THE ROLE OF SUPPLEMENTARY IRRIGATION FORFOOD PRODUCTION IN A SEMI-ARID COUNTRY - PALESTINE

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ABSTRACT

Palestine consists of the West Bank and the Gaza Strip. The proclaimed state of Palestine has a land area of 6,657km³. Water is always considered as an essential factor of life and development in arid and semi-arid countries. In Palestine the total per capita water consumption is 139m³.

- The total available water for Irrigation is 239 MCM which is responsible for irrigating only 330,000 dunums out of 2,314.000 dunums cultivated that can be irrigated if water is available i.e. 5% of the total cultivated land.
- The average rainfall is 450mm and unfortunately there isn't any water harvesting structures i.e. dams, most of this rainwater flowing towards the Dead Sea or the Mediterranean Sea as waste. So harvesting this water in individual farmer land and using this water for supplementary irrigation to irrigate olive trees, almonds, grapes and cereals will be of a great impact on the Palestinian land for feed production. It should be noted that there are few farmers who practice supplementary irrigation for production of vegetables that are planted in summer as individual initiative. The quantity and quality of production that they have is extremely tangible.
- Since most of the land in Palestine is planted by olive, grape, and cereals, supplementary irrigation should be introduced and practiced where the production of wheat via irrigation by treated

wastewater was three times that under rain fed planting project implemented in a pilot project.

Reuse of treated wastewater for irrigation as supplementary irrigation will increase the irrigated area in Palestine and will replace the fresh water that can be used for domestic purposes.

The Need for Supplementary Irrigation in Palestine

As it was mentioned before, Palestine is a semi-arid country, where the average rainfall is 450mm. The availability of water is questionable. Furthermore, the availability of water for agriculture is reducing in a tangible way due to the followings:

1. The normal increase in growth rate, the population of the country is increasing, so the demand for domestic water is also increasing. This will affect the availability of water for agriculture.
2. Since rainwater is the only source of water, the quantity of rainwater (rainfall) has been decreasing in the recent years.
3. There is a huge conflict on water issues at this stage between the Palestinians and the Israelis since Israel occupied Palestine. It should be mentioned here that during early negotiations in the peace process, four main issues have been delayed since 1992; they are Jerusalem, refugees, water and borders. Still after 8 years of negotiations, there hasn't been any significant movement on these issues. So the quantity of water that can be available for the Palestinians will probably not be increased.
4. The quality of ground water wells especially in Gaza and Jericho becomes saline and shortly it cannot be safely available for agriculture.

From the above, it seems that extra availability of water for additional irrigated area or even to sustain the irrigated area is not an easy task.

Total cultivated area in the West Bank is 2,100.00 dunums, but the irrigated area is 110,000 dunums. From the small experience (pilot project) for this field as well as other country experience i.e. Syria. It has been proven that the production of crops under supplementary irrigation is 3 times higher than under rain fed crop, in addition to the increase in the quality of the product. So if supplementary irrigation has been practiced we can easily increase the production of rained crops to three times or twice. This will play a major role in providing

food for the people and even exports can take place and the net income of the country will be increased.

BACKGROUND

It is foreseen that the world's food production has to be doubled in the next 25 years, and thus, the agriculture continues to be an important sector in the 21st century. Meanwhile, the agriculture sector remains the largest user of the water resources, and it is evident that there is a decline of agricultural water due to increasing demands from cities, industries, and hydropower utilities in the developing countries such as Asia. Much of the water has to come from irrigation water savings.

Population and economic growth in many developing countries of Asia have created serious problems, such as the shortage of food, the scarcity of water, and the deterioration of the environment.

Some of the irrigation and drainage projects have been seriously criticized due to their high-cost and low-efficiency for the construction and maintenance. The concept of maximum yield is now changing to optimum yield for creating an efficient irrigation schedule. The water saving is the most sustainable conservation, because it reduces the new construction needs to meet the increased water demand. The major issues of agricultural water are how to increase withdrawals about 15 – 20% by water saving, how to increase storages 10 – 15% by new irrigation facilities, and how to conserve the water quality of irrigation.

INTRODUCTION

Historical Palestine is located between the Mediterranean Sea and the Jordan River, as well as to the Red Sea from the south. The present proposed Palestinian state consists of West Bank and Gaza Strip. The other part of Palestine is occupied by Israel in 1948. This study focuses on the West Bank and the Gaza Strip. The proclaimed state of Palestine has a land area of 6657 square kilometres (Kateeb 1993). Population senses has been taken place recently by the Bureau of Statistics early 1998. It is reported that the population of the West Bank is 1571571 and Gaza Strip is 963026 where the total population of the Palestinian people is 2534598 people.

Ground water is the main water source in the country. It is recharged by rainfall. Rainfall varies from 100mm in the south east to 800 mm in the north. The average rainfall is 550mm (Sbeih - 1995). Where the average rain fall in Jordan Valley is from 100 mm to 270 mm/year (Zaru - 1992), and in Gaza is 200 - 400 mm/year (Abu Safieh - 1991).

Not all the rainwater is available to the Palestinian due to Israeli Military orders. Water is abstracted from the ground water through 340 wells in the West Bank and 1781 wells in Gaza. In addition to that springs contribute a lot, where half of the irrigation water in the West Bank is due to springs.

The quality of the available water varies from almost rain water to Brackish water. In the Jordan Valley where it is the lowest point in the elevation in the world where temperature is very high in this area especially in summer. As example, the chloride content is reaching 68 mg/l and the SAR reaches 11.7 where the TDS reaches 5000PPM. Still the utilization of this saline water is not as efficient and environmentally safe as it should be where further utilization of this water could play a major role in developing the area where still the irrigated area consists of not more than 6% of the cultivated area in the West Bank.

It should be mentioned that not only saline water does already exist and utilized unproperly, but it also seems to be that the additional water that can be allocated for irrigation is also saline water which is going to be from:

1. The Eastern aquifer to be used in Jordan Valley
2. From the treated waste water from different cities and villages in the West Bank

WATER SOURCES IN OCCUPIED PALESTINE

a) West Bank

Two main water sources are available for Palestinian in the occupied Palestine (West Bank and Gaza Strip) for agricultural, domestic and industrial use. These are rainfalls and ground water sources - Palestinians consume water mainly through ground water wells and springs (where rainfall is considered the main recharge). The total

annual water springs discharge varies according to the rainfall. The total annual flow of the 113 fresh water springs in the West Bank ranges between 24 MCM (as in the year 1978/79) to 119.9 MCM (as in the year 199/92) and with an average of 52.9 M.C.M. as calculated from the annual flow in the past 24 years. Around 86% of the total annual flow of these 113 springs is within the eastern drainage (in/or toward the Jordan Valley), while the other 14% is within the western and south-west (Nusseibeh 1995) where the total estimated annual water discharge from ground wells is 60 M.C.M. (Awartani 1992). So that the total annual water available to Palestinian is 113 M.C.M. In addition to that there is another 2.5 M.C.M. is collected directly from the rainfall in cisterns in Palestinian houses. So that the total available water is 116 M.C.M./year, for more information see Table No. I.

b) Gaza Strip

Water situation in Gaza Strip is very critical. The Gaza Strip lies on top of two water strata. The upper is fresh water, the lower carries saline water. The annual consumption of water is at present in the vicinity of 100 M.C.M. These aquifers get replenishment of some 60% leaving a deficit of 40 M.C.M. of water (Shawwa 1991).

Even the Gaza water is lower in quality than West Bank, but due to the complication of the situation there and due to the geographic location where my work is more in the West Bank. This paper will address West Bank issues more clearly.

Basic land and water indicators for Israel and the Occupied Palestinian and other Arab territories

(1dunum = 1,000 m^2)

	West Bank	**Gaza Strip**	**Israel**
Total area (dunums)	5 573 000	360 000	20 000 000
Population (1988)	900 000	600 000	4 300 000
Area of land cultivated (dunums)	2 100 000	214 000	4 250 000

Area of land irrigated (dunums)	110 000	120 000	850 000
Percent of total irrigated land	5	56	44
Percentage of total land cultivated	38	59	21
Annual water consumptoin for irrigation (million m^3)	95	80	1320
Annual water consumption for households (million m^3)	27	21	325
Annual water consumption for industry (million m^3)	3	2	125
Total annual water consumption (million m^3)	125	103	1770
Total per capita water consumption (m^3)	139	172	411
Per capita water consumption per household (m^3)	30	35	75
Per capita water consumption for industry (m^3)	3.3	3.3	29
Per capita water consumption for irrigation (m^3)	106	133	307

Source: Israeli land and water policies and practices in the occupied Palestinian and Arab territories, unpublished study in Arabic (Economic and Social Commission for Western Asia, Baghdad, 1990), p. 8

IRRIGATED AREAS IN THE OCCUPIED PALESTINE

In Palestine, being a semi arid country, we are confronted by a demographic growth, and agricultural development as well livestock and industrial development. Thus in essential growing water requirement makes the rational management of water resources supremely important in order for development to be lasting and for environment to be served.

On a global basis at least 60% of all water abstracted at present is used for agricultural production. In Palestine 70% of all water consumed is due to agriculture.

Here in Palestine, agriculture is considered to be one of the main national income. Agricultural production contributes 47.61% of the total national income in 1970.

The potential for irrigation to raise both agricultural productivity and the living standards of the rural poor has long been recognized. Irrigated agriculture occupies approximately 17% of the world's total available land but the production from this land comprises about 34 % of the world total.

In Palestine, irrigation is considered to be the spinal chord of plant production for the following reasons:

1. Palestine is considered as a semi arid region where some of the crops cannot be grown without irrigation (example, citrus).

2. In the Jordan Valley, which constitutes the main agricultural production for the country, irrigation is a must due to low rainfall and high temperature.

3. With irrigation the same plot of land can be planted up to three times per year while it cannot be planted more than two times with dry farming.

4. Different varieties and crops can be planted in any region due to the availability of water i.e. more flexibility of planting several crops at different regions in different times of the year.

5. **Job creation:** Since the labour requirement per irrigated durum is more than double that of job required per dry farming per one season. This has now become more vital due to continuos of closures of the West Bank and Gaza Strip where the number of labourers that are working in the Palestinian part that occupied in 1948 is sharply reduced.

6. Agricultural production is much higher for irrigated farming than for dry farming per dunum per season. As example average tomato production per dunum is as follows:

- Dry farming: 2-3 ton per dunum per season.
- Irrigated (open land) 6-8 ton per dunum per season
- Irrigated (greenhouse) 12-16 ton per dunum per season

7. Net income per dunum of dry farming does not exceed $150 while from irrigated area the net income can exceed $1500 per dunum

8. Especially in Palestine, where the horizontal expansion in agriculture by increasing the total cultivated area due to the Israeli occupation, and shortage of water. The vertical expansion could be the main parameter to play with. Irrigation will be the main element in this formula. So that providing extra water for irrigation to irrigate as much as possible of the cultivated area is a must. This implies that Palestinian should use any drop of water. Regardless the quality of that water practically and efficiently:

Table no. 2 shows the irrigated area in each district in Palestine where the total irrigated area in 1993-94 was 217,000 dunum (PSBS 1996).

AVAILABLE AREA THAT IS READY FOR IRRIGATION

Where in Gaza Strip the irrigated area could be doubled or tripled in terms of topographical situation but due to the limitation of the water both quality and quantity it is very difficult to increase the irrigated area while in the West Bank the area that could be irrigated in terms of topographical conditions estimated to be 535 thousand dunums (Awartani 1991) as in table 3.

Table 1. Distribution of area that could be irrigated in the West Bank

Location	Dunum
Plains in Jenin and Tulkarem	**99,600**
High land	**277,40**
Eastern slopes	**64.6**
Jordan Valley	**93.5**
Total	**535.1**

Source (Awartani 1991)

Where in the study conducted by PWA in 1992 in order to develop a plan for the western Ghore the following locations could be the most suitable area to be ready for irrigation:

1. Northern Ghore

The areas suitable for irrigated agriculture in this region include:

18000 dunums in Ein Al Beida, Bardalla villages
5300 dunums in the Ghore
3500 dunums in the Ghore

But the Ghore and Zhor areas are mostly closed by the Israeli Military orders.

2. El-Bique Valley

This is a large flat area to the west of the hills of northern Ghore. This area includes about 18500 dunums of fertile smooth deep soil. The Palestinian farmers as rainfed excluding 5500 dunums where the two settlements their (Baquat and Roi) are occupying cultivate all this area.

3. Upper El Fara' valley area (Semi-Ghore)

In this area, there are 13100 dunums that are suitable for irrigation and can be easily irrigated as follows:

Sahl Tubas	3600 dunums
Sahel Tayassear	900 dunums
Sahel Tammun	1900 dunums

Sahel El Fara'	5000 dunums
El Nassarieh (additional)	1700 dunums

Where there are another 7000 dunums, which are already irrigated.

4. The Middle and South Ghore

This region extends from approximately grid north 180 (northern of Marj Najeh) in the north to the Dead Sea in the south and from the Jordan River in the east to the feet of the west-bank mountains.

The total area that could be ready for irrigation in this area is 145500 dunums. In summary, the total area that can be used in irrigated agriculture in the western ghore will be:

Northern Ghore	26800 dunums
Biquia valley	18500 dunums
Semi-Ghore	201000 dunums
Southern Ghore	145500 dunums
Total	210900 dunums

Where about 44000 (PCBC 1991) dunums of this area is currently irrigated. So the total additional area that could be irrigated in the West Bank is (210900 - 44000 + (535,100 - 93,5000) = 608500 dunums.

It should be mentioned that the Jordan Valley produces more than 59% of the vegetables produced in the West Bank. It also produces 100% of the bananas produced in Palestine.

PALESTINIAN EXPERIENCE OF SUPPLEMENTARY IRRIGATION

Still the term supplementary irrigation is not even used formally and officially in Palestine. Until this time there is not any plan of implementing any project of supplementary irrigation. This is mainly due to the lack of qualified staff at the Ministry of Agriculture as well as to the lack of great interest to agriculture from M.O.A. due to the following reasons:

1. The lack of responsibility of the Palestinian Authority on most of the agricultural land due to the occupation.
2. The lack of finance and funding to development projects.

Nevertheless, there are individuals who attempt to use supplementary irrigation, an example of that are few farmers in Sinjel town in the Ramallah area.

DESCRIPTION OF AGRICULTURAL AREA IN SINJEL

This village is located just between Ramallah and Nablus cities, situated 20km to the north of Ramallah. The total agricultural area in the village excess 4000 dunums, out of these areas. About 1000 dunums are plain and flat.

This 1000 dunums is planted with vegetables in summer and cereals in winter. All of this area is rain fed, there are no source of water for irrigation since this area is located close to the village (houses), it is easy for the farmers to bring water by mobile tanks.

Usually the farmers in summer, bring some water and store them in a container (barrel) of 200 liter capacity each, since the ownership of land is between 3-5 dunums, the number of barrels used are 6-8.

In summer farmers used to plant vegetables, at the time of planting the seedlings, farmers used to irrigate the seedling by a bucket. Farmers used to mix the fertilizer water and irrigation at the time of planting the seedlings. Later on, after 20 days the second irrigation with fertilizer is applied. The third one and the last one are provided with fertilizer before flowering. The total amount of water applied per each plant is not more than 1 liter, for a dunum of 1000 plants, 1000 liter is applied 1 cubic meter of water applied for the whole season per one dunum. While for the irrigated area the minimum irrigation water requirement is 70m^3/dunum per the season.

In this village, Singel, and through my investigation, in the year 2000 I found 3 farmers who are using this approach technology, when I asked one of them what is the result that you will expect, he broadly replied:

1. The quality of agricultural product that I used to obtain for the last two years where I used to use supplementary irrigation is much better than the product of my neighbor in the same plot of land in the village, so the price per 1 kg. That I got is much higher also.

2. The total production is much higher than that of my neighbor, i.e. I got 4 tons each per dunum, my neighbor got 2 tons of squash per dunum.

3. The period of production that I have is much bigger than that of my neighbor has, this means that total income that I gained is much higher. I used the produce vegetables for 2 months, while my neighbor only one month, i.e. the harvesting period is much higher when supplementary irrigation used.

I informed this farmer that I am working on an irrigation project coordinator for an NGO that provides funds for farmers. Since this farmer believes that he was happy from his production since he has only 3 dunums and all of his family working in this plot of land, he did not ask what service that since that we offered, this totally indicated that he is happy, and he did not need any further assistance. At that time there was visiting irrigation professor from Canada. This professor told me that we should use him as a model to encourage people using appropriate technology.

Another example of using supplementary irrigation is found in Hebron where a farmer from Al Tamimi family, who has a grape field and luckily a pipe water pass through his field and used to get some water from this pipe and provide some water for his grape. In winter since the rainfall in Hebron is not exceeding 300mm, as well as in July.

It is well known in Hebron, that the quality of grape of that man is the best in Hebron, since Hebron is of the biggest producing city (country) in Palestine.

Since the municipality constructed a pilot treatment plant, it thought of planting crops using the treated effluent. This was funded by American Near East Refugee Aid (ANERA). Three crops were selected by the Agriculture Department to be planted for the first time in Palestine using treated wastewater:

- Artichokes on 150m² - plantead on October 31, 1993.
- Onion frozen production on 500m² - planted on November 6, 1993.

- Wheat on 1000 m² - planted on November 22, 1993.

Drip irrigation as well as sprayers were used. Several treatments were made as follows:

1. Irrigation with wastewater used, fertilization was used.
2. Same as above, but without application of fertilization.
3. Irrigation not used but fertilization was used.
4. No irrigation and no fertilization (dry land farming).

All the agricultural practices were used (pesticides, ploughing, seed control, etc..)

Table 13. Results of El Bireh wastewater treatment pilot plant using treated wastewater.

Treatment	**Production of wheat (anber variety), all the plants, kg/dunum**
Irrigation with treated wastewater with Fertilizer	2520
Irrigation with treated wastewater without Fertilizer	20036
Without irrigation, with fertilizer	1600
Without irrigation, without fertilizer	572

Notes:

1. Time of planting was October 1993; all the crops received rainfall during the growing period.
2. Time of harvesting was June 2, 1994.
3. Production with irrigation with treated wastewater with fertilization was five times without irrigation and fertilization.
4. Production increased the soil when irrigated with treated wastewater where fertilization was applied on both cases (irrigated and non-irrigated).

SUPPLEMENTAL IRRIGATION

Definition

ICARDA defines supplemental irrigation (SI) as; the addition of essentially rain fed crops of small amounts of water during times when rainfall fails to provide sufficient moisture for normal plant growth, in order to improve and stabilize yields. Accordingly, The

concept of SI in areas having limited water resources is built on three bases:

First: water is applied to rain fed crops, that would normally produce some yield without irrigation;
Second: since precipitation is the principal source of moisture for rain fed crops, SI is only applied when precipitation fails to provide essential moisture for improved and stabilized production and;
Third: the amount and timing of SI are not meant to provide moisture stress-free conditions rather to provide minimum water during the critical stages of crop growth to ensure optimal instead of maximum yield.

The management of supplemental irrigation is seen as a reverse case of full or conventional irrigation (FI). In the latter the principal source of moisture is the fully controlled irrigation water, while the highly variable limited precipitation is only supplementary. Unlike FI the management of SI is dependent on the precipitation as a basic source of water for crops grown.

Water resources for supplemental irrigation are mainly surface, but shallow groundwater aquifers are being increasingly used lately. Non-conventional water resources are of a potential for the future, but an important one emerging is water harvesting. (Dwas 2001).

Improving Production with SI
Research results from ICARDA and other institutions in the dry areas as well as harvest from farmers showed substantial increases in crop yields in response to the application of relatively small amounts of supplemental irrigation. This increase covers cases with low as well as high rainfall. Average increases in wheat grain yield under low, medium and high annual rainfall in Tel Hadya reached about 400%, 150% and 30% using amounts of SI of about 180, 125 and 75mm respectively. Generally, optimal SI amounts range from 75mm to 250mm in areas with annual rainfall between 500 to 250 mm, respectively. Determining the optimal amount under various conditions will be discussed later (Oweis 2001).

When rainfall is low, more water is needed but the response is greater, but increases in yield are remarkable even when rainfall is as

high as 500 mm. The response was found to be higher when rain distribution over the season is poor. However, in all rain fed areas of the region it was found that some time in the spring there is usually a period of stress, which threatens, yield levels. This soil moisture stress usually starts in March, April of May, if total annual rainfall received is low, average or high respectively (Oweis 2001).

In Syria average wheat yields under rain fed conditions are only 1.25 t/ha and this is one of the highest in the region. With SI the average grain yield was up to 3t/ha. In 1996 over 40% of rain fed areas were under SI and over half of the 4 mil tons national production was attributed to this practice. Supplemental irrigation does not only increase yield but also stabilizes farmer's production. The coefficient of variation in rain fed production in Syria was reduced from 100% to 10$ when SI was practices. This is of special socio-economic importance since it affects farmer's income (Oweis 2001).

METHODOLOGY

Since the ownership of land is very small in size i.e. from 5-10 dunums, supplementary irrigation can be easily implemented for vegetables, trees and to cereals to some extent constructing of small poonds of 40-50 m^3 capacity, i.e. this pond can be located on a 14-18 meter square area. This pond can be located on the lowest point in elevation of the individual land. This land serves two farmers if agreed upoon where it can be sited on the border of each farmer land.

Distributing of water to the plant can be done manually by lifting the water and distributing it to the plants by a bucket. Another way of distributing this wataer that this water can be lifted manually from the pond and poured into a barrell that can be located on the dip of the pond with ½ meter raised over the surface so wter can be distributed to the plant by gravity through pipe line. The farmer can distribute the water pipe from the plant to another. These methods can be implementd easily with zero operation cost. Since only the farmer himself can conduct this job easily, another method of distributing water is by using a small pumped electricity is available since the head required is very small.

In the case of cereals water can be distributed easily by establishing ?, so water can be discharged into the farm ? then water can flow by

gravity. In order to reduce the cost of pumping farerms can cooperate between themselves when each farmer can construct his pond on the highest point in elevation on his land. His pond can receive water from his neighber's field and so on…

The Economy Of Supplementatry

To construct a pond of 50 m^3 the following is needed with estimated costs:

1. Excavation of 50 m^3 = $3900
2. Construction works = $2000
3. Plastering = $ 500
4. Parallell, pipes, buckets = $ 120

Total estimataed cost: $3100

Revenues

Assume a plot of land of 5 dunums planted with vegetables. The production of vegetables of rainfed per dunum is 3 tons/dunum, the production of dunum with supplementary irrigation is 4.1 ton.

The price per ton is $200 for rainfed crops.
The price per ton for supplementary irrigation is $250.

So the income per rainfed dunum = 3 x 200 = $600.

The income per supplementary irrigation is 4 x 250 = $1000
The net income due to supplementary irrigation will be 1000? = 400 per dunum.

5 dunums x 400 = 2000 per session per 5 dunums.

Results of Al Beireh Pilot Wastewater Treatment 1994

Crop	**Kind of Treatment**	**Production kg/dunum**	
		Seed	**Hay**
Wheat 870 Typte	Irrigation with fertilizer	687.5	1375
	Irrigation without fertilizer	656.70	1373
Rainfed	Rainfet with fertilizer	537.5	1187.5

with fertilizer	Rainfed without fertilizer	500	1531.25
Wheat Annber Type	Irrigation with fertilizer	864	1656
	Irrigation without fertilizer	824	1212
Fertilizer	Rainfed with fertilizer	600	1000
	Rainfed without fertilizer	236	336

CONCLUSION AND RECOMMENDATIONS

1. In Palestine the total cultivated area is 2,314,000 dunums, while the irrigated area is 230,000 dunums, so any efforts for increasing the productivity of the cultivated area should be considered due to the large area, while the production of the irrigated area is on its maximum.

2. Providing of extra water or even to sustain the existing water for both irrigation and domestic purposes is questionable due to the increase demand for domestic purposes first and due to the Palestinian-Israeli water conflict.

3. Practicing supplementary irrigation is not costly and did not need that much complicated technology.

4. The irrigated area only represents 6% of the cultivated area, where the land that can be easily irrigated is estimated to be 608,600 dunums. In the West Bank only, which is 6 times the land that is already irrigated but water is needed.

5. The salinity of the ground water is deteriorated by time due to over pumping, sea intrusion and the low rainfall especially in the Jordan Valley and in the Gaza Strip, so providing fresh water for irrigation is questionable.

6. The additional water that will be available for the Palestinians will be either from : a. Eastern aquifer, b. Jordan River, c. Treated wastewater. Where all of this water is saline water, where there are another source such as the mountain aquifers, but this seems to be difficult to be secured soon.

7. The early possible of expansion in irrigation will be in Jordan Valley where the existing water wells and the future water that might be available is saline.

8. Since the treated water is in the full control of the Paletinians, more attention and care should be paid in order to better and safe utilize of this water for developing the agricultural sector in Palestine, and this water can be used for supplementary irrigation.

9. The productivity of one cubic meter of water with supplementary irrigation is much higher than that of irrigated land since the water prepared by irrigatied dunum is 7 times more than the required for supplementary irrigation.

10. The existing irrigated area is already exhausted since this land used to be planted two or three times a year where the other land used to be cultivated once a year even it kept falow on some years.

11. Palestinian Agricultural Ministry and Palestinian Water Authority should recognize the situation and consider supplementary irrigation as a major element for food supply.

REFERENCES

Abdul Jabar, Q. 1996 – Chemical analysis of Jericho wells. PH.a. Jerusalem.

Abu Arafeh A. – Jordan Valley, Jerusalem 1984, published by Arab Studies Society.

Al Khateeb, N. Palestinian water supplies and demands. A proposal for the development of a required water master plan, IPC, Jerusalem.

Awartani, H. Irrigated Agriculture in the Occupied Palestinian Territories, 1991 Al Najah National Univseristy, Nablus.

Awartani, H. Ground water wells in the Occupied Palestinian Territories, 1992 – PHg, Jerusalem.

Nusseibeh, M. and Nasser Eddin, T. 1995 – Palestinian Fresh Water Springs, Jerusalem, Palestine.

Palestinian Water Authority, 1992, Water Development Plan, Jerusalem, Palestine.

Sbeih, M. Recycling of treated wastewater in Palestine: Urgency, obstacles, and experience to date, 1995. Published by Wlsevier.

Oweis, T. 2001, Supplemental Irrigation for field crops, water saving and increasing water productivity: challenges and options. Univaersity of Jordan, Amman, Jordan.

ICID, 2001, the First Asian Regional Conference of International Commission on Irrigation and drainage. Agricultural, Water and Environment, General Report. Saoul, Korea.