KAFA'A[1]

Knowledge and Action
Fostering Advances in Agriculture

Baseline Assessment
On-Farm Water Management, Crop Production and Marketing
September 2004

Prepared by
Development Alternatives Inc.

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[1] Official name: "Education and Information Program to Improve Irrigation Water Use Efficiency" (Project #273-C-00-03-00022)

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Abbreviations and Acronyms

AZB	Amman-Zarqa Basin Highlands
CWN	Center Wholesale Market
Dunum	1,000 m^2, 0.1 hectare
EureGap	European Union retailer and Good Agricultural practices
FTA	Farm Turnout Assembly
GTZ	Deutsche Gessellshaft Fur Technische Zusammenarbeit
IAS	Irrigation Advisory Service
HACCP	Hazard Analysis and Critical Control Points
ISO	International Standards Organization
JD	Jordan Dinar
JVA	Jordan Valley Authority
KAC	King Abdullah Canal
KTD	King Talal Dam
MCM	Million Cubic Meters
MOA	Ministry of Agriculture
MWI	Ministry of Water and Irrigation
USAID	United States Agency for International Development
WUA	Water User Association

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Executive Summary

KAFA’A is a USAID funded long-term project (Contract No. 273-C00-03-00222-00) aimed at raising the efficiency of water use in Jordan’s agriculture. KAFA’A (Knowledge and Action Fostering Advances in Agriculture) is founded on the premise that greater and better knowledge among farmers is the most effective way to impart awareness of opportunities to save irrigation water and to increase the value of production per unit of water.

In order to implement the many tasks aimed to achieve the anticipated results of improving water use efficiency and crop production, KAFA’A has implemented a Baseline Survey with the following objectives:

- Establish a baseline describing the current agricultural situation in terms of cropping patterns, irrigation techniques, water use, and efficiency of water management. Such baseline data will serve as reference points to measure progress during the life of the project;
- Establish baseline data regarding farmers’ knowledge, attitudes, and practices about irrigation water and their perceptions about opportunities for raising water efficiency;
- Identify the more efficient uses of irrigation water in agriculture through more appropriate choices of crops and varieties, irrigation techniques, planting times, and marketing options; and
- Identify project initiatives for future interventions, especially for implementation during the early months of the project as part of the demonstration farms.

The baseline survey was designed and conducted between February and April 2004; due to timing of cropping season critical data on production and marketing of the current 2004 crop year was not fully available. Most of the economic analysis in this report is therefore based on the retrospective data provided by farmers for the 2003 agricultural year.

The main finding that emerges out of the baseline survey data is that vegetable crops as a group are many times more efficient users of irrigation water than citrus and banana trees. There are several straightforward reasons for this result: Vegetables short life spans (five months on average) contrast with the perennial nature of citrus and bananas; at any given time, a dunum of vegetables requires half as much water as a dunum of citrus and one third as much as a dunum of bananas; vegetables are grown in the colder fall, winter, and spring months, while citrus and bananas endure the hot summer months when they consume half the water they need over the year. Finally, many vegetables are grown under greenhouse conditions thus raising yields and revenues several fold without a significant increase in water needs.

Farmers can also raise water efficiency by selecting the planting time for their crops in order to take advantage of the cooler months in winter when water requirements are minimal. However, farmers also know that market gluts of particular products can make prices tumble, so they tend to spread out plantings throughout the growing season.
The economic analysis was carried out using gross revenues and water consumption estimates that are subject to potential errors. Gross revenue figures were computed based on reported yields and prices for each crop grown in 2003 by the survey sample farmers. The accuracy of

these figures is subject to considerable potential recall error, but there is large enough number of observations and consistency in the sample data to make the aggregate estimates fairly robust. Net revenues were not computed because it would have been too costly and cumbersome to obtain cost of production data for each crop. Thus, the considerable cost of setting up plastic tunnels for green house vegetable was not considered; nor was the cost of establishing a citrus orchard or a banana grove and waiting for several years before production begins.

Water consumption by each crop or each farm was not available. Instead, we used estimates of crop water requirements provided by the Jordan Valley Authority, computed for each crop based on weather factors along the Jordan Valley. Alternatively, we used water delivery schedules also provided by the JVA based on their rule of thumb estimates for vegetables (2 mm/day), citrus (4 mm/day), and bananas (6 mm/day) with adjustments for cooler months. The results of the economic analysis were fairly consistent in both cases, either using crop water requirements or water delivery schedules: vegetables outperform by far citrus and bananas in terms of value per unit of irrigation water. Citrus trees receive about two thirds (65 percent) of the water supplied by JVA in the Jordan Valley but generate less than one third (31 percent) of the value of production; vegetables crops on the other hand use 22 percent of the irrigation water delivered but generate 62 percent of the gross value of production.

In general, large gains in water efficiency can therefore be accomplished simply by shifting water and farmland from citrus crops to vegetable crops, especially vegetables crops grown under green house conditions. To be sure, there are large differences both within vegetable crops and within citrus crops. Navel oranges, for example, consistently perform better in terms of gross revenue per dunum and per 1000 m^3 of irrigation water than other citrus crops, while clementines tended to perform poorly in most cases. Similarly tomatoes and cucumbers under plastic tunnels perform very well in terms of relative water use efficiency, while others vegetables in open field conditions can give mediocre results. Bananas provide very high gross returns per dunum but consume enormous amounts of water (1600 m3 per dunum per year) as opposed to vegetables (227 m^3 per year) and therefore relative water use efficiency in bananas is very poor.

Crop water use efficiency in the North Jordan Valley is considerable lower than in the Center Jordan Valley because citrus trees are the dominant crops in the North while in the Center vegetable crops predominate. The North also has the better quality soils in the valley and uses the best quality water. In the Center and South the soils are less desirable and irrigation water is mixed with either treated waste water or underground water. Many farms in the Center and South also leave areas uncultivated for lack of reliable water supply from JVA. The South also suffers from high soil and water salinity problems. Finally, in terms of employment, vegetable crops generate significantly more person months in employment than citrus trees. These factors reinforce the view that using fresh water and the best soils to produce citrus and bananas is not the best social or economic policy.

JVA has now imposed restrictions on any new planted areas to citrus and bananas, the two crop categories that consume most water. JVA would like to reserve some areas strictly for vegetables. However, JVA's power to enforce those restrictions is undermined by a few privilege farmers who ignore the rules, and by a court order that JVA provide water even to citrus and banana fields planted without proper permits. Farmers know that once these fields are established they are entitled to receive the higher water allocations for citrus and bananas.

Why do farmers want to increase the areas planted to the least water use efficient crops? Because current prices that JVA charges farmers for irrigation water do not reflect the true value of water. At 10 fils (0.010 JD) per cubic meter the cost of 1000 m3 of water needed per dunum of citrus is only 10 JD per year, while the value of production is about 450 JD. Households in Amman are paying 40 to 50 times more (0.400 to 0.500 JD per m^3). In years with water shortages JVA has rented farm units (35-dunum average) for about 1000 JD per year to save 20,000 cubic meters of water by leaving the land fallow; this is equivalent to 50 JD per 1,000 m^3 (0.500 JD/m^3). To the extent that farmers are now receiving highly subsidized water relative to its opportunity cost, it should not be a surprise that they are treating water as a free good.

At present, Jordan Valley farmers irrigate all of the water delivered to their farms by JVA. They exert little control to adjust on-farm use to the water requirements of their crops. Apart from a few exceptional individuals, farmers are not using flow meters, tensiometers or watermarks to measure and control irrigation scheduling. Not all the water flow meters installed by JVA at every farm's FTA box are working for several reasons; even those which are working properly are not being used for controlling water use or water billing.

Farmers in the Jordan Valley do not derive tangible benefits from reducing irrigation water. Farmers gain little financially from investing in equipment and techniques to improve irrigation scheduling or by using only the minimum water requirements in their fields. For example, a citrus farmer who reduces water consumption by one third (300 m^3/dunum) only saves 3 JD per year in water charges. Without tangible financial benefits it is likely that better knowledge and exhortations to save water might not translate into better irrigation practices.

Suggested project interventions, based on the assessments of on-farm water management, crop production, and marketing, include:

- Design and implement a maintenance and operation program for drip irrigation for farmers and irrigation operators, including irrigation set time, maintenance of media filters, and system repairs
- Implement "hands on training" of irrigation scheduling for the major crops identified in the assessment and for proposed alternative crops, monitoring soil moisture by "hand feel method", soil augers, and electronic sensors
- Evaluate irrigation system performance on farmers' fields for distribution and uniformity
- Promote the transition of surface to drip irrigation
- Establish a chain of demonstration sites showing farmers improved water management techniques throughout the project area
- Use these demonstration sites as information distribution centers where farmers can obtain advice on crop husbandry, marketing options, and irrigation management
- Work with JVA to establish a Water Delivery Management Committee for the Jordan Valley to oversee the allocation of irrigation water with transparency and fairness

- Monitor salt accumulation in irrigated soils in the Jordan Valley, southern Ghors, and Amman-Zarqa Basin
- Develop a crop-suitability planning tool to aid farmers in determining the best adapted crops for specific soil and microclimatic conditions.
- Train farmers and extension personnel to use the crop-suitability planning tool
- Base fertilizer recommendations on soil nutrient analyses
- Monitor soil moisture and irrigation results in a network of farms surrounding each demonstration site
- Train agricultural laborers in irrigation management and crop husbandry practices, including agrochemical use, transplanting, and packaging
- Consider the importation of Vetiver grass to improve water quality along the water delivery system of the King Talal reservoir, the Zarqa River, and around farm ponds.
- Work with NCARTT in screening alternative crops, including stone fruits, ornamentals, and indigenous species
- Work with JVA in irrigation pond maintenance, such as preventing leaks, evaporation, and algae growth
- Work with JVA to improve irrigation flow and pressure in water delivery
- Design a credit or revolving grant program for farmer associations and cooperatives to allow small and economically disadvantaged farmers access to more efficient irrigation equipment
- Promote private sector participation in marketing services and enforce standards for agricultural products in compliance with international requirements
- Conduct a follow-up survey each year to monitor the impact of the introduced techniques and water management recommendations
- Institutionalize the use of the farm code number within the MWI and all government, donor agencies and private sector dealing with data collection, processing and management for farms in the Jordan Valley and Southern Ghors.

Introduction

Jordan faces a critical water shortage, with only 750 million cubic meters (MCM) per year of renewable surface and groundwater to supply an increasing water demand that reached 1,200 MCM (MCM) in 2002. In addition to the historic problems of water scarcity and irregularity, resource planners face increasing water demand due to rapid urban expansion, industrial and tourism development, over-abstraction of groundwater and inefficient use of irrigation water. Farmers in the Jordan Valley and the highlands will find it increasingly difficult to justify their priority claim over water resources.

The results of previous studies, such as WQIC (1994-1998), Amman-Zarqa Basin WRPS (1999-2001), and pilot programs including the Jordan Valley IAS (1999-2001) and IOJOV (1995-present), stressed that efficient agricultural water use needs to be integrated with good agricultural production and marketing practices. In effect, improved crop production and marketing methods can compensate for increasingly tight water supplies and declining water quality. Technical assistance in crop production and marketing can facilitate and serve as an incentive for farmers to adopt less water-intensive crops, more efficient on-farm water management practices, and improved market access that ultimately will reduce agricultural water use and protect national water resources, while increasing farm income.

The KAFA'A project (Knowledge and Action Fostering Advances in Agriculture) is a USAID funded program (Contract No. 273-C00-03-00222-00) aimed at raising the efficiency of water used in agriculture in Jordan. KAFA'A staff and participating farmers and stakeholders from public and private institutions, NGOs, cooperatives and farmers associations will assist the MWI, MOA, and JVA in providing technical assistance on efficient on-farm water management, crop production, and marketing practices. One of the initial deliverables of the KAFA'A project is a baseline assessment of on-farm water management and crop production practices in the Jordan Valley and the Amman-Zarqa Basin (AZB) Highlands.

The KAFA'A Baseline Survey constitutes the initial attempt at the start of the project to determine the current state of farmers knowledge, attitudes and practices as well as describing the current situation on the ground in terms of cropping patterns, irrigation methods, and marketing practices. The Baseline Survey was designed also to find out the current levels of water efficiency, identify the more and the less efficient crops and irrigation practices. Efficiency was measured in terms of value of production per unit of irrigation water used.

Based on the findings from the baseline survey KAFA'A will design its future interventions in order to raise farmer's awareness of how to make better use of irrigation water. The results from the Baseline Survey will also serve as reference points to evaluate how effectively the messages from KAFA'A have reached farmers and how effectively these messages motivate them to improve decisions making regarding water use and water efficiency.

The economic analysis of the Baseline Survey data proceeded in a logical sequence of steps: First, we determined the cropping patterns that farmers have adopted in different regions of the Jordan Valley and the Southern Ghors. Second, we obtained data on crop water requirements by month for the different zones of the Jordan Valley, differentiating between open field cultivation and green housing using plastic. Third, we determined from the data collected estimates of gross revenue obtained for each crop in each sample farm, as reported by the farmers themselves during survey interviews. Fourth, the two sets of data on gross revenue and water requirements were combined to arrive at estimates of revenue per thousand cubic meters for each crop and each zone. Fifth, a parallel economic analysis was carried out using water delivery schedules provided by the Jordan Valley Authority to contrast with the earlier analysis. Sixth, the types of crops and farming practices that yield higher efficiency ratios and those with the lower efficiency ratios were identified. Seventh, farmers' perceptions about the relative profitability of crops and their suitability for growing under water scarcity or using saline or treated wastewater were noted. Finally, the relative labor demand of different crops was evaluated.

The Baseline Survey was designed and carried out between February 2004 and data collection took place in March and April. The economic analysis was based mainly on the cropping patterns, yields, and revenues reported by farmers for the previous season in 2003, for which we had a complete data set on production, marketing, and water use. Data for the 2004 season was incomplete in terms of yields, production, and prices.

A KAFA'A database and reporting system has been developed as a project information management system that will support project planning, monitoring and reporting. Sampling methodology, survey instrument design and data entry systems are described in the first phase of the assessment report, February 2004. A team of Agricultural engineers, who are also farmers in the project areas, interviewed over 700 farmers, insuring high and reliable quality of data collection (see Appendices).

The KAFA'A database and reporting system serves as a project planning and monitoring tool. Database automation fosters ease of data entry (and reduced errors), updating survey data, and data reporting. Although not defined as a project deliverable, a geographic information system (GIS) component was built into the KAFA'A project database to allow for spatial analysis of the survey. GIS technology can help to reveal important spatial relationships that are not easily discerned using conventional statistical reporting. For example, a spatial analysis of where farmers are using drip irrigation in the Jordan valley helps to determine specific extension needs and to demonstrate where these farmers are located with relation to irrigation canals, markets and land resources. The Jordan Valley Association JVA might use this information to plan extension activities aimed at fostering efficient utilization of irrigation resources.

Baseline Survey Objectives

The primary objectives of the baseline survey of on-farm water management and crop production are to:

1. Collect information and develop a detailed understanding of current knowledge, attitudes, and practices (KAP) related to on-farm water management and crop production, providing a baseline against which progress will be monitored;

2. Identify marketing constraints (particularly to exports) and sources of market information; and

3. Promote farmer participation in defining their needs, identifying constraints, and designing project interventions to promote changes in farmer attitudes and behaviors concerning improved water use efficiency and crop production.

The survey was designed to measure the success of KAFA'A in reaching target results, and to test the relationship of those results to the overall objective of increasing agricultural water use efficiency and productivity. The survey was also designed to test a basic hypothesis of the KAFA'A project - that farmers using efficient irrigation technologies and practices to produce high-value, water-efficient crops that are appropriate for their water quality, and marketing them in competitive markets, will make highly productive use of irrigation water. The following assumptions underlie this hypothesis:

- Irrigation efficiency depends on irrigation technologies as well as on-farm water management and crop production practices;
- Appropriate use of irrigation scheduling equipment (tensiometers, water marks, evaporation pans), and irrigation records are indicators of water use efficiency;
- High-value crops, less water-intensive crops, salinity-tolerant crops and crops appropriate for low-quality treated wastewater can be defined *a priori;*
- Exporting to EU and Gulf states is an indicator of competitive marketing capabilities;
- Jordanian farmers follow two distinct marketing strategies - crop specialization or crop diversification.

Survey Methods and Implementation Plan

The design and implementation of the baseline survey follows the following eight steps, each of which is described in greater detail below:

1. Review the results of previous surveys, programs and studies concerning on-farm water use, irrigation practices, and crop production;
2. Collect relevant information from MWI, JVA, and MOA databases;
3. Conduct field reconnaissance trips to the Jordan Valley and AZB Highlands to inform the farmers and ensure their participation in the design of the survey questionnaires;
4. Develop questionnaire;
5. Select the survey sample;
6. Train enumerators and field-test the questionnaire;
7. Define interview protocol; and
8. Prepare a field survey implementation schedule.

Literature Search and Data Inventory

The survey design team reviewed reports on on-farm irrigation practices, cropping strategies, and new crops that Jordanian farmers can produce competitively for world markets. Jordanian government counterparts and other foreign organizations provided an extensive body of literature on irrigation system management, crop water requirements, and export marketing. Many of these reports contain useful information that can be integrated with the KAFAA survey results.

For example, "A Study of Groundwater Use and Users in the Northeastern Amman-Zarqa Basin Highlands" by Associates in Rural Development (ARD) in 2001 provides useful information on irrigation using groundwater in the Highlands. The baseline survey in the Jordan Valley and Highlands is consistent with information from the 2001 Highlands survey.

Farmers Participation, Preliminary Interviews

The survey design team spent two days interviewing farmers in the Jordan Valley and Amman-Zarqa Highlands. They engaged farmers in informal conversations about management practices and on-farm irrigation, allowing the team to observe farm conditions and assess whether farmer responses are consistent with current conditions and practices. These field visits provided valuable background information on crop production methods, irrigation resource delivery, problems with water pressure, duration of irrigation schedules and lack of transparency in water distribution practices.

Questionnaire Development

The survey team used an iterative process to design the questionnaire, and exploited every opportunity to test it. The primary basis for the questionnaire was the list of indicators and results in the KAFA'A annual work plan. Project staff and local consultant Dr. Kamel Radaideh provided feedback on early drafts of the questionnaire, which was subsequently tested on five modern, progressive farmers meeting at KAFA'A to discuss marketing constraints. Enumerators and respondents were asked to comment on the technical usefulness and cultural appropriateness of the survey questions.

Two final questionnaires were developed, one for the Jordan Valley (JV) and Ghor Es-Safi and the other for Amman Zarqa Basin Highlands. The JV and Ghor Es Safi questionnaire addresses on-farm water management, cropping patterns, and marketing strategies. It include questions on farmers' knowledge (high-value and less-water intensive crops, and crops appropriate for saline water and treated wastewater), attitudes (production constraints, marketing requirements, opinions of contract production, foreign competition, governmental extension services, and expectations of future labor costs), practices and behaviors (farm and irrigation management, cropping patterns in 2003 and 2004, agricultural production and income in 2003, destination markets and marketing strategies, and exports in 2003). The AZB Highlands questionnaire is designed to complement the rapid appraisal survey conducted in the year 2000. It addresses the operation and maintenance of the irrigation systems, knowledge of efficient water use practices, knowledge of less water-intensive crops and crops appropriate for saline water and treated wastewater, and marketing.

Survey Sample

The survey covers five geographical areas namely the North, Central, and South Jordan Valley, Ghor Es-Safi, and the Amman-Zarqa Basin. To ensure statistically significant results regarding vegetable and tree crop producers in each of the five survey areas, the sample of respondents is stratified to include representative sub-samples of farmers in each area (Table 1). The baseline survey will cover 800 farm units including 80 in AZB Highlands. The remaining 720 interviews are distributed proportionately on the basis of the number of farms units in each area (see Table 1 below). The relatively high proportion of interviews in the Jordan Valley, compared to the Highlands, will allow the survey team to focus in detail on management practices on farms with different water sources and qualities. Survey results will be weighted to reflect the characteristics of the total farm population.

Enumerator Selection and Training

To increase the reliability of survey data, KAFA'A hired highly-qualified agronomists and water engineers who have extensive experience in irrigated farming. The six members of the survey team included:

- Three senior agricultural production specialists who own and manage their own farms;
- A senior irrigation engineer who has extensive experience in crop production and modern irrigation management practices;
- A crop protection /IPM specialist who also has data management experience; and
- A senior water management specialist/farm owner and survey team leader

Table 1. Stratified Survey Sample

Location	Principal Crops	Type of Production	Irrigation	Number of Interviews
North Jordan Valley	citrus	Field	drip	230
			surface	
	vegetables	Greenhouse	drip	
		Field	drip	
	bananas	Field	surface	
Middle Jordan Valley	vegetables	Greenhouse	drip	250
		Field	drip	
	tree crops	Field	drip	
		Field	surface	
Jordan Valley - Karama	vegetables	Field	drip	120
			surface	
	tree crops, dates, grapes,	Field	drip	
	bananas	Field	surface	
Ghor Es-Safi	vegetables	Field	drip	120
		Greenhouse	drip	
	bananas	Field	surface	
	tree crops, dates, grapes,	Field	drip	
Amman Zarqa Basin (AZB) Highlands	tree crops	Field	drip	80
	vegetables	Field	drip	

The survey team attended a four day training program which is briefly described below:

- Day one included an introduction to the KAFA'A project, survey objectives, a description of the questionnaire, interview protocols, practice interviews, and a participatory review of the questionnaire;
- Day two was used to field test the questionnaire in the Jordan Valley;
- Day three included an assessment of field tests, adjustments to the questionnaire, an overview of sample selection, and training on the survey database and data management;
- Day four focused on identification of farms within the survey sample, and preparation of field survey maps and survey schedule.

Interview Protocol

The duration of interviews was about 60-90 minutes, plus the time required for travel to the farm, enumerator assessment of current operations, and establishing a rapport with farmers. On average each enumerator completed four to six interviews per day.

Enumerators were assigned to each of the five study areas (Table 2). Each enumerator is responsible for engaging farmer-respondents in conversation, developing rapport, and assuring respondents that information on individual farms will remain confidential. He was also responsible for explaining the purpose of the interview, the objectives of the KAFA'A project, and any potentially confusing technical terminology (e.g., "water-efficient crops"). This introduction was designed to assure farmers that the focus of KAFA'A is on increasing the productivity of water by increasing crop yields and farmgate prices.

Prior to each interview, enumerators reviewed farm profiles and complete an enumerator checklist. They ensure that all questions were answered, and that the farmers' responses were consistent, e.g., that the irrigated areas of individual crops added up to the total irrigated area. Immediately after each interview, enumerators reviewed the information provided by farmers, standardized variety names and unit measures (e.g., number and weight of boxes, and yield/dunum) and assessed the validity of the information collected. Enumerators also completed a checklist of observations and general assessments of farm management, irrigation efficiency, and marketing strategies. These checklists were designed to be completed without requiring answers from farmers.

Table 2. Enumerator Teams

North Jordan Valley	Middle Jordan Valley	South Jordan Valley	Ghor Es-Safi	Amman Zarqa Basin	JVA, IAS Staff
Mohammad Fakhouri Consultant, Senior Agricultural Production Specialist Farm owner / manager	Ziad Ahmed Tommalieh Consultant, Senior Agricultural Production Specialist . Farm owner / manager	Nabeel Maroun Consultant, Senior Agricultural Production Specialist Farm owner/manager	Suhail Qutteaineh Consultant, Senior Agricultural / Irrigation Engineer	Kamel Radaideh Consultant, Survey Team Leader / Farmer	Leith El Wakid Husam Alaidy Ahmad Bukhary Khaled Ourikat Zuheir Madadheh

Yehya Zaqi Al Attal , Enumerator/Data Manager, Agronomist, Crop Protection Specialist, IPM Trainer

Farming schemes in the Jordan Valley and AZB

The relevance of any data gathered in the agricultural sector is closely related to the socially organized human strata composition of the sample and its relationship to the land. Many decisions corresponding to the farmer in both areas of the project often times are not made by the farmer owner of the land. In the short and long term behavior of the person farming the land is dictated by his relationship to the land.

KAFA'A included in the survey a section to find out who is farming in the project areas and what is the legal relationship of the land user to the land itself. Table 3 shows the results of 795 sampled farms, in which the nationality of the person interviewed resulted in three countries of origin: 88 percent are Jordanian and 12 percent Egyptian in the North Jordan Valley. The percentage of Jordanian origin decreases as we move from the citrus dominated North to the vegetable dominated South and Southern Ghors to a 63 percent. The Center and South show an average of 10 percent Pakistani. The AZB holds 72 percent of Jordanian origin. Management wise, the origin groups are distributed in the same fashion, most of the Jordanians are in ownership and land leased. Egyptian and Pakistani are the majority of laborers in charge and sharecroppers.

Cropping patterns in the Jordan Valley

KAFA'A baseline survey of about 10 percent of farmers in the Jordan Valley collected information on what crops were grown in 2003 and 2004. Those data provide a representative picture of the relative importance of different crops in the main zones of the valley. Table 4 and Figure 1 depicts the results for the Jordan Valley in terms of dunums planted to each crop by farms in the survey sample, and in percentage of the total area in 2003, the most recent year for which farmers had a complete season. It is remarkable how different the crop pattern in the North is from those in the Center and South Jordan Valley.

Citrus dominates the landscape in the North Jordan Valley with clementines, navel oranges and sour oranges occupying 40 percent of the land. Other citrus account for an additional 25 percent of the land. Thus, a total 65 percent of the land in the North Jordan Valley is planted to citrus orchards. Other significant crops present in the North are zucchini (5.4 percent), tomatoes (5.2 percent), and bananas (5.2 percent). Minor crops accounting for the remaining percent of the area include mainly winter vegetables: wheat, potatoes, okra, eggplant, green beans, berseem (clover), cabbage, molokhiya (jew's mallow), guava, pomegranate, date palm, and cauliflower, Appendix II, Figure 1.

Table 3. Interviewee nationality and management relationship to the land

	J. V. North		J. V. Central		J. V. South		Southern Ghor (Safi)		AZB	
	Count	%	Count	%	Count	%	Count	%	Count	%
Nationality										
Egyptian	28	12.0	49	20.5	39	31.2	41	34.5	22	28.2
Jordanian	206	88.0	171	71.5	70	56.0	75	63.0	56	71.8
Pakistani			19	8.0	16	12.8	3	2.5		
Total	234		239		125		119		78	
Nationality & Relation to Land										
Jordanian										
Laborer in Charge	32	15.5	29	17.0	10	14.3	12	16.0	7	12.5
Land Leased	47	22.8	73	42.7	40	57.1	22	29.3	10	17.9
Land Owner	126	61.2	67	39.2	10	14.3	26	34.7	37	66.1
Sharecropper	1	0.5	2	1.2	10	14.3	15	20.0	2	3.6
Subtotal	206		171		70		75		56	
Egyptian										
Laborer in Charge	25	89.3	34	69.4	16	42.1	22	53.7	20	90.9
Land Leased	3	10.7	13	26.5	9	23.7	3	7.3	1	4.5
Land Owner					1	2.6			1	4.5
Sharecropper			2	4.1	12	31.6	16	39.0		
Subtotal	28		49		38		41		22	
Pakistani										
Laborer in Charge			5	26.3						
Land Leased			13	68.4	1	33.3	1	33.3		
Sharecropper			1	5.3	2	66.7	2	66.7		
Subtotal			19		12		3			
Total	234		220		108		116		78	

By contrast, tomatoes are the dominant crop in the Center and South Jordan Valley zones, occupying 20 and 25 percent of the area, respectively, Table 4. Potatoes are second in the Center with 12 percent, followed by cucumber (11 percent), zucchini (9 percent), onions (5.6 percent), and wheat (4.9 percent). Clementines, navel oranges, shamouti oranges and other citrus account for 17 percent of total planted area. Wheat (4.9 percent), maize (3.7 percent), and eggplant (4.0 percent) also occupy significant shares of land, Appendix II, Figure 2. In general, irrigated land in the Center Jordan Valley goes primarily to vegetables crops, while in the North it is mainly citrus.

After tomatoes, which occupy 24 percent of the land in the South Jordan Valley, the other main crops are eggplant (17.8 percent). Maize, zucchini, lettuce, hot peppers, and potatoes contribute percent shares between 4 to 8 percent. Next come cucumber, squash, broad beans, bananas and cauliflower, each contributing between 2 to 4 percent additionally, Table 4, and Figure 3 in Appendix II. Other minor crops include wheat, onions, grapes, and cabbage. Citrus are present but they account for a barely significant percent of the planted area.

Table 4. Cropping pattern among survey sample farmers in the Jordan Valley. 2003

Crop code	Crop name	Total	North	Center	South	Total	North	Center	South
		Dunum				Percent			
80	Tomato	1,782	340	899	544	13.4	5.2	19.6	24.1
19	Clementine	1,237	1,053	184	-	9.3	16.2	4.0	0.0
57	Orange, Sour	926	879	47	-	6.9	13.5	1.0	0.0
86	Zucchini	905	350	402	153	6.8	5.4	8.8	6.8
51	Orange Navel	815	656	154	5	6.1	10.1	3.4	0.2
64	Potato	770	127	555	89	5.8	1.9	12.1	3.9
27	Eggplant	689	102	185	402	5.2	1.6	4.0	17.8
25	Cucumber	573	-	489	84	4.3	0.0	10.7	3.7
85	Wheat	487	222	225	40	3.6	3.4	4.9	1.8
42	Mandarin	446	365	81	-	3.3	5.6	1.8	0.0
8	Banana	394	339	-	55	3.0	5.2	0.0	2.4
40	Maize	355	12	169	174	2.7	0.2	3.7	7.7
56	Orange Shamouti	334	196	135	3	2.5	3.0	2.9	0.1
88	Pomely	323	210	113	-	2.4	3.2	2.5	0.0
49	Onion, Dry	275	7	255	13	2.1	0.1	5.6	0.6
55	Orange, Red	260	260	-	-	1.9	4.0	0.0	0.0
38	Lemon	240	209	28	3	1.8	3.2	0.6	0.1
47	Okra	226	114	68	44	1.7	1.8	1.5	1.9
35	Hot Pepper	203	8	61	134	1.5	0.1	1.3	5.9
11	Broad Beans	188	33	93	62	1.4	0.5	2.0	2.7
39	Lettuce	187	8	43	136	1.4	0.1	0.9	6.0
58	Orange, Valencia	152	152	-	-	1.1	2.3	0.0	0.0
33	Grapefruit	149	137	12	-	1.1	2.1	0.3	0.0
76	String Beans	140	85	45	10	1.0	1.3	1.0	0.4
26	Date Palm	130	41	89	-	1.0	0.6	1.9	0.0
48	Olive	127	74	6	47	1.0	1.1	0.1	2.1
16	Cauliflower	112	26	36	50	0.8	0.4	0.8	2.2
12	Cabbage	97	36	42	19	0.7	0.6	0.9	0.8
15	Carrot	90	-	90	-	0.7	0.0	2.0	0.0
36	Jew’s Mallow	87	76	11	-	0.7	1.2	0.2	0.0
20	Clover Trefoil	71	71	-	-	0.5	1.1	0.0	0.0
74	Squash	66	-	-	66	0.5	0.0	0.0	2.9
32	Grape	65	15	10	40	0.5	0.2	0.2	1.8
34	Guava	62	47	15	-	0.5	0.7	0.3	0.0
52	Orange, French	56	54	2	-	0.4	0.8	0.0	0.0
54	Orange, Local	54	54	-	-	0.4	0.8	0.0	0.0
63	Pomegranate	47	47	-	-	0.4	0.7	0.0	0.0
77	Sweet Pepper	44	25	19	-	0.3	0.4	0.4	0.0
59	Parsley	37	4	-	33	0.3	0.1	0.0	1.5
53	Orange, King	24	24	-	-	0.2	0.4	0.0	0.0
9	Barley	23	17	6	-	0.2	0.3	0.1	0.0
73	Spinach	22	22	-	-	0.2	0.3	0.0	0.0
67	Radish	14	10	-	4	0.1	0.2	0.0	0.2
24	Cress	12	-	-	12	0.1	0.0	0.0	0.5
45	Mint	11	-	-	11	0.1	0.0	0.0	0.5
71	Snake Cucumber	11	-	11	-	0.1	0.0	0.2	0.0
21	Coriander	9	-	-	9	0.1	0.0	0.0	0.4
28	Fennel	4	-	-	4	0.0	0.0	0.0	0.2
61	Peas	4	-	-	4	0.0	0.0	0.0	0.2
66	Pumpkin	4	-	-	4	0.0	0.0	0.0	0.2
3	Apple	3	3	-	-	0.0	0.0	0.0	0.0
22	Cowpeas	3	3	-	-	0.0	0.0	0.0	0.0
18	Chicory	2	-	-	2	0.0	0.0	0.0	0.1
81	Turnip	2	-	2	-	0.0%	0.0	0.0	0.0
70	Siliq	2	-	-	2	0.0%	0.0	0.0	0.1
	Totals	13,347	6,512	4,579	2,257	100.0	100.0	100.0	100.0

For the Jordan Valley as a whole, the two main crops in terms of area planted are tomatoes (13.4 percent) and clementine oranges (9.3 percent), Figure 1. Tomatoes are followed by sour oranges, zucchini, navel oranges, potatoes, and eggplant that contribute, each, between 5 to 7 percent. Shares between 3 and 4 percent are contributed by banana, cucumbers, mandarin orange, and wheat. A large group of annual crops contribute percentage shares ranging from 1 to 3 percent: maize, hot peppers, green beans, okra, lettuce, and string beans. Minor citrus species account for most of the rest of the cultivated land, including oranges (Shamouti, Red, Valencia), lemon, and grapefruit.

Three quarters of irrigated land in the Southern Ghor is exclusively used for growing tomatoes. The only other crops present in any significant rate are bananas (12 percent), watermelons (6.5 percent), and string beans (5.3 percent), Figure 2.

In general, the Jordan Valley has a wide variety of crops growing along the valley, with marked local differences between North, Center, and South. A wide range of vegetable crops predominate in the Center and South, while citrus dominate agriculture in the North Jordan Valley. Soil and water salinity problems limit the choice of cropping possibilities in the South.

Observers point out that some farmers in 2003 have left part of their farmland uncultivated in response to reduced water availability. This is apparently more frequently done in the south zone. Unfortunately, in our survey data collection this possible non-use of irrigated land was not foreseen and properly accounted for. Subsequent monitoring efforts under the project need to take into account the possibility of farmers letting part of their irrigated area under fallow.

Crop areas reported by the survey sample farmers for the 2004 season roughly maintain the same relative importance in the three zones of the valley.

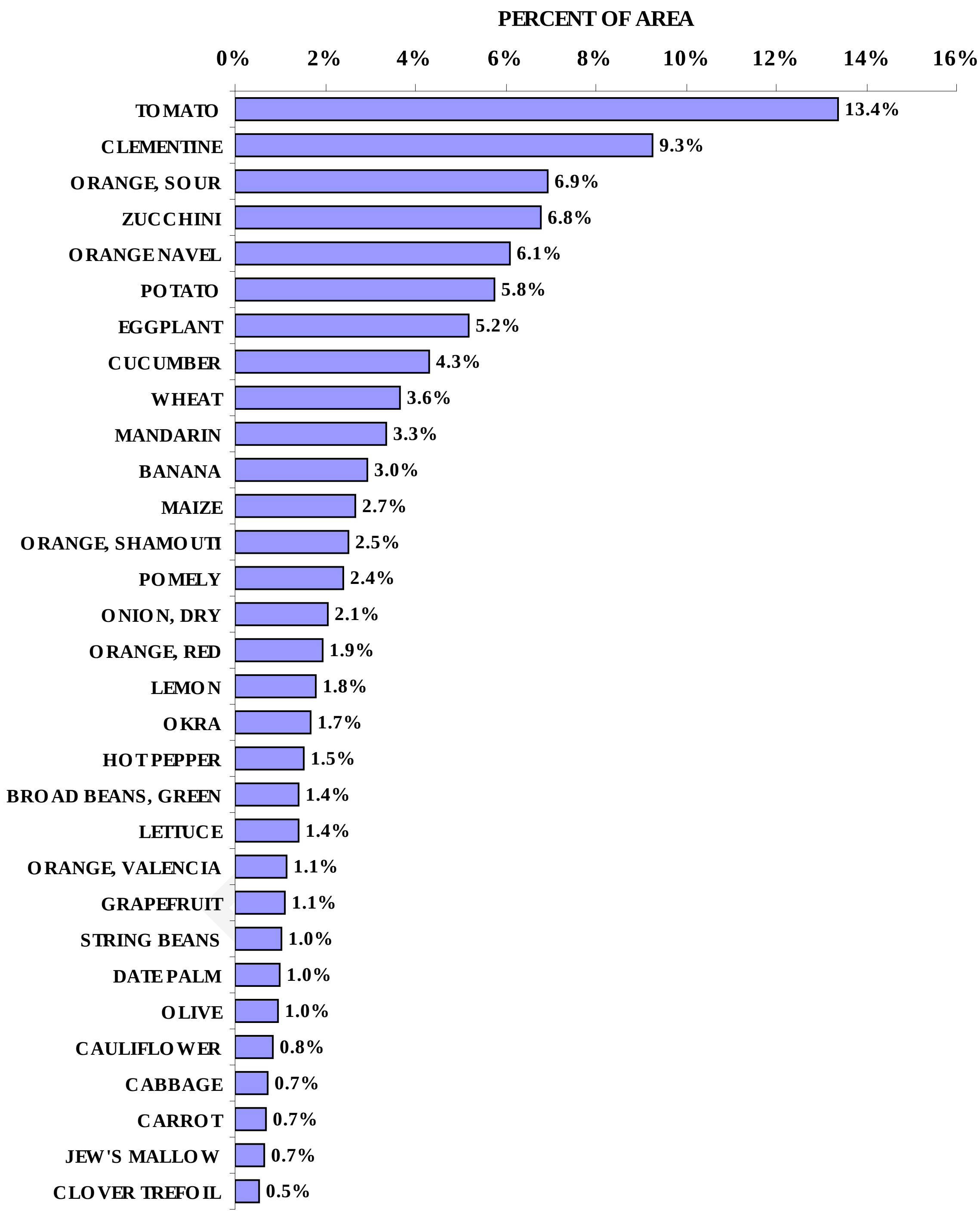

Figure 1. Cropping pattern among survey sample farmers in the Jordan Valley, 2003

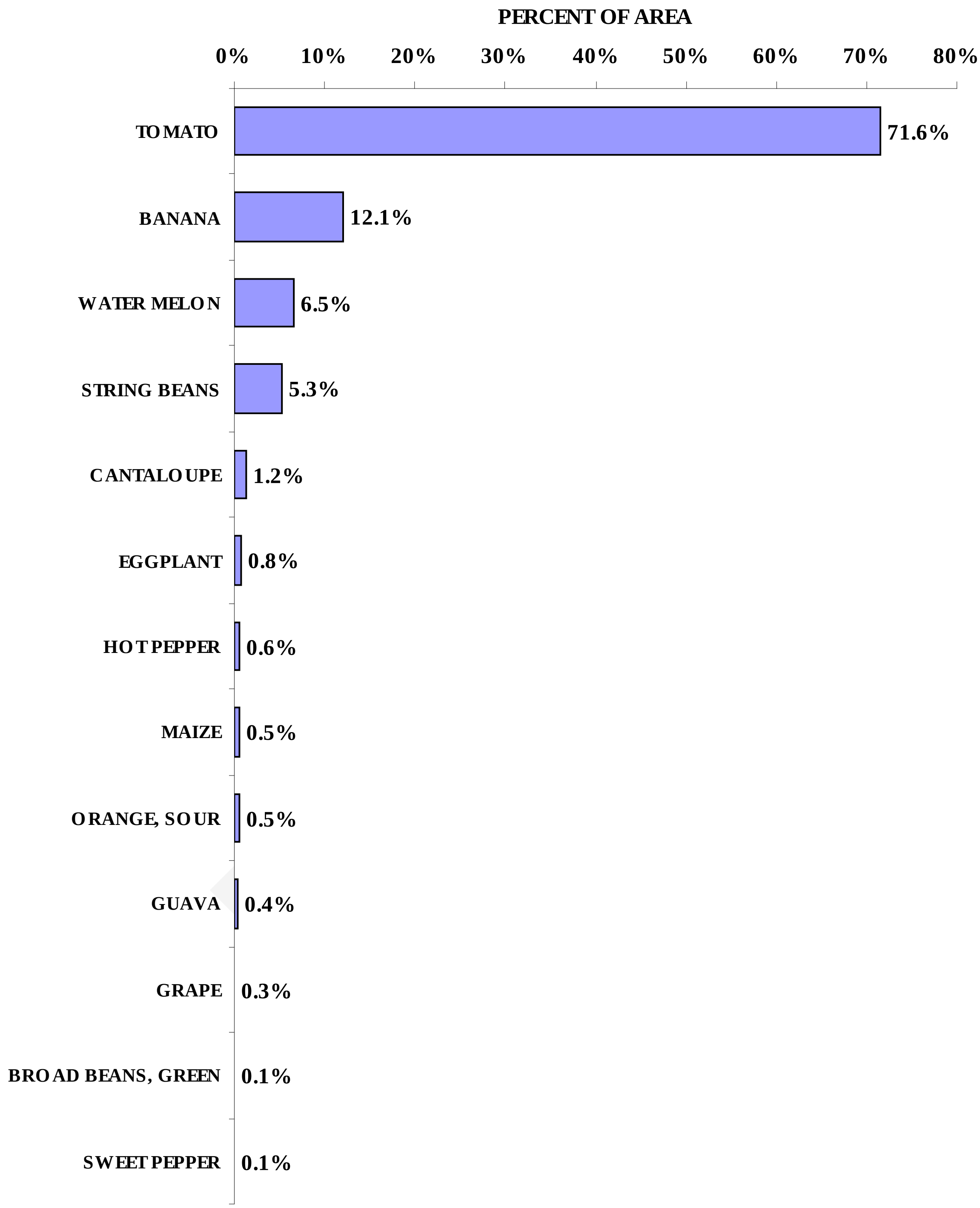

Figure 2. Cropping pattern among survey sample farmers in the Southern Ghor. 2003

Agricultural Calendar

The calendars differ only slightly. Apart for perennial crops – citrus trees and bananas – the only vegetable crops grown in the summer months are maize and sorghum. Nearly all vegetables grown in the Jordan Valley disappear in the summer months (July through August). The growing cycles for the main vegetable crops found in North, Center, and South zones of the Jordan Valley are shown in Tables 1, 2, and 3 in Appendix II. Plantings for fall vegetables begin in September and continue through October. Spring plantings begin in January and February for harvest through mid-June. Of course, farmers do not in general plant all at once but spread their plantings during several months to avoid market gluts at peak periods.

Summer supply of vegetables is assured by production in the highlands, where it is cooler. JVA does not allow vegetable production during the summer months and will not deliver water in those areas designated for vegetable production only. Exceptions are made only for hardship cases and for a few crops – okra and jew's mallow, for example.

Crop Water Requirements

The Jordan Valley Authority provided the KAFA'A baseline assessment team two sets of water requirement tables for the main crops in the valley. The first set of crop water requirements is also included in Appendix II, Tables 1 to 3 for the North, Center, and South zones, respectively. These tables were generated by a JVA study using crop reference evapotranspiration (ETo) using meteorological data from whether stations in the Jordan Valley. Crop coefficients for different stages of the plants are then combined with the ETo values to derive monthly requirements in either millimeters or cubic meters per dunum.

JVA also provided KAFA'A with the newly adopted water delivery schedule for vegetables, citrus trees, and bananas. This schedule will be discussed later; for the moment the analysis will be carried out using the tables of crop water requirements mentioned above.

It is noticeable first of all that water requirements in the south zone are much higher than in the north zone, mainly as a result of higher temperatures and consequently increased evapotranspiration. Citrus and bananas have the highest total water consumption requirements, reaching 1,800 m^3 per dunum for citrus and 2,300 m^3 per dunum for bananas in the south zone, and about 200 m^3 less in the north zone for both crops. Maize and sorghum have exceptionally high water requirements compared to other annual crops (1,700 m^3 for maize) mainly because they are grown in the hot summer months which demand high water consumption. For most vegetable crops however, water consumption ranges between 300 and 600 cubic meters per year, depending on the life span of the crop, and whether it is grown in the coldest winter month or during the warmer fall and spring months. The same crop can have strikingly different requirements depending on planting time: squash planted in November needs 171 m^3 per dunum, but squash planted in August requires 541 m^3, Table 1, Appendix II.

Figures 4, 5, and 6 in Appendix II show total water requirements for the selected crops in Tables 1, 2, and 3 also in Appendix II, and make it visually graphic how different crops and planting times can affect crop water requirements. Paradoxically, farming methods do not appreciably affect water requirements: greenhouse tomatoes require roughly the same amount of water than open field tomatoes. Of course, yields of vegetables grown greenhouses are several times the yields obtained in open fields, and therefore the productivity of water is higher.

Gross Crop Revenue

The baseline survey questionnaire requested from sample farmers the area planted to each crop, but also the estimated yield per dunum and the average price received per dunum. Only the information for 2003 was used to estimate revenues because the survey was conducted in February and March 2004, halfway through the winter season. Yields were normally obtained in number of boxes per dunum, and the average weight in kilograms per box was recorded.

Note on data exclusion: The survey data contain several instances where the revenue figures were suspected, either because they are extremely high, or extremely low. In those cases those entries were removed from the calculations. A “flag” or dummy variable was introduced in the original Access data table for section 9 of the questionnaire (T9_Crop_Baseline) to exclude certain entries from the analysis. The flag value was set to “1” when the entry is acceptable and to “0” when the entry is not acceptable for analysis. Unacceptable entries were those with either no revenue generated, or those with value below 20 dinars per dunum. Most of the extremely low values were attributed to data collection or data entry errors. Analysis regarding revenue was therefore based on entries for crops that generated significant revenue. Fields of bananas or tree crops that were not at production stage are therefore not included in the analysis, nor are those field crops that failed completely. The process also excluded a few crop entries for fields with 10,000 dinars per dunum and above because they were deemed excessively high and atypical.

The value of production was computed for every crop in each farm unit in the sample. Figure 3 shows gross revenue per dunum in the North Jordan Valley, for the crops with the largest planted area in that zone. Figure 3 also shows the value of production per 1000 cubic meters of water, as estimated using the crop water requirements tables.

Few of the crops in the North Jordan Valley generate over 500 JD per dunum, with the notable exceptions of bananas, navel oranges, red oranges, lemon, potatoes, and French and local oranges. Most citrus crops yield gross revenues between 300 and 400 dinars per dunum. Among the worst performers in terms or revenue per dunum are grains such as wheat, barley, and maize, and berseem (clover).

In terms of gross revenue per thousand cubic meters of water, the top performers are vegetable crops like potatoes, eggplant, lettuce, tomatoes, and bananas. Citrus varieties as a group generate revenue per unit of water below 400 dinars per 1,000 m^3.

By contrast, in Figure 4 many of the bars representing gross revenue per dunum and per thousand cubic meters of water in the Center Jordan Valley exceed 1,000 JD. Many of the predominant crops in the zone have revenue exceeding 500 JD per dunum, including potatoes, tomatoes under plastic tunnels, zucchini, cucumbers, cabbage, sweet peppers, and a few citrus trees (navel, shamouti, and French oranges). The Center Jordan Valley also performs well in terms of gross revenue per thousand cubic meters of water requirements, with the top performing crops being cucumbers and tomatoes grown under greenhouses, zucchini, and cabbage. Several open field vegetables also generate gross revenues per 1000 m^3 of water above 500 JD, including potatoes, tomatoes, broad beans, hot and sweet peppers, lettuce and cauliflower. The weakest performers in terms of revenue per unit of water are again the grain crops – wheat, barley, and maize. Citrus trees are weak performers with the exception of navel oranges that yield over 500 JD per 1000 m^3 of water.

A similar picture emerges for the South Jordan Valley in Figure 5. Cucumbers and tomatoes grown under greenhouses have outstanding revenues per dunum as well as per thousand cubic meters of water. Maize and wheat are among the poorest performers. Several open field vegetables perform relatively well, with revenues per 1000 m^3 of water above 500 JD, including tomatoes, eggplant, zucchini, potatoes, squash, and cauliflower.

In general, vegetable crops have some of the highest gross revenues both per dunum and per thousand cubic meters of water, especially those vegetables that are grown under greenhouses as cucumbers and tomatoes. Investments in green housing using plastic raises water and land productivity, though they also require sizeable investments that may be beyond the reach of many farmers. Grains perform on average very poorly, both in terms of returns per unit of land and water. Citrus crops are in general weak performers, with the notable exception of navel, shamouti, and red oranges.

Monthly water requirements per zone

It is possible to generate a profile of monthly water requirement by zone based on the cropping patterns prevalent in the three zones of the Jordan Valley, as they emerge from the baseline survey, combined with the crop water requirements obtained from the Jordan Valley Authority. Figure 6 shows graphically the wide variation in requirements for the North zone, from a low of 32 m^3 per dunum in January to over 160 m^3 per dunum in July and August. Most of high water consumption occurs in the hot summer months from May through October. The prevalence of citrus trees in the North Jordan Valley explains this highly demanding pattern of water requirements in the North.

Water requirements in the Center Jordan Valley are much lower than in the North, with the highest monthly demand occurring in October, 83 m^3 per dunum, half as much as in the North, Figure 6. The lowest water demand also happens in January (19 m^3 per dunum). April also exhibits a high water demand because many vegetables are in full production and the weather beings to warm up, but throughout most of the year crop water requirements in the Center zone remain below 60 m^3 per dunum (2 mm per day). This is mainly due to the prevalence of vegetable crops with low water requirements.

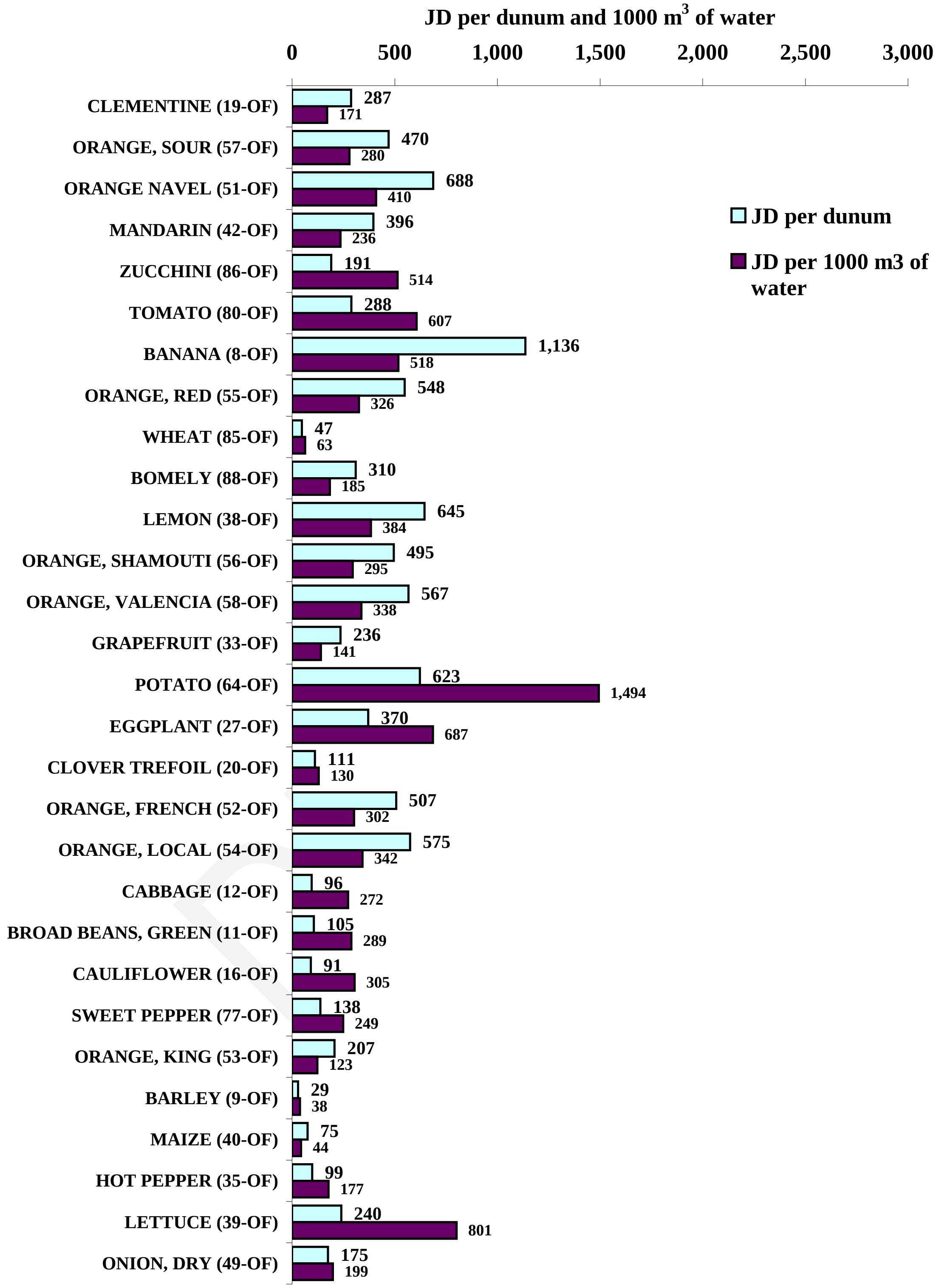

Figure 3. Value of production per dunum and per thousand cubic meters of irrigation water for major crops in the North Jordan Valley, 2003

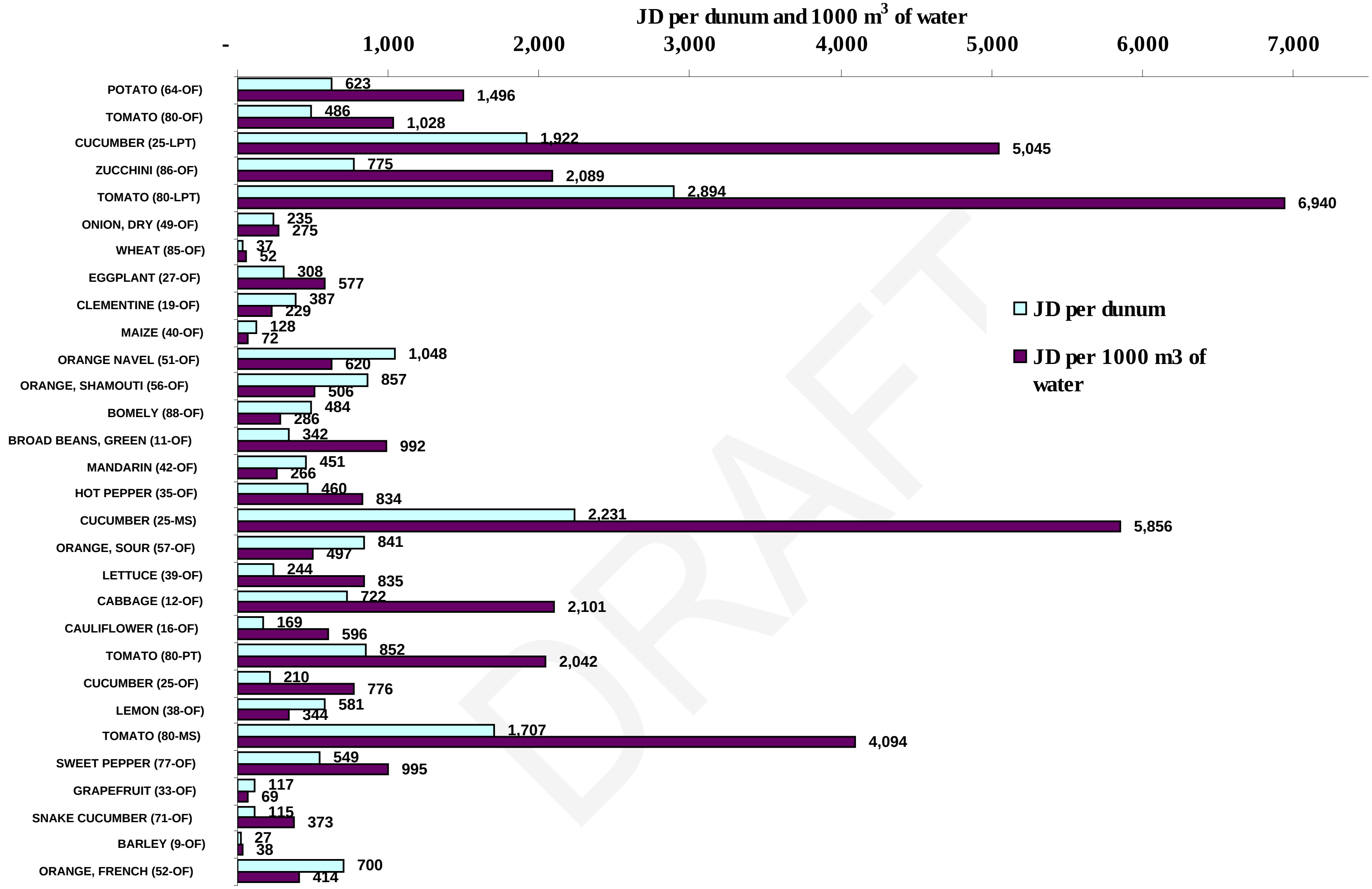

Figure 4. Value of production per dunum and per thousand cubic meters of irrigation water for major crops in the Center Jordan Valley, 2003

In both the North and Center zones the coldest winter months are also those when precipitation can reach significant levels, and on occasions it becomes unnecessary for JVA to provide water for irrigation because rainfall is sufficient to satisfy plant requirements.

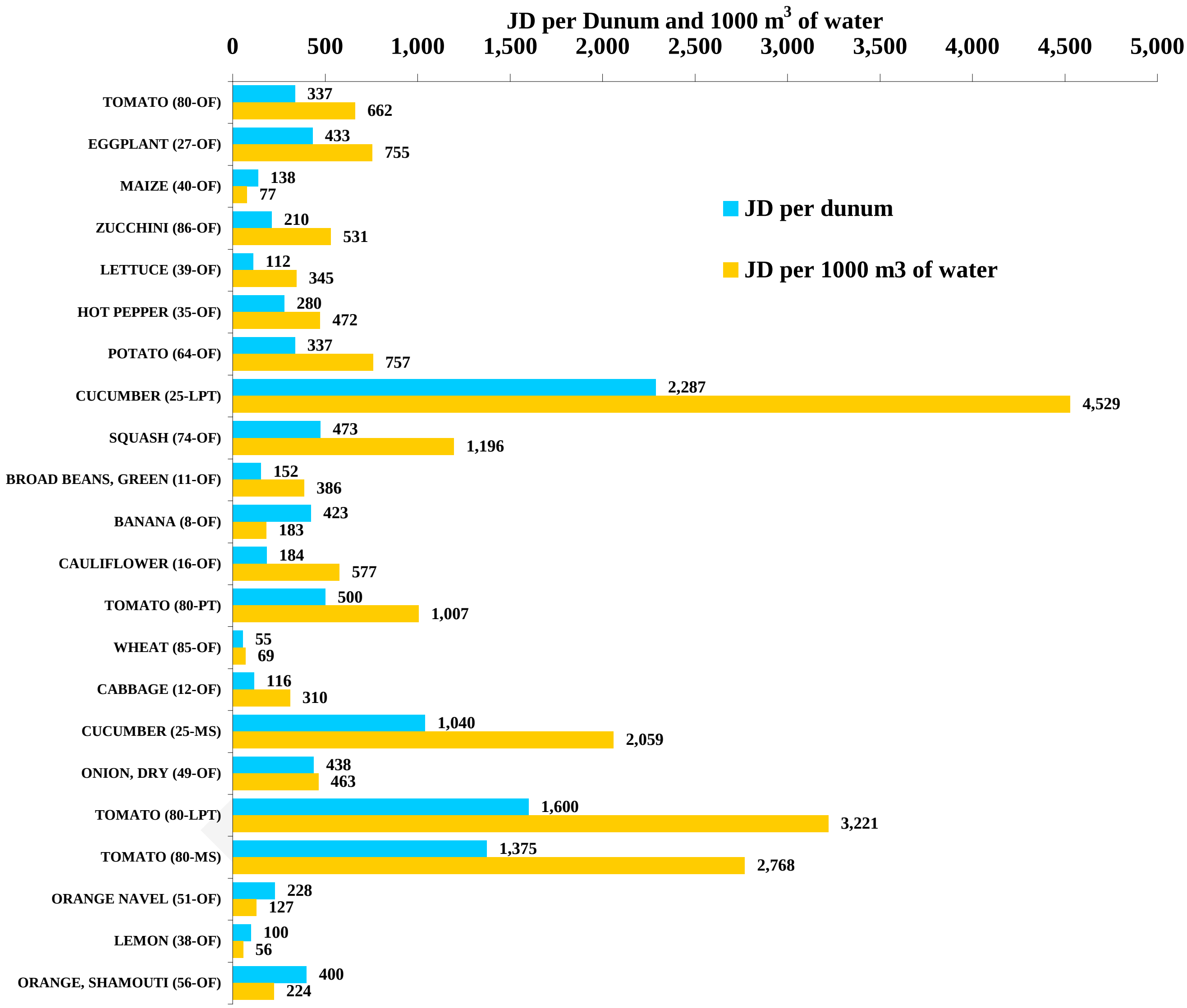

Figure 5. Value of production per dunum and per thousand cubic meters of irrigation water for major crops in the South Jordan Valley, 2003

The contrast between the North zone and the Center zone is striking, with the South zone being very closely similar to the Center. Figure 7 in Appendix II combines all three zones into a single profile for the entire valley, which resembles the profile of the North zone because so much of the irrigation water is spent on the North zone.

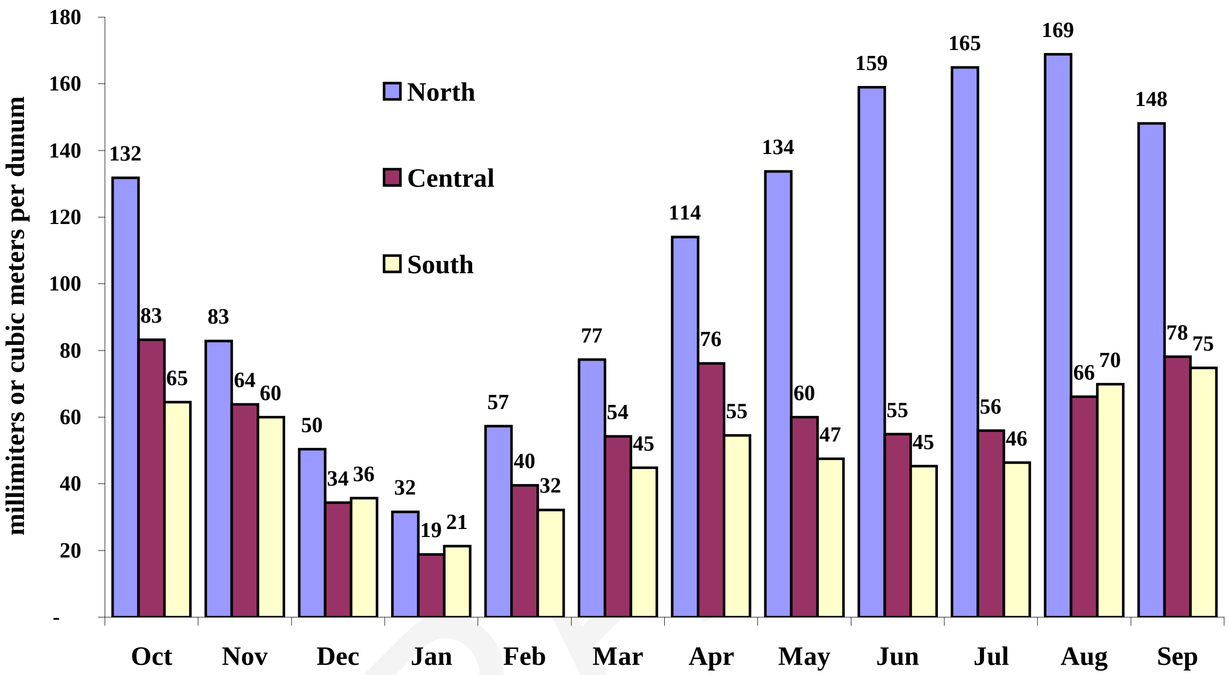

Figure 6. Jordan Valle monthly irrigation water requirements, by zone

Water productivity by zone

Figure 7 condenses all the previous information on gross revenues and crop water requirements into a single graph comparing value per unit of land and water in the three zones of the Jordan Valley. The first three columns depict value of production in dinars per dunum in the North, Center, and South zones. An average dunum in the North generates 422 dinars per dunum, compared to 855 dinars for an average dunum in the Center zone, and 371 dinars in the South.

The second set of columns in Figure 7, however, contrast the water requirements by an average dunum in the North of 1,320 cubic meters, compared with only 685 m^3 in the Center, and 597 m^3 in the South. The North zone requires twice as much water per dunum as the Center, but generates only half as much in gross revenue.

The contrast in terms of value per unit of water is made graphically by the three rightmost columns in Figure 7: One thousand cubic meters of water in the North produce 320 dinars while in the Center they generate 1,247 dinars, and in the South 621 dinars.

Figure 8 makes the same contrast in water productivity per zone but in terms of how much water is required to produce one dinar of value: In the North zone 3.13 cubic meters are required, while in the Center 0.80 cubic meters suffice, and in the South 1.61 m^3 are needed.

For the Jordan Valley as a whole, the baseline survey cropping pattern combined with the JVA tables of crop water requirements indicate that on average it takes 1.74 cubic meters of water to produce one dinar of product value. In other words, one cubic meter of water produces 0.57 JD of gross revenue, Figure 8.

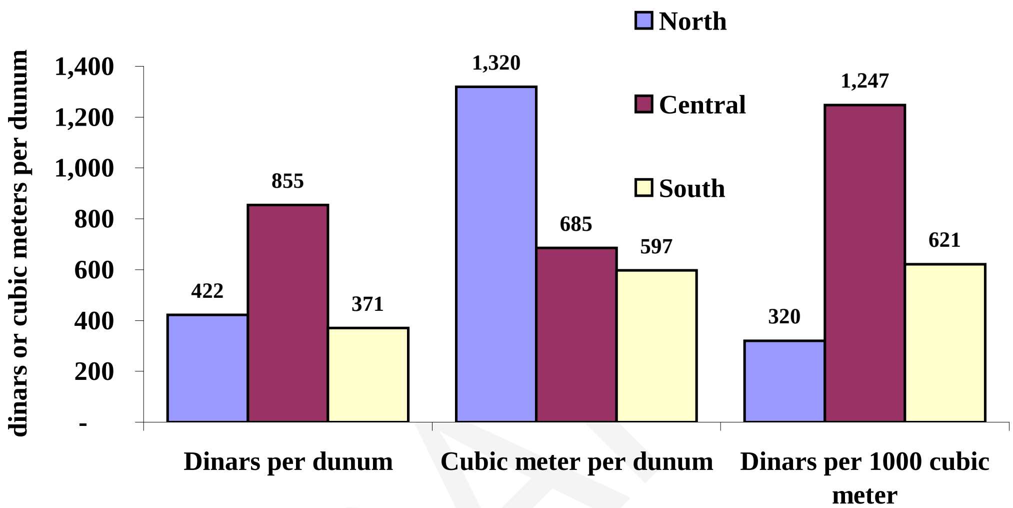

Figure 7. Water productivity in the Jordan Valley, by zone. 2003

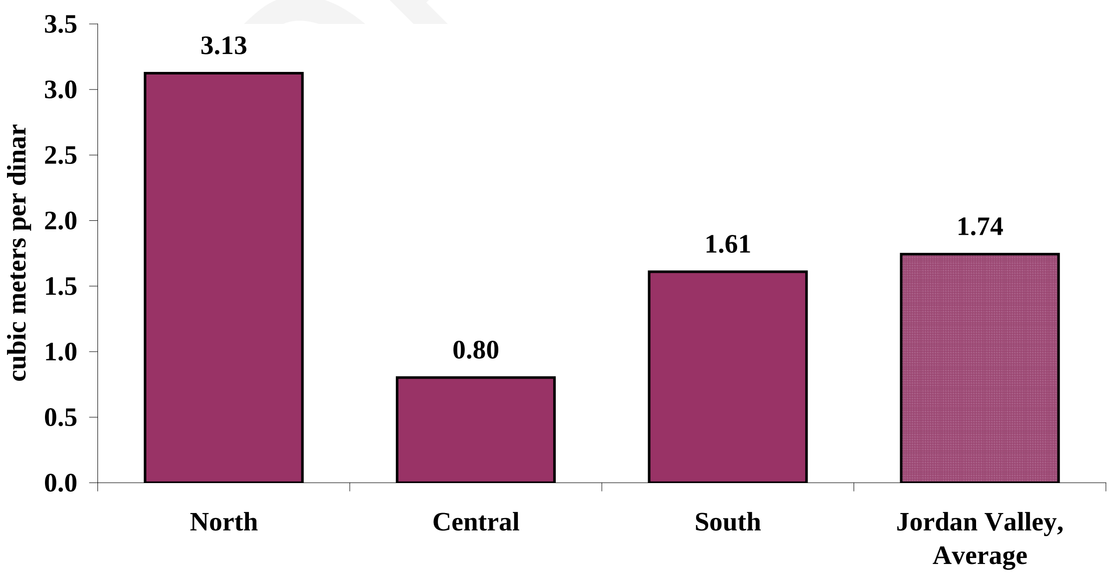

Figure 8. Irrigation water needed to produce one dinar of value in the Jordan Valley, 2003.

Water Deliveries compared with Crop Water Requirements

Crop water requirements tables provided to the baseline assessment team were computed using theoretical calculations based on temperature and humidity recordings at meteorological stations in the Jordan Valley and crop-specific parameters obtained experimentally from overseas research centers. These are not values derived experimentally in Jordan. The Jordan Valley Authority acknowledges that they do not abide by these crop water requirements in deciding how much water is delivered to different zones or different farms.

In practice JVA uses simpler rules to decide how much water to deliver to a farm. It distinguishes three categories of crops only: vegetables, citrus, and bananas. The general rule of thumb is that in the hotter months of the year JVA delivers 2 mm per day for vegetables, 4 mm per day for citrus trees, and 7 mm per day for bananas. In the cooler winter months JVA delivers only half as much water, and depending on the rainfall it might not be necessary to delivery any water at all. This schedule has only been recently adopted by JVA management as an improvement over the earlier rules of thumb, but it is not fully implemented yet. Table 4, Appendix II converts that delivery schedule per day into cubic meters per dunum to be delivered per month. (Note: even though JVA mentioned that it delivers slightly more water in the South zone the assessment team was unable to obtain a separate delivery schedule for that zone).

In the case of vegetables we need to take into consideration that there are two planting times within one growing season, namely fall plantings and spring plantings. Vegetable crops have a life cycle of about five months on average, some more and some less. Table 4, Appendix II differentiates water delivery schedules for fall and spring vegetables, but in the baseline survey the questionnaires did not request from farmers the planting time for vegetables. In practice, of course, farmers spread their vegetables plantings through out the growing season to avoid supply gluts and low prices. In the absence of planting time information, it was assumed that a dunum of vegetables receives the average water volume between fall and spring. The bottom figures in Table 4 in Appendix II, reflect that determination.

Figure 8 in Appendix II shows graphically the combined water delivery schedule for fall and spring vegetables, with a maximum of 2mm in May and November, and low deliveries of 1 mm in January and February. Figures 9 and 10 in Appendix II, present monthly water delivery for citrus and bananas throughout the year; maximum deliveries occur in the hotter summer months of 5 mm of citrus and 7 mm for bananas. When graphed at the same scale, Figure 9, the contrast in water delivered per average dunum of vegetables, citrus and bananas becomes apparent. We need to recall that the figures for vegetables reflect the average delivery distributed throughout the entire growing season.

Figure 10 puts together the 2003 cropping pattern in the three zones from the baseline survey with the JVA water delivery schedule to show the distribution of monthly water delivery through the year, with a maximum of 120 cubic meters per dunum in October and low deliveries of about 50 m^3 per dunum from November through April for the North. The Central zone shows a maximum delivery of 50 m^3 per dunum in October with minimum values of 22 m^3 in July, roughly half as much per dunum as in the North zone.

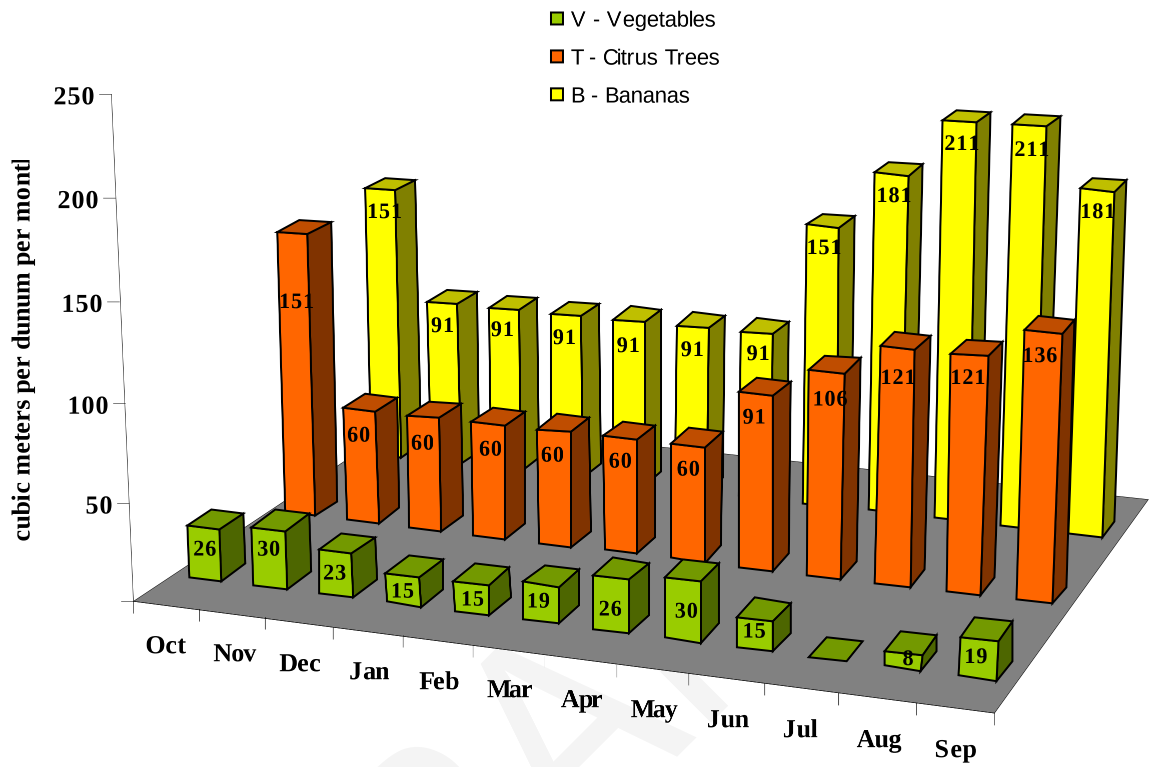

Figure 9. Jordan Valley Authority. Irrigation water delivery for vegetables, citrus trees, and bananas.

The contrast between the three zones of the Jordan Valley in terms of monthly water deliveries is evident. The differences are emphasized in the summer months when in the North JVA delivers about 100 m^3 per dunum due mainly to the presence of citrus trees while water delivery in the Center and South are minimal, less than 25 m^3 per dunum, because vegetable growing in those months has stopped. For the entire Jordan Valley, average monthly water delivery per months is illustrated in Figure 11 in Appendix II; the maximum deliveries occur in September and October while the lowest deliveries take place in January and February.

A new MS Access database file was created for section 9 of the baseline survey, using the water delivery schedules instead of the crop water requirements. The new file is named T9_Crop_Baseline_2nd_CWR. Using the new set of irrigation water data, it is possible to compute the water used by each crop field in the baseline survey and perform the same water productivity analysis as before.

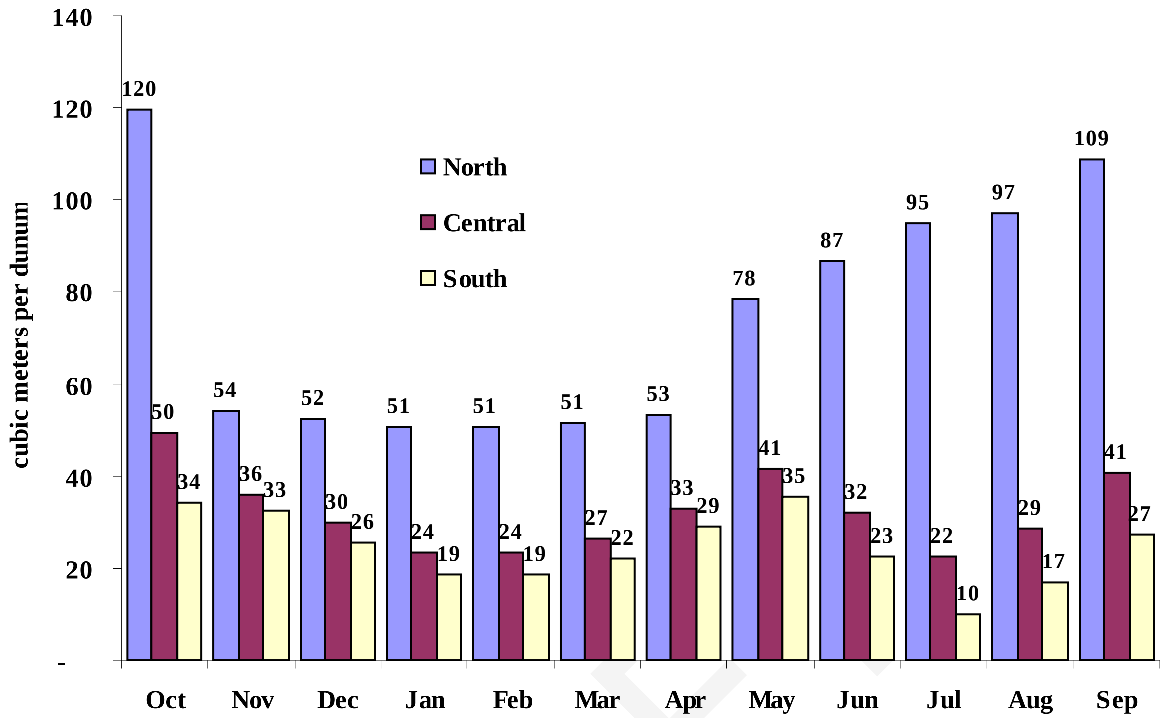

Fig. 10. Monthly water delivery schedule in the Jordan Valley, by zone, 2003

Figure 11 consolidates the information on gross crop revenue and irrigation water delivery per crop to arrive at global estimates of value per unit of water in the three zones of the Jordan Valley. The three columns on the left show average gross revenue per dunum in the North (423 JD), Center (896 JD), and South (391JD). In the middle columns the new estimates of irrigation water delivery per dunum are shown: 896 m^3 in the North, 387 m^3 in the Center, and 294 m^3 in the South. Once again, the contrast between the North and the other zones is striking: the average dunum in the North consumes twice as much water as a dunum in the Center, but generates less than half gross revenue. The last three columns on the right make those relationships more dramatic: while farmers in the Center generate 2,316 JD per thousand cubic meters of irrigation water, and farmers in the South generate 1,332 JD, farmers in the North only generate 471 JD. Conversely, Figure 12 shows that it takes 2.12 cubic meters to generate 1 dinar of value in the North, while in the Center the same product value only needs 0.43 cubic meters of irrigation water, and in the South 0.75 cubic meters.

Using JVA's water delivery schedules for the three crop categories (vegetables, citrus, and bananas) seems to corroborate the main findings of the earlier analysis using crop water requirements. The absolute water consumption figures are lower but the relative magnitudes observed between the three zones in the valley remain valid. The poor performance irrigation water, as a function of cropping pattern, in the North zone of the Jordan valley in comparison to the Center and South zones is an important conclusion of this assessment.

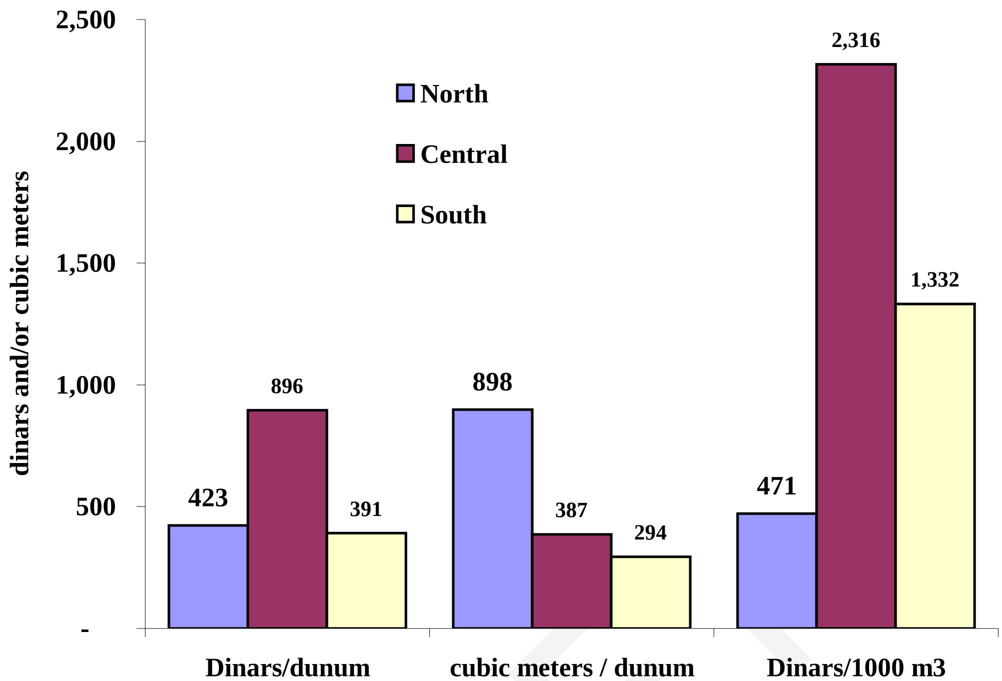

Figure 11. Jordan Valley. Value of production and water consumption per dunum, and dinars per thousand cubic meters of water among survey sample farms, by zone. 2003

Similar analyses were conducted to identify the relative productivity of water for different crops and different farming methods in the three zones of the Jordan Valley. Figure 12 in Appendix II, shows the value per dunum and per thousand cubic meters of water in the North zone for the major crops found in that zone. Gross revenues per dunum remain the same as in Figure 3, but revenue per 1000 m^3 of irrigation water are more favorable now because water deliveries are considerably lower than the crop water requirements used before in calculations about water consumption. The relative ranking of crops remains roughly the same as before: potatoes, eggplant, tomatoes, okra, molokheya, and sweet peppers remain the most rewarding users of irrigation water; among citrus trees only navel oranges, lemon and valencia oranges have revenues per 1000 m^3 over 500 JD.

Over half of the vegetable crops in the Center zone have gross revenues above 1000 JD per thousand cubic meters of irrigation water, Figure 13 in Appendix II. The outstanding performers are once again those vegetables grown under plastic green houses (cucumbers and tomatoes), although there are several high value vegetables in open field conditions that perform well: potatoes, tomatoes, dry onions, eggplant, okra, broad beans, string beans, and lettuce. A similar pattern emerges in the South zone among open field vegetables. Green houses are less prevalent in the South than in the Center Figure 14, Appendix II. Also included in Figure 13 are the crop productivity comparisons for the Southern Ghor, where open field tomato is the main crop returning nearly 1,500 JD per thousand cubic meters of irrigation water. Open field watermelons and eggplants, as well as string beans under plastic green houses, also provide outstanding returns on irrigation water.

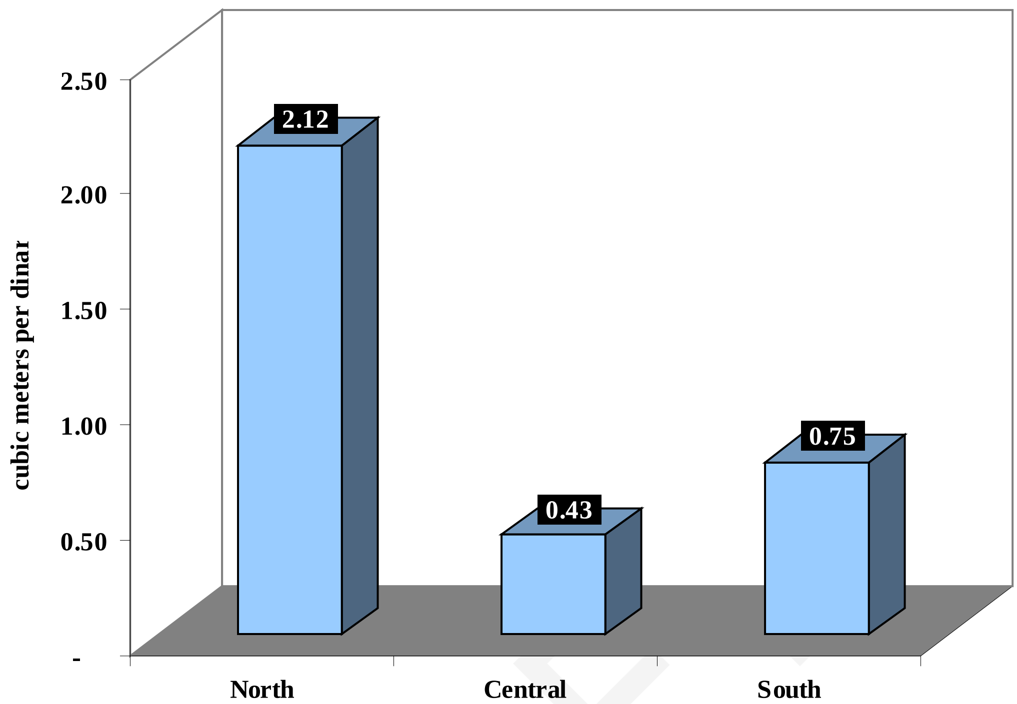

Figure 12. Jordan Valley. Cubic meters of irrigation water required to produce one dinar of product value among farms in the survey sample, by zone. 2003

A direct comparison of the relative productivity of irrigation water used on vegetables, citrus trees, and bananas is shown in Figure 14. An average dunum planted in vegetables generates 643 JD in gross revenue, compared with 1,036 JD for bananas and 465 JD per dunum of citrus trees. However, when irrigation water consumption is taken into account, vegetables only consume 227 cubic meters per dunum compared with 1,634 m^3 by bananas and 1,089 by citrus trees. The combined end results of these crop computations is seen in the three right-most columns in Figure 14: Vegetables generate 2,836 JD per thousand cubic meters of irrigation water, while citrus trees only generate 427 JD and bananas 634 JD for the same amount of irrigation water.

Figure 15 draws the contrast in productivity of irrigation water between vegetables, citrus, and bananas very clearly in terms of how many cubic meters are needed to produce one dinar of product value: Vegetables require only 0.35 cubic meters to produce 1 JD while citrus trees require 2.34 m^3 and bananas 1.58 m^3 in irrigation water.

For all three zones in the Jordan valley the average gross revenue per dunum (582 JD) is roughly comparable to the cubic meters of irrigation water consumed per dunum (618 m^3), meaning that each cubic meter of irrigation water delivered generates about 1 JD of product value, Figure 16.

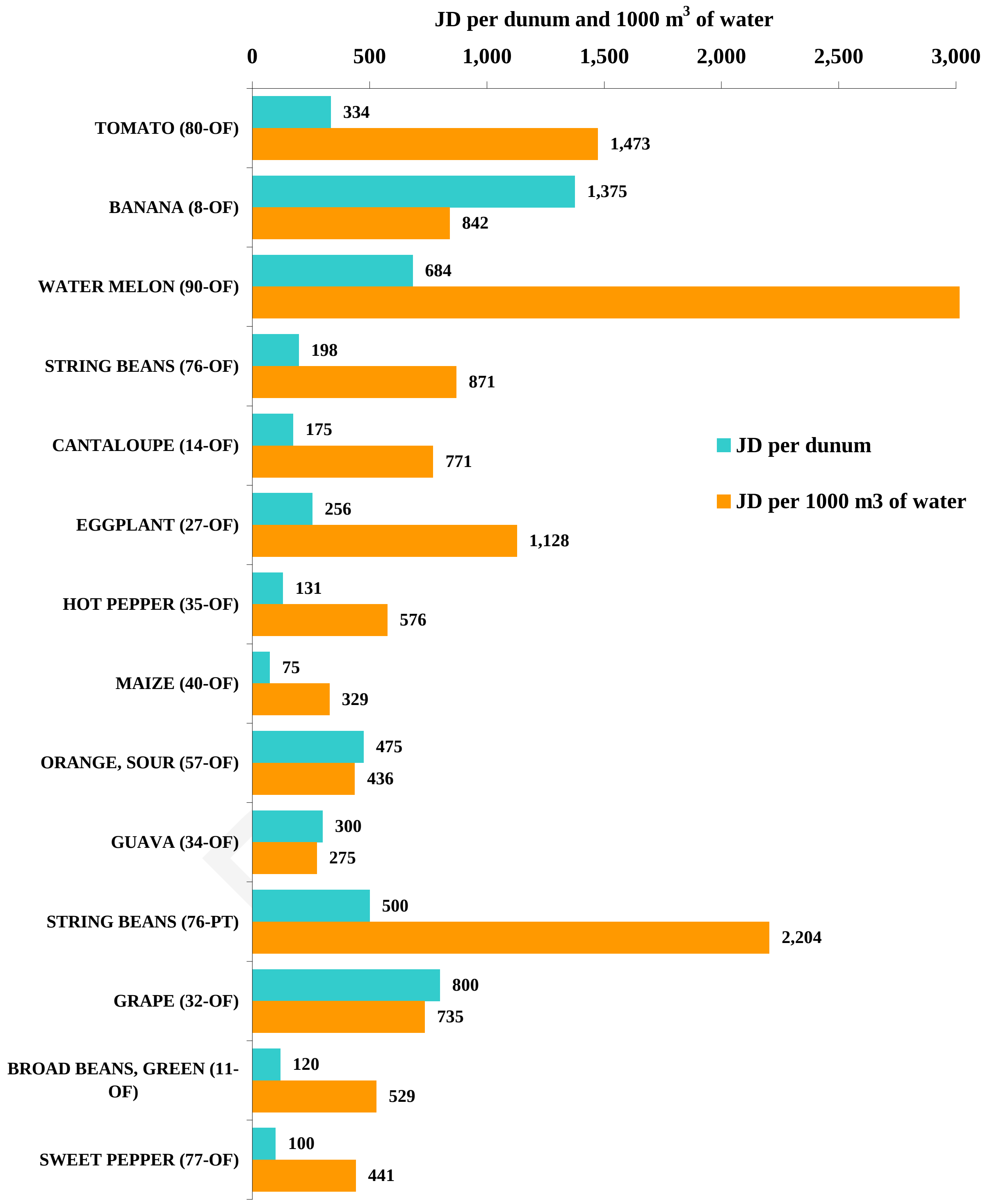

Figure13. Value of production per dunum and per thousand cubic meters of irrigation water delivered for major crops in the Southern Ghor, 2003

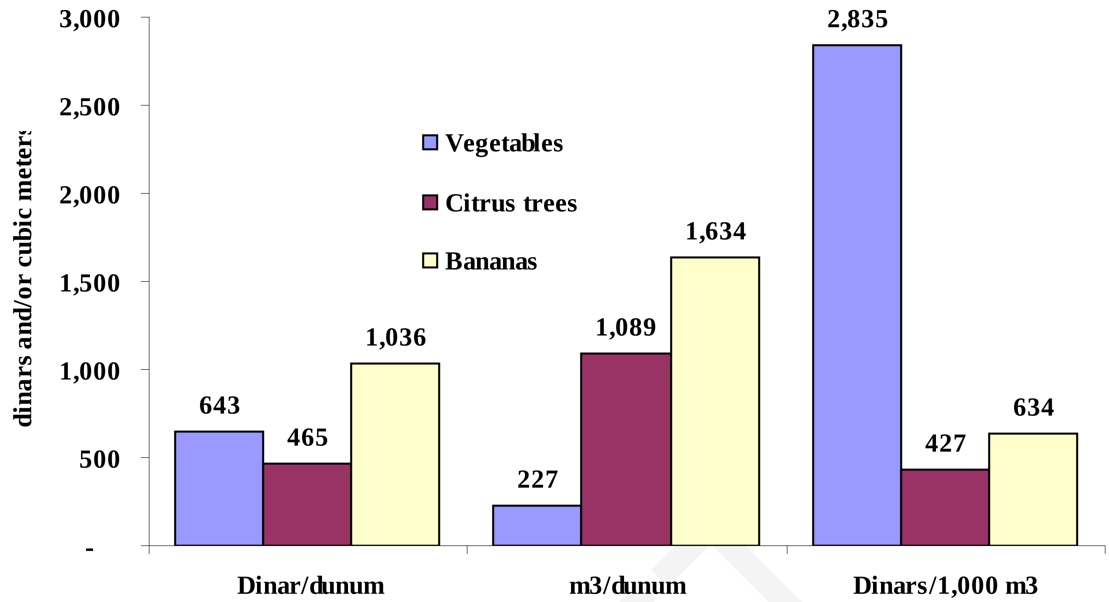

Figure 14. Jordan Valley survey. Value of production and water consumption and dinars per thousand cubic meters of irrigation water among survey sample farms, by product category. 2003

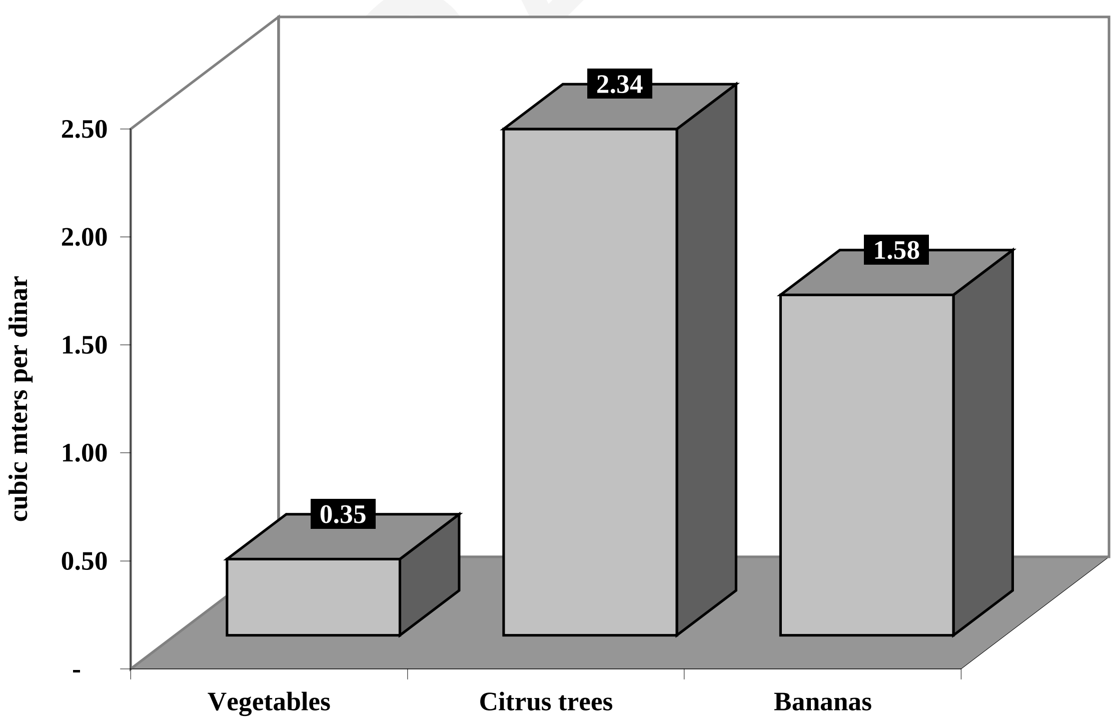

Figure 15. Jordan Valley. Cubic meters of irrigation water needed to produce one dinar of value, by product category, 2003

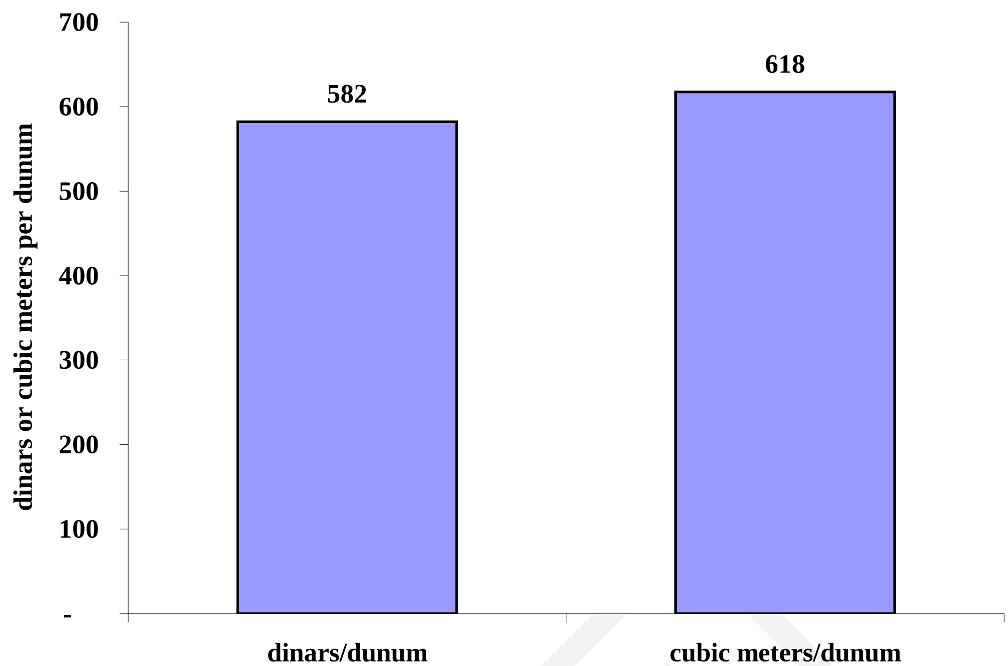

Figure 16. Jordan Valley. Average production value and water consumption per dunum. 2003

Most of the water delivered by JVA goes for irrigating citrus trees according to Figure 17. Using the cropping patterns in the survey sample farms, the water delivery for vegetables, citrus trees, bananas, and other fruit crops was computed. For other fruit crops the same water delivery schedule specified for citrus trees was used. The results of these calculations appear in Figure 17.

A total of 8.4 million cubic meters were delivered to the entire sample of farmers, of which 5.46 million (65 percent) went to citrus trees, compared with 1.82 million to vegetable crops (22 percent), and 0.64 million to bananas (7.7 percent).

The same water use figures appear in Figure 18 accompanied by the total gross revenues reported by farmers from vegetable crops, citrus crops, bananas, and other tree crops. Total gross revenue from all crops in the Jordan Valley survey sample amount to 7.9 million JD, of which 4.95 million JD (62 percent) are contributed by vegetable crops, 2.43 million JD (31 percent) by citrus trees, and 0.41 million JD (5.1 percent) by bananas.

Vegetables crops use 22 percent of the irrigation water delivered but generate 62 percent of gross revenue. By contrast citrus trees consume 65 percent of the water but only generate 31 percent of the gross value of production.

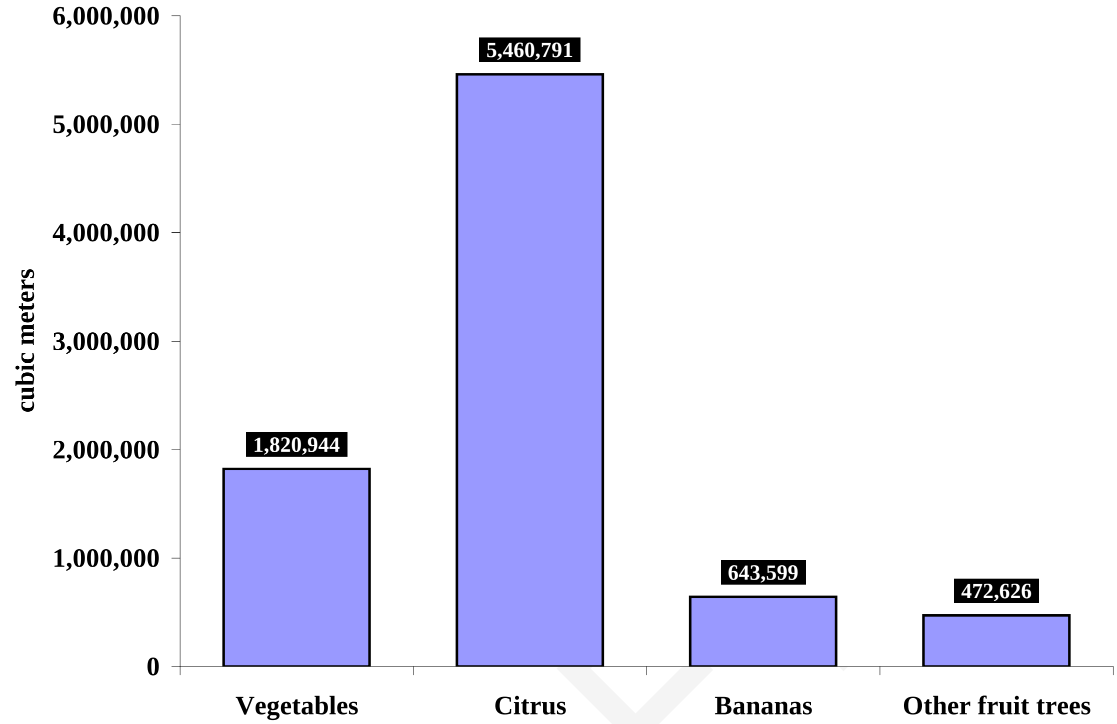

Figure 17. Jordan Valley. Irrigation water consumption in the survey sample farms for vegetables, citrus, bananas and other tree crops, 2003

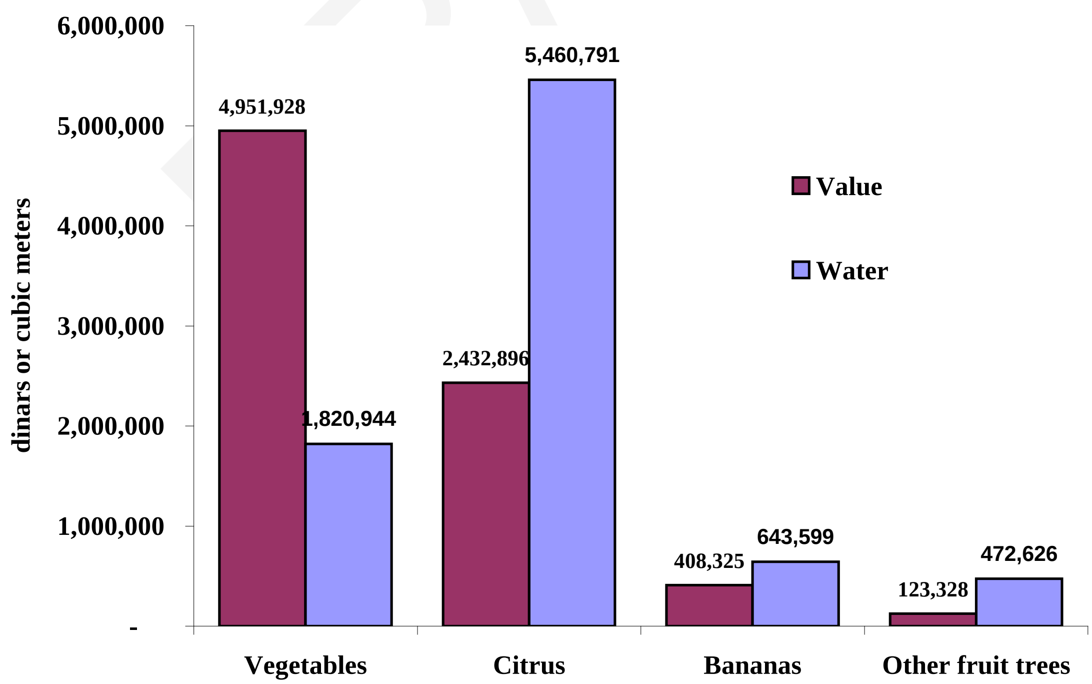

Figure 18. Jordan Valley. Production value and irrigation water consumption in the survey sample farms on vegetables, citrus, bananas, and other tree crops, 2003

Farmers' perceptions about water use and crop profitability

The KAFA'A project has several goals; anticipated results 1 and 2 of the project goals (Component 1) deal with farmer's knowledge and behavior respectively. Section 5, 7, and 9 of the survey asked several questions testing their knowledge of water source and quality (Sec. 5), as well as cash crops (Sec. 7) and collected information on behavior through questions on cropping patterns (Sec. 9).

Tables 5 and 6 show the farmer current knowledge on their water supply source and the quality of the water received. Table 5 describes the supply source in the North, where all the water received can be categorized as fresh (see description at bottom of the table); the Center and South receive about 80 percent of the water blended of fresh and treated wastewater.

The farmer's understanding about the quality of water received as a function of the supply source is shown in Table 6. In the North zone, farmers response goes in good correlation with the land relation to farmers shown in Table 1, above 90 percent related the source with fresh water. The Center zone shows some contradiction attaining fresh water to the KTD, 14.3 percent; the same happened in the South zone with KAC + KTD, 48 percent gave category of fresh water to the blended water from the two sources.

Table 5. Source of irrigation water and quality description

	J. V. North		J. V. Central		J. V. South		Southern Ghor (Safi)		AZB	
Source	Count	%	Count	%	Count	%	Count	%	Count	%
Groundwater	2	0.8	2	0.8	16	12.6	34	28.1	78	100.0
KAC	176	74.5	43	17.9						
KTD			5	2.1						
KAC + KTD			189	78.8	100	78.7				
Other	58	24.6	1	0.4	11	8.7	87	71.9		
Total	236		240		127		121		78	

KAC: King Abdullah Canal, surface fresh water mostly from the Yarmouk River

KTD: King Talal Dam, blended fresh and treated waste water

Other: fresh water from other small dams and wadis in the rift

Section 7 of the baseline survey asked farmers to name four crops, which in their view were the most profitable in the respective area. They were also asked to name four crops that performed well under water shortage, using saline water, and using treated wastewater. The details by zone are shown in Appendix II, Tables 5 through 8 and Figures 15 through 19. The AZB highlands farmers do not face (yet) the problem of water quality so their knowledge of crops was tested on profitability and water use efficiency; the results are shown on Table 6.

Table 6. Farmer's knowledge of the irrigation water Quality

	Water Quality	J. V. North		J. V. Central		J. V. South		Southern Ghor (Safi)		AZB	
	Groundwater:	Count	%	Count	%	Count	%	Count	%	Count	%
Groundwater	Fresh	2	100.0	2	100.0	3	18.8	34	100.0	78	100
	Saline					6	37.5				
	Treated					6	37.5				
	Other					1	6.3				
	Subtotal	2		2		16		34		78	
KAC	Blended			3	7.0						
	Fresh	174	98.9	40	93.0						
	Saline	2	1.1								
	Subtotal	176		43		0		0		0	
KAC + KTD	Blended			3	60.0	7	7.0				
	Fresh			1	20.0	48	48.0				
	Saline					4	4.0				
	Treated			1	20.0	23	23.0				
	Other					18	18.0				
	Subtotal	0		5		100		0		0	
KTD	Blended			122	64.6						
	Fresh			27	14.3						
	Saline			11	5.8						
	Treated			26	13.8						
	Other			3	1.6						
	Subtotal	0		189		0		0		0	
Other	Fresh	53	91.4	1	100.0			85	97.7		
	Blended	5	8.6			1	9.1				
	Saline					2	18.2	2	2.3		
	Treated					8	72.7				
	Subtotal	58		1		11		87		0	
	Total	236		240		127		121		78	

Several issues arose regarding the interpretation of farmer responses to these questions in the Jordan Valley. First, whether to give the same weight to the first crop mentioned as to the last crop mentioned. After some discussion it was felt that first responses should get some greater weight than others, and that the weight should progressively diminish. We assigned arbitrarily a weight of 2 to the first response and 1 to the fourth response, and intermediate weights of 1.66 and 1.33 to the second and third responses respectively. For every crop the number of times it was cited by a farmer as a first, second, third, or fourth response was recorded, and weighed those counts using the above weights.

The weighted counts for crop profitability were estimated for the three zones in the Jordan Valley and the Southern Ghor, and all four zones combined. In Appendix II Table 5 and Figure 8, show farmers' perception of profitability in all four zones. It is remarkable how many of the top ranked crops cited are the most popular vegetable crops in the valley, starting with tomatoes, eggplant, string beans, zucchini, potatoes, cucumbers, and hot peppers. Only navel oranges and sour oranges make the top ten. Bananas are ranked 10^{th} followed with shamouti oranges.

Tomatoes are viewed by farmers in the Jordan valley as the most profitable crop by far and except for navel oranges, other citrus rank very low in perceptions of profitability. Farmers' perceptions about the profitability of vegetable crops are thus in rough agreement with the analysis of efficiency of water use in this report. Clementines and mandarins are ranked very low in farmers' perception of profitability, Table 5 in Appendix II. Farmers may welcome assistance to help them convert land in the less profitable citrus crops, clementines for example, to more profitable vegetable crops.

The strong correspondence between crops viewed as more profitable by farmers and those with the larger planted areas is easier to see in the Center zone (Table 6 in Appendix II), where tomatoes are reported the most profitable crop, followed by potatoes, cucumber, eggplant, zucchini, string beans, onions and peppers.

In the South zone of the Jordan Valley the same vegetable crops are ranked slightly different in profitability, starting with eggplants, tomatoes, and zucchini (See Table 7 in Appendix II). A significant number of farmers acknowledge not knowing which crops are most profitable. In the Southern Ghor tomatoes are overwhelmingly the first choice for profitability, reflecting also its dominance in the cropping pattern of the area (See Table 8 and Figure 19 in Appendix II).

Farmers' perceptions about the suitability of crops to conditions of water scarcity, or tolerance for saline water, or wastewater show the lack of knowledge in the subjects. For the Jordan Valley and the Southern Ghor the results are summarized in Table 7 and in Appendix II, Figures 16 to 18. The principal vegetable crops are also given the highest ranking for efficient water use, including tomatoes, eggplant, string beans, zucchini, peppers, onions, and date palm. Citrus crops and bananas were ranked very low for water use efficiency. In this regard, farmers' perceptions seem to concur with key conclusions from the analysis of water efficiency in this report.

AZB farmers in the highlands of AZB had similar response to two questions on profitable and less water use crops, Table 8; the water quality was not addressed in the AZB survey because the covered area is on groundwater wells; however KAFA'A is considering the fact that in the near future a trade has to be made between fresh water for municipal use and treated wastewater for agriculture, and consequently prepare the farmers for such change. The two demonstration plots in the AZB will be targeting this problem.

The number of farmer responses was smaller regarding suitability of crops for saline water and wastewater. The most frequent response to naming crops best suited for blended water was "Don't Know" (See Figure 19 in Appendix II). Only tomatoes and eggplant received significant mention. Tomatoes and eggplant were also cited as tolerant of saline water, along with date palms and barley, but most farmers could not respond or answered, "Don't know."

The assessment team concludes therefore that farmers in the sample do not have a clear understanding or knowledge of which crops are more suitable to adverse water conditions of scarcity, salinity, and waste contamination. It would be a measure of success if at the end of the KAFA'A project farmers are able to respond to a similar inquiry in a more discriminating manner. The current figures will be a valuable reference in the future to assess the efficacy of programs to impart better knowledge among farmers of crop response to poor water conditions.

On-Farm Irrigation Water Management

The adoption of water-efficient technologies and improved on-farm management practices are called for in anticipated result 3 of KAFA'A Component 1. Table 9 shows several questions asked to the farmers, which relate directly to on-farm water management; the use of sand media filters is higher in the Center and South zones in direct relationship to the low water quality. However when visiting farms in any of the areas, is common the sight of early life abandoned (broken or useless) sand media filters reflecting poor operation and maintenance.

Most farmers do some cleaning of laterals and emitters, mostly on a weekly basis; however, regarding to cleaning emitters, the most used method is the "mechanical", which consist of cleaning with any sharp pointed device (needle or nail) distorting all the hydraulic purpose of a low flow-localized emission source.

Water flow measurement, currently JVA is addressing the serious problem of accounting for water deliveries to the farmers through another USAID funded project targeting the improvement of the delivery system in the valley. Records is a must in any program for improving performance in any activity; over 82 percent of the farmers surveyed reported not keeping records, a weighted average of 78 percent of farmers, who do not keep records (Table 9) justified not doing so because they "would not use" the data. Such attitude is hiding the lack of knowledge on the 'know how" in irrigation management technologies. The AZB shows the highest percentage (40 %), which indicates a response to the need of control because of the higher water cost in the area.

Needs for appropriate marketing techniques

Since KAFA'A launching workshop in October 2003, and the series of meetings with farmers that followed that event, marketing has taken high priority as a request from the agricultural sector, main stakeholders, and the farmers.

The baseline assessment survey tested the awareness of the farmers on international food quality standards as an essential step for export marketing improvement; the majority of the farmers in the five project sub areas have no knowledge of EurepGap, ISO, or HACCP and their standards requirements for agricultural products; from 72 to 96 percent of the farmers surveyed do not know about these organizations, Table 10.

Table 7. Ranking of selected crops according to profitability and use of irrigation water, blended water, and saline water, as reported by survey sample farmers in the Jordan Valley and Southern Ghor, 2004

Crop code and name	Profitability	Water Use	Blended Water	Saline Water
80: TOMATO	16.5%	5.4%	6.2%	12.9%
27: EGGPLANT	8.1%	6.1%	6.4%	11.3%
76: STRING BEANS	5.7%	10.1%	0.5%	0.6%
86: ZUCCHINI	5.7%	7.4%	1.4%	2.0%
64: POTATO	5.3%	1.6%	1.0%	1.0%
51: ORANGE NAVEL	4.6%	0.1%	0.2%	0.1%
25: CUCUMBER	3.6%	1.3%	0.8%	0.1%
35: HOT PEPPER	3.0%	3.6%	0.9%	1.1%
57: ORANGE, SOUR	2.9%	1.9%	0.3%	0.0%
8: BANANA	2.7%	0.1%	0.3%	0.8%
56: ORANGE, SHAMOUTI	2.5%	0.1%	0.2%	0.0%
49: ONION, DRY	2.0%	2.4%	1.5%	2.0%
90: WATER MELON	1.9%	0.3%	0.1%	0.4%
40: MAIZE	1.8%	1.8%	2.1%	2.7%
11: BROAD BEANS, GREEN	1.7%	3.4%	0.5%	0.5%
87: Don't know	1.6%	3.4%	17.5%	8.7%
26: DATE PALM	1.4%	4.8%	1.1%	6.0%
38: LEMON	1.3%	0.2%	0.1%	0.2%
85: WHEAT	1.3%	3.9%	1.2%	2.1%
47: OKRA	1.1%	2.9%	0.5%	0.8%
55: ORANGE, RED	1.1%	0.1%	0.1%	0.0%
77: SWEET PEPPER	1.1%	0.7%	0.2%	0.3%
58: ORANGE, VALENCIA	1.0%	0.2%	0.1%	0.0%
74: SQUASH	1.0%	1.2%	0.8%	0.9%
36: JEW'S MALLOW	0.8%	0.3%	1.0%	1.2%
39: LETTUCE	0.8%	0.5%	0.3%	0.1%
12: CABBAGE	0.7%	0.9%	0.7%	0.7%
14: CANTALOUPE	0.7%	0.8%	0.0%	0.6%
19: CLEMENTINE	0.6%	0.2%	0.1%	0.1%
32: GRAPES	0.6%	0.5%	0.1%	0.2%
75: STRAWBERRY	0.5%	0.1%	0.0%	0.0%
16: CAULIFLOWER	0.4%	1.1%	0.6%	0.8%
9: BARLEY	0.4%	2.0%	1.5%	5.0%
34: GUAVA	0.4%	0.0%	0.0%	0.5%
52: ORANGE, FRENCH	0.4%	0.0%	0.0%	0.0%
61: PEAS	0.3%	0.4%	0.2%	0.2%
1: ALFALFA	0.3%	0.3%	0.9%	0.9%
88: BOMELY	0.3%	0.1%	0.1%	0.1%
42: MANDARIN	0.2%	0.3%	0.0%	0.0%
48: OLIVE	0.2%	3.8%	0.7%	1.1%
30: FLOWERS	0.2%	0.0%	0.3%	0.0%
20: CLOVER TREFOIL	0.2%	0.1%	0.8%	0.4%

Table 8. Ranking of crops by farmers in AZB, according to profitability and use of water

	Most Profitable		Less Water	
	Crop	%	**Crop**	%
AZB	Tomato	17.7	Squash	18.8
	Peach	13.3	Peas	17.7
	Cantaloupe	11.9	String Beans	15.6
	Grape	9.7	Sweet Pepper	14.6
	Forest trees	8.8	Forest Trees	13.5
	Apricot	8.0	Onion Dray	4.2

Farmers were also asked weather if they belong to an export organization or if they would like to participate in one; over 74 percent do not belong to any organization. The central wholesale market (CWM) in Amman was, on a weighted average, ranked in the top as a source of information for exports. This confirmed the findings of the marketing assessment when the farmers were asked about requirements for increase in exports. Table 10 shows first choice of contracts and pre-contracts for agricultural products in the Center and Southern Ghors zones (27 percent); better quality products was chosen in the North (41 percent); export buyers in the South (66 percent); and different varieties in the AZB (62 percent).

Decreasing water use

Decreasing water use is the goal in anticipated result 5 in Component 1; at least half of the farmers in the project area will use an average of 10 percent less water by the end of the project.

Irrigation systems used in each area, incentives and project action, technical information, and information sources are summarized in Table 11. Surface system irrigation is still a high percent in use, mostly in the North zone (48 percent); equipment for efficient irrigation was chosen with high percentages in the North (56 percent), Center (50 percent), and Southern Ghors (55 percent); the South zone requested mostly training (89 percent). A weighted average for all the areas resulted in 77 percent requiring technical information; currently the best source of information is in the private sector.

Table 9. Farmer's On-Farm irrigation water management

		J. V. North		J. V. Central		J. V. South		Southern Ghor (Safi)		AZB	
		Count	%	Count	%	Count	%	Count	%	Count	%
Use Sand Filters?	Yes	9	10.5	101	56.4	40	35.4	5	4.3	76	100.0
	No	77	89.5	78	43.6	73	64.6	112	95.7		
	Total	86		179		113		117		76	
Clean Laterals?	Weekly	54	62.8	114	63.7	81	71.7	62	53.0	2	2.6
	Montly	25	29.1	40	22.3	28	24.8	42	35.9	14	18.4
	Seasonally	7	*8.1*	13	7.3	2	1.8	12	10.2	59	77.6
	Yearly			11	6.1	2	1.8	1	0.9	1	1.3
	Never			1	0.6						
	Total	86		179		113		117		76	
Flowmeter Works?	Yes	227	97.0	127	53.4	66	56.9	6	5.0	78	100
	No	4	1.7	106	44.5	44	37.9	113	95.0		
Keeps Irrigation Records?	Yes	40	17.1	41	17.3	7	5.6	5	4.2	32	40.5
	No	194	82.9	196	82.7	119	94.4	114	95.8	47	59.5
	Total	234		237		126		119		79	
	Why not? Would not use	107	55.7	173	88.3	95	80.5	82	72.2	42	89.4
If there was a drought?	Reduce Irrig. Area?										
	Yes	117	50.2	163	81.9	93	88.6	91	76.5		
	Change Irrigation Scheduling?										
	Irrigate at night	19	16.2	57	35.0	46	49.5	11	12.1		
	Irrigate More frequent	91	77.8	68	41.7	42	45.2	75	82.4		
	Other	3	2.6	27	16.6	3	3.2				
	No	4	3.4	11	6.7	2	2.2	5	5.5		
	Subtotal	117		163		93		91			
	Reduce Irrig. Area?										
	No	116	49.8	36	18.1	12	11.4	28	23.5		
	Change Irrigation Scheduling?										
	Irrigate at night	5	4.3	1	2.8	1	8.3	2	7.2		
	Irrigate More Frequent	105	90.5	18	50.0			23	82.1		
	Other	1	0.9	9	25.0						
	No	5	4.3	8	22.2	11	91.7	3	10.7		
	Subtotal	116		36		12		28			
	Total	233		199		105		119			

Table 10. Farmers Knowledge of food quality standards for increasing exports and their source of information.

			J. V. North		**J. V. Central**		**J. V. South**		**Southern Ghor (Safi)**		**AZB**	
			Count	%	Count	%	Count	%	Count	%	Count	%
Awareness of Quality Standards	EurepGap	Yes	11	4.7	43	18.1	16	12.7	7	5.8	6	7.6
		No	223	95.3	195	81.9	110	87.3	113	94.2	73	92.4
	Like to learn?	Yes	215	96.4	172	88.2	29	26.4	108	95.6	70	95.9
	ISO	Yes	41	17.5	66	27.7	17	13.5	29	24.2	12	15.2
		No	193	82.5	172	72.3	109	86.5	91	75.8	67	84.8
	Like to learn?	Yes	187	96.9	147	86.0	28	25.7	90	98.9	64	95.5
	HACCP	Yes	9	3.8	20	0.1	14	11.1	9	7.5	1	1.3
		No	225	96.2	218	91.6	112	88.9	111	92.5	78	98.7
	Like to learn?	Yes	217	96.4	194	89.0	28	25.0	107	96.4	75	96.2
	Organization	Yes	24	10.3	61	25.7	10	7.9	17	14.2	5	6.3
		No	210	89.7	176	74.3	116	92.1	103	85.8	74	93.7
	Like to Belong?	Yes	165	78.6	76	45.2	20	17.4	56	54.4	62	84.9
Info. Source	CWM		61	59.8			4	66.7	71	68.9		
	Buyers				28	31.8						
	None										58	74.4
	Requirements for Increase in Export Crops											
First Choice	Better Quality products		95	40.6								
	Contracts				63	27.2			33	27.7		
	Export Buyers						83	66.4				
	Different Varieties										49	62.0

CWM = Central Wholesale Market

Agricultural labor use in the Jordan Valley

The baseline survey assessment team also wanted to estimate how much rural employment is generated by the main crops grown in the Jordan Valley and its implications for irrigation water management.

Section 12 of the baseline survey obtained information from farmers regarding use of family labor and hired laborers. Question 8 and 9 asks for the number of person months used in the farm by permanent and temporary workers, respectively. Farmers were asked to specify whether labor was used for land preparation and planting, for irrigation and weeding, or for harvesting. Responses however were for the entire farm, not for individual crops. Most farmers grow several crops at the same or at different times in the year. Only in the North it is common to find farms that have only citrus trees. In the Center and South most farms grow a diversity of vegetables through the growing season between September and June. No attempt was done in the survey to separate labor for the different crops in the farm, for that would have required much more time and effort from farmers in the sample, and without written records the data would not be very accurate.

Table 11. Current Information Systems and Farmer's Choices and Incentives for Increasing Water Use Efficiency.

		J. V. North		**J. V. Central**		**J. V. South**		**Southern Ghor (Safi)**		**AZB**	
		Count	%	Count	%	Count	%	Count	%	Count	%
Irrigation Type	Drip	117	50.0	164	74.5	97	89.0	115	60.5	76	98.7
	Sprinkler	5	2.1	6	2.7	4	3.7	1	0.5	1	1.3
	Surface	112	47.9	50	22.7	8	7.3	74	38.9		
	Total	234		220		109		190		77	
Actions / Incentives	Efficient Irrigation Equipment	130	56.0	117	49.6			65	54.6	27	34.2
	Irrigation Scheduling Equipment	58	25.0	56	23.7					38	48.1
	Training					112	88.9				
	Encourage adherence to regulations							24	20.2		
	Information on New Crops					6	4.8				
TI[a]	Yes	117	75.6	216	90.8	112	88.9	64	53.8	79	100.0
	No	57	24.4	22	9.2	14	11.1	55	46.2		
	Total	174		238		126		119		79	
Inform. Source	Private sector	137	59.3	135	57.4	114	93.4	83	70.3	33	41.8
	Government	67	29.0	57	24.3	6	4.9	12	10.2	45	57.0
	Other Farmers	25	10.8	33	14.0	2	1.6	20	16.9	1	1.3

[a] Require technical information (TI) from an extension service

At first sight, the North Jordan Valley generates higher labor employment than the Center and South (see Figure 19). Permanent labor is roughly the same in all three zones, about 2 work months per dunum, but temporary labor requirements are remarkably higher in the North than in the Center and South, where vegetables are predominant. Part of the explanation for this seemingly paradoxical result is that in the North citrus trees require labor all year round, while tomatoes or cucumbers only grow 4 to 5 months in the year and labor requirements are therefore concentrated in a few months. Many farmers are able to produce two vegetables crops in a growing cycle.

Figure 20 provides a better understanding of the relative efficiency of labor use in the three zones of the Jordan Valley, using estimates of production value per work month, and water consumption per work month. In the North one work month of labor generates 87 dinars in value of production and requires 212 cubic meters of irrigation water. In the Center by contrast, one work month produces 187 dinars of value while consuming only 133 cubic meters of water. Labor productivity and irrigation water consumption are lowest among sample farms in the South.

It is possible to estimate from the available data rough labor coefficients for the main crop categories using statistical inference. The main crops were aggregated into a few more or less homogeneous categories. The ad hoc categories are defined for convenience in the statistical analysis, to avoid dealing with nearly one hundred individual crops. All citrus were combined into a single group; several kinds of cucumbers and zucchini were also consolidated into a single group. Tomatoes are kept as a distinct category because they are such a major crop; bananas are also separate because they are distinct from all other crops. Eggplants and peppers are combined into one because they have similar production cycles. Separate categories were assigned for cereals (wheat, barley, and maize) and other vegetables. We can then determine how many dunums are planted in each crop category at each field unit in the survey sample.

For every farm (field unit) we combined the reported work months of permanent and temporary labor into a single number of labor months used on that farm. Using the regression data analysis procedure available in an Excel spreadsheet, it is possible to estimate an equation relating the amount of labor used with the areas planted to each crop category. The estimated equation was:

Work months used on farm = 20.01
+ 0.33 * dunums in citrus
+ 0.61 * dunums in bananas
+ 0.73 * dunums in tomatoes
+ 1.48 * dunums in cucumbers
+ 0.63 * dunums in eggplants and peppers
+ 0.47 * dunums in other vegetables

On average a farm requires 20 work months of labor per year, plus additional labor depending on the kind of crops. The labor coefficients are statistically significant, but the coefficient for cereals is omitted because it is not statistically significant, i.e., wheat and barley do not generate significant additional labor requirements. Table 9 in Appendix II shows the results of the regression analysis that generated the above coefficients and Figure 21 shows the relative magnitudes of employment generated by each dunum of the above crop categories. Much of the observed variation in labor used can be attributed to the types of crops grown, but there are many other factors that affect labor but are not in the equation.

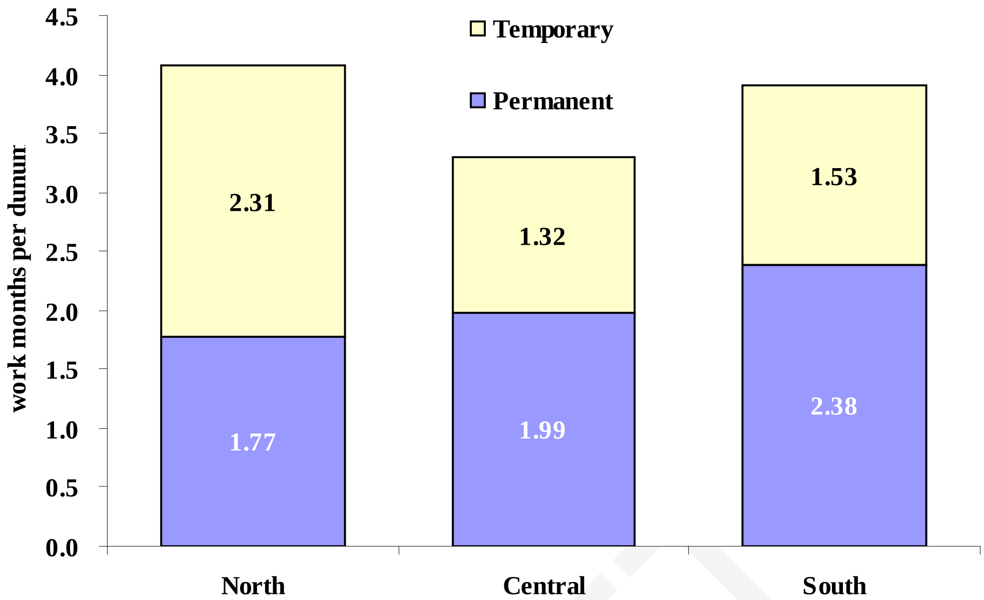

Figure 19. Jordan Valley Survey. Permanent and temporary agricultural labor used by farmers in the survey sample. 2003

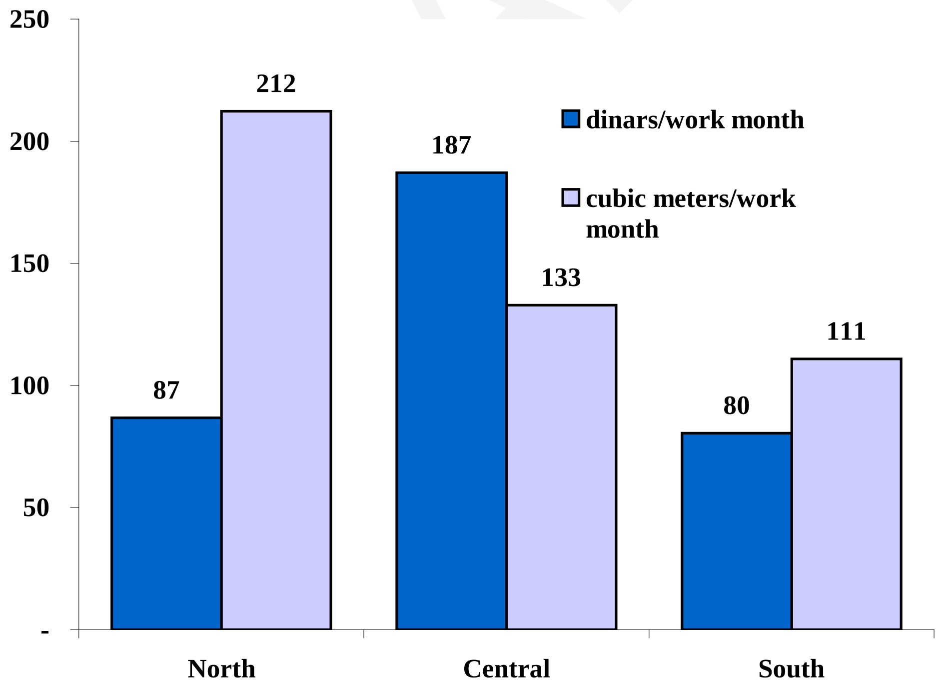

Figure 20. Jordan Valley Survey. Agricultural labor used by survey sample farmers, by zone, 2003

Citrus trees require only 0.33 work months of additional labor per dunum, while cucumbers required more than four times as much -- 1.48 work months per dunum. This exceptionally high employment value for cucumbers is mainly the result of cucumbers being grown in greenhouses using string to provide the support trellis and therefore can produce high yields and demand lots of labor. Tomatoes are still mostly grown in open fields, but greenhouse tomatoes have similar high employment implications. On average tomatoes require 0.73 work months of additional labor per dunum and eggplants and peppers 0.63 work months. Bananas require almost as much, 0.61 work months, but we must recall that this is for the entire year while for vegetables the added labor is used in during a period of about five months.

Management of irrigation water in order to generate rural employment in the Jordan Valley would clearly be enhanced by shifting land and water resources towards the production of high yielding horticultural crops, especially under greenhouse conditions, because those occupy lots of labor while using considerably less water than citrus or bananas. Citrus crops are particularly weak in generating demand for on farm labor.

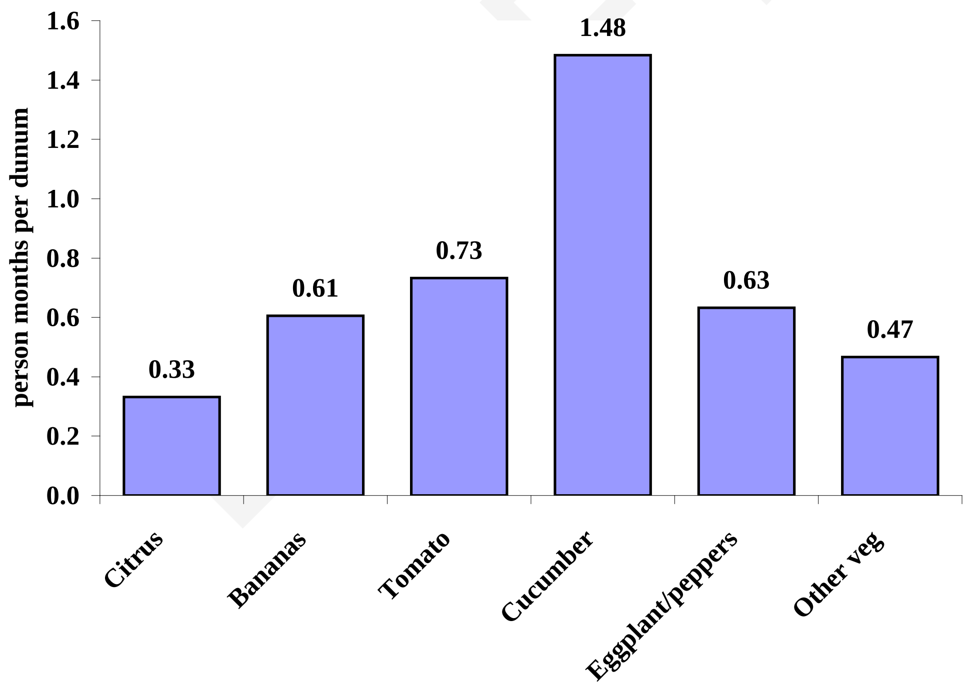

Figure 21. Additional agricultural labor months per dunum of major crop categories among survey sample farms, 2003 (see regression results)

Improving Farm Water Management in the Project Areas

The objective of the KAFAA project is to enhance farmers' knowledge, attitudes, and practices regarding the use of water in agriculture in Jordan, particularly in the Jordan Valley where farm production is nearly totally dependent on scarce irrigation water.

Farmers in the Jordan Valley have many options to reduce water consumption and to enhance productivity per unit of irrigation water. We distinguish three kinds of farm management initiatives that can affect farm water consumption:

1. Water-saving technologies: Examples are using watermarks and tensiometers for irrigation scheduling; or using flow-meters to measure volume of water applied to a given field. Management within current technologies, such as choosing crops that generate greater value per unit of water, or adjusting planting times to coincide with less water demanding months.
2. Other yield and revenue-enhancing measures: For example, using bumblebees to increase pollination and raise yields in tomatoes and strawberries. Even though these measures do not save water directly, they raise income per unit of water used.

In many respects the current irrigation system in the Jordan Valley is highly advanced and technologically sophisticated. The water distribution network in the Jordan Valley is predominantly through underground pipelines with individual outlets to each farm (field unit); each farm has its own FTA (farm turn-out assembly) control box that regulates and measures the amount of water supplied to each farm; the system is designed to operate under pressure so as to enable farmers to install drip irrigation to deliver water to localized areas closed to the plants; most irrigation is done through drip irrigation or micro-sprayers. The Jordan Valley Authority (JVA) controls the entire delivery system up to the FTA, through a computerized network and water deliveries are calibrated and follow strict schedules.

Nevertheless, there are many shortcomings in the current system of water distribution and use in agriculture in the Jordan Valley that are fairly well known and understood. The principal and universal complaint that farmers express is low pressure in water delivered to farms. Farmers claim that the amount of water received from JVA is far below what is expected and at such low pressure that their drip irrigation systems cannot perform well. Farmers are obliged to build storage reservoirs to hold water when delivered by JVA and then use their own pumps to operate their drip irrigation systems properly. In the absence of a reliable water supply farmers use all the water that is made available whenever it is available by JVA. To be on the safe side, farmers tend to over-irrigate, that is, to use more water than needed by the plants, just in case the next water delivery is delayed.

A "ditch rider" system was originally envisioned whereby roving JVA officers in motorcycles opened and closed FTA valves along a main water line according to a strict calendar and schedule to match the water requirements for every farm. The ditch rider system has completely broken down, partly for lack of transport but mainly because it is nearly impossible for JVA to keep track of each single farm's water needs. Farmers themselves need to be responsible for opening and closing valves, but the current water delivery system largely neglects and distrusts farmers. JVA has basically given up on controlling individual farm water intakes, and uses instead broad water delivery schedules of so many hours per week for groups of farms.

Farmers often times leave their water intake valves open to ensure that whenever JVA operates the pumps they receive water to store in their farm reservoirs. Most farm reservoirs are lined with heavy-duty plastic sheets but are not sealed, and therefore contribute to significant leakages of water. JVA on the other hand, attributes the low pressure to farmers keeping their valves open out of the rotation schedule. Very few farmers bother to close the valves leading to their farms after receiving the amount of water needed. While JVA views this "stealing water" as the key reason for low pressure, the practice is so widespread that there is no social stigma or sanction attached to it since farmers are effectively stealing water from each other.

Another major shortcoming of the system is the failure to use the water meters already installed at the outlet to every farm to measure and control water delivery. The meters are enclosed in a locked steel box (the FTA) that only the JVA "ditch rider" can open. Farmers in the KAFAA baseline survey report that most of those meters are in working order in the North Jordan Valley, but neither farmers nor the JVA are recording the readings in the water meters to monitor water delivery and use. There are many conflicting claims about what is wrong with the water flow meters. Some farmers claim that readings are inflated because JVA uses cheaper gas meters that record air as well as water and that JVA pump station water intakes are poorly designed and draw a lot of air with the water (this was partly confirmed by JVA). JVA claims that farmers regularly sabotage the meters by inserting stones and wires to jam the moving parts of the meter to avoid paying for water. Farmers counter claim that the stones and foreign matter come with the water provided by JVA. There is no easy way to verify these complaints and counter complaints, but the end result is that water meters installed at each farm are not being used by farmers or JVA.

Despite the lack of individual meter readings, JVA continues to invoice farmers for water delivered, but the amount is calculated based on JVA's estimates of hours of pumping to a main pipeline and average volume of water based on the diameter of the orifice in the regulator at every farm. The amount invoiced is therefore roughly the same for every farmer, and reportedly ranges between 180 and 250 JD per year, for volumes roughly between 20,000 and 25,000 cubic meters for an average field unit of 30 dunums. The average costs of roughly 1 piaster per cubic meter is considered very low, not even sufficient to cover the operation and maintenance of the system, and certainly too low to induce farmers to save water. Why farmers bother to damage water meters to save a few piasters in water charges is not obvious. On the other hand, once farmers perceive that their water charge is the same regardless of the actual volume of water delivered or used, they lose all incentives to make an effort to save irrigation water.

Farmers report paying JVA about 200 JD per year plus or minus adjustments of a few dinars for water delivered to a typical farm unit, average 35 dunums. Farmers do not have a clear understanding of what items are incorporated in their JVA bills, how much is for operation and maintenance costs, for administrative fees, and for volume of water used. JVA water bills are treated as a fixed annual cost rather than as a variable cost dependent on water actually consumed, and despite the payment being so low farmers complain that they are not getting their money's worth in services. The total revenue collected by JVA is on the order of 1.5 million JD

(7,500 farm units paying 200 JD each). This is not enough to cover the operating budget for JVA. Farmers are practically getting irrigation water at nearly zero cost; what farmers pay right now barely contributes to operation, maintenance and administrative costs of the system.

There exist already a repertoire of water saving techniques and strategies that farmers in the Jordan Valley could adopt. Efforts are being made by JVA and several donor supported projects to promote alternative strategies to induce farmers to make better use of irrigation water. A regional French project to improve irrigation water management focuses on promoting the use of watermarks and tensiometers to improve irrigation scheduling. Their experience and JVA's indicate that farmers could save 30 to 40 percent of current water consumption without reduction in yields. The GTZ is promoting farmers' participation in decision making through the creation of water users associations empowered to manage their own small networks. Independent companies and contractors have been successful in persuading farmers to grow crops under plastic tunnels and greenhouses and to use integrated pest management methods as a way of raising crop yields, product quality and product value. This is also a way of raising productivity per unit of water used. These major investments and changes in crop production technology clearly show that farmers respond quickly when they perceive that such changes result in higher incomes and profits.

The KAFAA project relies on voluntary decisions within the farmers' control concerning production and marketing of farm products. It is therefore essential to understand what can motivate farmers to change their current practices voluntarily. Administrative controls and measures imposed by external authorities are weakly effective in improving on-farm water use efficiency and therefore are not contemplated, except insofar as they provide a framework of reference for decisions made by farmers. GTZ's experience indicates that collective decision making through water users associations is possible and effective as long as provisions are made for fair enforcing mechanisms. We adopt the working hypothesis that farmers are ready and willing to adopt water saving strategies when they operate within a proper structure of economic incentives and other motives of social responsibility.

During the preparation of this baseline assessment the team put forward a proposal to do a water valuation pilot trial in collaboration with one GTZ new water users association near the center of the valley. Farmers in the group would be assigned given irrigation water allowances and encouraged to save water by compensating farmers at the rate of 50 JD for each thousand cubic meters saved from their allowance. This is 50 times the current rate paid by farmers for water, but reflects the opportunity cost of fresh water for other uses. Farmers who would like to use more water than their allowance can buy it at the same rate (50 JD per 1000 m^3). All member farms in the GTZ group are already provided with working flow meters to monitor water consumption. The proposal was actively discussed and considered but in the end it was deemed outside the scope of the KAFA'A project.

A Numerical Illustration

A numerical example might illustrate KAFA'A's project predicament.

Ahmed, a citrus farmer in the North Jordan Valley requires about 1000 cubic meters (m^3) of irrigation water per dunum per year. Farmers at present pay about 10 fils (0.010 JD) per cubic meter. Ahmed's water cost is therefore about 10 JD per dunum per year (about $14). Gross revenue from oranges is about 450 JD per dunum (about $640).

KAFA'A can demonstrate to Ahmed that he can save 30 percent of current water consumption by installing a system of tensiometers (or resistance blocks) and water flow meters to help him schedule irrigation. The investment in these instruments comes to about 50 JD per dunum, and will require daily or regular monitoring of all these instruments.

If farmer Ahmed were to do this, he would save 330 m^3 of water per dunum and as a result will reduce his water bill by 3.300 JD (about $4.70) per dunum per year. Will farmer Ahmed invest 50 JD and go through the trouble of recording and monitoring the tensiometers and flowmeters in order to save 3.30 JD per year? Probably not.

The key point here is to recognize that current prices for irrigation water are too low to make it worthwhile for a typical citrus farmer in the Jordan Valley to adopt the leading technical improvement that KAFA'A and other donors are promoting – resistance blocks and tensiometers for better irrigation scheduling.

Would vegetable farmers be more amenable to install tensiometers? Vegetable farmer Lamia earns about 700 JD per dunum of vegetables, and requires 225 m^3 per dunum per year. (In some years when she is able to grow two vegetables crops in the same piece of land she needs twice as much water, 450 m^3). If farmer Lamia were to spend 50 JD to install tensiometers to improve irrigation scheduling, she would be able to save 30 percent of current consumption, or 75 m^3 per dunum. At current prices for irrigation water that is worth 0.75 JD per dunum. Would farmer Lamia spend 50 JD to save 0.75 JD per dunum per year? The obvious answer is "no".

Conclusion: at current prices, should be reconsidered and use as an incentive to save water along with promoting tensiometers, resistance blocks, and flow meters.

Revenue enhancing measures such as using bumblebees to increase pollination and yields, growing vegetables under green houses, and using better packaging for strawberries … do not change the equation. Even if farmer Lamia were to double revenue per dunum, the investment question remains the same: Will she spend 50 JD to save 0.75 per dunum per year? It is not a question whether she can afford it or not; even if she can afford it, the investment must pay to be justified.

Many dunums of land remain idle in the South Jordan Valley for lack of irrigation water. Farmer Lamia herself faces that problem in her farm: she has dunums that could be cultivated with vegetables and generate revenues of 700 JD per dunum, but she has no assurances from JVA that she can have the 225 m^3 of water required. Would farmer Lamia be willing to pay, say 100 JD for those 225 m^3 of water needed to grow 700 JD worth of production? Probably yes. Farmer Lamia is willing to pay 0.45 JD per cubic meter of water (as much as families in Amman for household consumption).

We have then a paradoxical situation that citrus farmer Ahmed in the North Jordan Valley continues to waste 330 m^3 of water per dunum because he has no incentive to save that water. Meanwhile, farmer Lamia has land in her farm being wasted because she cannot have access to 225 m^3, even though she is willing to pay 100 JD for that water. The basic irrigation problem in the Jordan Valley is that farmers have no incentive to save water so as to release it to other farmers willing to pay for that water.

The obvious solution is for the Jordan Valley Authority (JVA), the organization that delivers irrigation water to both farmer Ahmed and farmer Lamia, to buy water from farmer Ahmed and sell it to farmer Lamia, and pay Ahmed with the 100 JD that Lamia is willing to pay. If that could be arranged, would farmer Ahmed be willing to spend 50 JD in tensiometers to save 330 m^3 of water, for which he could get the 100 JD per year that Lamia is willing to pay? Of course.

All that is needed is for JVA to agree to buy from farmer Ahmed irrigation water that he saves, and sell it to farmer Lamia at the price she is willing to pay.

The KAFA'A project could and should attempt to persuade JVA that it is a good and practical idea for JVA to become a buyer and seller of water to the same farmers that it is serving already. However, it will take longer that the expected life span of the KAFA'A project to persuade JVA of the merits of this arrangement.

Alternatively, there is nothing to stop some other organization, say GTZ or a private broker, to do the same in a smaller scale, in an area where farmer Ahmed and farmer Lamia are farming nearby. That way GTZ or a private broker could reward farmer Ahmed for the 330 m^3 of water that he saves in his citrus, using the money that farmer Lamia is willing to pay for the 225 m^3 per dunum she needs for her vegetables.

Hence the need for a market for farmers to trade rights to water allotments.