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Impact of Full Cost Recovery of Irrigation Water on the Farming Economics in the Jordan Valley

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ABSTRACT

The main objective of this paper is to determine the impact of increasing water price or the full recovery cost for different water qualities on the planted area, water use, total net income and the price of water that farmers are welling to pay in the Jordan Valley. A linear optimizing model is used. The main result of the study shows that at the full cost recovery of $0.05 /m^3, which has been considered as the highest level of block charge rate, the entire irrigated area is 25,621 ha with total water demand of 234.1 MCM and surface water demand of 162.9 MCM. The total water expenses are $9.02 million and the total net income is $ 142.8 million of which about 79% comes from surface water. In addition, as the average price of current water use increases, the water price that the farmer willing to pay (WTP) was also increased but always the at lower levels compared with the average current price of water use.

Introduction

Water is an essential factor in agriculture and plays a decisive role in economic growth and development. Water resources have been allocated on the basis of social criteria maintaining the community welfare, by ensuring that water is available for human consumption, for sanitation, and for food production. Societies have invested capital in infrastructure to maintain this allocation. The demand for water and ability to control its location, timing, quality and quantity are becoming critical with the growing demand for municipal, industrial and agricultural uses in the arid region.

Water scarcity is the single most important natural constraint on Jordan's economic growth. Rapid increases in population and economic

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development have placed unprecedented demands on the resource. Actual water uses have actually exceeded the available Jordanian supply. Renewable ground water in the Jordan Valley (JV) is being exploited at unsustainable rates and water quality is deteriorating. Existing demands are not being satisfactorily met and development costs for the remaining resources are rising rapidly (SALMAN, 1994).

Traditionally the government has played a dominant role in managing water resources, but with inefficient use of water, poor cost recovery for operating and maintenance expenses. The mounting cost of developing new water sources, and problems with the quality of service in agency-managed systems has led to a search for alternatives that make water allocation and management more efficient.

The main objective of this case study of Jordan Valley region is to determine the impact of increasing water price or the full recovery cost for different water qualities, on the planted area, water use, total net income and the price of water that farmers are welling to pay.

2. Background and the irrigation system in the Jordan valley

The backbone of the irrigation system in the Jordan Valley is the King Abdullah Canal, which was build in several stages from 1959 to 1989. The canal now stretches over a total length of 110 km from the Yarmouk river at Adasiyeh to almost at the shores of the Dead Sea. The King Abdullah Canal is basically a transport open canal, with a maximum width of 11.30 m, a maximum (water) depth of 2.80 m and a maximum conveyance capacity of approx. 20 m^3/s. The canal irrigates approx. 23,710 ha of arable land. The water resources for the canal come from the Yarmouk River (48%), the conveyer from Lake Tiberias (24%), King Talal Dam (15%), Mukheibeh wells (5%), the side wadis in the northern part of the Valley (4%) and the side wadis in the southern part of the Valley (4%). Apart from the aforementioned area irrigated from the Canal, approx. 7,450 du is irrigated directly from other sources (from which King Talal Dam, and Hisban Kafrin Dam), through separate conveyors (MWI, 2000).

In the rivers and wadis delivering the water resources to the conveyance system, there are 6 retention reservoirs, with a total storage capacity of 165 million m^3. Five of these reservoirs (with a storage capacity of 110 million m^3) are normal retention reservoirs that hold the surplus discharge of their respective rivers. The sixth, Karamah Dam, is an intermediate reservoir that is filled with surplus water from other water sources, conveyed by the King Abdullah Canal in winter. The stored water is used in summer for irrigation.

3. Current costs and revenues of irrigation in the Jordan valley

Over the last few years the financial position of the Jordan Valley Authority (JVA) has deteriorated rapidly to the point that if no remedial measures were taken soon then, at current projections, JVA would be financially weak before too long. Revenues generated are insufficient to cover JVA's obligations and the gap has been widening at an accelerated rate (JVA, 1997).

The increasing need to reallocate water from rural to urban uses has limited irrigation possibilities and increased the demand for additional water supplies. Brackish water supplies and the use of poorer-quality wastewater return flows have affected farm production, and non-irrigation activities, such as the development of a tourism infrastructure, have risen in importance to the Kingdom.

Cost-of-service recovery, funding, and commercialization issues have become increasingly prominent concerns as well. Maintaining and improving service levels, and introducing institutional changes to carry them out, have intensified JVA 's need for flexible and sophisticated analytical and policy tools for utility and financial planning. They will permit the Authority to respond better to future needs of the country. On the other hand, increasing water tariffs may threaten the future of agriculture and socio-economic situation of the region.

The current JVA irrigation tariffs system has been in place for several years and makes no seasonal, geographic or water quality distinctions. It is structured into four usage block charges See Table 1.

The cost of water is relatively expensive in Jordan due to its limited availability. Water for municipal and industrial (M&I) uses is either abstracted from deep bore holes in the highlands or pumped from the Jordan Valley. The estimated cost of M&I supplies delivered to the consumer is 1.115 $\$/m^3$. The total estimated costs of irrigation water in the Jordan Valley 0.052 $\$/m^3$ of which about 0.029 $\$/m^3$ as O&M costs. Groundwater used by farmers in the highlands is not publicly funded. Revenues are less than half the costs incurred. Irrigation revenues are also well below the cost of providing the service (FORWARD, 1998).

The total costs of consumed irrigation water consist of the sum of operation and maintenance (O&M) and capital costs. O&M costs of supplied irrigation water increased from $ 5.29 million in 1990 to $ 6.07 million in 2000 (Table 2). The capital costs assigned for irrigation uses vary between $ 5.63 million in 1990 and JD 8.69 million in 2000. This indicates an average increase of the capital costs of irrigation water by 4.83% per year between years 1990 and 2000 (FORWARD, 1998).

The total costs (capital and O&M) were $ 10.92 million in 1990 and reached $ 14.76 million in 2000, i.e. an average annual rate of growth of 4.l9% in the period 1990-2000. Meanwhile, irrigation water revenue increased from $ 1.22 million in 1990 to reach $ 6.83 million in 2000 i.e. at an average annual increase of 20.99% per year (Table 2).

The estimated average costs of irrigation water over the period 1990-2000, is 0.052 $\$/m^3$, of which 0.023 $\$/m^3$ as O&M costs (44%). It is worth mentioning that the subsidy incurred by the government is estimated at 0.035 $\$/m^3$, representing 67% of the total costs. This in turn will affect the financial situation of the Jordan Valley Authority and thus, the development of the irrigation sector in the Jordan Valley (Table 3).

It should be noted that the operation and maintenance of the irrigation system are the task of the Field Operations Administration. Technically, Operation and Maintenance take place at five hierarchical levels. These are: Dams, King Abdullah Canal (KAC), Pumping stations and Secondary irrigation system (MWI, 1993).

4. Methodology of the study

A linear optimizing model is used. It uses data on available land, water requirements per unit land area for different crops, and net revenues per unit of land area generated by the growing of those crops in different locations. These net revenues do not include payments for water, which are handled separately. The model takes prices and quantity allocations for water and generates that cropping pattern which maximizes net agricultural income at the regional level. By varying water price of specific quality under consideration, while keeping prices of other water qualities constant (*ceteris paribus*), one can see the impact of water prices on water demand of other water qualities and general water demand.

The model can also be used to examine the effects of water quantity allocations between crops and between location as a result of changes in the prices of agricultural outputs or water restrictions on specific crops and locations.

4.1 Objective function

The objective function is formulated at both the regional level and the district level. Its objective is to maximize net income by selecting the optimal mix of water-consuming activities (field crops, vegetables, and fruit trees). The decision variables are the land areas of the activities. Each activity is characterized by its water requirements per dunum (one dunum equals 0.1 hectare) (SHATANAWI, 1998) and the net income it produces per dunumnot including water payments. These activities are allocated according to their location in different districts and according to the various qualities of irrigation water.

The objective function (equation 1) that maximized the total annual net income of agriculture in the district. Net income is considered in two parts. The first is what was referred to as WRC. WRCj, the water-related contribution of activity j, is defined as the gross income generated by activity j per unit area less all direct expenses (machinery, labor, materials, fertilizers, ...etc) associated with doing so, except for direct payments for water. It measures the maximal ability of the activity to pay for water (DOPPLER, 2002).

The second component of net income consists of direct payments for water under each quality and its value is subtracted from its corresponding WRC. It is important to note that such payments do not include water-related expenses because these expenses are included in the price charged by the government for the different water qualities to cover the operational and maintenance costs of the conveyance and distribution irrigation system.

4.2 Constraints

The model has two main constraints: water and land constraints. The quantity of irrigation water is allocated according to season, location and quality for each activity. The resulted cropping pattern should at least satisfy the domestic demand and no enormous change in the actual cropping pattern is allowed by use of constraints on areas.

4.2.1 Water constraints

The first step is to determine the net water requirements of activities planted in the Jordan Valley. We took into consideration the fact that the efficiency of the irrigation system was 72% as estimated by Ministry of Water and irrigation (MWI).

Each activity can, in principle, use one or more of water qualities; surface, brackish and recycled over the whole year, this forms 12 months water requirements for a given activity. In addition model has been formulated to contain water prices under each water quality.

In addition, there is another, conditional constraint. If an activity uses brackish or recycled water, the brackish or recycled quantity has to be blended in a ratio of (3:1) with surface water in order to improve the irrigation water quality as currently required by the MWI. We impose this requirement as part of the water requirements of the activities involved: Thus, an activity that requires a certain amount of recycled or brackish water per dunum is assumed also to require one-fourth that amount of surface water.

The second step is the formulation of the supply and the storage-transfer constraints. This was done to specify that current inflows can be either used for current irrigation or can be stored for later seasons [equation 2]. In this respect, the use of the Jordan Valley example may be a bit special because of the zero cost of using gravity flow in the conveyance system of the King Abdullah Canal.

4.2.2 Land constraints

The second set of constraints involves land areas. Land areas can be specified according to the district, to crop groups and according to water qualities. In this way we can ensure that each crop will enter the solution, in order to produce sufficient quantities of all current crops to meet domestic demand and export activities, so the retail prices of crops in general will be stable for the coming season.

4.3 Mathematical notation of the model

The objective function of the model can be written as:

$$MaxZ = \sum_{j}\sum_{m} x_{jm}\, wrc_{jm} - \sum_{i}\sum_{m} \left(p_{im}\, w_{im}\right) - \sum_{i}\sum_{m} g_{im}\, w^{+}_{(i-1)m} \qquad (1.1)$$

where Z represents the maximum achieved total net agricultural income; x_{jm} is the total land area of activity j using water quality m; wrc_{jm} is the water related contribution of activity j using water quality m; p_{im} is the price of water at month i of quality m; and w_{im} is the supply in month i of irrigation water of quality m. g_{im} is the per-cubic meter cost of storing water of quality m in order to transfer it from month

i-1 to season i; $w^{+}_{(i-1)m}$ is the quantity of water of quality m that is so stored.

This objective function is subjected to the following constraints:

$$\underset{i \quad m}{} a_{ijm} x_{jm} + \underset{i \quad m}{} (\; w^{\circ}_{im} \quad w^{+}_{i \; 1,m} + w_{i+1,m}) \quad 0 \qquad (1.2)$$

Here: a_{ijm} is the water requirement of activity j for water quality m at month i in location k; W°_{im} is the total supply of water of quality m in month i, excluding storage; $W^{+}_{i-1,m}$ is the transfer of water of quality m from the month before i; $W^{-}_{i+1,m}$ is the transfer of water of quality m to the month after i.

$$\sum_{j}\sum_{n} x_{jn} \quad A_n \qquad (1.3)$$

A_n is the total allocated area for crop category n, where the crop categories are field crops, vegetables and fruit trees.

Finally, This research followed the same procedure used by BOOKER *et al*, to estimate the willingness to pay price for ground water for groundwater (WTP). WTP is calculated by the following formula:

$$p = p \quad \frac{x}{x^{0}}^{\frac{1}{\;}} \qquad (1.4)$$

Where p is the marginal willingness-to-pay for additional use, is the current price for consumptive use, X is the total quantity of consumptive use in optimal situation, is the current quantity of consumptive use and (eta) is the price elasticity of demand.

5. Results and discussion

In the calculation process we used actual 2000 figures for the right-hand-side (RHS) values of the constraints for water amounts, total land area and land area of citrus and banana crops are predetermined, because in the short term these land areas are fixed. The land areas for annual crops such as field crops and vegetables have more flexibility in the short term. Therefore, we permitted deviations up to 20% from the 2000 data. The prices per m^3 of several types of water in 2000 were: surface water \$0.049;

brackish \$0.009; recycled \$0.013, as an average for all seasons. However, the price of water could be seasonally determined for each kind of water. The outputs of these runs for the optimal land area; water use and mix of activities were compared with the corresponding actual 2000 values.
The total available planted area, which already developed in Jordan Valley, is estimated about 31,161 ha, of which 11,812 in the northern district, 7,451 ha in the middle and 11,898 ha in the southern district.

The results of systematically changing the surface water price are presented in Table 4. The columns of Table 4 are explained by their respective headings. For example, the first row of the table reads the following: at the full cost recovery of \$0.05 /m^3 which has been considered as the highest level of block charge rate, the entire irrigated area is 25,621 ha with total water demand of 234.1 MCM and surface water demand of 162.9 MCM. The total water expenses are \$9.02 million and the total net income is \$ 142.8 million of which about 79% comes from surface water.

The third row of the table reads as follows: for surface water price Ps = \$0.15 per m^3, the entire irrigated area is 25,503 ha of which 12,368 ha irrigated with surface water, the total water demand is 233.0 million m^3 of which 151.7 million m^3 is surface water, the total water expenses is \$23.72 million of which \$19.71 million the expenses of surface water. The net income is \$126.4 million of which \$91.6 million coming from surface water. The profitability of one hectare is \$10075, whereas the profitability of one cubic meter is \$0.735.

When the price of surface water raises from \$0.10 to 0.15 per m^3 a reduction in the irrigated area occurs (from 25,621 ha to 25,023 ha). This is due to the fact that some field crops like wheat; barley and alfalfa leave the optimal solution, because they are no longer competitive with the other crops. The quantity of surface water demanded is reduced by 5.7 MCM. On the other hand, the use of other water qualities, mainly recycled, increases by 3.5 MCM, partially compensating the decline in surface water

The own-price elasticity of surface water demand is about -.0.04 at the actual surface water price of \$0.049 per m^3. This is a very low elasticity, but that is very largely a consequence of the very low actual price at which it is evaluated. At the midpoint of the range of surface prices studied (\$0.575 per m^3), the own-price elasticity of surface water demand is about -0.91. This means that, starting at that price; an increase of 1% in the price of surface water will decrease the quantity demanded by about 0.91%, so that demand is slightly inelastic (Table 7). Using the same procedure, the total water quantity demanded is regressed on surface water price, holding the prices for brackish and recycled water constant. The over-all water demand elasticity is -0.027, at the actual surface water price \$0.049 per m^3, but -0.42, at the average of \$0.575 per m^3 of surface water. This means that, increasing the price of surface water by 1% decreases the demand for all kind of water by 0.42%.

Following the same procedure as for surface water, the results of varying the brackish and recycled water prices are presented in Table 5 and Table 6, respectively. The price elasticities of demand of brackish and recycled water, in Table 7, are estimated at -0.29 and -0.43, at the actual water prices of \$0.009 and \$0.013 per m^3, respectively, The price elasticities of demand of brackish and recycled water, at the respective midpoint prices of \$0.03 and \$0.017 per m^3 are -1.01 and -1.21, respectively, so that demand is almost unitary elastic for brackish water and elastic for recycled water (Table 7).

The price levels at which the absolute value of the price demand elasticity is equal or greater than one were determined. The water price level at which the price elasticity of water demand is unitary elastic was \$0.0299 per m^3 for brackish water and \$0.11 per m^3 for recycled water.

The effect of increasing brackish and recycled water prices on over-all water demand is an elasticity of -0.01 with respect to the recycled water price and -0.06 with respect to the brackish water price at the actual prices. Even at the midpoints of the ranges studied, the elasticity is also small, being -0.07 with respect to the recycled water price and -0.03 with respect to the brackish water price.

Having in mind that the actual planted area in the Jordan Valley (25,600 ha), applying water price of 0.05 \$/m^3 (at full recovery cost) would not affect the planted area, or the quantity demanded of irrigation water in the Jordan Valley, However the total net income would relatively decreased as a result of increasing water expenses. These additional expenses can be considered as returns to the JVA, and can be used to improve the situation of the irrigated and social infrastructures in the valley. Increasing returns from the irrigation water would attain the JVA to respond better to future needs of the valley.

5.1 Farmers' willingness to pay for irrigation water

Starting form the current water use in Jordan Valley and the projected quantities under different levels of water prices and economic demand for water use are assumed to follow the constant elasticity the marginal willingness to pay (WTP).

The last columns of tables 4, 5, and 6 represent the marginal willingness-to-pay for additional use of water for the three water qualities: surface, brackish and recycled respectively. From the tables mentioned above, it could be noticed that, as the average price of current water use increases, the water price that the farmer willing to pay (WTP) was also increased but always at the lower levels compared with the average current price of water use.

6. Conclusions and recommendations

With the growing water problems facing the region of JV, new techniques are needed to manage this valuable economic resource. Although water is essential for human survival this does not imply that governments must deliver all water services to the individual consumer. It is time to consider a change in the traditional role of government in the provision of water resources from that of a builder and provider of all water services to one of a facilitator and regulator of service providers. Failure to decentralize the delivery of water services and the lack of stakeholder, community, and private-sector involvement, has yielded a vicious cycle of unreliable service, low willingness to pay, and a further decline in capacity to provide the services. Inadequate coordination of interstate water resource use and Development has caused over-exploitation and pollution of important surface and groundwater resources. Under pricing of water and the lack of cost recovery has resulted in excessive water use, pollution, resource misallocation, and non-sustainable water service entities.

There are many opposing views about pricing water. Politicians often argue that water must be cheap to ensure that the poor have access to it. Frequently, the poor do not benefit from low tariffs, partly because they lack water connections and they usually use relatively small quantities of water. High-income groups tend to benefit from low tariffs; in addition, most of Jordan Valley farms are shifted from subsistence farms to commercial one. Moreover, when water charges are low, people tend to use it carelessly and not in an efficient way. Under these conditions, the poor involuntarily subsidize the wealthy people.

The cost of production and delivery of a unit quantity of water includes initial investment, operation, and maintenance costs. The price of water or tariff charged to consumers should include costs plus interest on capital, depreciation, expansion, and return on assets. Using this framework, one can cost each new system that is built and then establish appropriate tariffs. Alternatively, costs incurred in setting up new systems can be added to costs of existing ones, for a method of average costing and pricing. Either method has advantages and disadvantages, depending on the political situation, rural-urban balance, and the established institutions that provide water and sanitation services.

The costing and pricing of water do not take into account the willingness to pay. The willingness to pay depends on the beneficiaries' perception but does not necessarily go with the ability to pay, which depends on income. The World Bank estimates that the cost of water should not exceed 5-6% of the incomes of the poorest households. This puts a ceiling on who may be charged a particular tariff. Recently, as a result of inflation and depreciation of local currencies, the cost of production and delivery of water has increased considerably, thus frustrating the problem of cost recovery. The problem of cost recovery in water supply must be approached from an integrated planning framework that combines three considerations:

- The need to supply basic needs at affordable costs, sufficient for the maintenance of public health and appropriate social dignity;
- The need to recognize the market imperfections resulting from the behavior of consumers who are either insulated from price mechanisms or not provided with public education on the cost implications of certain water-use habits; and
- Savings that can be achieved from improved water control in the system (accepting some reduction in reliability of supply at times of water shortage).
- However, there are no data to quantify price elasticities of water demand. Therefore, a large Socio-economic survey should be done in the Jordan Valley area.

Table 1. The current JVA irrigation Water Tariff

Usage Level (m^3)	Tariff ($\$/m^3$)
0 – 1000	0.0114
1001 – 2000	0.0171
2001 – 3000	0.0286
= 3001	0.0500

Source: JVA

Table 2. Costs and Revenues of Irrigation Water in Jordan Valley ($ millions)

Year	Irrigation Water Quantity (MCM)	O & M costs	Capital Costs	Total Costs	Revenues	Deficit/subsidy
1990	214.721	5.29	5.63	10.92	1.22	-6.92
1991	243.121	5.47	5.77	11.24	0.95	-7.35
1992	334.921	6.55	5.19	11.75	0.95	-7.71
1993	276.221	4.23	5.73	9.95	3.29	-4.76
1994	260.921	4.69	6.26	10.95	4.48	-4.62
1995	220.721	5.33	6.30	11.63	3.82	-5.58
1996	225.621	5.61	8.01	13.62	4.23	-6.71
1997	265.021	6.72	7.83	14.55	4.65	-7.08
1998	216.221	5.89	7.97	13.86	5.64	-8.22
1999	233.965	5.98	8.33	14.31	6.23	-8.08
2000	230.592	6.07	8.69	14.76	6.83	-7.93
Average	247.459	5.62	6.88	12.50	3.84	-6.81

Source: Jordan Valley Authority

Table 3. Costs and revenues per one cubic meter of irrigation water in JV ($\$/m^3$)

Year	O & M costs	Capital Costs	Total Costs	Revenues	Deficit/subsidy
1990	0.025	0.026	0.051	0.006	-0.045
1991	0.023	0.024	0.046	0.004	-0.042
1992	0.020	0.016	0.035	0.003	-0.032
1993	0.015	0.021	0.036	0.012	-0.024
1994	0.018	0.024	0.042	0.017	-0.025
1995	0.024	0.029	0.053	0.017	-0.035
1996	0.025	0.035	0.060	0.019	-0.042
1997	0.025	0.030	0.055	0.018	-0.037
1998	0.027	0.037	0.064	0.026	-0.038
1999	0.026	0.036	0.061	0.027	-0.035
2000	0.026	0.038	0.064	0.030	-0.034
Average	0.023	0.029	0.052	0.016	-0.035

Table 4. Responsiveness To Incremental Increase In Surface Water Price

Price $/m3	Planted Area		Water Use		Water Expenses		Total Net Income		Profitability of		Water Price WTP $/m3
	Total ha	Surface Water ha	Total MCM	Surface MCM	Total $ Million	Surface $ Million	Total $ Million	Surface $ Million	Land $/ha	Water $/m^3	
0.05	25,621	11,720	234.1	162.9	9.02	7.26	142.3	112.8	11875	0.811	0.0490
0.10	25,621	11,795	235.2	157.4	16.67	13.80	134.1	102.1	11152	0.776	0.0509
0.15	25,023	12,368	233.0	151.7	23.72	19.71	126.4	91.6	10075	0.735	0.0530
0.20	23,513	10,155	214.0	131.5	27.27	22.18	119.4	73.2	10245	0.704	0.0620
0.25	22,052	8,632	207.1	118.5	30.65	24.08	113.3	59.6	10303	0.670	0.0696
0.30	21,811	8,730	206.0	117.4	36.24	28.56	107.5	54.7	10060	0.622	0.0703
0.35	21,811	8,730	206.0	117.4	42.11	33.32	101.6	50.3	10060	0.572	0.0703

Source: calculated by the researchers

Table 5. Responsiveness To Incremental Increase In Brackish Water Price

Price $/m³	Planted Area		Water Use		Water Expenses		Total Net Income		Profitability of		Water Price WTP $/m³
	Total ha	Brackish Water ha	Total MCM	Brackish MCM	Total $ Million	Brackish $ Million	Total $ Million	Brackish $ Million	Land $/ha	Water $/m³	
0.0050	25,621	3,085	234.6	31.1	8.73	0.40	142.5	1.6	10082	0.052	0.0090
0.0075	25,621	2,736	234.3	24.4	8.81	0.36	142.4	1.3	8905	0.054	0.0115
0.0100	25,621	2,413	234.1	18.1	8.87	0.30	142.4	1.1	7519	0.061	0.0154
0.0125	25,621	2,413	234.1	18.1	8.90	0.34	142.4	1.1	7519	0.059	0.0154
0.0150	25,621	2,413	234.1	18.1	8.94	0.37	142.3	1.0	7519	0.057	0.0154
0.0175	25,590	2,399	234.0	18.0	8.97	0.40	142.3	1.0	7484	0.056	0.0155
0.0200	25,107	2,145	231.6	14.8	8.95	0.36	142.3	0.9	6904	0.063	0.0188

Source: calculated by the researchers

Table 6. Responsiveness To Incremental Increase In Recycled Water Price

Price $/m^3$	Planted Area		Water Use		Water Expenses		Total Net Income		Profitability of		Water Price WTP $/m^3$
	Total ha	Recycled Water ha	Total MCM	Recycled MCM	Total $ Million	Recycled $ Million	Total $ Million	Recycled $ Million	Land $/ha	Water $/m^3$	
0.01	25,621	10,077	234.7	61.5	9.60	1.95	141.6	27.0	6106	0.439	0.0130
0.03	25,107	9,272	232.4	51.3	10.19	2.39	140.7	23.1	5531	0.451	0.0151
0.05	24,923	8,940	230.3	48.5	10.81	2.99	139.9	21.6	5426	0.446	0.0158
0.07	22,853	3,143	211.2	23.0	9.82	1.77	139.5	12.0	7331	0.521	0.0292
0.09	22,785	2,686	210.0	21.5	10.03	1.97	139.1	10.9	7987	0.510	0.0310
0.11	22,133	2,688	202.6	11.5	9.38	1.23	138.9	4.6	4273	0.399	0.0519

Source: calculated by the researchers

Table 7. Price Elasticities For Different Qualities Of Irrigation Water

Quality of Irrigation Water	Price elasticity at actual price	Price elasticity at Mid-point
Surface	-0.0414	-0.9068
All water	-0.0269	-0.4229
Brackish	-0.2930	-1.0052
All water	-0.0101	-0.0344
Recycled	-0.4272	-1.2117
All water	-0.0632	-0.0712

Source: calculated by the researchers

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