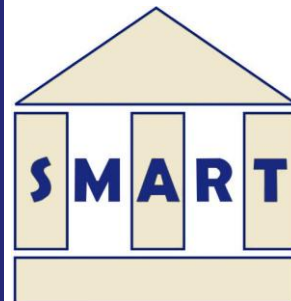


Integrated Water Resources Management in the Lower Jordan Rift Valley

Sustainable Management of Available Water Resources with Innovative Technologies



Work package 7, Deliverable D 703

Assessing the Impacts of Different Water Qualities and Quantities on Farmer Income and Their Economic Situation in the Jordan Valley

Author: Prof. Dr. Amer Salman⁽¹⁾

Author: Prof. Dr. Emad Al-Karablieh⁽¹⁾

⁽¹⁾ **University of Jordan - Amman-Jordan**

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Corresponding author:

Author name: Prof. Dr. Amer Salman
Institution: University of Jordan
Address: Amman 11942 Jordan, P.O.Box 13204
Email: asalman@ju.edu.jo & Drsalmanamer@yahoo.com
Telephone: +962-7-99 203 222

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Project Coordination:

Main Coordinator:	Assistant Coordinators	
Prof. Dr. Nico Goldscheider Institute of Applied Geosciences, Karlsruhe Institute of Technolgy Adenauerring 20b 76131 Karlsruhe Germany Phone: +49 (0) 721 608 45465 Fax: +49 (0) 721 606 279	Prof. Dr. Martin Sauter Department of Applied Geology Göttingen University Goldschmidtstrasse 3 37077 Göttingen Germany Phone: +49 (0)551 39 79 11 Fax: +49 (0)551 39 93 79	Dr. Stefan Geyer & Dr. Roland Mueller Helmholtz Centre for Environmental Research (UFZ) Permoserstr. 15 04318 Leipzig Germany Phone: +49 (0)341 235 30 00 Fax: +49 (0)341 235 2885

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1 Introduction

In Jordan The settlement pattern is heavily influenced by water availability. About 91% of the total population lives in the north - western part of the country, with 58% living in Amman and Zarqa area, The growth in water demand in Jordan has led to the exhaustion of surface water and to the over extraction of ground water.

The Treated Wastewater (TWW) generated at 22 existing wastewater treatment plants for public sector“ treated about 110 MCM in year 2009 (Influent), and the quantity of TWW was about 102 MCM per year (Effluent). is considered as an important component of Jordan’s water resources. Due to the topography and the concentration of urban population above the JV escarpment, the majority of TWW is discharged into various water courses and flows into the downstream of AZB or to the Middle and southern JV where it is used for irrigation (MWI, 2009).

The Treated Wastewater is reused for irrigation purposes with 98.1 MCM/year, would be 53% of the total irrigation water used in the Jordan Valley. The As-Samra treatment plant is the largest in Jordan. Water flows end up in King Talal Reservoir about 24 km downstream of Amman Zarqa Basin (AZB). This water is being used for irrigation in the middle and the southern part of JV after blending it with fresh water. it is worthwhile mentioning that The amount of TWW used in irrigation rose from 59 MCM (10%) in 1996 to 70 MCM in 2006 (20%) nationwide and later increased to 98 MCM (53%) (MWI, 2009).

2 Justification

The premise of carrying out this research is to assess the socio-economic impact of using the treated wastewater compared to the fresh water in the Jordan Valley.

3 Objectives

This Research aiming at comparing between two basins in the Jordan Valley using two different water qualities, namely TWW comes from King Talal Dam (KTD) and blended with fresh water and used for irrigation in first basin (Basin 20) and the fresh water which comes through King Abdullah Canal (KAC) which originates from Yarmouk River in the northern part of Jordan and used in the second basin (Basin 10).

The specific objects of this research aim at making a comparison between the two basins which are irrigated with two different water Qualities by using different economic indicators such as:

- 1- Yield (Kg/du) & Gross Margin (JD/du),
- 2- Profitability (JD/m³) and/or Shadow prices (JD/m³)
- 3- Water quantity m³/du and water content, The requirements of different inputs such as fertilizers, labor

4 Methodologies

4.1: Data Collection

Data Collection process was started in by developing a questionnaire for the purpose of collected data about the gross margins of the different crops in the two basins under study (Basin 10 & 20). these data was used to update gross margins in study area that has been collected previously. Moreover, additional secondary data were collected from the Department of Statistics to update the prices of all crops grown in the area under study. third stage of data update was through the experts opinions, where the researchers have met many farms whom they are characterized with long experience in the field of agriculture in the Jordan Valley.

The population of the study is consisted of all farmers that are growing vegetables in basins 22 & 10 in the Jordan Valley. Basin 10 is irrigated by King Abdullah Canal (KAC) using fresh water and Basin 22 is irrigated with TWW from King Talal Dam (KTD), and blended with fresh water from KAC.

In addition, The study used only secondary data; the secondary data was obtained from different official sources they are; the Ministry of Water and Irrigation (MWI), Department of Statistics (DOS) (DOS, 2010), Jordan Valley Authority (JVA), Ministry of Agriculture (MOA), and from PhD and MSc students.

The data included the following:

1. Gross water requirement for all crops grown in NJV and MJV taken from previous studies and then updated with recent prices (DOS, 2010).
2. Water supply quantities, from JVA (2008 -2010)
3. Cultivated crop areas in both NJV & MJV from DOS 2008-2010.
4. Farm gate prices of crops grown in both NJV & MJV from DOS 2008-2010.
5. Actual cropping patterns DOS 2008-2010.

4.2: The mathematical structure of the LP model

The Linear programming model is consists of two main parts(Salman et al, 2011) and (Doppler et al, 2002); The objective function and the constraints. this structure can be illustrated as follows:

The Objective Function

$$Max Z = \sum_j \sum_m \sum_K X_{jmk} * \left[WRC_{jmk} - \sum_i \sum_m (P_{im} W_{im}) \right] \dots (1)$$

(Z) is the Total Gross Margin (GM), (X_{jmk}) is total planted area by crop (J), and (m) is the water quality (fresh or fresh blended with TWW), (k) is the basin (number 21 and 22), (i) is months (12 months started from October), (j) is vegetable crop types, (WRC_{jmk}) is the Water Related contribution which is the GM of Crop (J) using water quality (m) in basin (k) without subtracting the costs of irrigation water, (P_{im}) is the price of one cubic meter of irrigation water in month (i) of water quality (m), and (W_{im}) is the available water supply in cubic meters in month (i) according to water quality (m).

The model constraints:

These constraints are mainly the Water Constraints, labor, fertilizer and land constraints.

The Water Constraints:

$$\sum_j \sum_m \sum_k a_{ijmk} X_{jmk} + \sum_i \sum_m (-W_{im}^0 - W_{i-1,m}^+ + W_{i+1,m}^-) \leq 0 \dots (2)$$

Where (a_{ijmk}) is the water requirements of crop (j) in cubic meters in month (i) irrigated by water quality (m) in basin (k) , (W_{im}^0) is the total water supply quantity in cubic meters in month (i) of water quality (m). ($W_{i-1,m}^+$) is the water quantity transferred from month (i-1) of quality (m). ($W_{i+1,m}^-$) is the water quantity transferred to the later month (i +1) of quality (m)

The Land Constraints.

$$\sum_j \sum_k \sum_n X_{jmk} \leq A_{kn} \cdots (5)$$

(A_{kn}) is the total allocated area for all crops in basin (k) for crops in the sample (n).

5 ANALYSIS

In this part of the study, Gross Margins analysis results will be discussed and will consider the impact of two different water qualities namely blended TWW and fresh water, depending on different technical and economical indicators that resulted from the analysis.

5.1: Results of the Descriptive Analysis [Gross Margin Analysis]

In addition to other factors, farmers rely on GM of crops to decide which crops are to be grown where farmers normally avoid to grow risky crops with low GM's. When comparing between selected vegetables according to their GM's, productivity per dunum and profitability per cubic meter of irrigation water. Results show that in general there is an increase in the productivity of vegetable crops that are irrigated with BTWW compared to those irrigated with fresh water during Autumn and spring seasons. Consequently, the GM's of crops irrigated BTWW were higher than those irrigated by fresh water, this has been reflect of the profitability of one cubic meter of water. In table 1, the average GM value and the profitability and productivity of one cubic meter of one for vegetable crops irrigated by BTWW was 525.0 JD/du, and 1.439 JD/m³ and 10.351 kg/m³ respectively. While it was 485.1 JD/du and 1.280 JD/m³ and 9.054 kg/m³ for those vegetables irrigated fresh water (Figure 1). During the autumn and spring seasons the situation has not changed where the Gross Margin and the profitability of crops irrigated with BTWW water was higher than those irrigated with fresh water. (for more clarification please see tables in the Annex).

Table 1: Summary of Gross Margins Calculations as an Average for all crops grown in the Jordan in selected basins irrigated by BTWW and Fresh Water

Water Quality		BTWW	Fresh
Total Production	Kg/du	3,913.4	3,585.8
Total Returns	JD/du	811.7	797.1
Total Variable Costs	JD/du	286.7	312.0
Water Quantity	m ³ /du	397.4	433.6
Gross Margin (GM)	JD/du	525.0	485.1
Productivity of Water	Kg/m ³	10.351	9.054
Profitability of Water	JD/m ³	1.439	1.280

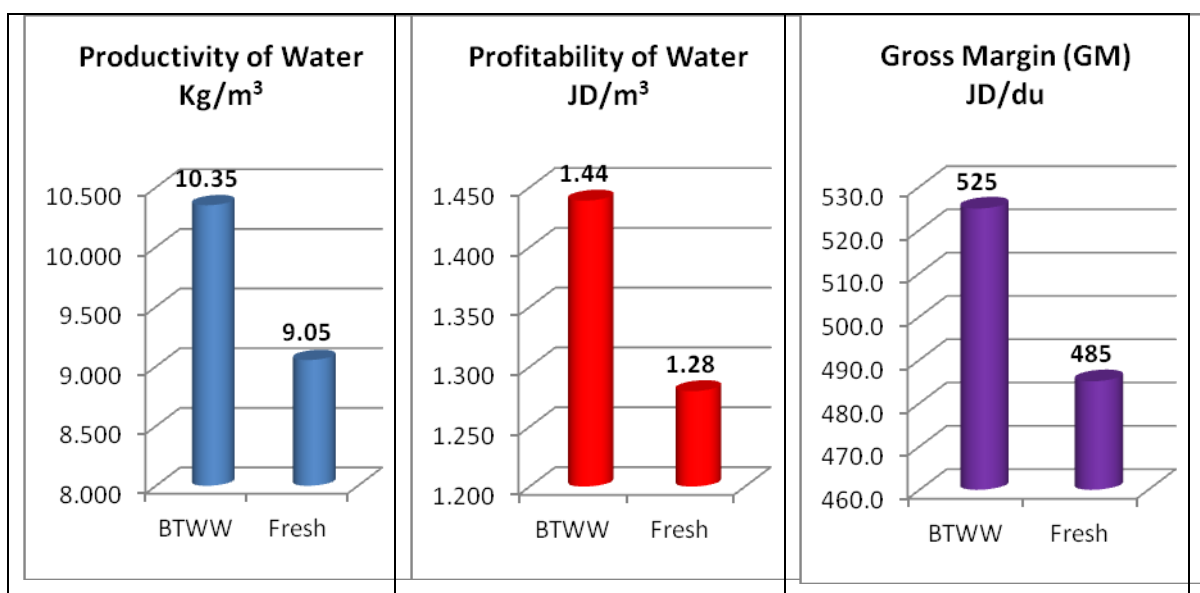


Figure 1: Productivity & Profitability of Water and the Gross Margins of Vegetables grown in Basins irrigated by Blended Treated Wastewater and Fresh Water In the Jordan Valley.

5.2: Results of the Normative Analysis Using different Modeling approaches in the Northern and Middle Jordan Valley

In this part of the study, the analysis is mainly relied on the different sources of data:

- 1- Secondary data from the annual census of the department of statistics for different years.
- 2- Data of the farm management study carried out by the Department of statistics.
- 3- Data collected by the researchers in the study area basins 22 & 10 in the Jordan Valley. Basin 10 is irrigated by King Abdullah Canal (KAC) using fresh water and Basin 22 is irrigated with TWW from King Talal Dam (KTD), and blended with fresh water from KAC.

The total Planted area in the Northern Jordan Valley (NJV) is estimated at about 114 thousand dunums, of which about 49% planted with citrus while the rest is allocated to winter and summer vegetables with about 20.6% and 12.5% respectively and for the cereals and other fruit trees with a summation of 18% of the total planted area in the NJV(Table 2 and Figure 2).

The total Planted area in the Middle Jordan Valley (MJV) is estimated at about 98.0 thousand dunums, of which about 57% planted with winter vegetables while the rest is allocated to summer vegetables with about 17.6% and to the cereals with about 9.7%, citrus with 8.4% and other fruit trees with 7.7% of the total planted area in the MJV. It can be clearly seen that the NJV is specialized with citrus fruits while the MJV is specialized with vegetables mainly winter vegetables (Table 2 and Figure 2).

Table 2: Planted area in Dunums of Cereals, Vegetables and Fruits in the North and Middle Jordan Valley for the year 2010.

	North JV	%	Middle JV	%
Cereals	11,395.4	9.9	9,502.9	9.7
Winter Vegetables	23,602.3	20.6	55,250.3	56.6
Summer Vegetables	14,378.1	12.5	17,184.4	17.6
Citrus	55,849.1	48.7	8,199.0	8.4
Other Fruits	9,344.7	8.2	7,490.4	7.7
Total	114,569.7	100.0	97,627.1	100.0

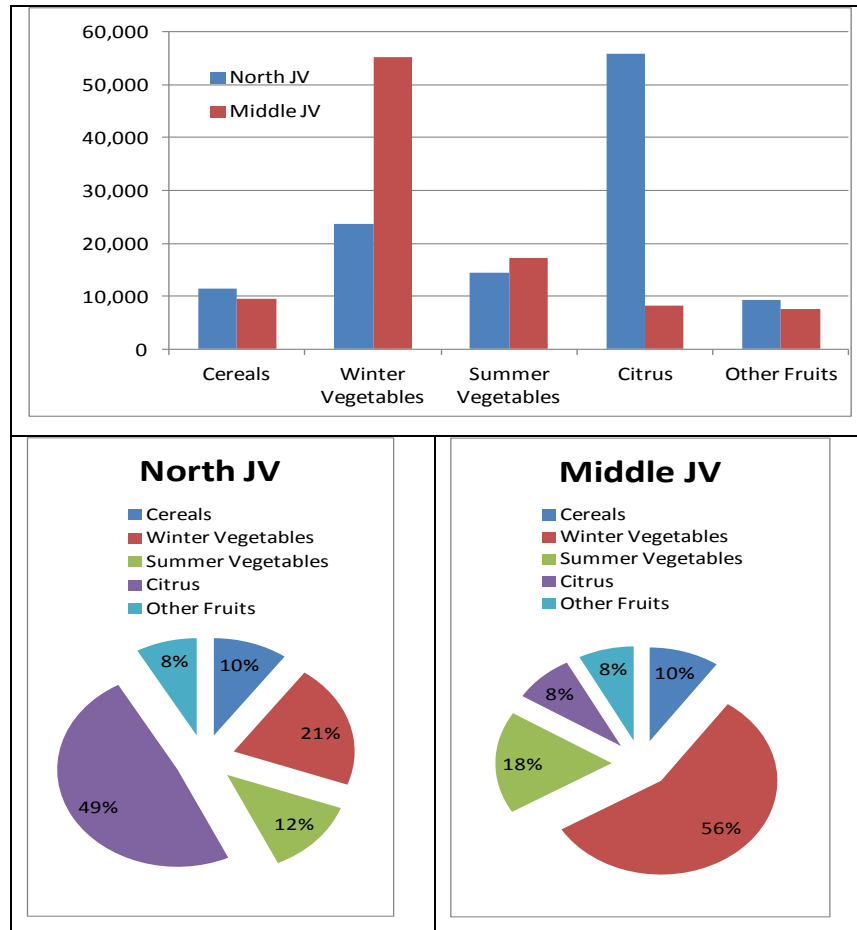


Figure 2: Planted area in Dunums of Cereals, Vegetables and Fruits in the North and Middle Jordan Valley for the year 2010.

As mentioned before, the main aim of this part of this research is to assess the Impacts of using the blended treated wastewater (BTWW) compared with the use of fresh water on the economics of agriculture in the Jordan Valley. Thus in this part of the study, the northern Jordan Valley (NJV) has been select as an area that is irrigated with fresh water and the Middle Jordan Valley (MJV) as an area irrigated with blended treated wastewater. through this comparison the following indicators will be discussed to see the impact of using the BTWW on socioeconomic aspects in the region, these are:

- 1- The impact of using the BTWW on the yield of different crops planted in the NJV and MJV.
- 2- Water consumption, Water content and the productivity of water of the different crop groups that are irrigated using BTWW in the MJV and those irrigated fresh water in the NJV.

- 3- The Total returns, total costs and the net profits for the different crops groups (Cereals, vegetables and fruits) that are irrigated with fresh water in the NJV and those irrigated with BTWW in the MJV.
- 4- The profitability of the shadow prices (JD/m³) for all crop groups namely; Cereals, Winter Vegetables, Summer Vegetables, Citrus and other fruits in the NJV and MJV.

5.2.1, Impact of Using BTWW on the Yield in the study area

Figure 3 shows yields of cereals planted in the NJV and MJV. These crops are Wheat, Barley, Chick-peas, Maize, Sorghum, Garlic and clover. It can be seen that the yield of cereals that are irrigated using BTWW are higher than those irrigated by fresh water, the average yield for cereals irrigated using BTWW was 1.41 ton/dunum in MJV, while it was 1.29 ton/dunum for those irrigated using fresh water in the NJV.

On the other hand it can be clearly seen that the yield of winter and summer vegetables planted in the MJV and irrigated using BTWW, are higher than those vegetables in the NJV which are irrigated with fresh water. For instance the average yield of tomatoes in the MJV was 7.78 ton per dunum while it was 5.99 ton/dunum for tomatoes planted in the NJV. Moreover the average overall yield for winter vegetables was 3.05 ton/dunum in the MJV and was 2.66 ton/dunum for NJV (Figure 4). For summer vegetables the situation did not change, where Figure 5 shows that clear increase in the yield of vegetables that are irrigated with BTWW in the MJV compared to those irrigated with fresh water in the NJV. For example, the yield of summer Tomatoes was 5.07 ton/du in the MJV while it was 4.53 ton/dun in the NJV. The overall average of the yield for summer vegetables was 3.21 ton/dunum for those planted in the MJV while it was 2.54 ton/dunum for vegetables planted in the NJV irrigated with BTWW.

The situation has changed in the case of fruits, the yield of all kinds of citrus irrigated by fresh water (1.85 ton/dunum) was much higher than those irrigated by BTWW in the Middle Jordan Valley where it was 1.28 ton/dunum. The situation for the other fruits exhibited the same manner as in the case of vegetables where the yield of other fruits trees irrigated by BTWW was 1.27 ton/dunum, while it was 1.13 ton/dunum for those irrigated by fresh water in the NJV (see Figure 6).

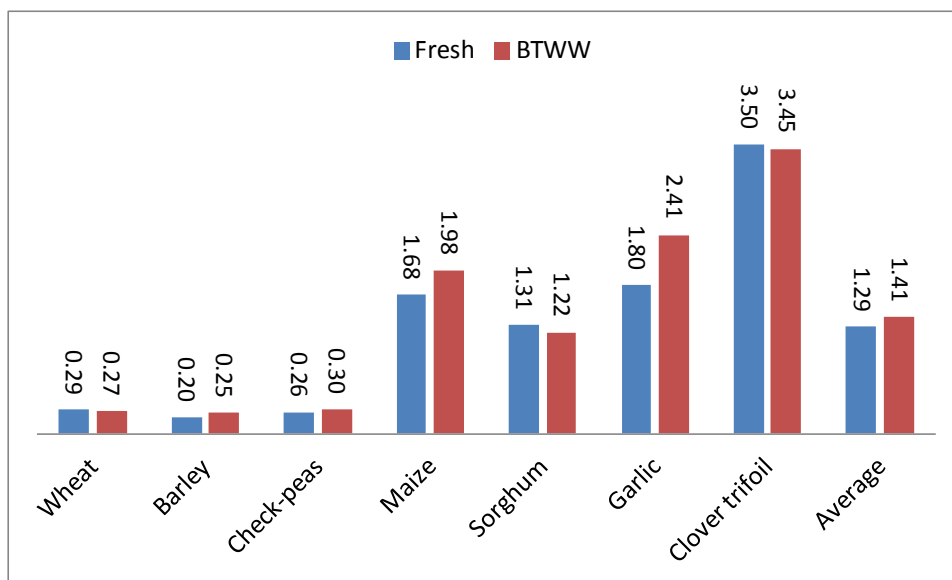


Figure 3: Yield of Cereals in the North (irrigated by Fresh Water) and Middle (Irrigated by BTWW) Jordan Valley in tons/dunum

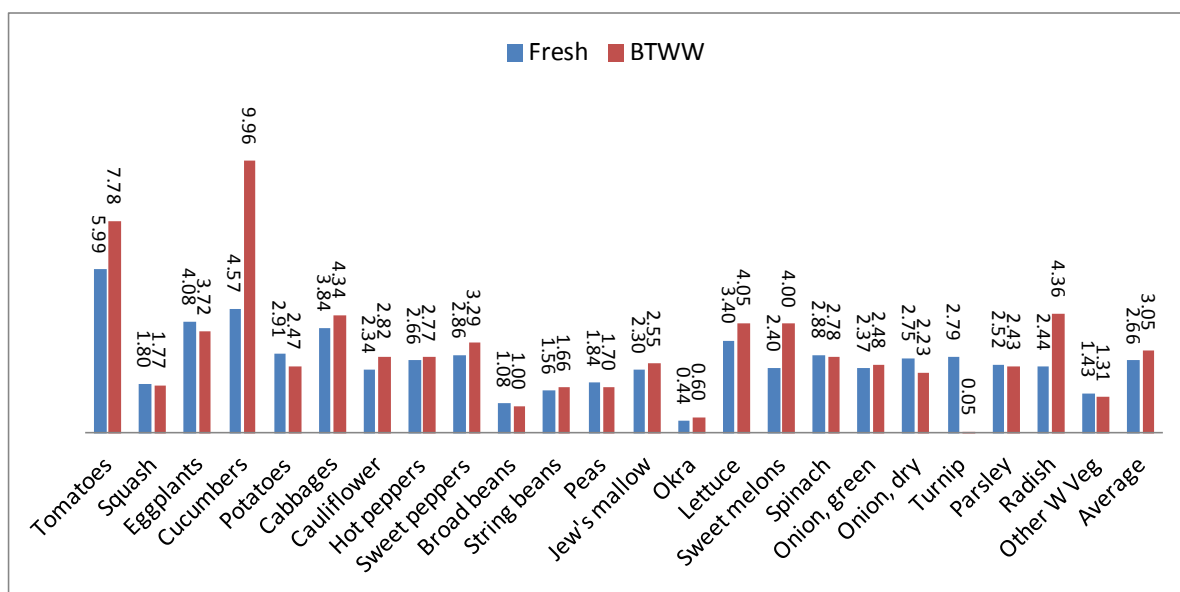


Figure 4: Yield of winter Vegetables in the North (irrigated by Fresh Water) and Middle (Irrigated by BTWW) Jordan Valley in tons/dunum

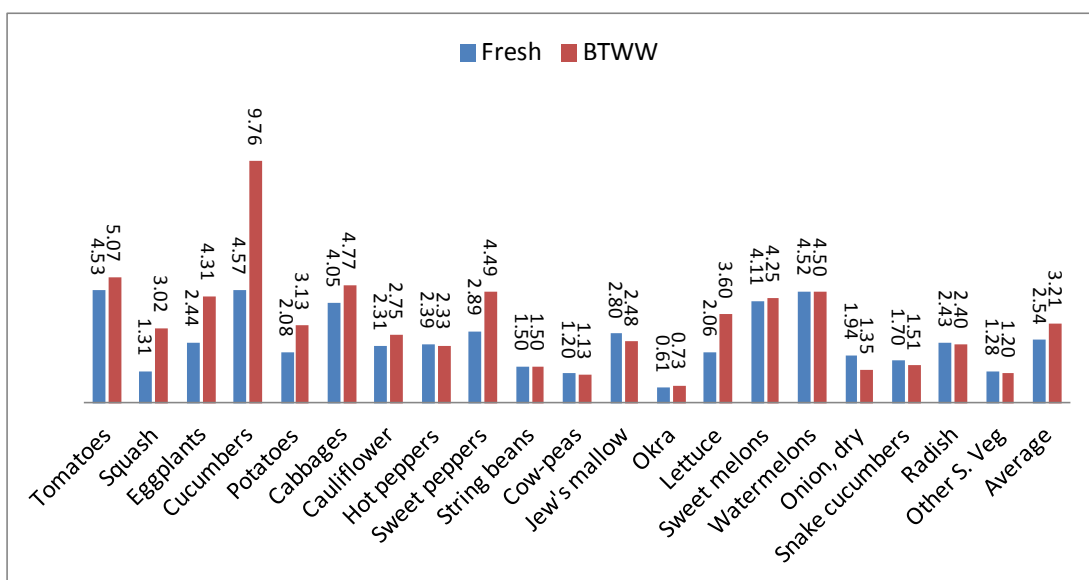


Figure 5: Yield of Summer Vegetables in the North (irrigated by Fresh Water) and Middle (Irrigated by BTWW) Jordan Valley in tons/dunum

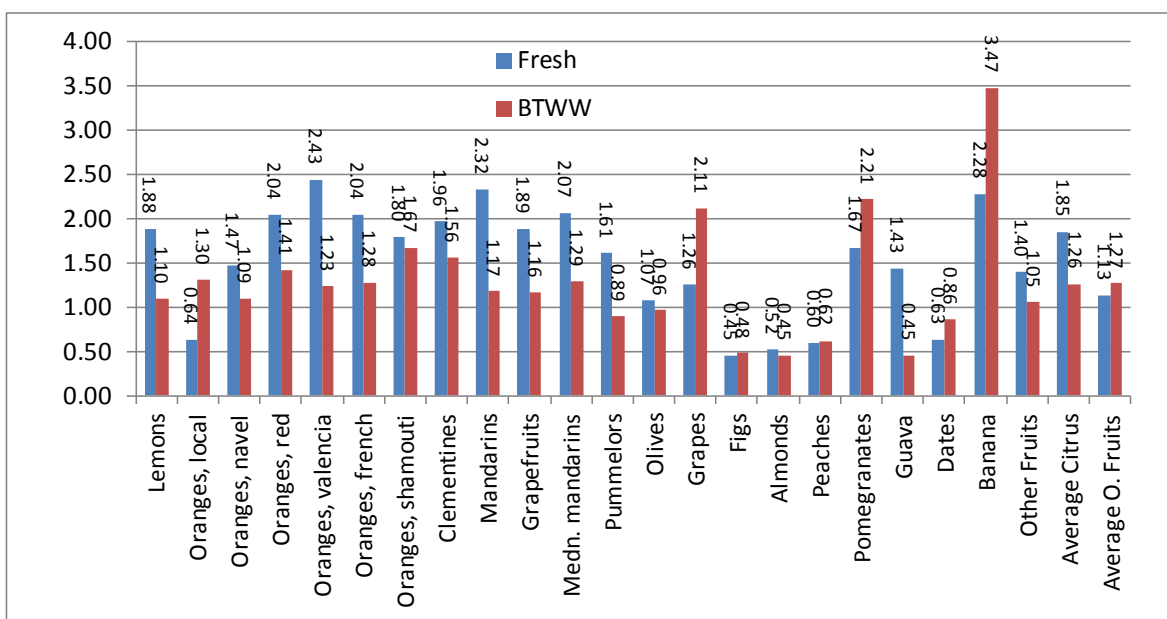


Figure 6: Yield of Fruit Trees in the North (irrigated by Fresh Water) and Middle (Irrigated by BTWW) Jordan Valley in tons/dunum

5.2.2, Water consumption, Water content and the productivity of water of the different crop groups

One of the main outputs of the Model is that Water Consumption (Karablieh, 2011), Water Content and Water productivity, which were calculated in the NJV and MJV. Table 3 shows total water consumption for irrigation water in the NJV was about 78 MCM of which about 71% went to the Citrus. while in the MJV the situation is not biased as it is in the NJV. There is an equity between all crop groups that are irrigated using BTWW in the MJV, where the consumption of winter vegetables from the BTWW was 35% of a total of 44 MCM, while the rest went to Citrus (19%), other fruits (19%), summer vegetables (15%) and to the Cereals (12%), see Figure 7.

Furthermore, water content in crops produced is estimated. it measures how much cubic meters of irrigation water are contained in one ton of crop production. The grand average of water content for all crops irrigated with fresh water in the NJV was 484 m³/ton. However, the average water content for cereals in the NJV was 590 m³/ton, 147 m³/ton and 160 m³/ton for winter and summer vegetables respectively, while it was the highest for fruit trees with about 748 m³/ton (Table 3). The water content in the produced crops in the MJV was higher in the case of Cereals (632 m³/ton), winter vegetables (327 m³/ton) and fruits (925 m³/ton), while it was slightly lower in the case of summer vegetables due to the prevention of summer agriculture during drought periods (Figure 8).

The third indicator after water consumption and water content is water productivity which can be considered as the inverse of the water contents, it measures the productivity of one cubic meter of water in kilograms of crop production. The higher water productive crop groups are the vegetables where one cubic meter of winter vegetables can produce around 10 kg in both the NJV and MJV and about 8.0 and 11 kg/m³ in the case of summer vegetables in the NJV and MJV, respectively. while it was low in the case of cereals (around 2.5 kg/m³) and much lower in the case of fruit trees in the NJV and MJV as well (Table 3 & Figure 8).

This indicator can be the decision maker in drawing the water and the export policy of agricultural crops. It can be clearly seen by using the water productivity indicator, that exporting irrigated fruits is not rational from the water policy point of view. Thus it is better to export low water consumptive crops or high water productive crops to increase the efficiency of water use per kilogram or ton of crops produced.

Table 3: Water consumption, Water content and Water productivity of Selected crops and crop groups produced in the Northern and Middle Jordan Valley

	Northern Jordan Valley			Middle Jordan Valley		
Crop	Water Consumption (m ³) in 2010	Water content (m ³ /ton)	Water Productivity (Kg/m ³)	Water Consumption (m ³) in 2010	Water content (m ³ /ton)	Water Productivity (Kg/m ³)
Wheat	1,070,629	544.3	1.837	165,726	1,010.5	0.990
Barley	325,821	1,020.4	0.980	485,284	992.2	1.008
Maize	143,069	405.0	2.469	3,701,109	365.4	2.737
Clover trefoil	953,972	171.0	5.848	1,086,209	180.9	5.527
Cereals	3,068,846	590.46	2.55	5,485,777	632.03	2.54
Tomatoes	814,010	50.2	19.909	2,758,421	45.5	21.972
Squash	601,602	119.6	8.359	1,634,777	115.0	8.693
Eggplants	178,214	90.7	11.026	1,310,478	75.2	13.303
Cucumbers	635,496	65.3	15.324	3,225,193	34.4	29.059
Potatoes	2,218,712	110.6	9.038	2,688,185	101.8	9.824
Cabbages	138,781	70.0	14.277	389,089	67.0	14.919
Sweet peppers	730,664	132.8	7.529	861,218	92.5	10.814
String beans	124,009	180.2	5.550	199,846	120.4	8.306
Winter Vegetables	6,798,399	147.51	10.13	15,347,573	326.69	10.74
Tomatoes	1,041,051	77.8	12.853	1,350,164	81.1	12.336
Squash	338,428	171.1	5.844	210,191	70.0	14.278
Eggplants	417,505	148.8	6.721	309,585	64.1	15.606
Cucumbers	25,724	63.7	15.709	51,184	31.6	31.664
Potatoes	238,398	99.3	10.072	175,955	87.6	11.421
Cabbages	11,828	73.0	13.696	1,025	71.6	13.957
Sweet peppers	122,175	155.8	6.417	31,215	49.1	20.346
String beans	230,922	182.7	5.474	11,028	150.0	6.665
Summer Vegetables	5,005,124	160.58	8.16	6,567,378	142.55	11.04
Citrus	55,092,988	600.9	1.871	8,579,891	850.9	1.206
Olives	1,492,509	614.7	1.627	484,314	729.9	1.370
Grapes	815,204	621.2	1.610	615,995	383.6	2.607
Dates	1,812,688	2,085.7	0.479	6,519,393	1,619.2	0.618
Banana	2,277,989	469.8	2.128	24,654	373.5	2.677
Other Fruits	8,095,179	921.4	1.49	8,532,302	1014.1	1.46
Fruit Trees	63,188,167	747.5	1.699	17,112,193	925.0	1.323
Total/Average	78,060,536	484.2	4.840	44,512,922	593.2	5.40

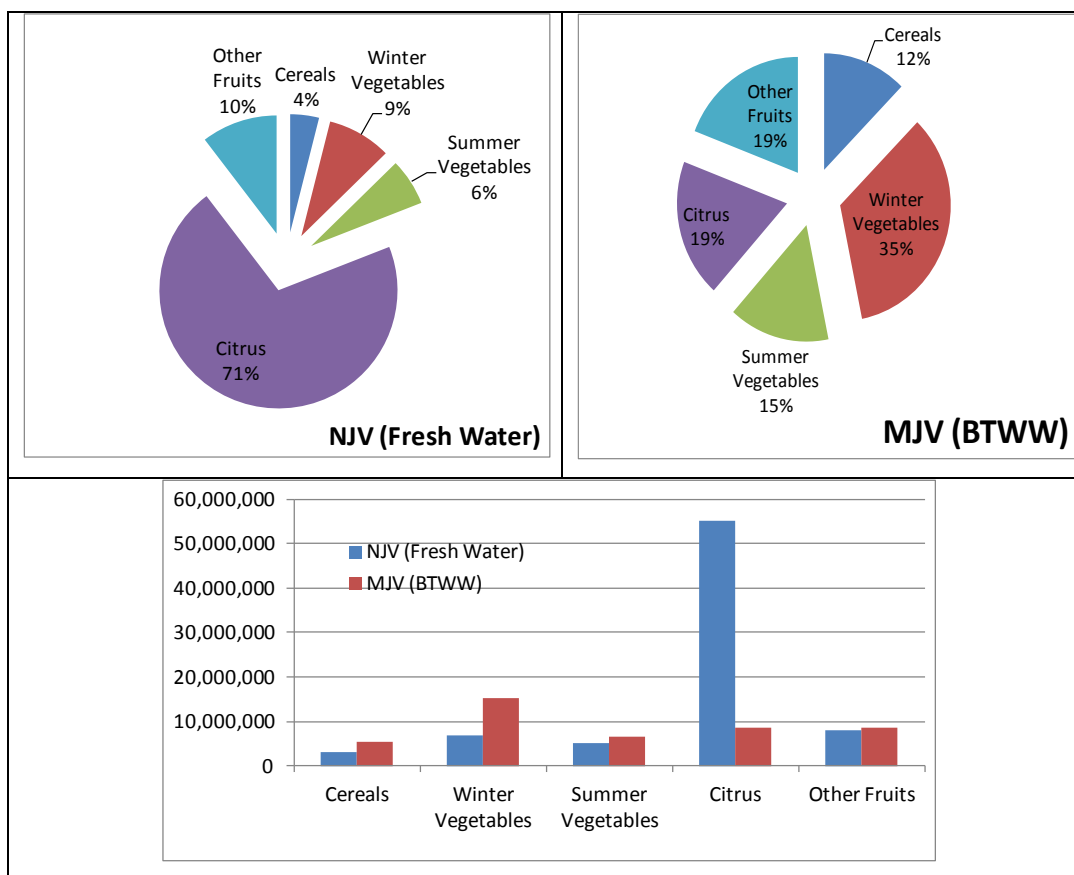


Figure 7: Water Consumption (m3) in 2010 for different crop groups in the North (Irrigated by Fresh Water) and Middle Jordan Valley (irrigated by BTWW).

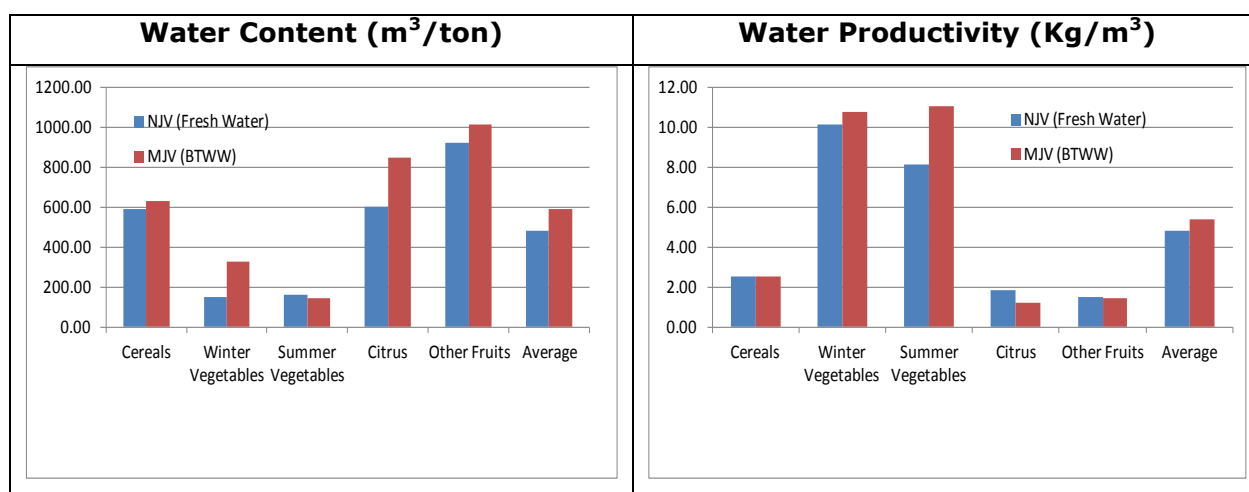


Figure 8: Water content (m3/ton) and Water Use efficiency (Kg/m3) for each crop group in the North (Using fresh Water) and Middle (Using BTWW) Jordan Valley.

5.2.3 Returns, Costs and Profits Agricultural crops in the NJV and MJV

Table 4 shows the returns, costs and net profits for the different crop groups in the MJV (irrigated by BTWW) and in the NJV (irrigated by fresh water). The main results showed that most of crops registered higher net profit for all that are planted in the MJV (199 JD/dunum), which are irrigated by BTWW compared to those planted in the NJV and irrigated with fresh water (188 JD/dunum). It is worthwhile mentioning that citrus is considered as the only exceptional case which has registered higher net profit in the NJV (208) (irrigated by fresh water) compared to those planted in the MJV which have an average net profit of 134 JD/dunum. (Figure 9).

the last indicator that was estimated was the profitability of the water for each crop group in the NJV and MJV. Results show that the average profitability of all crops per cubic meter of BLTWW was 0.518 JD/m³ in MJV, while it was 0.477 JD per one cubic meter of fresh water in the NJV (Table 5). Between all crop groups the higher profitability per one cubic meter was for the winter and summer vegetables. this can be applied for all vegetables irrigated by fresh of BTWW water, on the other hand the fruits were the lowest in their profitability per cubic meter of water, no matter it was fresh of BTWW. (Table 5 and figure 10). Lastly the cost of irrigation water costs represented between 7% for fresh water and 9% in the case of BTWW, it is worthwhile mentioning that the cost of water are determined by the level of price and the amount of water quantity consumed, having in mind that in the Jordan Valley there is no price discrimination between fresh water and BTWW.

Table 4: Total Returns, Total Costs and Net Profits (JD/du) for different crop groups irrigated by fresh water in the NJV and irrigated by BTWW in the MJV

Water Source	Fresh			BTWW		
Crop	Total Return (JD/Dunum)	Total Cost (JD/du)	Net Profit (JD/Dunum)	Total Return (JD/Dunum)	Total Cost (JD/du)	Net Profit (JD/Dunum)
Cereals	310	208	102	360	243	117
Winter Veg.	584	345	239	675	398	277
Summer Veg.	475	293	182	581	357	224
Citrus	571	363	208	393	259	134
Other Fruit Trees	525	317	208	601	359	242
Average	493	305	188	522	323	199

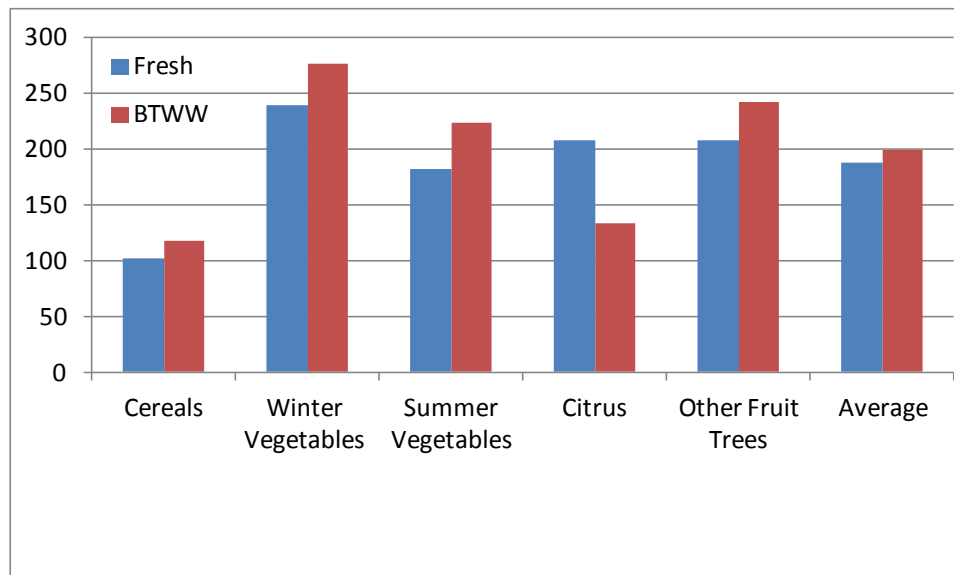


Figure 9: Net Profit (JD/du) for different crop groups irrigated by fresh water in the NJV and irrigated by BTWW in the MJV

Table 5: Profitability per cubic meter of irrigation water for fresh water in the NJV and for BTWW in the MJV and the percentage of water expenses to the total production costs

Crop	NJV (Fresh Water)		MJV (BTWW)	
	Profitability (JD/m ³)	Percent of Water Cost	Profitability (JD/m ³)	Percent of Water Cost
Cereals	0.267	10%	0.264	11%
Winter Veg.	0.942	3%	1.040	6%
Summer Veg.	0.642	4%	0.835	4%
Citrus	0.241	9%	0.158	13%
Other Fruits	0.293	10%	0.293	10%
Average	0.477	7%	0.518	9%

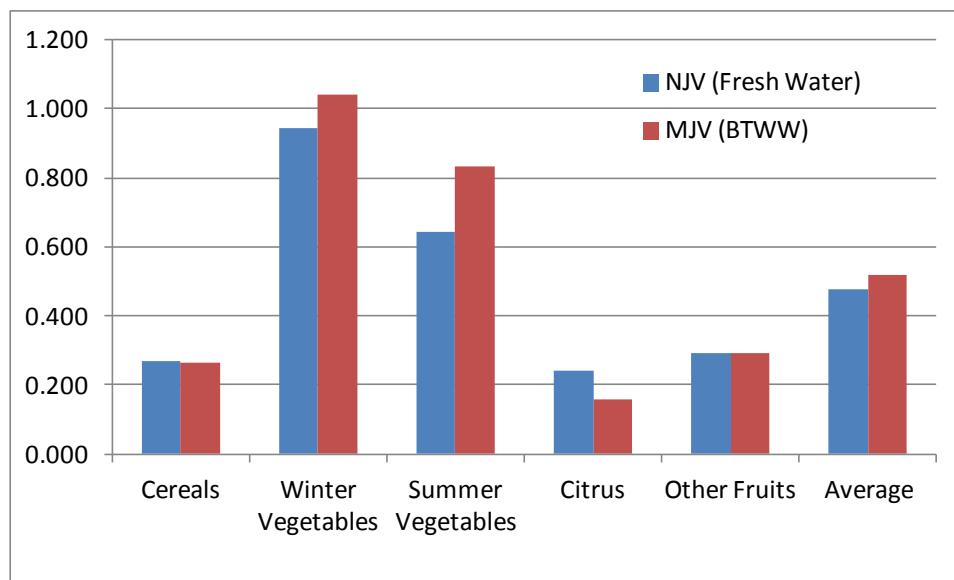


Figure 10: Profitability per cubic meter of irrigation water for fresh water in the NJV and for BTWW in the MJV and the percentage of water expenses to the total production costs

6 Conclusions

One the most important conclusion is that using the blended treated wastewater has a high potentiality and advantage compared to its counterpart the fresh water in the Jordan Valley, but the BTWW quality has to be kept with the technical standards to make the use for the BTWW in the long run still possible in a profitable way.

Results showed that agricultural crops produced using BTWW has higher yields, lower water content and higher productivity compared to those produced under fresh water. Thus keeping the use of BTWW in high standards, would open many opportunities to the agricultural products in the foreign markets and would increase the income generated from foreign trade of agricultural products and at the end increase contribution of agricultural sector in the GDP.

The agricultural policy shall be oriented to plant those vegetable crops that are low water consumptive and highly productive and to give up exporting those crops with high water content, so we export water from poor water country to rich water countries.

As time is running the scarcity of water will increase and the government will divert more fresh water from agriculture to other domestic uses especially with the increase of demand due to the increase in population. In addition, the supply of TWW will increase after implementing the DISI and Red-Dead projects. This would give the opportunity to use TWW in agriculture not only in the Jordan Valley, but in the Highlands to reduce the over pumping of ground water in the highlands.

7 References

Amer Salman, Emad Al-Karablieh , Abbas Al-Omari, Iyad Hussein & Tamer Al-Assad (2011):
Water Allocation Model (WAM), 1st Water and Environment International Conference
26-29 October, Marrakech, Morocco.

Department of Statistics / DOS (2010): Agricultural Survey Census.

Emad K. Al-Karablieh, Amer Z. Salman, Abbas Al-Omari, Heniz-Peter Wolff, Tamer Al-Assa'd,
Ali Subah (2011). Estimation of the Economic Value of Irrigation Water in Jordan. 1st
Water and Environment International Conference. 26-29 October, Marrakech, Morocco.

MWI (2009): Water for Life. Jordan's Water Strategy 2008-2022. Rev. 10.270309

Werner Doppler, Amer Salman, Emad K. Al-Karablieh and Heinz-Peter Wolff (2002): "The
impact of water price strategies on irrigation water allocation under risk - the case of
Jordan Valley" Agriculture Water Management, Volume 55/3, 2002, p 171-182.

ANNEX -A-

Table 1: Summary of Gross Margin Calculations as Comparison between Blended Treated Wastewater and Fresh Water during Autumn Season in The Jordan Valley.

Water Quality		BTWW	Fresh
Total Production	Kg/du	4,359.5	3,877.2
Total Returns	JD/du	874.5	788.1
Total Variable Costs	JD/du	354.2	339.4
Water Quantity	m ³ /du	408.3	468.4
Gross Margin (GM)	JD/du	520.3	448.7
Productivity of Water	Kg/ m ³	11.687	9.417
Profitability of Water	JD/ m ³	1.347	1.102

Figure 1: Productivity & Profitability of Water and the Gross Margins of Vegetables grown in Basins irrigated by Blended Treated Wastewater and Fresh Water In the Jordan Valley during the Autumn Season.

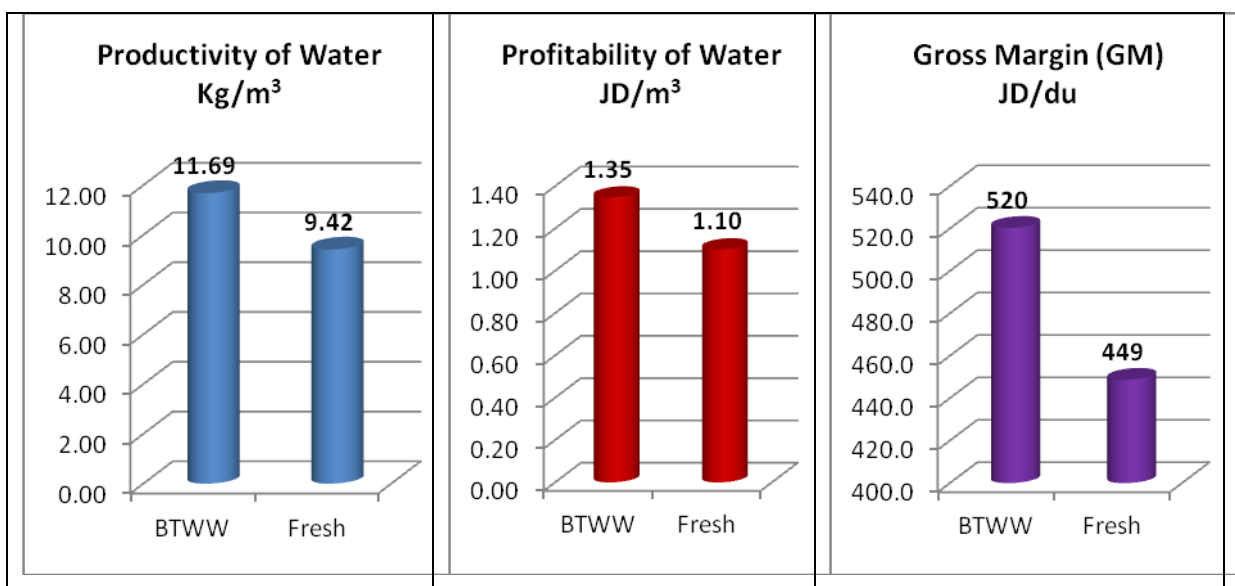


Table 2: Summary of Gross Margin Calculations as Comparison between Blended Treated Wastewater and Fresh Water during Spring Season in The Jordan Valley.

Water Quality		BTWW	Fresh
Total Production	Kg/du	3,398.7	3,294.3
Total Returns	JD/du	739.2	806.2
Total Variable Costs	JD/du	208.9	284.7
Water Quantity	m ³ /du	384.8	398.7
Gross Margin (GM)	JD/du	530.3	521.4
Productivity of Water	Kg/ m ³	8.810	8.690
Profitability of Water	JD/ m ³	1.545	1.458

Figure 2: Productivity & Profitability of Water and the Gross Margins of Vegetables grown in Basins irrigated by Blended Treated Wastewater and Fresh Water In the Jordan Valley during the Spring Season.

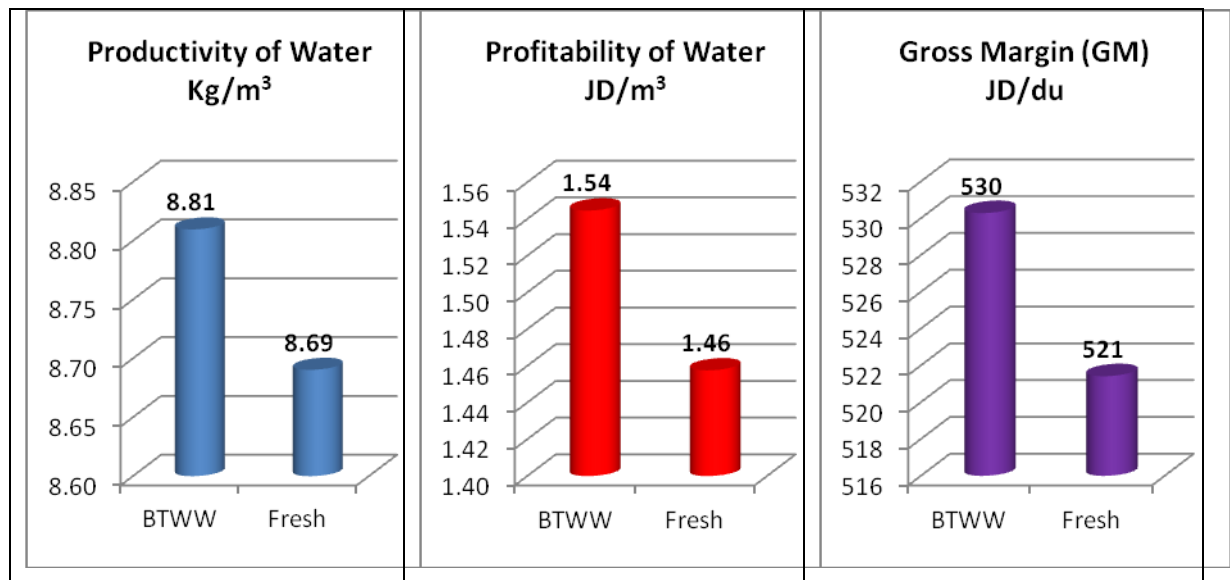


Table 3: Summary of Gross Margin Calculations as Comparison between Blended Treated Wastewater and Fresh Water under the Plastic Houses in The Jordan Valley.

Water Quality		BTWW	Fresh
Total Production	Kg/du	5,533.2	5,357.8
Total Returns	JD/du	1,134.4	1,225.0
Total Variable Costs	JD/du	455.1	526.4
Water Quantity	m ³ /du	442.4	512.1
Gross Margin (GM)	JD/du	679.3	698.6
Productivity of Water	Kg/ m ³	13.678	12.953
Profitability of Water	JD/ m ³	1.683	1.616

Figure 3: Productivity & Profitability of Water and the Gross Margins of Vegetables grown in Basins irrigated by Blended Treated Wastewater and Fresh Water In the Jordan Valley under Plastic Houses.

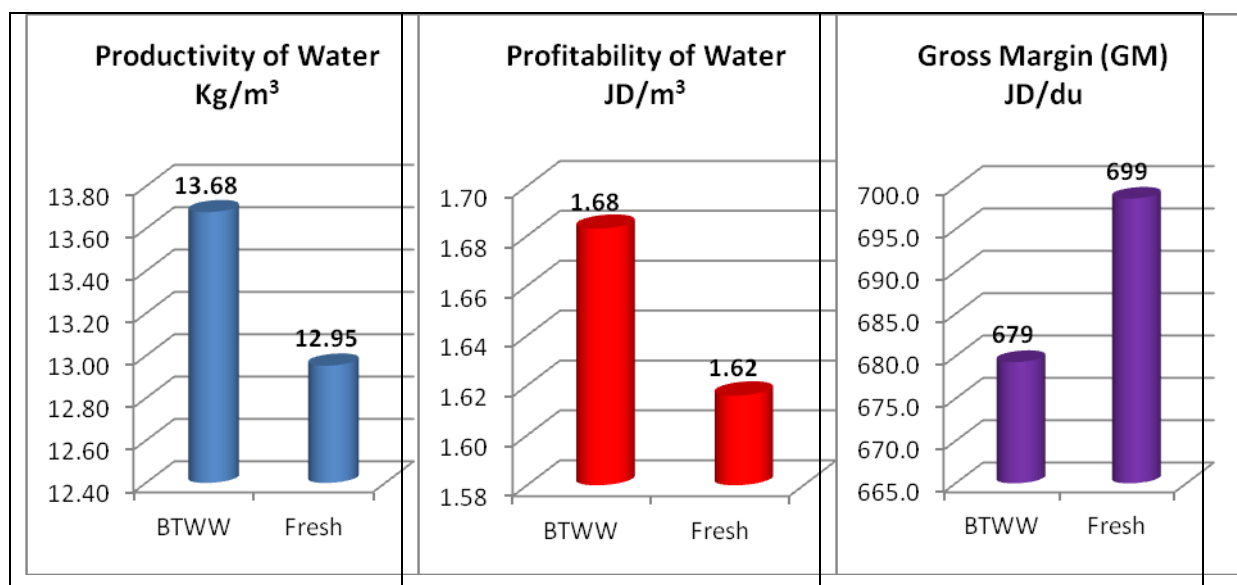


Table 4: Summary of Gross Margin Calculations as Comparison between Blended Treated Wastewater and Fresh Water in the Open Field in The Jordan Valley.

Water Quality		BTWW	Fresh
Total Production	Kg/du	3,018.6	2,559.8
Total Returns	JD/du	650.4	549.4
Total Variable Costs	JD/du	201.3	188.0
Water Quantity	m ³ /du	372.6	388.1
Gross Margin (GM)	JD/du	449.1	361.4
Productivity of Water	Kg/ m ³	8.536	6.796
Profitability of Water	JD/ m ³	1.337	1.085

Figure 4: Productivity & Profitability of Water and the Gross Margins of Vegetables grown in Basins irrigated by Blended Treated Wastewater and Fresh Water In the Jordan Valley in the Open Field Production.

