

## OBTAINING GAINS IN EFFICIENCY WHEN WATER IS FREE

Ross E. Hagan<sup>1</sup>  
Jochen Regner<sup>2</sup>

### ABSTRACT

Improvements in on-farm water use efficiencies in the Jordan Valley have been demonstrated by a USAID project. A GTZ project is establishing water users' organizations in the Jordan Valley that demonstrate increased water distribution equity. With improved distribution equity, the demonstrated gains in efficiency should increase. Water delivery service fees or a "water price" played no role in the average 20% reduction in water use and average 5% increase in production or yield. Also, in Jordan at the time of the project neither the responsible water distribution agency nor the Ministry of Agriculture Extension Service offered assistance to farmers in on-farm water management. The key for unlocking the potential for water conservation was knowledge transfer to the farmer. On a few selected farms the benefits to be gained from improved management were demonstrated, extension information on irrigation system management was provided to farmers, and a resource of trained irrigation specialists from the Jordan Valley Authority was available to farmers.

### INTRODUCTION

Jordan is one of the most water-scarce countries in the world, with a projected water deficit of 260 MCM/year in the year 2005. According to the Ministry of Water & Irrigation Wastewater Policy, "*Wastewater is a perennial water source and shall form an integral part of renewable water resources and the national water budget.*" As urban and industrial uses increase, water used for agriculture will continue to transition to the lower quality wastewater, bringing changes in cropping patterns. Municipal and industrial demand consumes about 30% of the water with agriculture taking the remainder. The Highlands and the Jordan Rift Valley are the two areas of irrigated agriculture in Jordan. About 84,000 acres (33,000 hectares) or 40% of Jordan's irrigated area is in the Jordan Rift Valley.

Long before any government was involved, farmers developed traditional systems for sharing water sources, which are still in place in areas of the Jordan Rift Valley – including the West Bank. In large part these systems became redundant as the government took over management of irrigation in Jordan's East Bank in the 1950s and 1960s. The Jordan Valley Authority (JVA) of the Ministry of

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<sup>1</sup> Head of Water Resources Activities, USAID/Egypt, APO AE 09839-4902

<sup>2</sup> Team Leader, Water Resource Management in Irrigated Agriculture (WMIA), GTZ, P.O. Box 926238, Amman 11190, Jordan

Water and Irrigation emerged from preceding organizations in 1977 with a mandate for all socio-economic development in the Valley.

Today JVA is responsible for distributing all water on the East Bank. The water storage, conveyance and distribution system is technically sound with an overall efficiency of about 80%. In normal years farms receive water two to three times a week at times specified by JVA. Officially, farmers have no control over the time or amount of water received. Nevertheless, some farmers influence JVA staff to their benefit. Farmers have a right of water usage but do not own rights to water. Water is allocated seasonally based on the area planted to crop categories. The allocation of irrigation water is attributed to the agricultural area; it is transferred with the land and cannot be separated.

US delegations visiting the Middle East often state that problems of low water use efficiencies and shortages of funds for operation and maintenance of water delivery services can be remedied with a higher "price for water", an inappropriate choice of words that often causes irritation and difficulties in moving the discussion forward. Nevertheless, encouraging efficient water use practices without increasing low fees for delivery is a difficult problem for water managers.

With low delivery service fees, improvements in the equity of water allocation and technical assistance in on-farm water management can among others be effective tools for encouraging efficient management of water resources. With equitable water allocation, managers can promote water conservation and increase economic returns from each cubic meter of the water resource. Users' active participation is essential to improve water distribution equity and for water allocation procedures to succeed. To obtain support from government decision makers, it is often necessary to raise their awareness of the economic value of water resources. Also, it is sometimes required to educate governmental leaders and employees that users are capable of managing water resources. Prerequisites for active users' participation include a legal framework permitting users participation in decision making, two-way information flow between irrigation management professionals and users, and amicable relations between all parties.

### USERS ORGANIZATIONS

With government takeover of water distribution and allocation, farmers learned they needed to cooperate with government authorities. The JVA took from the traditional groups all the responsibility and trouble of water distribution. If a farmer obtained bad service, he could approach the Authority for improvements much easier than starting quarrels with neighbors. Farmers no longer need to cooperate with each other and subsequently exert efforts to get more water, sometimes using illegal methods. They see their neighbor as a competing rival who appropriates more than his official share of water using political connections,

money, and transgressions. Law enforcement has problems with influential farmer clans who have the political clout to lobby for a disproportionate share of water. It is equally difficult if transgressions become every farmer's daily routine. These actions occur at the expense of the community at large, as a commonly shared resource is unevenly exploited.

The JVA provides water without prior consultation with farmers, and with no consideration of on-farm demand. This results in conflicts among farmers and between farmers and JVA leading to waste, corruption, and physical destruction of distribution lines and equipment. Years of constant growth in irrigated land, coupled with a series of dry years, have pushed the system to the limit. The support and active involvement of farmers is needed to ensure sustainable changes and improvement in irrigation management in the Jordan Valley.

Key water distribution challenges facing farmers can be summarized as: (1) unreliable water supply, both in quantity and quality; (2) pressure to adopt drip without receiving extension support, and without an on-demand water supply; (3) poor JVA management and lack of JVA interest in farmers' needs; (4) lack of trust and confidence between JVA and farmers; (5) illegal transactions to secure scarce supply that erodes trust among the farmers; and (6) the growing gap between water demand and availability due to (i) sequence of dry years (ii) raised domestic and industrial demand (iii) intensified cropping practices

A sustainable improvement of water distribution services is only possible through an active farmers' role. Indeed, Farmers are convinced they have to actively participate for a more efficient water supply. Only farmers can protect the system from transgressions by using social pressure to monitor and reduce theft and corruption. Their cooperation in the final distributaries utilizes local know-how and decreases water distribution costs and improves service. Communities of farmers must be organized on common interest and preferably as legal bodies. A valuable source of organizational experience lies with the traditional systems of water rights and irrigation management that were practiced in the Jordan Valley.

### **The Process for Establishing Water User Organizations**

The Water Resource Management in Irrigated Agriculture project (WMIA) was established by GTZ to organize farmers as a service organization. The length of time required to organize farmers as a user group varies considerably. The process must be allowed sufficient time and it has taken as little as one month and as long one year. Any new idea will be resisted at the beginning, especially by those who stand to lose from improved equity and transparency in water distribution. Even those who expect improvement fear change – any form of social change in a small, close-knit community can be difficult. Farmers need to overcome a history of bad experience with individuals misusing systems for their individual profit. The JVA had to learn that they can only improve delivery

efficiency by sharing responsibility for operation and maintenance with farmers. The approach taken requires time, patience, and the ability to listen closely to farmer and JVA needs, fears, and wishes for the future.

Support was provided for improving irrigation services at the local level. A series of formal workshops for farmers and JVA provided an opportunity to disseminate information about established Jordan Valley water user groups, discuss their applicability to new areas, and increase rapport and understanding. Training workshops for staff and JVA focused on communication and participatory community development skills. Farmers and JVA were directly involved in participatory planning workshops for Phase II, which helped to improve their communication and management skills. Addressing farmers fear for the sustainability of the organizations and the inherent legal issues for formalization of water user participation was necessary.

Beyond support for developing water user associations, a range of broader activities focused on improving communication and understanding between farmers, the JVA, and WMIA. Since local governors have authority to communicate both officially and unofficially with all those involved in Jordan Valley activities they were brought into the process. These events reinforced participant skills in communication and planning, and their understanding of the opportunities and constraints in Jordan Valley irrigated agriculture. They also reinforced relationships and strengthened communication among farmers themselves and between the farmers and JVA staff at all levels.

The WMIA focused on establishing water user groups. As a part of this activity, WMIA also formulated operating rules and procedures with agreements formalizing the rights and duties of the water user organization and issuance of decrees from the JVA Secretary General to the relevant Directorates for each new active group, listing group members and foci of group-JVA cooperation.

The nine water user groups established to date have taken three organizational forms: Committees (6), Water Councils (2), and Cooperative (1). Cooperatives are the only fully legally recognized form of farmer organization, having legal affiliation with the Jordan Cooperative Corporation (JCC). Water Councils and Committees are as yet not legally recognized, although they do have an official letter of recognition from the JVA Secretary General.

Most **Committees** are established in the Southern Ghors. Committees are based on traditional forms of farmer management that existed before the JVA, and still exist in other parts of Jordan. They are formed by representatives chosen by the farmers in a general assembly after several informal meetings. Farmers are hesitant to pass on power to a small number of delegates, and in many areas prefer this informal system before committing themselves to anything more formal such

as a cooperative. Farmers monitor representatives carefully. If they find an underperforming representative, they appoint another farmer in his place.

The committee meets as a group approximately twice a month with the Director of the relevant JVA Directorate, and coordinates water deliveries on a daily basis with their local JVA counterpart and one or several WMIA Project Advisors. During their meetings with the Director, minutes are taken which outline any agreements made. Initially, the WMIA representatives take minutes, but as farmers gain experience, a farmer representative takes on this and other management tasks.

The committee is the weakest of the organizations, but it does serve as a basis for more formal structures. Farmers are able to test the commitment of their fellow farmers, and of the JVA, and to experiment with working together. In several areas, committees have opened discussions with WMIA on their desire to form Cooperatives or another legally recognized form of organization.

**Water Councils** were established in the direst situation in terms of distribution management, infrastructure breakdown, and transgressions. The desperation of farmers in these areas provided an opportunity for successful implementation. Water Councils are more formal than committees, with the concept also based on a traditionally utilized mechanism for conflict solving. Each Council has 15 farmer members chosen through informal appointment by the concerned farmers – not through a formal election process. The Water Council is presided over by a *Mutasarif* (sub-governor). He represents the Ministry of Interior, i.e. police force, at the Sub-Governorates level, the lowest administrative division.

Each council is divided into two groups, one focusing on operation and the other on maintenance. The Council, on their behalf of its members, helps JVA define and resolve problems in water distribution and convenes on penalties for cases of transgressions. The Mutasarif provides executive power through his legal authority to hold transgressors accountable for their actions – both for illegal water use from JVA irrigation lines, and for illegal wells. Relevant high ranking JVA staff attend meetings and offer assistance and advice when necessary. The Water Council is not involved in payments or discussions of water rights.

As mentioned, **Cooperatives** are the only legally recognized form of farmers' organization. The statutes of the cooperative detail the objectives and rules chosen by the members. Frequent meetings between the cooperative and JVA and a rigorous daily control of regular water distribution helped improve water management in the area. Illegal water use has greatly reduced. Indicators of success include the self-operation of farm units, monitoring of water distribution, and a reduction in illegal water use to less than 10% of the former level.

Continual monitoring, evaluation and re-evaluation are the keys to project success. If farmers lose interest, a reassessment is conducted. In some cases, the reassessment brings to light issues that can be immediately tackled. In others, it is considered best to temporarily suspend activities and wait for the farmers themselves to request further assistance.

### **Results/Lessons Learned**

Farmers and JVA are particularly receptive to forming organized groups for irrigation management in areas having high levels of illegal water use.

Farmers and JVA officials working together can improve delivery efficiency and reduce transgressions to below 10% in most areas. Overcoming technical flaws in the water distribution network and adapting the water allocation cycle to actual farm water demands can reliably deliver water at stable high pressures to the farm gate. Farmers will not have to maximize soil store of water out of fear they may miss the next water delivery. Soil storage usually results in over irrigation causing damage to the crop and decreasing yields. With improved service, farmers use the available water to intensify cultivation and increase farm incomes.

By November 2003, nine water user groups covered 25% of the irrigated area in the Jordan Valley. These groups represent 2,530 farmers, about 27% of all farmers in the Valley. An additional eight water user groups were well under way in other areas, which will bring the total irrigable area in the Valley covered by water user groups to 36%, serving 34% of all Jordan Valley farmers.

Farmers have found that speaking as a group rather than as individuals is a useful tool for providing demand oriented water distribution services and ensure transparency, and equity. JVA staff realize that working with a group representative spares them from dealing with individual farmers, each with their own agenda. This streamlined communication makes JVA staff more effective in operation and maintenance of the water distribution system.

In all organizational forms, farmers have taken on greater management responsibilities as they get used to working together. In areas with established groups, the farmers themselves initiate meetings, set agendas, keep meeting minutes, provide reports, and manage communication with JVA.

Until recently, there were complaints from farmers about weak communication with JVA. This was solved with an innovation that improves communication and gives farmers a stronger feeling of project "ownership". The JVA agreed to allow water user groups to choose JVA staff members with whom to work. This gives the group an opportunity to choose someone who is supportive of the concept of farmer participation. If they are not content with the official, they can discuss issues with the WMIA project staff and JVA and chose a new JVA counterpart.

JVA has seen: farmer participation improving its organizational efficiency, farmer organizations helping to reduce needed personnel (for activities such as operating farm gates and reporting technical or operational flaws), reductions in illegal water use that reduce the need for emergency plans to supply farmers who did not receive water; and reductions in repair and maintenance and thereby an increased satisfaction with JVA services. Farmers who receive reliably water see less need for transgressions. They survey together with JVA the regular water distribution and provide a physical protection of the infrastructure. The dramatically reduced number of transgressions removes the need for intensive intervention by JVA. Although specific data has not been gathered, there appears to be higher efficiency of water distribution measurable by an improved, constantly pressurized water system, implying no transgressions/losses. JVA also has had a significant decrease in penalties charged for transgressions

### **IRRIGATION ADVISORY SERVICE PROGRAM**

When construction of the King Abdullah Canal (KAC) began in the 1960's one unit of the development organization was dedicated to assisting farmers make best use of the water being provided. Services included assistance in all aspects of irrigation water use and in crop selection and production. As the pace of development in the Valley accelerated in the 1970's, this unit was disbanded and members transferred to construction-oriented divisions. In subsequent years the Jordan Valley Authority (JVA) offered no assistance to farmers and operated as if its responsibility stopped at the farm gate turnout. The Ministry of Agriculture had no water specialists and claimed it too has no responsibility for on-farm water use. In retrospect, JVA's dissolution of the unit was a mistake that has proven costly to Valley agriculture.

The Jordan Valley has been in recent years in perpetual drought, irrigation water supplies are insufficient to meet all agricultural demands. In its effort to increase irrigation efficiencies, the JVA has converted the delivery system off the KAC to pressurized pipelines and promoted the use of modern irrigation technology in the farm unit. Each farm unit has a single point delivery with a gate valve, flow restrictor, flow meter, and pressure regulator. In 1993 about 40% of the 24,400 acres (9,600 hectares) of the central Jordan Valley Directorate office was irrigated using micro irrigation; this percentage had increased to 52% by 1996 and 100% by 2003. JVA personnel report that all land under irrigation in the Jordan Valley and Southern Ghors now use micro irrigation.

In the 1993-94 crop season, just before the start of a new program on water management in the central Jordan Valley, a baseline survey was conducted. The baseline survey found the annual average management efficiencies for high technology trickle irrigation systems were lower than those for low technology surface irrigation systems, 64% and 76%, respectively. The most sophisticated production systems, plastic houses using trickle irrigation under plastic mulch,

had the lowest efficiency numbers, 44%. In 1998 farmers that participated in the survey were revisited. Efficiency levels had fallen in the intervening years to an average of 42% for plastic houses and 46% for open field trickle systems. A study of on-farm irrigation efficiencies in the Highlands gave similar results.

The low value for management efficiency in plastic houses was investigated in more depth. It was concluded that water losses in plastic houses were due to a lack of knowledge. Farmers knew neither how much water to apply nor the crop water requirement. Farmers did not realize that irrigation requirements under plastic houses are about 35% less than those under open field conditions. Field observations and site visits to growers using plastic houses showed that the soil moisture content was always near saturation. In many cases, runoff was observed at the end of the plastic houses and in some cases algae growth was observed.

Studies concluded that poor design of on-farm drip irrigation networks, improper maintenance and use of screen and media filters, no control of algae and organic slimes, and poor operation and maintenance practices contribute to low efficiency. About 75% of all farms experienced significant emitter plugging beginning with the second year of lateral line use. The data clearly showed irrigated agriculture in the Jordan Valley was far from reaping the water conservation benefits possible with a pressurized pipeline delivery system and drip irrigation application.

Although a high percentage of all micro irrigation equipment used in Jordan is manufactured locally, most of the components are manufactured according to dimensions used in other countries. Basic micro irrigation system designs also are imported from countries where fields are significantly larger than is typical - in Jordan. Consequently, many components installed in local systems are oversized for the short row lengths typical to the Jordan Valley. Though more costly to install, an oversized system is more forgiving of mistakes and will function efficiently even with some major installation flaws. A study of water application uniformity for newly installed trickle irrigation systems in the Jordan Valley found the systems "good" with EU values above 85%, some were in the "excellent" range. With proper management, water-use efficiencies can be high.

Farmers in the Jordan Valley can be classified into three groups: 20% have full technical knowledge and experience with irrigation and agriculture, 30% have some knowledge and experience with irrigation and agriculture, and 50% have none; but all want to learn more but don't where to go to get the right information. About eighty percent of Jordan's farmers need assistance.

### **Pilot Implementation**

To promote the goal of higher efficiencies in water use, in 1997 with support from USAID the JVA created (one could say recreated) a pilot Irrigation Advisory Service (IAS) division with three field staff to assist farmers in these activities. In



working with farmers IAS staff learned the value of being flexible to best serve the client. Some farmers change water applications by reducing the duration of irrigation, others change irrigation frequencies but the duration of applications is fixed and still others accept changes in both frequency and duration of water applications. To promote improved management practices the IAS team spoke to meetings of MOA Extension Agents, farmer organizations, and gatherings of farmers on crop water demands and irrigation scheduling.

Results from demonstration farms under the IAS program in the Jordan Valley have shown that water consumption at the farm level can be reduced by an average of 20% with an average increase in production of 5%. The most striking case was a farmer growing eggplant that reduced his water use by 47% and increased production by 22%. It is apparent that farmers were over-irrigating to the extent they were saturating the soil, in effect drowning their plants. Farms that received water reliably obtained higher production increases and greater water savings than did their neighbors with greater variability in water deliveries.

There are empirical measures of IAS program success. Farmers request that they not be delivered water on their normal rotation. The IAS has requests for assistance exceeding their capacity to fulfill. Farms whereon demonstrations are conducted quickly adopt the demonstration irrigation program. Neighbor farmers adopt the new schedules. These practices made it impossible to collect data for a statistically valid analysis of results; in no case was a "check" site carried through the season. This is why average values are used to report success.

At the end of its pilot period in 2000 the IAS ended. The concepts, extension literature, and training materials developed are being used by JVA in a new Modern Farms program, which is expanding in the Jordan Valley and the Highlands. Farmers who participated in the pilot program continue to use the knowledge gained and the improved practices are slowly spreading in the Valley.

### **Lessons Learned**

At the farm level, a decrease in water consumption reduces the farmer's costs. This has larger implications in the uplands where farmers incur higher costs for pumped water than farmers in the Jordan Valley. Upland farmers pay \$0.09 to \$0.21 /m<sup>3</sup>, while in the Jordan Valley farmers pay an average fee of \$0.03 /m<sup>3</sup>, a price that has changed little over the last decade. Water is one of several inputs needed for crop production and its use is evaluated on its cost versus the perceived benefit received. Currently, water delivery fees offer no economic incentive for farmers to conserve water. In the Jordan Valley water delivery fees are 0.5% to 2% of total input costs. Studies in Egypt show that for the cost of water to be a driver in water conservation, delivery fees would have to equal about 25% of net farm income in order to achieve a 15% decrease in water use.

In Jordan the two key levels of focus for irrigation water conservation are on-farm water distribution system management and maintenance practices and off-farm operation and management of the delivery system. On-farm offers the most significant savings in water use. However, it is also the place where it will be most difficult to achieve best use of water. The delivery of water to the farm offers less direct water savings but potentially large indirect savings. Most savings will come from changes in operation and management (software), which enables customers to optimize their use of water resources (indirect savings), and few from changes in physical infrastructure (direct savings).

From the time of the studies and pilot IAS program to the present, Jordanian small farmers, the 80% who want to know more, have been hampered by a lack of extension literature and assistance in the proper operation and maintenance of micro irrigation, fertigation practices, crop water requirements, and most other aspects of on-farm water management. Farmers also need an irrigation water delivery schedule compatible with the on-farm micro irrigation system, a change from the current rigid delivery schedule to a flexible delivery schedule, perhaps a limited rate demand schedule. Cleaning the water in the delivery system of physical contaminants could allow farmers to do away with pools, currently used to store water between deliveries and to settle out contaminants, and use the pressure in the JVA delivery pipeline.

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<sup>3</sup> WQIC = Water Quality Improvement and Conservation