, under mixed farming conditions in the same farm together with the other predominant crops. In 2010, about 337,000 dunum were cultivated in the Jordan Valley, with an irrigation intensity of 99 percent (which remained quite stable during 2005–10).

Effect of Tariffs on Farm Incomes

Current Farm Incomes

Yield outputs are derived using surveys based on discussions with primary informants and cross-checked with relevant secondary and other professional sources (such as the Ministry of Agriculture, the National Center for Agricultural Research and Extension, the Agriculture Credit Corporation, and the private sector). Output farm gate prices are derived from multiple primary informants. Sensitivity simulations have been attempted by using the Department of Statistics' average 2010 prices and by referring to FOB prices[1] deducting marketing costs[2] or by considering whichever best price is obtainable by the producers. Detailed crop budgets are presented in appendix C.

The effect of water tariffs is not negligible, but since many farmers in the Jordan Valley are already suffering losses on the basis of current market prices, they are often not able to generate sufficient revenues to offset their production costs. Other than farmers who grow dates, none of the farmers are able to generate profits (excluding numerations for labor and management). Even farmers using greenhouse technologies are barely able to produce positive net returns. Yet, when producer prices increase, the effect of a change in irrigation water tariffs can mostly be easily offset. The Jordan Valley is struggling with its profitability due to the political conflict in Syria, which has an adverse impact on farmers' ability to sell their produce outside the country.

An attempt has been made to project the economics of the above-described production systems for the entire Jordan Valley (see tables 9.1 and 9.2), based on their respective frequency and proportion, as pointed out by the World-Bank commissioned 2012 survey.[3] To that end, only two scenarios have been used for calculations. The first scenario uses current market prices, and the second scenario uses free-on-board (FOB) or best market prices.

With current irrigation water tariffs, and under current market prices, farmers in the Jordan Valley suffer losses of about JD 13 million per year. If producers are able to fetch best market prices and conditions, the farmers in

TABLE 9.1 Jordan Valley—Simulation at Current Market Prices
Jordanian dinar, millions

Indicator	Vegetables (open field)	Vegetables (greenhouse)	Vegetables mix (open field and greenhouse)	Dates (open field)	Citrus surface	Citrus drip	Banana
Planted area (dunum)	116,310	41,427	39,389	10,101	32,925	32,925	18,434
Analysis of financial performance of planted area in the Jordan Valley							
Revenue	197	130	95	30	12	25	32
Total costs	222	128	99	15	20	26	23
Net revenue	–25	2	–4	15	–8	–1	9
Summary of financial performance of total planted area							
Total revenues				521			
Total costs				534			
Net returns				–13			
Net returns				–2.4%			

TABLE 9.2 Jordan Valley—Simulation at Best Market Prices
Jordanian dinar, millions

Indicator	Vegetables OF	Vegetables GH	Vegetables mix OF and GH	Dates (OF)	Citrus surface	Citrus drip	Banana
Planted area (dunum)	116,310	41,427	39,389	10,101	32,925	32,925	18,434
Analysis of Financial Performance of Planted Area in the Jordan Valley							
Revenue	248	231	152	73	32	64	32
Total costs	222	128	99	15	20	26	23
Net revenue	26	102	53	58	12	38	9
Net revenue							
Summary of Financial Performance of Total Planted Area							
Total revenues				829			
Total costs				534			
Net returns				296			
Net returns				55.5%			

Note: OF = open field; GH = greenhouse.

the Jordan Valley are able to consolidate a net gain of about JD 296 million per year using current irrigation water tariffs based on about 300,000 dunum of planted area under irrigation. In either case, water costs make up no more than 0.3 percent of the total costs farmers incur to produce their crops. It shows that banana—a heavily sheltered crop due to import bans—is the most productive crop in the Jordan Valley. The production of dates, a crop recently introduced in the Valley, requires the trees to mature to generate positive net returns. Vegetables are not very profitable as measured by net revenues, although vegetables grown in greenhouses yield better net revenues than those grown in open fields.

Farm Incomes under Different Cost Recovery Scenarios

The impact of the different cost recovery scenarios are calculated for the different farm models. We apply the three different tariffs to the different farm models based on 2013 prices, and calculate for each the effect on net revenues for farmers and the change in water costs. Note that this is a static analysis since it is likely that when the cost structure of the farmers' uses, changes in cropping patterns can be expected. Because of the change in cost structure, farmers may decide to change the crops they cultivate in the medium to long term.

As can be seen in tables 9.3 and 9.4, the effect of producer prices is significant. If farmer prices are high, the effect of any increases in irrigation water tariffs is negligible. Water productivity, measured as the water used per gross

TABLE 9.3 Net Farm Incomes under Different Irrigation Tariffs at Current Market Prices

	Net returns (JD, millions)	Net returns as % of total costs	Water costs as % of total costs
Current irrigation water tariff	–13	–2.4	0.3
Scenario I (JD 0.066)	–19	–3.6	1.8
Scenario II (JD 0.132)	–29	–5.3	3.6
Scenario III (JD 0.162)	–34	–6.1	4.3

Note: These scenarios are based on 100 percent billing and collection efficiencies.

TABLE 9.4 Net Farm Incomes under Different Irrigation Tariffs at Best Market Prices under Different Cost Recovery Scenarios

Price of irrigation water	Net returns (JD, millions)	Net returns as % of total costs	Water costs as % of total costs
Current irrigation water tariff	298	55.5	0.3
Scenario I (JD 0.066)	289	53.6	1.8
Scenario II (JD 0.132)	280	50.8	3.6
Scenario III (JD 0.162)	275	49.5	4.3

Note: These scenarios are based on 100 percent billing and collection efficiencies.

TABLE 9.5 Water Costs as a Percentage of Total Costs, by Major Crop under Different Cost Recovery Scenarios

Crop	Current water tariff	Scenario I	Scenario II	Scenario III
Vegetables, open field	0.2	1.2	2.4	3.0
Vegetables, greenhouse	0.1	0.8	1.5	1.8
Vegetables mix	0.2	0.9	1.9	2.3
Dates	0.3	1.6	3.1	3.8
Citrus surface	1.4	7.7	14.3	17.0
Citrus drip	1.1	6.0	11.4	13.6
Banana	1.1	6.3	11.9	14.2

crop revenue under current survey prices, is highest for vegetables grown in greenhouses (JD 8.74 per cubic meter of water), followed by dates (JD 8.15), and then vegetables (mixed: JD 6.72), and open field vegetables (JD 4.71). Banana (JD 1.36, supported by an import ban), citrus drip (JD 1.00), and citrus surface (JD 0.49) show much lower levels of water productivity. It is likely that farmers will be more driven by net revenues; hence, the importance of supporting measures that will increase revenues or decrease costs. Banana's water productivity is low, but it is an attractive crop for farmers in terms of net revenues. Vegetables grown in greenhouses generate much higher levels of water productivity, but with the currently low survey crop prices and high costs, are not necessarily producing as much net revenues for farmers as banana.

Table 9.5 shows how total water costs are affected by irrigation water tariff increases in the farmers' total cost of crop production. It is not surprising that high-volume water crops such as banana and citrus are most affected by any changes in water tariffs. In the case of banana and citrus crops that are irrigated by surface techniques, the farmers' outlay for irrigation water will increase significantly. However, for most other crops, the effect of increases in the irrigation water tariff will be relatively limited.

Effect of Cost Recovery Scenarios for Poor Farmers

Profile of poor farmers. The survey conducted during December 2011–January 2012 defined poor farmers as those who rated their family as income-poor (Q6.6), which 39 farmers overall did (17 percent of the sample). About 56 percent of these poor farmers live in Karamah (while this region represents 31 percent of the full sample of surveyed farmers). Poor farmers are less likely to live in the Middle Ghors; 8 percent of the poor live in this region (while 33 percent of surveyed farmers in the full sample live in this region) (table 9.6).

About 67 percent of the poor farmers run family farms and 33 percent run entrepreneurial farms, compared to the full sample, in which 41 percent of the farmers run family farms and 59 percent run entrepreneurial farms. The poor farmers experience more water scarcity problems in general and tend to be

TABLE 9.6 Location of Poor Farmers in the Jordan Valley

Region	Full sample		Poor farmers	
	Frequency	Percent	Frequency	Percent
Northern Ghors	49	21	8	21
Middle Ghors	77	33	3	8
Karamah	74	31	22	56
Southern Ghors	36	15	6	15
Total	236	100	39	100

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.

TABLE 9.7 Profile of Poor Farmers

Indicator	Poor farmers Mean (*median*)	Nonpoor farmers Mean (*median*)	Mean test (significance)[a]
Number of farmers	39	197	n.a.
Farm size (dunum)	43 (*34*)	66 (*35*)	n.s.
Irrigated area (dunum)	37 (*30*)	38 (*32*)	n.s.
Share of irrigated area (%)	89 (*100*)	85 (*100*)	n.s.
Distance to the water source (m)[b]	119 (*50*)	142 (*50*)	n.s.
Estimated water use (m^3/year)	12,252 (*10,109*)	15,648 (*13,478*)	n.s.
Estimated per dunum water use (m^3/year)[c]	340 (*300*)	485 (*389*)	n.s.
Income category	1.15 (*1*)	2.54 (*2*)	(***)
Expenditures (JD/year)	6,760 (*3,525*)	16,343 (*9,550*)	(**)
Per dunum expenditures (JD/year/dunum)	205 (*106*)	395 (*236*)	(*)
Crop revenues (JD/year)	16,553 (*14,270*)	30,598 (*16,800*)	(*)
Per dunum crop revenues (JD/year/dunum)	487 (*376*)	666 (*409*)	n.s.
Crop net revenues (JD/year)	6,674 (*6,666*)	15,001 (*7,000*)	n.s.
Per dunum crop net revenues (JD/year/dunum)	212 (*169*)	295 (*156*)	n.s.
Open field method exclusively (%)	92	65	(***)
Open field method in combination (%)	95	82	(**)
Drip irrigation exclusively (%)	85	81	n.s.
Drip irrigation in combination (%)	85	85	n.s.
Vegetables as main crop[d] (%)	64	66	n.s.
Banana as main crop[d] (%)	18	5	(***)
Citrus as main crop[d] (%)	15	17	n.s.
Farm value (JD/m^2)	238 (*200*)	344 (*200*)	n.s.

Source: Survey for the "The Cost of Irrigation Water in the Jordan Valley" study.
Note: n.a. = not applicable; a. n.s., *, **, *** = not significant, significant at the 10% level, 5% level, and 1% level, respectively.
b. The average distance to the water source is calculated from answers to Q3.2. We take the middle point of each interval and the lower bound for the last interval ("more than 4 km"). A number of farmers did not answer this question. c. Calculated from answers to questions Q3.7. d. Obtained from answers to question Q4.1.

mostly located in the Karamah area. About 62 percent of the poor farmers—compared to 39 percent of the nonpoor farmers—consider "access to water for crops" to be the most important problem the government should solve.

Table 9.7 reports some average (and median) characteristics for poor farmers (column 2) and nonpoor farmers (column 3). Poor farmers are more likely to use open field methods (either exclusively or in combination with other methods) and grow banana than nonpoor farmers.

Notes

1. 2012 Global Trade Information Services, Inc.
2. Department of Statistics.
3. The World-Bank commissioned 2012 survey under the "The Cost of Irrigation Water in the Jordan Valley" study.

Chapter 10

Conclusions

The analysis in the previous chapters reveals that the Jordan Valley Authority (JVA) is unable to cover its basic operation and maintenance (O&M) costs from the revenues it generates. In the last two decades, the JVA has been unable to adjust its irrigation water tariffs at all, so they have remained unchanged since 1994, whereas expenditures have increased. In 2012, the JVA's O&M deficit amounted to more than JD 6 million, equivalent to about 40 percent of total recurrent expenditures. The large operating deficits within the context of increasingly aging infrastructure will and may already affect the quality of the service provided (the decline in billing and collection efficiency may reflect that the quality of the service is already being affected), whereas it also results in a crowding out of investment programs (increasingly diverting capital funding to pay for operational losses). Hence, the risks are increasing that the current irrigation water infrastructure is increasingly being compromised.

For the JVA, an eroding flow of revenues has resulted in an agency that has become increasingly dependent on government transfers as O&M needs have increased. The JVA has tried to deal with its lack of revenues while being faced with increasing O&M costs by selling land assets and postponing maintenance of its infrastructure assets, while using a more aggressive cross-subsidy policy. However, these interventions have their limits: the income from land sales is declining rapidly. The current cross-subsidy rate between industry and irrigation water is huge (average water tariffs of JD 1.25 and JD 0.011, respectively). Despite a rapid increase in revenues from industry, the price elasticity of demand suggests there are limits to using this tool much longer. Postponing maintenance is also a strategy with limited validity, since lack of maintenance tends to compromise the ability of infrastructure assets to provide reliable service to farmers and industry.

The financial viability of the JVA can be improved by increasing revenues, decreasing O&M costs, or both. There are several paths open to the JVA to improve its financial and operational performance through increasing revenues while reducing the costs of service delivery so as to improve O&M cost recovery in the JVA. While the JVA aims to increase revenues, it also has room to reduce its chronic inefficiencies. The most important potential efficiency gains are related to staff employment, maintenance, and energy use in the JVA.

Improving Revenues

Irrigation tariff increases. The analysis shows that the JVA needs significant tariff increases to become financially sustainable. Depending on the level of cost recovery, the minimum required tariff increases for irrigation water could be very large. If the JVA wants to at least cover its O&M costs in 2013, it will require—assuming that the current cross-subsidies are maintained and JVA will be able to achieve 100 percent billing and collection efficiencies—a tariff of JD 0.066 per cubic meter. If the government wants to pursue its objective as stated in the 2009 Water Strategy that depreciation should also be covered, the irrigation water tariff must be increased to JD 0.132 per cubic meter. If the electricity subsidies for water operators are eliminated by 2017, irrigation water tariffs must be further increased to JD 0.162 per cubic meter to cover JVA's operation and maintenance. Although the proposed tariffs are much higher than tariffs currently in place, a quick comparison with other countries shows that the proposed tariff levels are similar to those of other countries for which data are available. Yet, the tariff increases necessary to ensure JVA's financial viability are large, especially compared to current irrigation water tariffs, which have not been changed since 1994, and will require time to implement.

The more efficient the JVA becomes in providing the service, the lower will be the required tariff increases. The JVA has several routes to improving its efficiency.

Improvement of Billing and Collection Efficiencies. The farmer survey found that only 82 percent of farmers are actually billed for their water use. Of the farmers that are billed, revenue collection is only 75 percent. Hence, by improving efficiencies in revenue billing and collection, the JVA could increase its irrigation revenues by more than 60 percent. It is the improvement in efficiencies that will most effectively reduce the size of the required tariff increases. With current billing and collection efficiencies, the required tariff to cover O&M costs with 2013 electricity prices will be JD 0.108 per cubic meter; with 100 percent billing and collection efficiency, the tariff drops to JD 0.066 per cubic meter. Improvements in billing and collection efficiencies will also improve fairness of the system, because all who use the irrigation infrastructure will pay for it. With higher tariffs, the fairness of the system becomes significantly compromised if a large group of farmers are exempted from paying irrigation water tariffs.

Change in billing practices. The JVA currently bills farmers on the basis of quota allocations, whereas actual water supplied to farmers is often significantly lower. It is likely that under a new tariff regime, farmers may not be willing to pay for quota allocations they do not receive. There are many methods to measure and charge for actual water volumes used. Although new technologies play a role, it is important not to neglect the institutional component of improved billing practices. In 16 of the 20 registered water user associations (WUAs), responsibility for the distribution of irrigation water has been handed over to these associations. The WUAs could be put in charge of billing and collecting from farmers, use the funds to pay for their operations, and hand over any surpluses to the JVA. Where needed, the WUAs could implement awareness programs that aim to ensure that all farmers who use irrigation water pay for the water they use.

Change in the ability of the JVA and WUAs to retain their revenues. The JVA is a ministerial department that collects revenues but which then transfers the revenues to the Treasury. To ensure that the JVA has incentives to improve its billing and collection capacity, redirection of the revenue flow from the Treasury to the JVA and WUAs could provide better incentives to bill and collect tariffs from farmers. This may require the JVA to change its status to one similar to that of the Water Authority of Jordan.

Increasing Efficiency in Service Delivery

Irrigation tariff increases and other measures aimed at increasing the revenue-generating capacity of the JVA will improve its financial sustainability. Yet, efficiency improvements in the JVA through increasing energy efficiency, improvements in staff productivity, development of asset management, and staff productivity increases can further help generate (future) cost savings and reduce the size of the irrigation water tariffs.

Improvements in Energy Efficiency. Energy makes up a significant part of the O&M costs of the JVA. With the dismantling of energy subsidies, and the resulting increases in energy and electricity prices, the JVA is faced with increasingly higher energy costs. Due to Jordan's topography, water often has to be pumped over large distances and lifted to overcome altitude differences, which has made the water sector the largest electricity consumer in the country. More efficient electricity consumption is essential to improve the financial performance of the JVA and should be a priority in its capital investment program, especially since the water infrastructure managed by the JVA is reaching or has reached the end of its economic life. The government's effort to use energy more efficiently will have a positive impact on cost recovery in the JVA, but will also reduce the carbon footprint of the JVA by reducing emissions, while making the JVA less vulnerable to the volatility of energy prices.

The development and implementation of an asset management plan for the JVA. Linked to the above-mentioned need for energy efficiency improvements and a corresponding capital budget program, the JVA needs to develop and implement an asset management plan. An asset management plan helps the JVA, manage its infrastructure capital assets in such a way that it minimizes the total cost while providing the optimum level of water services. A high-performing asset management program incorporates detailed asset inventories, operation and maintenance tasks, and long-term financial planning to develop and maintain JVA assets. Such a plan can help extend asset life and assist in rehabilitation, repair, and replacement decisions through efficient and focused operation and maintenance, and improve the security and safety of assets, while reducing the overall costs for operations, maintenance, and capital expenditures.

JVA's role to change into bulk water supplier. In recent years, the JVA's mandate has been extended to also pump water to Amman. This additional mandate has not been guided by explicit agreements about who pays the costs for this service, or what costs are actually involved in pumping water to Amman. It is implicitly agreed that the JVA receives treated wastewater in return for pumping water to Amman, but it is not clear whether the costs associated with water pumping (especially with lower energy subsidies) are covering the cost of additional wastewater to be provided by the JVA. In 2012, water pumping costs amounted to JD 2.7 million (located in the capital budget)—making up 18 percent of total operating costs. The government should ensure that explicit agreements are reached about the costs of water pumping to Amman. With the increased importance of water pumping, the JVA is moving more into the direction of becoming a bulk water supplier. This move toward becoming a bulk water supplier would also explicitly recognize the increased role of water user associations in the maintenance of the distribution systems.

Impact of Tariff Increases on Poor Farmers

The impact of the tariff increases on farmers' incomes is in general moderate, because water costs make up only a small part of the total cost of farming. Yet, as can be expected, certain cropping patterns will be much more affected by the tariff increases than others. It is especially crops that tend to consume large volumes of water (citrus and banana), that will feel the impact of the irrigation water tariffs. According to the cropping pattern simulations, citrus is not a crop that generates profits even now, with very low irrigation water tariffs. Increasing tariffs will make these crops even more economically unviable to grow, as has begun to show in the declining citrus production and, more recently, the decline in cultivated area. In the case of banana, which benefits from import restrictions, only very large tariff increases (above JD 0.26 per cubic meter) will reduce the profit margin below 10 percent.

In 2012 and 2013, Jordan registered negative growth in the agricultural sector, while the productivity per worker also declined. To increase resilience among farmers to deal with irrigation water tariff increases, the agricultural sector will have to address issues related to, among others, the marketing of crops, and provide support to introducing new technologies that reduce the risks for farmers to transition to other cropping patterns, since the effect of increases in irrigation water tariffs does affect farmers who grow vegetables much less than those who grow citrus and banana.

When planning for irrigation water tariff increases, the government should evaluate the distributional impact of such increases. The farmer survey found that 17 percent of survey respondents could be classified as poor. Propoor farm policies can come in different forms, ranging from cross-subsidies in the irrigation tariff structure to direct income support to poor farmers. Because the number of farmers in the Jordan Valley is small, and the number of poor farmers even smaller, it is relatively easy for the government to provide income support to poor farmers in the Valley.

Appendix A

Allocation of Water in the Jordan Valley

Quotas are set according to water availability and demand patterns. Given that competition for water has increased, the quota system is reviewed on a regular basis, according to water availability. In 2004, the Jordan Valley Authority (JVA) established new quotas to better match supply of water and crop water requirements. Under current water policy directives, agriculture occupies third place in priority of allocation of freshwater, after municipal and industrial requirements, and first place in allocation of treated wastewater. As a consequence, freshwater has been increasingly transferred from irrigated agriculture to urban uses. In exchange, agriculture in Karamah is increasingly supplied with blended water (combining fresh surface water and treated wastewater (Venot et al. 2007).

The current annual quotas correspond to 3,600 cubic meters per hectare for vegetables, 7,650 cubic meters per hectare for citrus, and 12,550 cubic meter per hectare for banana. The new allocation implied a reduction of about 20 to 25 percent of previous quotas. The resulting water savings, about 20 million cubic meters per year, are reallocated for domestic water use in Amman (Venot et al. 2007). Details of the quotas per period of the year and crop is presented in table A.1.

The number of farms registered by the Control Centers at the JVA (Northern, Middle, and Karamah Directorates, and Southern Ghors) is about 10,000 units with a total area of 40,000 ha, of which 36,000 hectares are irrigable. The average size per farm is 3.9 hectares, and each farm has an irrigable area of about 3.5 hectares.

TABLE A.1 Current Annual Quota System, 2004

Period of the year	Quotas (m^3/ha/day)		
	Vegetables	Citrus	Banana
March 16–31	15	On demand but <= 20	On demand but <= 20
April 1–5	15	20	30
April 16–30	20	20	30
May 1–June 15	20	30	50
June 16–August 15	On demand but <=10	40	70
August 16–September 15	10	40	70
September 16–October 15	15	38	50
October 16–October 31	20	38	50
November 1–December 15	20	On demand but <= 20	On demand but <= 20
December 16–March 15	10	On demand but <= 20	On demand but <= 20

Source: Venot et al. 2007.

Appendix B

Water User Associations in the Jordan Valley

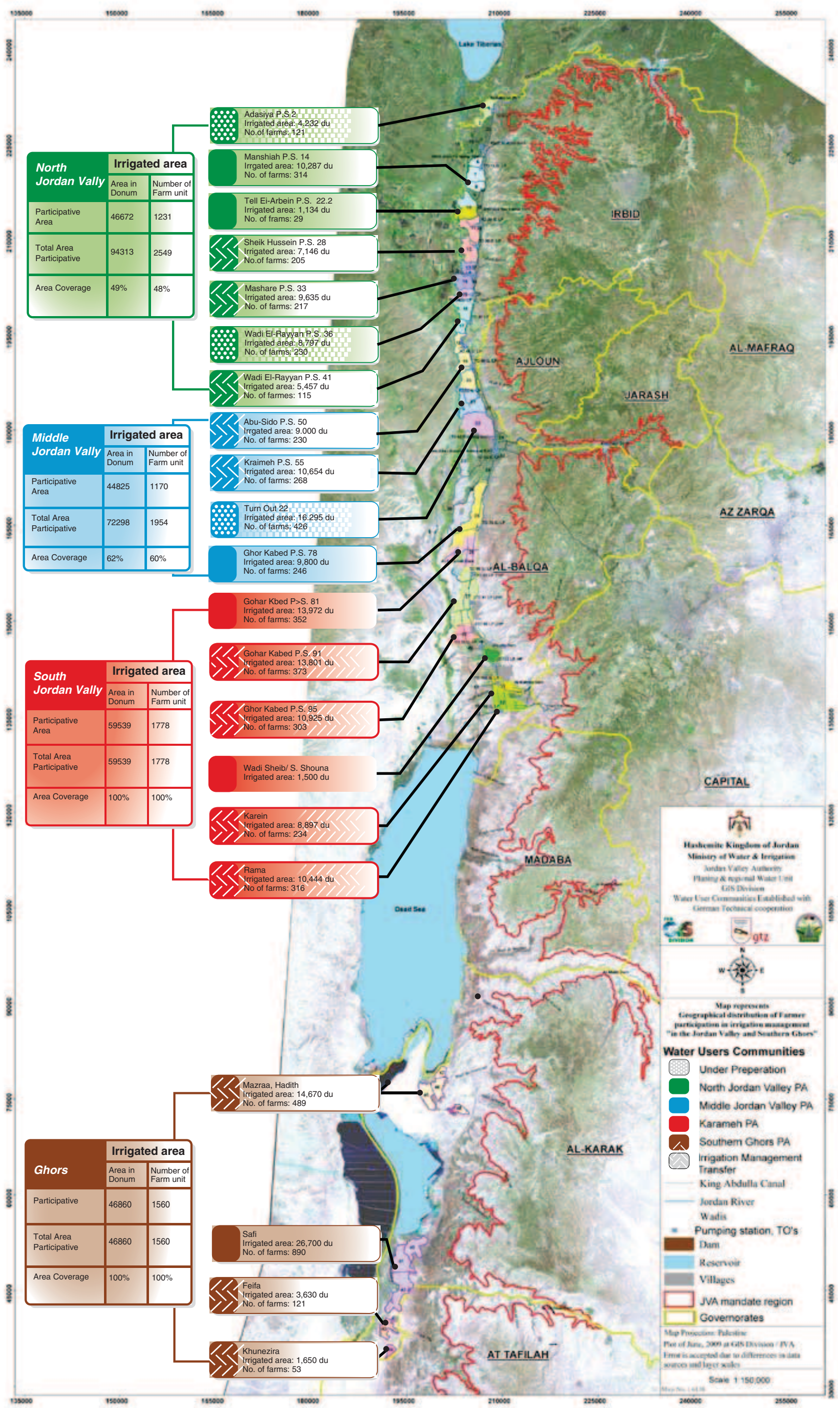
In 2001, the Jordan Valley Authority (JVA) launched[1] a participatory water resources management project, with the aim of responsibility sharing between the authority and the farmers. Water user associations (WUAs) have been established through a democratic process, including definition of responsibilities, duties, and management structure. The WUAs are now fully recognized by the JVA. Contracts with the WUAs regulate tasks transfer, where the associations are responsible for the distribution of water for irrigation. Although only 12 WUAs out of 23 have formally completed their contracts with the JVA (March 2012), the program encompasses 75 percent of the irrigated area (see table B.1 and map B.1). Eventually, full coverage of the Jordan Valley is expected. The WUA system is generally acknowledged as a positive achievement by the majority of the farmers who have been involved in the program. Attentive monitoring of the process and system is, however, warranted, to avoid disputes and to guarantee good management and overall sustainability.

TABLE B.1 Irrigated Area Covered by the Water User Association Program

Area	Size in dunum
North Jordan Valley	94,313
Middle Jordan Valley	72,298
South Jordan Valley (north of Dead Sea)	59,539
Southern Ghors	46,860
Total	**273,010**

Source: JVA.

MAP B.1 Geographic Distribution of Water Users Associations



Note

1. With the Deutsche Gesellschaft für Internationale Zusammenarbeit's (GIZ's) support and assistance.

Appendix C

Crop Budgets

Crop budget - TOMATO/GREENHOUSE*/DRIP IRRIGATION

** (half dunum)*

				Scenario 1	Scenario 2	Scenario 3
A. REVENUE:	Units			Survey price	DOS price	Farmgate prices derived from FOB/best prices
Yield	ton/0.5 dunum			10.0	10.0	10.0
Price farmgate	JD/ton			147	168	365
Revenue per half dunum	JD			1,470	1,683	3,648
B. COSTS:						
B.1 Operating costs						
		unit price, JD	quantity	subtotals, JD		
a) Labor				594.0		
Permanents (crop proportion per season)	Unit	1,800	0.33	594.0		
Temporary	JD/day	—	—	—		
b) Plant production & protection				508.0		
Land preparation	Unit/dunum	25	0.5	12.5		
Cost of seed/plant material	Seedlings	0.130	1,400	182.0		
Fertilizers, mineral	Unit	75	1	75.0		
Fertilizers, organic	Unit	45	1.5	67.5		
Pesticides & treatments	Unit	150	1	150.0		
Synthetic threads	Unit	2	8	16.0		
Black mulch	Unit/dunum	10	0.5	5.0		
c) Management cost				72.1		
Management cost	Lump sum	103	0.7	72.1		
d) Other costs				151.1		
Land rental	Dunum	143	0.5	71.5		
Water	JD/m^3/ season	0.035	180	6.3		
Electricity	JD/m^3 of water	0.06	180	10.8		
Packaging material	Unit	0.5	125	62.5		
B.2 Investment costs				228.2		

table continues next page

				Scenario 1	Scenario 2	Scenario 3
Depreciation of plastic film (3 y)	Plastic house unit	0.33	430	141.9		
Depreciation of green houses structure (30 y)	Plastic house unit	0.03	2,500	75.0		
Irrigation system and farm equipment (annual proportion)	JD/dunum	0.5	22.60	11.3		
Total costs:				1,553.4		
C. RETURNS:						
Net returns	JD			–83	130	2,094
Net returns (%)	%			–5	8	135

Source: Fileccia and Punda 2012.
Note: — = not available.

Crop budget – TOMATO/OPEN FIELD/DRIP IRRIGATION

				Scenario 1	Scenario 2	Scenario 3
A. REVENUE:	Units			Survey price	DOS price	Farmgate prices derived from fob/best prices
Yield	Ton/ dunum			4.0	4.0	4.0
Price farmgate	JD/ton			147	168	365
Revenue per dunum	JD			588	673	1,459
B. COSTS:						
B.1 Operating costs						
		Unit price, JD	Quantity	Subtotals, JD/ dunum		
a) Labor				180.0		
Permanents (crop proportion per season)	Unit	1,800	0.1	180.0		
Temporary	JD/day	—	—	—		
b) Plant production & protection				505.0		
Land preparation	Unit/ dunum	25	1	25.0		
Cost of seed/plant material	Seedlings	0.1	1,250	125.0		
Fertilizers, mineral	Unit	150	1	150.0		
Fertilizers, organic	Unit	45	1	45.0		
Pesticides & treatments	Unit	150	1	150.0		
Synthetic threads	Unit	—	—	—		
Black mulch	Unit/ dunum	10	1	10.0		
c) Management cost				103.0		
management cost	Lump sum	103	1	103.0		
d) Other costs				511.8		
Land rental	Dunum	143	1	143.0		
Water	JD/m^3/ season	0.270	360	97.2		
Electricity	JD/m^3 of water	0.06	360	21.6		
Packaging material	Unit	0.5	500	250.0		
B.2 Investment costs				47.6		
Depreciation of plastic film (3 y)	Plastic house unit	—	—	—		
Depreciation of green houses structure (30 y)	Plastic house unit	—	—	—		
Plastic tunnel (winter months)	JD/dunum	25	1	25.0		
Irrigation system and farm equipment (annual proportion)	JD/dunum	23	1	22.6		
Total costs:				1,347.4		
C. RETURNS:						
Net returns	JD			–759	–674	112
Net returns (%)	%			–56	–50	8

Source: Fileccia and Punda 2012.
Note: — = not applicable.

Crop budget - CUCUMBER/GREENHOUSE*

** (half dunum)*

				Scenario 1	Scenario 2	Scenario 3
A. REVENUE:	Units			Survey price	DOS price	Farmgate prices derived from FOB/best prices
Yield	Ton/0.5 dunum			6.0	6.0	6.0
Price farmgate	JD/ton			250	197	498
Revenue per half dunum	JD			1,500	1,181	2,985
B. COSTS:						
B.1 Operating costs						
		Unit price, JD	Quantity	Subtotals, JD		
a) Labor				594.0		
Permanents (crop proportion per season)	Unit	1,800	0.33	594.0		
Temporary	JD/day	—	—	—		
b) Plant production & protection				461.6		
Land preparation	Unit/dunum	25	0.5	12.5		
Cost of seed/plant material	Seedlings	0.113	1,200	135.6		
Fertilizers, mineral	Unit	75	1	75.0		
Fertilizers, organic	Unit	45	1.5	67.5		
Pesticides & treatments	Unit	150	1	150.0		
Synthetic threads	Unit	2	8	16.0		
Black mulch	Unit/dunum	10	1	5.0		
c) Management cost				72.1		
Management cost	Lump sum	103	0.7	72.1		
d) Other costs				430.9		
Land rental	Dunum	143	0.5	71.5		
Water	JD/m^3/season	0.270	180	48.6		
Electricity	JD/m^3 of water	180	0.06	10.8		
Packaging material	unit	0.5	600	300.0		
B.2 Investment costs				228.2		
Depreciation of plastic film (3 y)	Plastic house unit	0.33	430	141.9		
Depreciation of green houses structure (3 y)	Plastic house unit	0.03	2,500	75.0		
Irrigation system and farm equipment (annual proportion)	JD/dunum	0.5	22.6	11.3		
Total costs:				1,786.8		
C. RETURNS:						
Net returns	JD			–287	–605	1,199
Net returns (%)	%			–16	–34	67

Source: Fileccia and Punda 2012.
Note: — = not applicable.

Crop budget - POTATO/OPEN FIELD

				Scenario 1	Scenario 2	Scenario 3	Scenario 4
A. REVENUE:	Units			Survey price	DOS price	FOB prices	Farmgate prices derived from FOB/ best prices
Yield	Ton/0.5 dunum			3.5	3.5	3.5	3.5
Price farmgate	JD/ton			800	211	332	800
Revenue per half dunum	JD			2,800	739	1,162	2,800
B. COSTS:							
B.1 Operating costs							
		unit price, JD	quantity	subtotals, JD			
a) Labor				276.0			
Permanents (crop proportion per season)	Unit	1,800	0.1	180.0			
Temporary	JD/day	0.8	120	96.0			
b) Plant production & protection				1,780.0			
Land preparation	Unit/dunum	25	1	25.0			
Cost of seed potato	Seedlings	1	1,000	1,000.0			
Fertilizers, mineral	Unit	400	1	400.0			
Fertilizers, organic	Unit	45	1	45.0			
Pesticides & treatments	Unit	300	1	300.0			
Synthetic threads	Unit	—	—	—			
Black mulch	Unit/dunum	10	1	10.0			
c) Management cost				103.0			
Management cost	Lump sum	103	1.0	103.0			
d) Other costs				400.8			
Land rental	Dunum	143	1	143.0			
Water	JD/m^3/ season	0.170	360	61.2			
Electricity	JD/m^3 of water	0.06	360	21.6			
Packaging material	Unit	0.5	350	175.0			
B.2 Investment costs				47.6			

table continues next page

				Scenario 1	Scenario 2	Scenario 3	Scenario 4
Depreciation of plastic film (3 y)	Plastic house unit	—	—	—			
Depreciation of green houses structure (3 y)	Plastic house unit	—	—	—			
Plastic tunnel (winter months)	JD/dunum	25	1	25.0			
Irrigation system and farm equipment (annual proportion)	JD/dunum	22.6	1	22.6			
Total costs:				2,607.4			
C. RETURNS:							
Net returns	JD			192.6	–1,869	1,445	192.6
Net returns (%)	%			7	–72	–55	7

Source: Fileccia and Punda 2012.

Crop budget - MELON/GREENHOUSE*

** (half dunum)*

				Scenario 1	Scenario 2	Scenario 3	Scenario 4
A. REVENUE:	Units			Survey price	DOS price	FOB prices	Farmgate prices derived from FOB/best prices
Yield	Ton/0.5 dunum			1.0	1.0	1.0	1.0
Price farmgate	JD/ton			1,750	274	598	1,750
Revenue per half dunum	JD			1,750	274	598	1,750
B. COSTS:							
B.1 Operating costs							
		Unit price, JD	Quantity	Subtotals, JD			
a) Labor				594			
Permanents (crop proportion per season)	Unit	1,800	0.33	594			
Temporary	JD/day	—	—	—			
b) Plant production & protection				387			
Land preparation	Unit/d u	25	0.5	12.5			
Cost of seedlings/ nurseries	Seedlings	0.113	1,200	135.6			
Fertilizers, mineral	Unit	75	1	75.0			
Fertilizers, organic	Unit	45	1.5	67.5			
Pesticides & treatments	Unit	75	1	75.0			
Synthetic threads	Unit	2	8	16.0			
Black mulch	Unit/ dunum	10	0.5	5.0			
c) Management cost				72			
Management cost	Lump sum	103	1.0	72.1			
d) Other costs				131			
Land rental	Dunum	143	0.5	71.5			
Water	JD/m³/ season	0.270	180	48.6			
Electricity	JD/m³ of water	0.06	180	10.8			
Packaging material	Unit			—			
B.2 Investment costs				228			
Irrigation system & farm eq. depreciation	JD/dunum	22.6	0.5	11.3			
Depreciation of plastic film (3 y)	Plastic house unit	430	0.33	141.9			
Depreciation of green houses structure (3 y)	Plastic house unit	2,500	0.03	75.0			
Total costs:				1,412			
C. RETURNS:							
Net returns	JD			338	–1,138	–814	338
Net returns (%)	%			24	–81	–58	24

Source: Fileccia and Punda 2012.

Crop budget - BANANA/Drip Irrigation

A. REVENUE:	**Units**	**Avg. unit price, JD**	**Year 1**		**Years 2–5**	
			qty	***subtotals***	***qty***	***subtotals***
Output	JD/ton	450	—	—	4.75	2,138
B. COSTS:						
B.1 Operating costs						
a) Labor				104.00		292.00
Pruning	Person/day	10.00	0.40	4.00	1.00	10.00
Pesticides application	Person/day	10.00	2.00	20.00	6.00	60.00
Crop harvesting	Person/day	10.00	3.00	30.00	7.20	72.00
Other	Person/day	10.00	5.00	50.00	15.00	150.00
b) Plant production & protection				540.10		607.40
Seedlings	Seedlings	1.50	167.00	250.50	—	—
Fertilizers, organic	Unit	45.00	3.00	135.00	7.20	324.00
Fertilizers, ammonium sulphate	Kg	0.80	96.00	76.80	144.00	115.20
Fertilizers, triple super phosphate	Kg	0.80	16.00	12.80	32.00	25.60
Fertilizers, potassium sulphate	Kg	0.80	—	—	72.00	57.60
Fertilizers, other	Kg	20.00	2.00	40.00	3.00	60.00
Pesticides & treatments		50.00	0.50	25.00	0.50	25.00
Mulching (plastic)	Unit	10.00	—	—	—	—
c) Rented machine work				45.00		20.00
Land preparation and solarization	Dunum	25.00	1.00	25.00	—	—
Plowing & scarifying	Dunum	10.00	1.00	10.00	1.00	10.00
Pesticides application	Dunum	10.00	1.00	10.00	1.00	10.00
d) Management cost				103.00		103.00
Management cost	Lump sum	103.00	1.00	103.00	1.00	103.00
e) Other cots				281.05		281.05
Land rental	Dunum	143.00	1.00	143.00	1.00	143.00
Water	JD/m^3/season	0.04	1,255.00	50.20	1,255.00	50.20
Electricity	JD/m^3 of water	0.07	1,255.00	87.85	1,255.00	87.85
Packaging material	Unit	0.03	—	—	—	—
B.2 Investment costs				18.40		18.40
Irrigation system and farm equipment (annual proportion)	Dunum	18.40	1.00	18.40	1.00	18.40
Total costs:				1,091.55		1,321.85
C. RETURNS:						
Net returns	JD			–1,091.55		815.65
Net returns (%)	%			–100		62

Source: Fileccia and Punda 2012.
Note: — = not applicable.

Crop budget - DATES/DRIP IRRIGATION

A. REVENUE:	Units	Avg. unit price, JD	Years 1–5		Years 5–10		After 8 Years	
			qty	*subtotals*	*qty*	*subtotals*	*qty*	*subtotals*
Output	JD/ton	1,019	0	25	0.80	815	3.50	3,567
Output Medjool 1st class (at farm gate)	JD/ton	2,500	0	63	0.80	2,000	3.50	8,750
B. COSTS:								
B.1 Operating costs								
a) Labor				110.00		195.00		245.00
Pruning	JD/day	20.00	1.00	20.00	2.00	40.00	2.00	40.00
Fertilizers & pesticides application	JD/day	10.00	2.00	20.00	3.00	30.00	3.00	30.00
Crop harvesting	JD/day	10.00	5.00	50.00	7.00	70.00	12.00	120.00
Other (pollination, weeding)	JD/day	10.00	2.00	20.00	5.50	55.00	5.50	55.00
b) Plant production & protection				917.00		404.50		404.50
Seedlings	Seedlings	40.00	14.00	560.00	—	—	—	—
Fertilizers, organic	Unit	45.00	1.00	45.00	1.50	67.50	1.50	67.50
Fertilizers, mineral	Unit	1.60	70.00	112.00	70.00	112.00	70.00	112.00
Pesticides & treatments	Unit	200.00	1.00	200.00	1.00	200.00	1.00	200.00
Pollination	Lump sum	25.00	—	—	1.00	25.00	1.00	25.00
Mulching (plastic)	Unit/ dunum	10.00	—	—	—	—	—	—
c) Rented machine work				45.00		72.50		125.00
Land preparation	Dunum	25.00	1.00	25.00	—	—	—	—
Plowing & scarifying	Dunum	10.00	1.00	10.00	1.00	10.00	1.00	10.00
Pesticides application	Dunum	10.00	1.00	10.00	1.00	10.00	1.00	10.00
Harvesting (hydraulic lift)	Dunum	105.00	—	—	0.50	52.50	1.00	105.00
d) Management cost				206.00		206.00		206.00
Management cost	Lump sum	206.00	1.00	206.00	1.00	206.00	1.00	206.00
e) Other costs				179.70		257.20		527.20
Land rental	Dunum	143.00	1.00	143.00	1.00	143.00	1.00	143.00
Water	JD/m^3/ season	0.035	360.00	12.60	360.00	12.60	360.00	12.60
Electricity	JD/m^3 of water	0.06	360.00	21.60	360.00	21.60	360.00	21.60
Packaging material (boxes)	Unit	0.50	5.00	2.50	160.00	80.00	700.00	350.00
B.2 Investment costs				35.00		35.00		1,688.00
investment depreciation	Dunum	35.00	1.00	35.00	1.00	35.00	1.00	35.00

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Financial losses for (non/less productive years)				1,653.00
Total costs:		1,492.70	1,170.20	3,195.70
C. RETURNS:				
Net returns	JD	–1,467.22	–354.90	371.23
Net returns	%	–98	–30	12
Net returns (Medjool)	JD	–1,430.20	829.80	5,554.30
Net returns (Medjool)	%	–96	71	174

Source: Fileccia and Punda 2012.
Note: — = not applicable.

Crop budget - CITRUS/DRIP IRRIGATION

A. REVENUE:	Units	Avg.unit price, JD	Years 1–3		Years 4–7		After 8 Years	
			qty	*subtotals*	*qty*	*subtotals*	*qty*	*subtotals*
Gross output	JD/ton	230	—	—	2.00	460	4.00	920
Gross output (farm gate) at DOS prices	JD/ton	248	—	—	2.00	496	4.00	992
Gross output (farm gate) at FOB/best prices	JD/ton	581			2.00	1,163	4.00	2,326
B. COSTS:								
B.1 Operating costs								
a) Labor				50.00		93.00		176.00
Pruning	JD/day	20.00	1.00	20.00	2.00	40.00	3.00	60.00
Pesticides application	JD/day	10.00	1.00	10.00	1.30	13.00	2.60	26.00
Crop harvesting	JD/day	10.00	—	—	2.00	20.00	7.00	70.00
Other (weeding, etc.)	JD/day	10.00	2.00	20.00	2.00	20.00	2.00	20.00
b) Plant production & protection				234.00		237.00		330.00
Seedlings	Seedlings	2.50	56.00	140.00	—	—	—	—
Fertilizers, organic	Unit	45.00	1.00	45.00	2.40	108.00	3.40	153.00
Fertilizers, ammonium sulphate	Unit	0.80	30.00	24.00	60.00	48.00	100.00	80.00
Fertilizers, triple super phosphate	Unit	0.80	—	—	40.00	32.00	60.00	48.00
Fertilizers, potassium sulphate	Unit	0.80	—	—	30.00	24.00	30.00	24.00
Pesticides & treatments	Unit	50.00	0.50	25.00	0.50	25.00	0.50	25.00
Mulching (plastic)	Unit/ dunum	10.00	—	—	—	—	—	—
c) Rented machine work				28.50		3.50		3.50
Land preparation	Dunum	25.00	1.00	25.00	—	—	—	—
Plowing & scarifying	Dunum	2.00	1.00	2.00	1.00	2.00	1.00	2.00
Pesticides application	Dunum	1.50	1.00	1.50	1.00	1.50	1.00	1.50
c) Management cost				103.00		103.00		103.00
Management cost	Lump sum	103.00	1.00	103.00	1.00	103.00	1.00	103.00
d) Other costs				219.68		221.68		223.68
Land rental	Dunum	143.00	1.00	143.00	1.00	143.00	1.00	143.00
Water	JD/m^3/ season	0.035	765.00	26.78	765.00	26.78	765.00	26.78
Electricity	JD/m^3 of water	0.06	765.00	45.90	765.00	45.90	765.00	45.90

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Packaging material (boxes)	Unit	0.10	—	—	—	—	—	—
Other	Lump sum	2.00	2.00	4.00	3.00	6.00	4.00	8.00
B.2 Investment costs				22.60		22.60		22.60
Irrigation system and farm equipment (annual proportion)	JD/dunum	22.60	1.00	22.60	1.00	22.60	1.00	22.60
Total costs:				657.78		680.78		858.78
C. RETURNS:								
Net returns	JD			–658	—	–221		61.23
Net returns	%			–100		–32		7
Net returns at DOS prices	JD							133
Net returns at DOS prices	%							15
Net returns at FOB/best prices	JD							1,467
Net returns at FOB/best prices	%							171

Source: Fileccia and Punda 2012.
Note: — = not applicable.

Crop budget - CITRUS/SURFACE IRRIGATION

A. REVENUE:	Units	Avg. unit price, JD	Years 1–3		Years 4–7		After 8 Years	
			qty	*subtotals*	*qty*	*subtotals*	*qty*	*subtotals*
Gross output	JD/ton	270	—	—	0.80	216	2.00	540
Gross output (farm gate) at DOS prices	JD/ton	248	—	—	0.80	198	2.00	496
Gross output (farm gate) at FOB/best prices	JD/ton	581	—	—	0.80	465	2.00	1,163
B. COSTS:								
B.1 Operating costs								
a) Labor				50.00		93.00		176.00
Pruning	JD/day	20.00	1.00	20.00	2.00	40.00	3.00	60.00
Pesticides application	JD/day	10.00	1.00	10.00	1.30	13.00	2.60	26.00
Crop harvesting	JD/day	10.00	—	—	2.00	20.00	7.00	70.00
Other (weeding, etc.)	JD/day	10.00	2.00	20.00	2.00	20.00	2.00	20.00
b) Plant production & protection				127.60		109.80		133.80
Seedlings	Seedlings	2.50	31.00	77.50		—	—	—
Fertilizers, organic, non-treated	Unit	24.00	1.00	24.00	2.40	57.60	3.40	81.60
Fertilizers, mineral	Unit	43.00	0.50	21.50	1.00	43.00	1.00	43.00
Pesticides & treatments	Unit	4.60	1.00	4.60	2.00	9.20	2.00	9.20
Mulching (plastic)	Unit/ dunum	10.00		—		—		—
c) Rented machine work				42.00		17.00		17.00
Land preparation	Dunum	25.00	1.00	25.00	—	—	—	—
Misc operations	Dunum	17.00	1.00	17.00	1.00	17.00	1.00	17.00
d) Management cost				103.00		103.00		103.00
Management cost	Lump sum	103.00	1.00	103.00	1.00	103.00	1.00	103.00
e) Other costs				215.68		215.68		215.68
Land rental	Dunum	143.00	1.00	143.00	1.00	143.00	1.00	143.00
Water	JD/m^3/ season	0.035	765.00	26.78	765.00	26.78	765.00	26.78
Electricity	ID/m^3 of water	0.06	765.00	45.90	765.00	45.90	765.00	45.90
Packaging material (boxes)	Unit	0.10		—		—		—
B.2 Investment costs				11.30		11.30		11.30
Irrigation system and farm equipment (annual proportion)	JD/ dunum	11.30	1.00	11.30	1.00	11.30	1.00	11.30
Total costs:				549.58		549.78		656.78

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C. RETURNS:

Net returns	JD	–549.58	–333.78	–116.78
Net returns	%	–100	–61	–18
Net returns at DOS prices	JD			–161
Net returns at DOS prices	%			–24
Net returns at FOB/ best prices	JD			506.08
Net returns at FOB/ best prices	%			77

Source: Fileccia and Punda 2012.
Note: — = not applicable.

Appendix D

Subsidy Principles

Principles for access to government subsidies need to be established, such as the following.

- **Subsidies should be predictable.**
  It is important to ensure that water and wastewater systems are realistically financed, regardless of affordability and whether alternative sources can be used. Fiscal transfers can be provided in the form of investment subsidies,[1] operation and maintenance subsidies, or both. These fiscal transfers should be agreed in advance to ensure that the utility does not end up in a vicious circle of inadequate maintenance, low service quality, low willingness to pay, and insufficient revenues for basic maintenance. To determine the amount of fiscal transfers needed, tariff levels need to be predictable, and a clear process for tariff revisions needs to be in place. The Bank can use tools like Water Public Expenditure Reviews to address the question of the role of government subsidies in the sector and how this will affect the development of the sector over time.

- **Subsidies should decline over time.**
  The path to full cost recovery should involve a phased approach, with tariffs increasing in importance and in stages to cover (a) operation and maintenance costs, which ensures that the utility is capable of serving the current customer base in the short term; (b) depreciation of assets, so that the utility will be able to replace worn-out assets and can serve the current customer base in the medium term; (c) new investment to enable the utility to expand its customer base; (d) and eventually, where needed, the environmental and resource costs of water.

- **Subsidies should be transparent.**
  Subsidies should be reviewed continuously to ensure they provide sufficient incentives to improve the performance of utilities with respect to operational efficiency and investment costs.

- **Subsidies should take affordability concerns into consideration.**
  Subsidies should be reviewed continuously to ensure that they target the intended beneficiaries. Government subsidies can be provided to fund capital and operation and maintenance costs to utilities. Yet, how individual affordability can be ensured depends, to a large extent, on tariff levels (affected by investment costs and operational efficiencies), their structure, and the process of tariff setting.

Note

1. When investment subsidies are provided, it is important that their operation and maintenance implications are considered to avoid overdesign.

Appendix E

Irrigation Pricing Systems

Type	Detail	Impact on demand*	Can assure supply-demand balance?	Equitable	Ease of administration	Stability and predictability of revenue
Area-based	A fixed rate per hectare of farm, unrelated to the area irrigated, type of crop, or volume of water received. This type of charge is commonly part of a "two-part" tariff—with the area-based charge designed to cover the fixed costs of the service.	No	No	Moderate	Good	Good
	A fixed charge per hectare irrigated, unrelated to type of crop or volume of water received.	Small	No	Moderate	Moderate	Good
Crop-based	A variable rate per irrigated hectare of crop, i.e., different charges for different crops, where the service charge is not related to the actual volume of water received, although the type of crop and area irrigated serve as proxies for the volume of water received.	Small	No	Moderate	Moderate	Moderate
Time-based	A fixed charge based on the amount of time irrigation is provided to each user. It is often used in supply-based irrigation where the flow of a canal is rationed to users on the basis of time.	Positive	Yes	Good	Good	Moderate
Volumetric	A fixed rate per unit of water received, where the service charge is directly related and proportional to the volume of water received.	Positive	Very difficult	Good	Low	Low
	A variable rate per unit of water received, where the service charge is directly related to the quantity of water received but not proportionately (for example, a certain amount of water per hectare may be provided at a low unit cost and additional water at a higher unit cost). This method is also referred to as a rising block tariff.	Positive	Difficult	Good	Low	Low
Quota or rationing	Entitlement to water is defined (absolutely or qualified by actual availability).	Controlling	Yes	Good	Not relevant	Low
Tradable water rights	Entitlement to water is defined (absolutely or qualified by actual availability) and may be sold to other users seasonally or in perpetuity.	Controlling	Yes	Good	Not relevant	Low

Sources: Bowen and Young 1983; Cornish et al. 2004.
Note: *Small: essentially no impact, except at extreme (and unlikely) charging levels. Positive: impact will be in desired direction, with magnitude dependent on level of charge. Controlling: specifies the maximum demand that will be available.

Appendix F

Jordan Valley Authority Staffing

	Level 1	Level 2	Level 3	Total
Corporate				
Office of the Secretary-General	3	0	1	4
Directorate of Human Resources	12	6	31	49
Directorate of Commercial	2	8	19	29
Directorate of Public Relations	4		1	5
Department of Transportation	1	1	27	29
Directorate of Finance	17	11	8	36
Tenders and Procurement Directorate	7	4	4	15
Total	***46***	***30***	***91***	***167***
Land				
Directorate of Land	17	19	30	66
Directorate of organization	3	5	7	15
Unit	2	4	2	8
Total Land	***22***	***28***	***39***	***89***
Water				
Directorate of Dams	47	17	178	242
Directorate of Water Harvesting	2	0	0	2
Directorate of Irrigation	7	3	4	14
Directorate of Water Resources	5	0	0	5
Directorate of Laboratories	5	7	12	24
Directorate of Attribution	4	2	59	65
Directorate of Underground Drainage	4	1	16	21
Directorate of the North Valley	11	19	194	224
Directorate of Central Valley	9	8	137	154
Directorate of Karamah	6	4	90	100
Directorate Water Management and Control	7	5	54	66
Unit Water Users Associations	2	1	1	4
Directorate of the South Valley	12	19	157	188
Total Water	***121***	***86***	***902***	***1,109***
Other Administration				
Directorate of Workshops and Equipment	2	0	4	6
Unit of Internal Oversight	4	1	0	5
Unit development and institutional performance	3	—	1	4
Business Planning Unit	6	3	1	10
Unit investment	4	—	1	5
Advisors	5	—	—	5
Total other administration				
TOTAL JORDAN VALLEY AUTHORITY	*213*	*148*	*1,039*	*1,400*

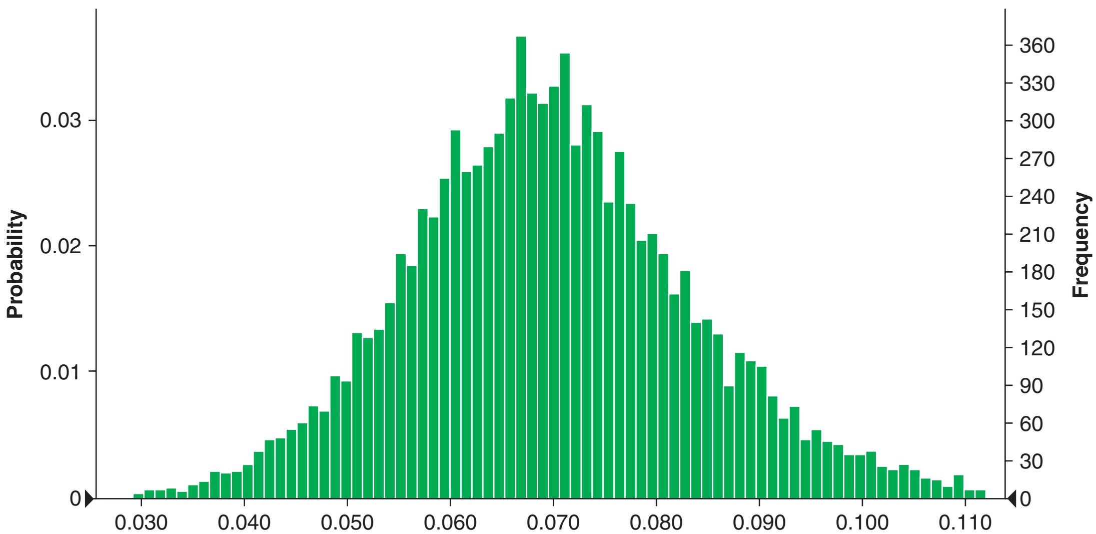
Note: — = not applicable.

Appendix G

Risk Analysis

Required irrigation tariff to cover Operation and maintenance cost with 2013 electricity prices and including cross-subsidies

Forecast:
Summary:
Entire range is from 0.012 to 0.208
Base case is 0.155
After 10,000 trials, the standard error of the mean is 0.000



Statistics:	Forecast values
Trials	10,000
Base case	0.155
Mean	0.070
Median	0.069
Mode	—
Standard deviation	0.015
Variance	0.000
Skewness	0.6570
Kurtosis	5.71
Coeff. of variation	0.2151
Minimum	0.012
Maximum	0.208
Range width	0.196
Mean Standard error	0.000

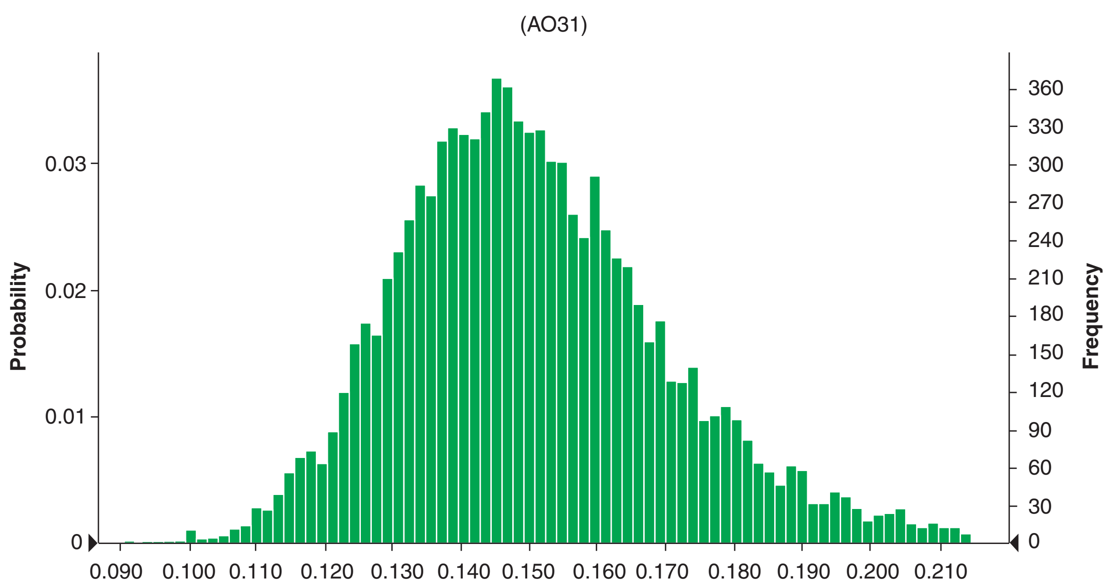
Forecast: (cont'd)

Percentiles:	Forecast values
0%	0.012
10%	0.052
20%	0.058
30%	0.062
40%	0.066
50%	0.069
60%	0.072
70%	0.076
80%	0.081
90%	0.089
100%	0.208

Forecast:

Required irrigation tariff to cover Operation and maintenance and depreciation cost with 2017 electricity prices and including cross-subsidies

Entire range is from 0.090 to 0.363
Base case is 0.263
After 10,000 trials, the standard error of the mean is 0.000



Statistics:	Forecast values
Trials	10,000
Base case	0.263
Mean	0.153
Median	0.150
Mode	—
Standard deviation	0.022
Variance	0.000

Skewness	1.45
Kurtosis	9.10
Coeff. of variation	0.1443
Minimum	0.090
Maximum	0.363
Range Width	0.273
Mean Std. Error	0.000

Forecast:

Percentiles:	**Forecast values**
0%	0.090
10%	0.129
20%	0.136
30%	0.141
40%	0.146
50%	0.150
60%	0.155
70%	0.161
80%	0.168
90%	0.180
100%	0.363

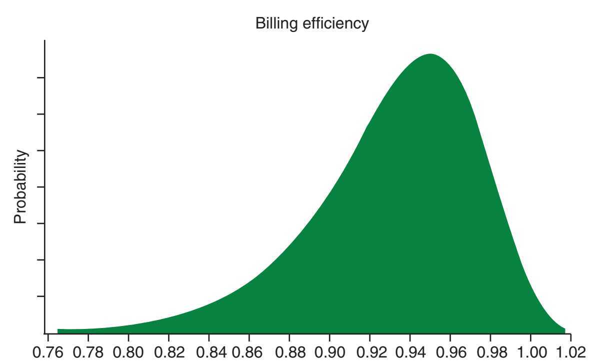
End of Forecasts

Assumptions

Assumption: Billing Efficiency

Minimum extreme distribution with parameters:

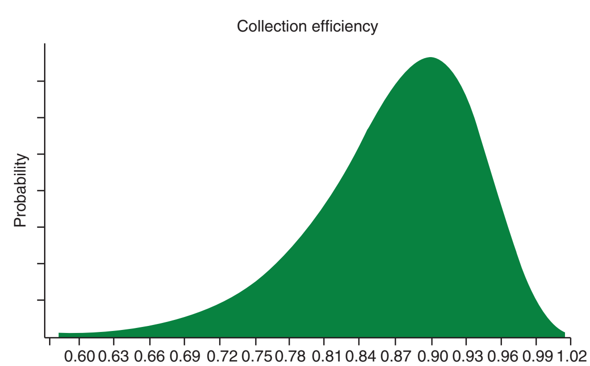
Likeliest	0.95
Scale	0.04



Assumption: Collection Efficiency

Minimum extreme distribution with parameters:

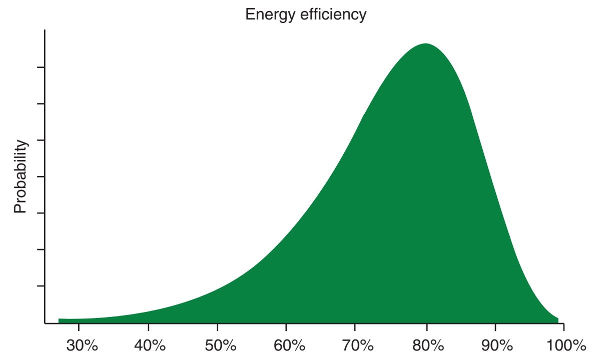
Likeliest	0.90
Scale	0.06



Assumption: Energy Efficiency

Minimum extreme distribution with parameters:

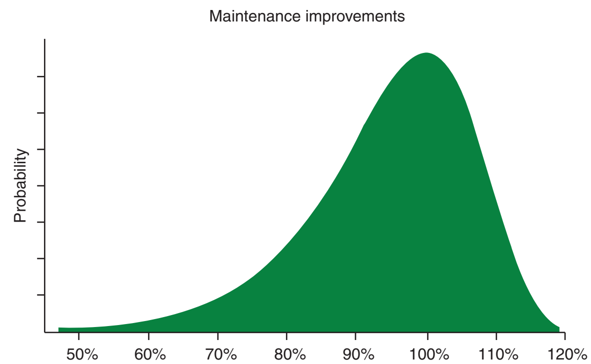
Likeliest	80%
Scale	10%



Assumption: Maintenance Improvements

Minimum extreme distribution with parameters:

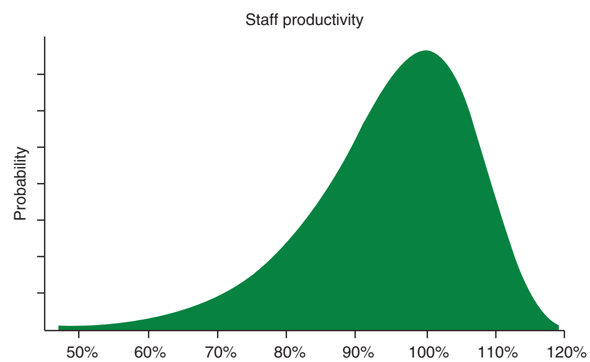
Likeliest	100%
Scale	10%



Assumption: Staff Productivity

Minimum extreme distribution with parameters:

Likeliest	100%
Scale	10%



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