Water and Irrigation Management in the Palestinian West Bank

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Water scarcity in the West Bank poses a critical constraint to further expanding, or even maintaining present irrigated areas. There is an increasing demand for agricultural water use to be restricted in favour of other water consumers, such as local communities and industry. The fundamental question this paper addresses, however, is how wisely irrigation water is used in the West Bank, and whether modernization of irrigation through improvements in canal operating system or in the design of water control structures can effectively improve their performance.

The West Bank is that part of the Palestinian areas that was occupied by Israel in 1967 war and is at present partially under Palestinian Authority (Figure 1). Since 1967 Israel has controlled water resource management in Palestine, including the licensing, operation, administration of wells and prohibition of new well drilling without authorization. In fact, Palestinians in the West Bank are limited to 125 MCM (million cubic meters) of their water resources per year for all purposes. From this quota, 93 MCM are used for agriculture to irrigate around 6 percent of the Palestinian cultivated area in the West Bank (1.68 million dunums, 1 dunum = 1000 square meters). In contrast, Israel enjoys a plentiful supply of water (1252 MCM) to irrigate 2,177,500 dunums that form 62 percent of its cultivated land.

The situation is exacerbated by the fact that Jewish settlers are consuming more than 80 MCM per year from Palestinian water resources. The total irrigated area of the Israeli agricultural settlements in the West Bank is 27,300 dunums, forming about 26.8 percent of the total Palestinian irrigated area. In the event of an Israeli withdrawal from illegal settlements in the West Bank, the area available to Palestinians would be 128,916 dunums.

Furthermore, the potential exists for horizontal expansion of irrigated areas in the West Bank once Palestinians restore their water rights in the Jordan River, the West Bank aquifers and assume control over their land. The potential exists for irrigating an additional 400,000 dunums of land in the Jordan Valley, Tulkarm and Jenin. According to the

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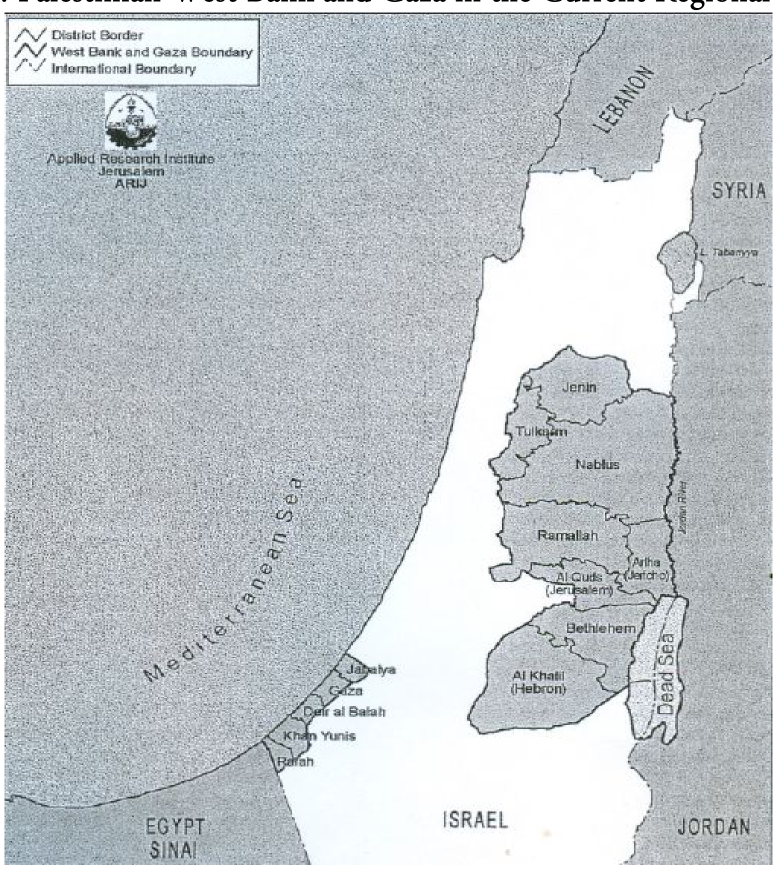
Johnston Plan, a West Ghour Canal was proposed to supply Palestinians with water but this project was never carried out. The West Ghour canal alone would provide enough water to irrigate at least an additional 150,000 dunums. According to the Oslo II agreement, Israel recognized the Palestinian water rights, but these are to be negotiated in the permanent status negotiations.

This paper will focus on the Israeli Palestinian water disputes in the groundwater aquifers and the Jordan River and evaluate the efficiency management of Palestinians in irrigated agriculture.

In order to achieve this aim, information was collected using a detailed questionnaire, covering the various crops and irrigation methods commonly used, in order to determine the water use efficiency at the farm level. In addition, the amounts of water needed to be applied to different crops was determined using the Modified Penman-Monteith method. Many factors were taken into consideration in calculating agricultural water demand. These include leaching requirements, based on the average salinity of 250 different groundwater samples from wells and springs used for irrigation in various districts of the West Bank.

Figure 1: Palestinian West Bank and Gaza in the Current Regional Context



Sources of irrigation water

Water resources in the West Bank include both surface and groundwater. The only permanent river which can be used as a source of surface water in the West Bank is the Jordan River. Compared with international rivers, this source is a very small one that discharges only 1.5 percent of the Nile's discharge. The Palestinians have no access to its water because of military closure of the areas adjacent to the river, as well as the divergence of its water upstream. Groundwater in the West Bank from wells and springs is currently the only source of water being used for irrigation. Groundwater consists of aquifer systems that are located and recharged from rainfall in the West Bank. The annual rainfall in the West Bank is estimated at 3 000 MCM (Abu Mayleh, 1993). Around 600 to 650 MCM of this rain is estimated to infiltrate the soil to replenish the aquifers annually. The remainder is lost either through surface runoff of evaporation. The system is divided according to flow direction into the following three units (Figure 2):

1. The western basin is the largest unit with a safe yield of 360 MCM per year (of which 40 MCM brackish). Eighty percent of the recharge area of this basin is located within West Bank boundaries. Groundwater flow movement is towards the coastal plain in the west, making this basin shared by Israelis and Palestinians. Israel overexploits the aquifers of this basin through their 300 deep groundwater wells to the west of the Green Line, as well as through Mekorot deep wells within the West Bank boundary, most of which are artesian wells (IPCRI, 1993). On the other hand, Palestinians consume only 7.5 percent of its safe yield. Palestinians extract their water from 138 groundwater wells tapping the western basin, 120 of which are for irrigation. There are 35 springs whose average flow discharge exceeds 0.1 liters per second located in the basin;
2. The north eastern basin has an annual safe yield of 140 MCM (of which 70 MCM brackish). Palestinians consume only 18 percent of the safe yield of this basin in the Jenin district and East Nablus (Wadi Al Far'a, Wadi El Bathan, as well as Aqrabaniya and Nassariya) for both irrigation and domestic purposes. There are 86 Palestinian wells in this basin, 78 of which are irrigation wells. The general groundwater flow direction is towards the Bisan natural springs in the north and northeast;
3. The eastern basin whose safe yield is 100 to 150 MCM per year (of which 70 MCM brackish). It lies entirely within the West Bank territory and was used exclusively by Palestinian villagers and farmers until 1967. After 1967, Israel expanded its control over this aquifer and began to tap it, mainly to supply Israeli settlements implanted in the area. Palestinians utilize 54 MCM of this aquifer while Israel utilizes 40 MCM and Israeli settlements use 35 to 50 MCM. The most important springs in the West Bank are in this basin; 79 springs with an average discharge greater than 0.1 liters per

second. These provide 90 percent of the total annual springs discharge in the West Bank. There are 122 Palestinian groundwater wells in this basin, 109 of which are for irrigation.

Are our farmers using the irrigation water wisely?

The total area of irrigated lands in the West Bank is 101,615 dunums, divided mainly between vegetables (67 percent), field crops and forages (6.5 percent), and fruit trees (26.5 percent). Although only about 6 percent of the total cultivated lands in the West Bank is irrigated, the agricultural production of this sector represents 52.6 percent (270 930 tons) of the total agricultural production. Irrigated agriculture in the West Bank, however, consumes about 92.94 MCM which is not enough for the current and future levels of development.

The study showed that there is a shortage of water in most irrigated areas. The percentage of crops suffering from water shortage increases from a low average of 22 percent in the Jericho district to a high average of 32 percent in the Tulkarm district. In the Jenin district about 25 percent of irrigated crops are suffering from water shortage. The prevailing condition is such that the rate of water loss exceeds the rate of water absorption, causing an internal water deficit to develop in the plant. As a counter measure, the plants may close the leaf pores (stomata), which could have an impact on cell development. Depending on the stage of growth of the crop, this will have a large economic impact on the business through a direct reduction in yield and/or quality of the crop. Thus, the return from water use for the districts of the West Bank could be increased if the quantity of water applied reached the ideal amounts

Currently, Palestinian farmers employ new agricultural technologies and their production is competitive to that of neighbouring countries. Palestinians have embarked on marketing their produce to Europe and other countries. In general, Palestine has become an exporter of vegetables, flowers, olive and citrus. Palestine imports field crops and limited types of fruit trees and vegetables where demand exceeds supply or which are not available during certain periods of the growing season.

Losses of water through irrigation network

Irrigation water is exposed to many losses from its source to the crop. Agricultural wells and springs are the main water resources for irrigated lands in the West Bank. The water from most of the springs is conveyed to the irrigated fields through concrete or clay open channels and canals or by pipes.

Earth ditches are popular in Al Fara'a because of their low cost and ease of use while the concrete canals are popular in the Jericho and Al Auja areas. Most of the farmers in the West Bank deliver water to their fields by means of plastic or metal pipes. The pipes are usually laid on the ground surface to minimize the cost of installation, but this practice reduces the life time of the pipe. In the farm, however, most of the systems are designed and installed by the farmers. This results in a non-uniform distribution of the network.

Additional sources for irrigation water

The farmers in the West Bank have tried to overcome water shortage through constructing agricultural ponds to collect spring water, as well as rainfall and flood runoff, through open concrete or earth canals to be used at the time of irrigation. Flood runoff in the West Bank was evaluated in the 1960s to be about 64 MCM per year (Rofe & Raffety, 1965). Small-scale utilization of such surface water is practiced in some Palestinian villages by constructing cisterns to fulfill their municipal and agricultural needs. Numerous agricultural ponds have been constructed since 1977, mainly in the Jordan Valley area to ameliorate the water shortage, and to facilitate the irrigation scheduling process. Some farmers use the ponds to mix the saline water from wells with good water quality from the springs to decrease its salinity. The majority of the ponds are made of clay, with the bottom and the walls covered with plastic sheets. Large quantities of water are lost through evaporation and seepage.

There is also a potential to collect rainwater from the roofs of plastic houses. There are about 5,964 dunums planted with vegetables under plastic houses and high plastic tunnels in the West Bank. The majority of these are located in Tulkarm and Jenin districts, where the average annual rainfall is about 585 millimeters. There is a potential to harvest 3 MCM per year of rainfall from the roofs of plastic houses in the West Bank.

Water savings using modern irrigation technology

Palestinian farmers currently employ new agricultural technologies like drip and sprinkler irrigation systems, resulting in a reduction of water losses and an improvement in agricultural production. On the other hand, surface irrigation is the oldest method of irrigation used in the West Bank. Furrows and basins were the most common method in the region. There was a certain difficulty involved in the management of water distribution in these installations.

The study showed that the application efficiency under surface irrigation was 55 percent. Drip and sprinkler irrigation methods have an application efficiency of 84 percent and 73 percent respectively, which are within the range of attainable efficiency.

Greater economic efficiency of water use

As explained above, the efficiency of water use can be physically improved by reducing the amount of water used per unit of crop yield. However, the economic efficiency of water use can also be raised in other ways. One method is to use water for purposes with a higher value added. For instance, if large volumes of water are allocated to a crop producing low value, the total amount of value generated will be low. For example, it has been observed that fruit trees consume large amounts of water before reaching the productive stage, and the output value during the production is low about 0.5 US-$ per cubic meter of irrigation water applied. Currently, Palestinian farmers are shifting from fruit trees towards high cash value crops such as vegetables and flowers. Palestinian farmers need to consider the viral relationship between the economy and agriculture. This must include sound analysis of the economic opportunities available for farmers and an outreach programme. This will help farmers to determine the economic feasibility of different crops and to have access to the appropriate technology for maximum economic efficiency.

Possibilities for improved water efficiency

The study showed that the Palestinian farmers are using irrigation water wisely but they need to maximize returns from agriculture by:

- Promoting research on water use efficiency and ensuring best management practices in agriculture. This should include attempts to increase supplies, for example through water harvesting development of natural springs, and wastewater reuse. Attention should also be paid to improving crop varieties, so as to enable cultivation using brackish water, and to reduce water requirements. Additionally, research needs to be conducted on the potential for increasing the productivity of rainfed agriculture in areas where there is good soil and adequate rainfall;

- Selecting crops with low transpiration rates or crops that produce high dry matter yield per unit of water transpired. For instance, corn requires relatively small quantities of water to produce one kilogramme of dry matter, in comparison with alfalfa that requires large quantities of water to produce one kilogramme of dry matter. Cereal crops, such as wheat and barley, and vegetables, such as potatoes, are intermediate in their requirements.

- Reallocating water resources from low to high value production.

- Changing planting dates to reduce the crop water requirement: for example, growing any crop during the cool months of the season when the vapour pressure gradients are apt to decrease the crop water requirements, and increase the efficiency of rainfall in irrigation.

- Enhancing the penetration of water into the soil through practices that keep the soil surface open, like tilling at suitable times, is important. Excessive tillage that destroys the surface roughness should be avoided in all cases. Tillage across slopes results in small ridges and encourages water infiltration. Terracing can help in controlling the amount of water lost in runoff.

- Using minute irrigation technology which refer to low application rate of irrigation water. Such technologies allow the infiltration of all the irrigation water into the soil without runoff, even in heavy soils where infiltration capacity is extremely low. A very slow and continuous water movement down the soil profile is achieved. At the same time, a favourable environment for root development is maintained with only minute fluctuations in soil moisture during the intervals between irrigation. Such conditions seem to be optimal for plant growth and may contribute to higher production and more efficient water use.

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