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INSTITUTIONAL SUPPORT & STRENGTHENING PROGRAM

ANALYSIS REPORT: SOCIO-ECONOMIC SURVEY OF GROUNDWATER WELLS IN JORDAN

December 2014

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DISCLAIMER

The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government

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ACRONYMS

ACC	Agricultural Credit Corporation
AZ	Amman/Zarqa Basin
du	dunum
FAO	Food and Agricultural Organization of the United Nations
hr	Hour
JD	Jordanian Dinar
MOA	Ministry of Agriculture
MWI	Ministry of Water & Irrigation
NCARE	National Center for Agricultural Research and Extension
SPSS	Statistical Package for the Social Sciences
WIS	Water Information System kept at MWI

1 Executive Summary

The Analysis Report for the Socio-Economic Survey of Groundwater Wells in Jordan presents the detailed analysis of the findings and results of a national Socio-economic Survey of all groundwater wells across Jordan for agriculture, industrial, drinking and tourism usage. The socio-economic survey collected socio-economic as well as technical data associated with groundwater abstraction and use in order to identify key issues and impacts of groundwater use across sectors and regions. The survey focused in particular on the farmers expressed needs and the challenges they face and the management issues for the government for groundwater abstraction. This Analysis Report is the result of the in-depth technical and statistical analysis of the survey findings which examines the survey data in a variety of ways in order to gain a comprehensive understanding of Jordan's groundwater. The result is significant insights and new information into how groundwater is being used, the overall levels of groundwater abstraction by sector and by basin, a detailed analysis of groundwater used in agriculture and where public policy and groundwater management measures could be targeted to reduce widespread over abstraction and depletion of Jordan's groundwater basins.

The Socio-Economic Survey Analysis Report was developed by the Institutional Support and Strengthening Program (ISSP), funded by the U.S. Agency for International Development (USAID). ISSP works to address key institutional constraints to the more effective and efficient management of Jordan's water sector. In close cooperation with the Government of Jordan's (GOJ) water institutions and water utilities, ISSP is supporting a broad-based sector reform to enact the national water strategy. The work of ISSP is concentrated on improved sector governance, reducing institutional conflicts of interest, separation of bulk water and retail management and associated policy, institutional and legal reform.

The goal of the Socio-economic Survey is to carry out the first national study of all groundwater wells in the kingdom in order to create an updated body of baseline data accompanied by insights into the socio-economic impacts of groundwater use in Jordan. The anticipated result is that this study will become a valuable groundwater management and policy-setting tool for water sector decision-makers. The urgent need for this study has been driven by recent political unrest in the region, the resulting refugee crisis in Jordan, and the resultant need to make well-informed and socially-acceptable policy decisions in response to these social and political pressures. The best possible basis for weighing these kinds of critical policy and management decisions for groundwater abstraction and use is reliable information and analysis for fact-based decision-making. This study was requested by the Ministry of Water and Irrigation (MWI) to support its efforts to better address management issues for groundwater abstraction across the Kingdom.

This activity is being implemented in three phases with specific deliverables for each, as detailed below:

- Phase 1 – National socio-economic survey where every known well in Jordan (legal and illegal) was visited, with targeted questionnaires for the each well type (agricultural, industrial, drinking/tourism, other). Results Reports completed for each basin (Amman-Zarqa, Mafraq, Azraq, Deir-Alla, Jezeh, Ramtha, Karak, Ma'an) which presented the survey results as completed by respondents, with no analysis as to validity of information or implications of data reported.
- **Phase 2 – Analysis of Socio-economic Survey (presented here in this report)** which carried out statistical and technical analysis of the reported survey findings and assessed their validity, determined results and implications for national groundwater use, income and employment generated by groundwater, conducted follow-up validation of technical data such as GPS coordinates and area under cultivation to ensure integrity of technical analysis. This Socio-economic Survey Analysis Report is the deliverable for this phase.
- Phase 3 – Policy and Management Implications of the National Socio-economic Survey pending in which the results of the analysis (Phase 2) will be assessed in order to determine recommendations for the Government of Jordan in terms of specific policies and groundwater management practices that could be changed or improved in order to achieve more sustainable groundwater use in Jordan.

As discussed above, this Analysis Report is the output of the second phase of this study. One of the major results of the analysis are the findings related to groundwater abstraction in the agriculture sector. During the national survey, farm owners and/or managers were asked to report their abstraction. The totals were calculated by multiplying the working hours of their wells by the well capacity as reported by the farmers. This analysis phase, however, spent a great deal of time and effort in examining other ways to validate abstraction levels, regardless of the quantities reported by farmers. It was determined that the most reliable way to determine abstraction levels for each farm was to use the crop water requirement published by the Dept. of Agriculture for each crop type. This is defined as the quantity of water required by a crop in a given period of time for normal growth under field conditions, which excludes the available rain fall resulting in a relatively accurate measure of the water to be used to grow each crop. ISSP then examined the area under cultivation for each farm, by crop type and calculated abstraction from this information. The survey respondents were fairly accurate in reporting area under cultivation, but ISSP further validated this information through follow-up site visits as well as using satellite imagery.

In brief, below are few key analyses that were extracted from the collected and verified data:

- Accurate GPS coordinates for 2024 wells were collected, a committee from the MWI and ISSP team worked together to review the coordinates, the results shows that study coordinates are more accurate than the excited coordinates at the MWI.
- Three distinct clusters of farms in the eight basins where developed based on the farm size, to form farming systems to facilitate monitor water use and forming specified polices; 1249 visited farms were divided into Small size farms (less than 50 du) presents 30.2%, Medium size farms (50 - 200 du) presents 39.4%, Large farms (more than 200 du) and presents 30.4%.
- The total area occupied by the large farms is 198,399 du, while the medium farms occupy 59,195 du, and the small farms occupy only 9,327 du.
- The total abstraction based on the crop water requirement for the large farms (380 farms) is 123,554,546 CM, while 257 farms of this category is abstracting 52,151,928 based on the abstraction records available at the Ministry. For the medium farms (492 farms) the total abstraction is 38,271840 CM, at the Ministry records the abstraction for 456 farms of this category is 42,729,654, and 6,934342 CM abstracted from the small farms (377 farms), the abstraction for 353 small farms based on the Ministry records is 11,747,499.
- Based on the study 324 farms abstract 150,000 CM and more based on the crop water requirement with a total of 116,290,842 CM. Reviewing the Ministry records 306 of these farms recorded to abstract 45,275,953 CM only.
- To verify the cultivated areas as reported by the farmers, special measures were carried out to make sure that our calculations are accurate and precise. A random sample was selected from all visited wells and was checked using the GIS application and Google Earth. Moreover, all cultivated areas of 700 du and more in all the basins were checked one by one and corrected accordingly.
- Only 5% (24 farms out of 492 farms) of the medium farming system export their products and use less than 150,000 CM (based on crop water requirement). While none of the farms that use more than 150,000 CM export any product.
- 58 large farms out of 382 farms use less than 150,000 CM (based on crop water requirement); out of these 58 farms only 4 farms export their products.
- A total of 62 out of 116 illegal wells 53% of all the surveyed small farming systems are located in Azraq basin.
- A total of 42 out of 77 illegal wells, 55% of all the surveyed medium farming systems, are located in Azraq basin.
- A total of 35 out of 40 illegal wells, (87.5%) of all the surveyed large farming systems, are located in Azraq basin.
- 9 farms in Azraq have more than one illegal well

- 3 farms in Amman-Zarqa have more than one illegal well
- 3 farms in Deir-Alla' have more than one illegal well, and
- 2 cases of licensed wells in Jezeh have a second illegal well (out of the 167 visited wells only)
- More than 60% of the illegal operating wells are owned by renowned Jordanian families.

Table 1 below presents the crops type that are exported from all the basins, most of the surveyed exporters farmers they do direct export. Some of them do indirect export for different reasons, such as difficulty to access the export markets, high competition, and high shipping cost.

Table 1: Main crops exported directly or indirect from the eight basins

Basin	**Directly exported crops***	**Indirectly exported crops***
Azraq	Olive oil, olives, Grape	Tomato, Cantaloupe, Watermelon
Mafraq	Tomato, Peach, Grape, Olive, Apricot, Peach (cake-like), Pear, Watermelon, Nectarine, Lettuce, Stone Fruits, Beans, Broccoli, Pomegranate, Apple, Cauliflower	Tomato, Peach, Grape, Olive, Apricot, Peach (cake-like), Cantaloupe, Watermelon, Nectarine, Capsicum, Eggplant
Amman-Zarqa	Olive, olive oil	Zucchini, Tomato, Capsicum
Ramtha	Lettuce, Onion, Broccoli, Celery, Capsicum, Beans	
Deir-Alla'	Tomato, Dates, Strawberry, Capsicum	Tomato, Strawberry
Jezeh	Tomato, Peach, Grape, Olive, Apple, Plum	Tomato, Lettuce,
Karak	Tomato	Tomato
Ma'an		Dates
• Direct export: farmers exporting directly to other countries • Indirect export: farmers sell to exporters		

Table 2 below shows one of the major analyses for the small farms that consume less than 50,000 CM per year, based on the crop water requirements, and family support. Most of the owners of small farms depend completely on the farm business as a major income for the family. Most of these businesses support more than 5 family members. The table also shows the legal well status.

Table 2: Small farms analysis income and family supported.

Small farms using less than 50,000 CM					
Farm income to the total income	Number of wells	Family members supported		Other income sources	Well legal status
Less than 20%	127	>5 members	71 cases	All have other income	22 illegal

		1-5 members	53 cases	All have other income	22 illegal
		None	3 cases	All have other income	2 illegal
20% - 50%	65	>5 members	50 cases	All have other income	13 illegal
		1-5 members	13 cases	All have other income	5 illegal
		None	2 cases	All have other income	-
51% - 80%	20	>5 members	13 cases	All have other income	4 illegal
		1-5 members	6 cases	All have other income	2 illegal
		None	1 case	All have other income	-
81% - 100%	148	>5 members	91 cases	83 no other income	29 illegal
		1-5 members	50 cases	45 no other income	8 illegal
		None	7 cases	No other income	1 illegal

Table 3 below presents some results for the large farms that use more than 150,000 CM per year, based on the crop water requirement. Most of the surveyed farms depends almost completely on the farming business and support more than 5 family members with very few cases of illegal wells.

Table 3: Large farms analysis income and family supported.

Large farms using more than 150,000 CM					
Farm income to the total income	Number of wells	Family members supported		Other income sources	Well legal status
Less than 20%	37	>5 members	22 cases	All have other income	5 illegal
		1-5 members	13 cases	All have other income	3 illegal
		None	2 cases	All have other income	1 illegal
20% - 50%	26	>5 members	12 cases	All have other income	4 illegal
		1-5 members	5 cases	All have other income	1 illegal
		None	-	-	-
51% - 80%	21	>5 members	16 cases	All have other income	2 illegal
		1-5 members	5 cases	All have other income	1 illegal
		None	-	-	-
81% - 100%	230	>5 members	127 cases	100 no other income	12 illegal
		1-5 members	79 cases	62 no other income	4 illegal
		None	24 cases	17 no other income	1 illegal

Only in 84 cases of the 1249 surveyed farms in the eight basins have livestock for commercial uses, Table 4 shows the livestock found in each of the three farming systems.

Table 4: Livestock for commercial use at the three farming systems

Farming system	**Livestock**	**Water use at the farm** (does not include the livestock consumption)	**Well legal status**	
Small farms	23 cases	All use < 40,000 CM	10 illegal wells	6 - Azraq 2 - Amman-Za 1 - Mafraq 1 - Deir Alla

Medium farms	34 cases	All use <150,000 CM	11 use 100 -150 thousand CM	3 illegal wells	1 - Mafraq 2 - Azraq
			23 use < 100,000 CM	6 illegal wells	4 – Azraq 2 - Amman-Za
Large farms	27 cases	2 use < 150,000 CM		-	-
		25 use > 150,000 CM		5 illegal wells	2 - Amman-Za 3 - Azraq

The collected data were verified and analyzed, and as a result, ISSP will develop tools for groundwater management, this is to support decision makers in managing groundwater resources to restore aquifers safe yield in ways that consider the implications of policy decisions on the users of groundwater on the basis of social and economic activities.

Olives are one of the major crops in all basins. Based on the survey, 45% of the abstracted water from the visited wells is used to irrigate olive trees. Cultivating olives in the highland is not considered to be very productive and is a large consumer of water, and is of low water values[1]. Table 5 below shows that, for the visited wells, 65% of the cultivated area is planted with olives.

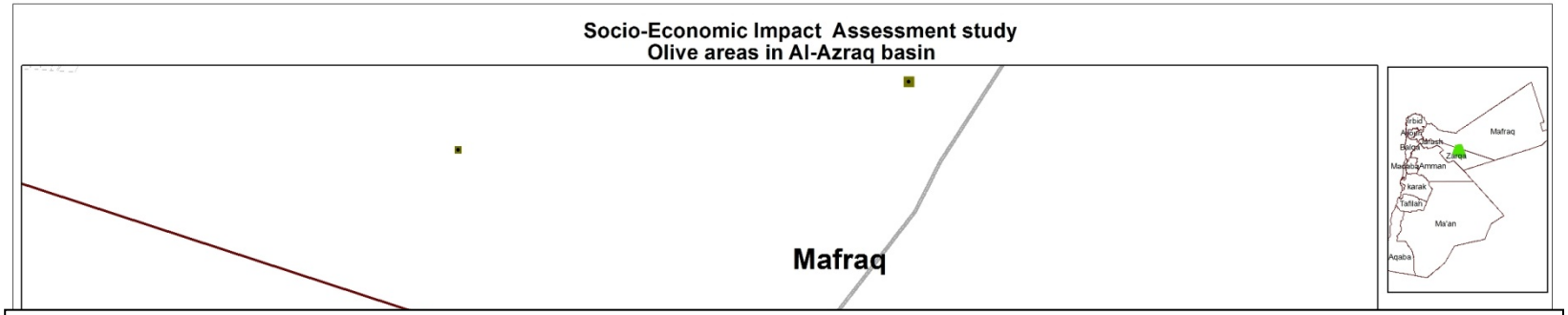
[1] "Water Valuation Study: Disaggregated Economic Value of Water in Industry and Irrigated Agriculture in Jordan", prepared by USAID/Jordan institutional support & strengthening program (issp) for Ministry of Water and Irrigation, Amman, October, 2012

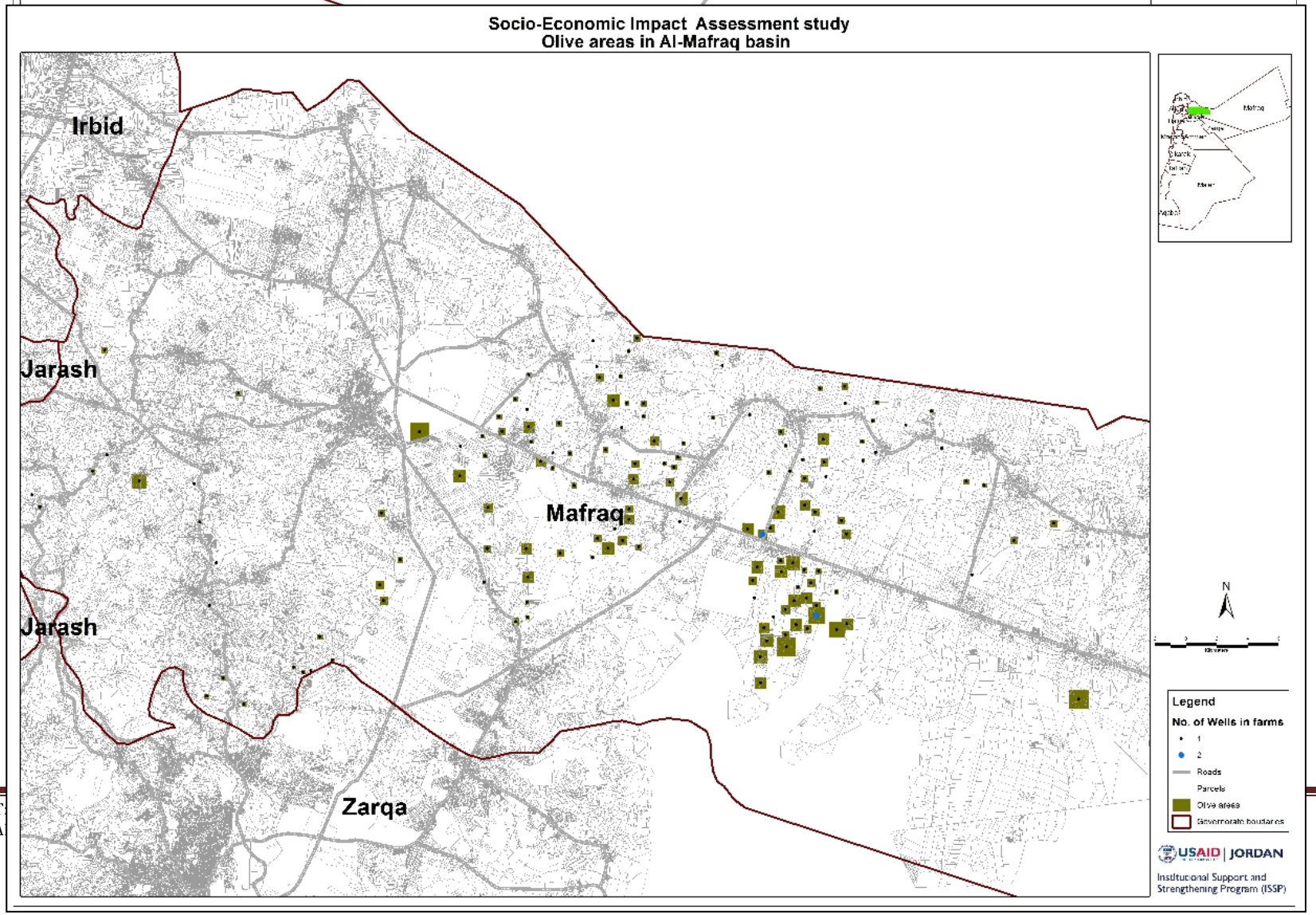
Table 5: Olive cultivated areas and abstraction in the visited farms at the eight basins.

Basin	Cultivated area (du)	Olives (du)	Olive Abstraction (CM) based on crop water requirement
Azraq	44,108	30,383	24,002,544
Mafraq	48,208	29,957	20,969,900
Ramtha	20,164	13,762	8,945,300
Amman Zarqa	21,700	16,750	11,724,650
Deir-Allah	232	129	70,950
Jezeh	29,268	22,276	14,479,400
Karak	4,559	1,952	1,268,800
Ma'an	20,351	7,330	5,863,800
Total	**188,590**	**122,539**	**87,325,344**

The study began in 2013 in close cooperation with the Ministry of Water and Irrigation and the Water Authority of Jordan (WAJ). A steering committee of senior officials responsible for groundwater management, analysis and policy from MWI and WAJ and it was responsible for guidance and follow up of the study progress. Regular steering committee meetings were held throughout the study implementation. These were meetings presented and reviewed the study tools developed by the ISSP team, fieldwork progress and updates, results and analysis. ISSP launched the fieldwork in an official ceremony in Mafraq under the patronage of the Ministry of Water and Irrigation.

The maps below show the olive concentration at the eight basins


Socio-Economic Impact Assessment study
Olive areas in Al-Azraq basin
Mafraq


Socio-Economic Impact Assessment study
Olive areas in Al-Mafraq basin
Irbid
Jarash
Mafraq
Jarash
Zarqa
N
Legend
No. of Wells in farms
1
2
Roads
Parcels
Olive areas
Governorate boudaries
USAID | JORDAN
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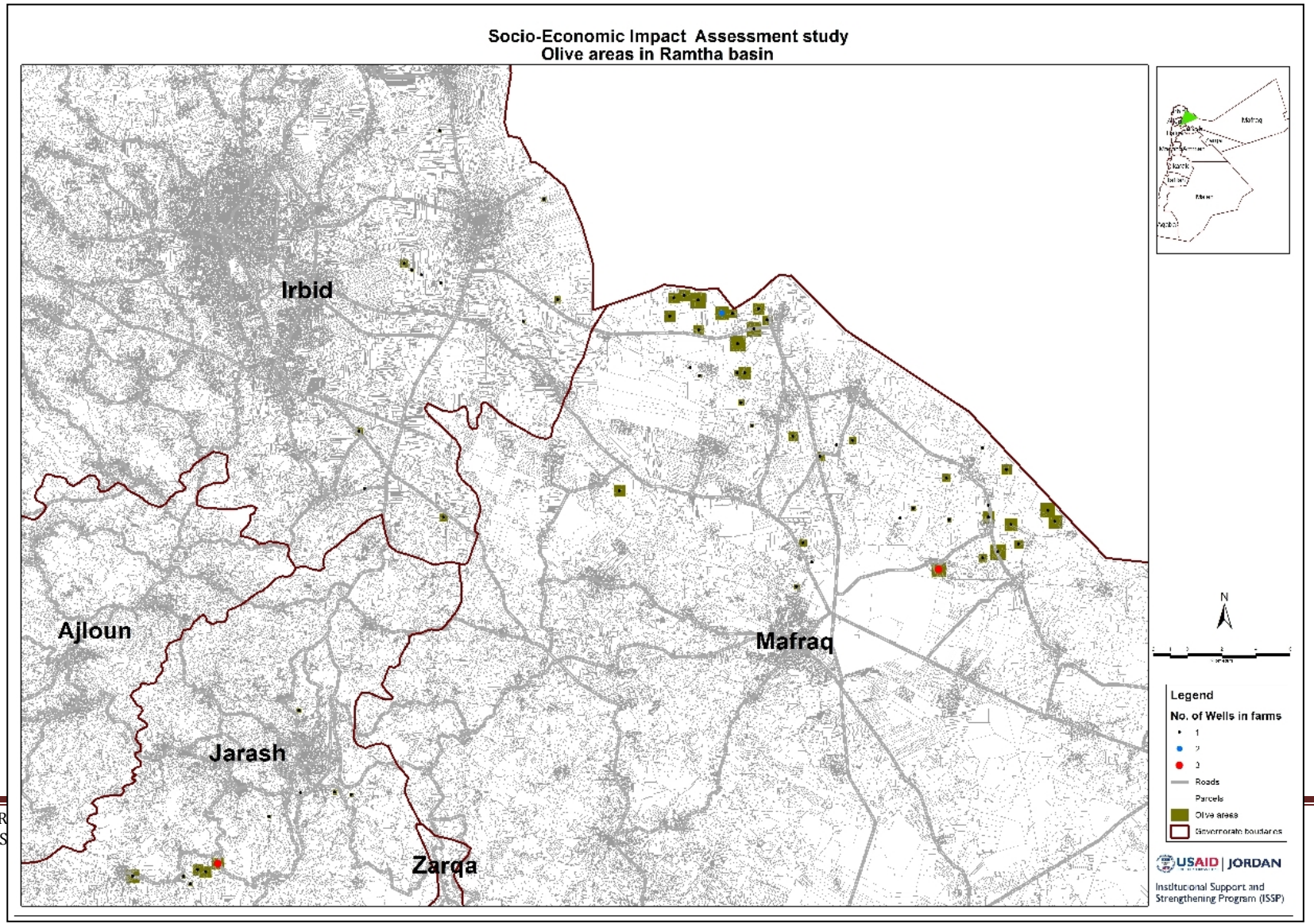
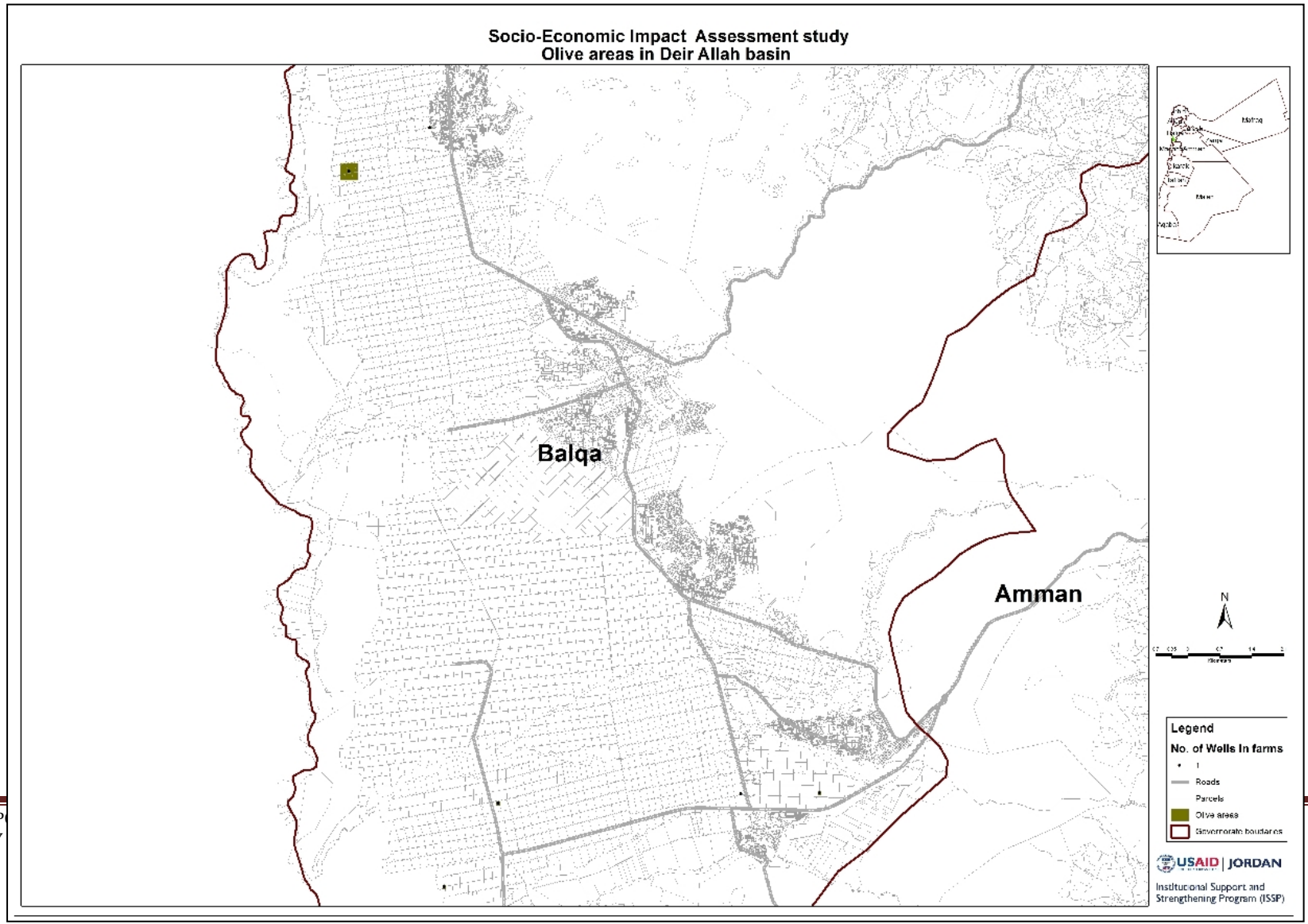

Socio-Economic Impact Assessment study
Olive areas in Ramtha basin
Irbid
Ajloun
Jarash
Zarqa
Mafraq
N
Legend
No. of Wells in farms
1
2
3
Roads
Parcels
Olive areas
Governorate boudaries
USAID | JORDAN
Institucional Support and
Strengthening Program (ISSP)


Socio-Economic Impact Assessment study
Olive areas in Deir Allah basin
Balqa
Amman
N
Legend
No. of Wells in farms
1
Roads
Parcels
Olive areas
Governorate boundaries
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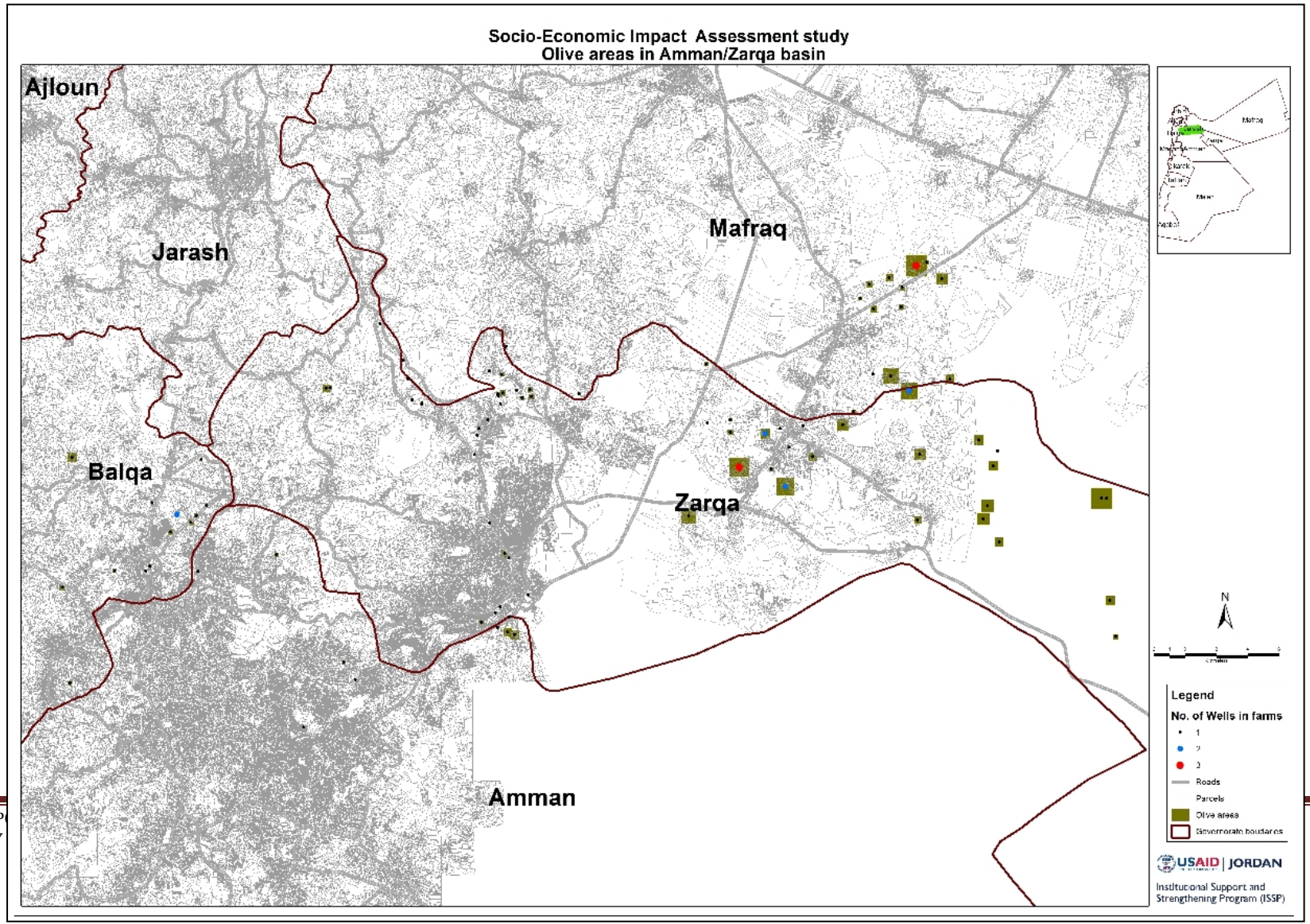
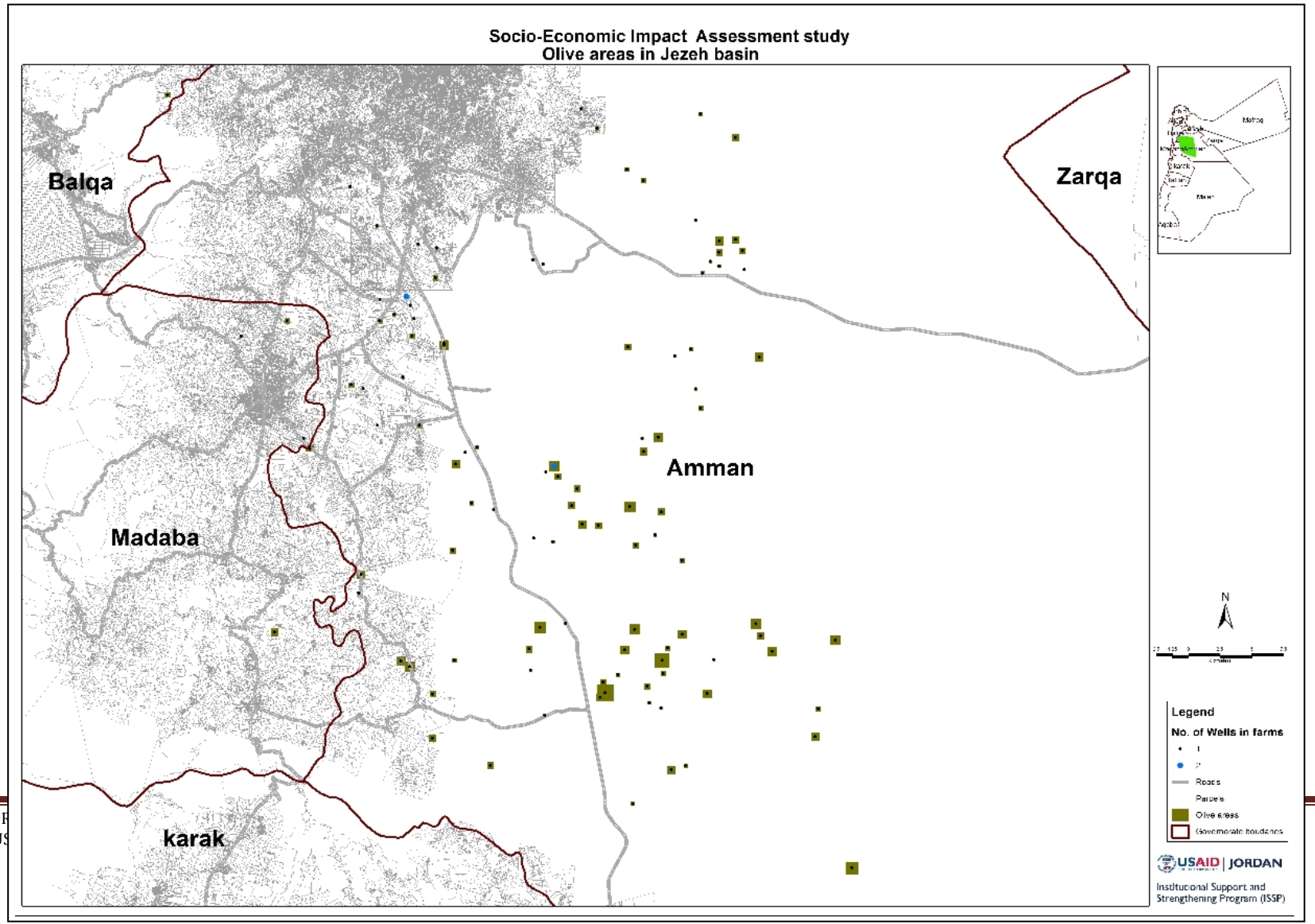
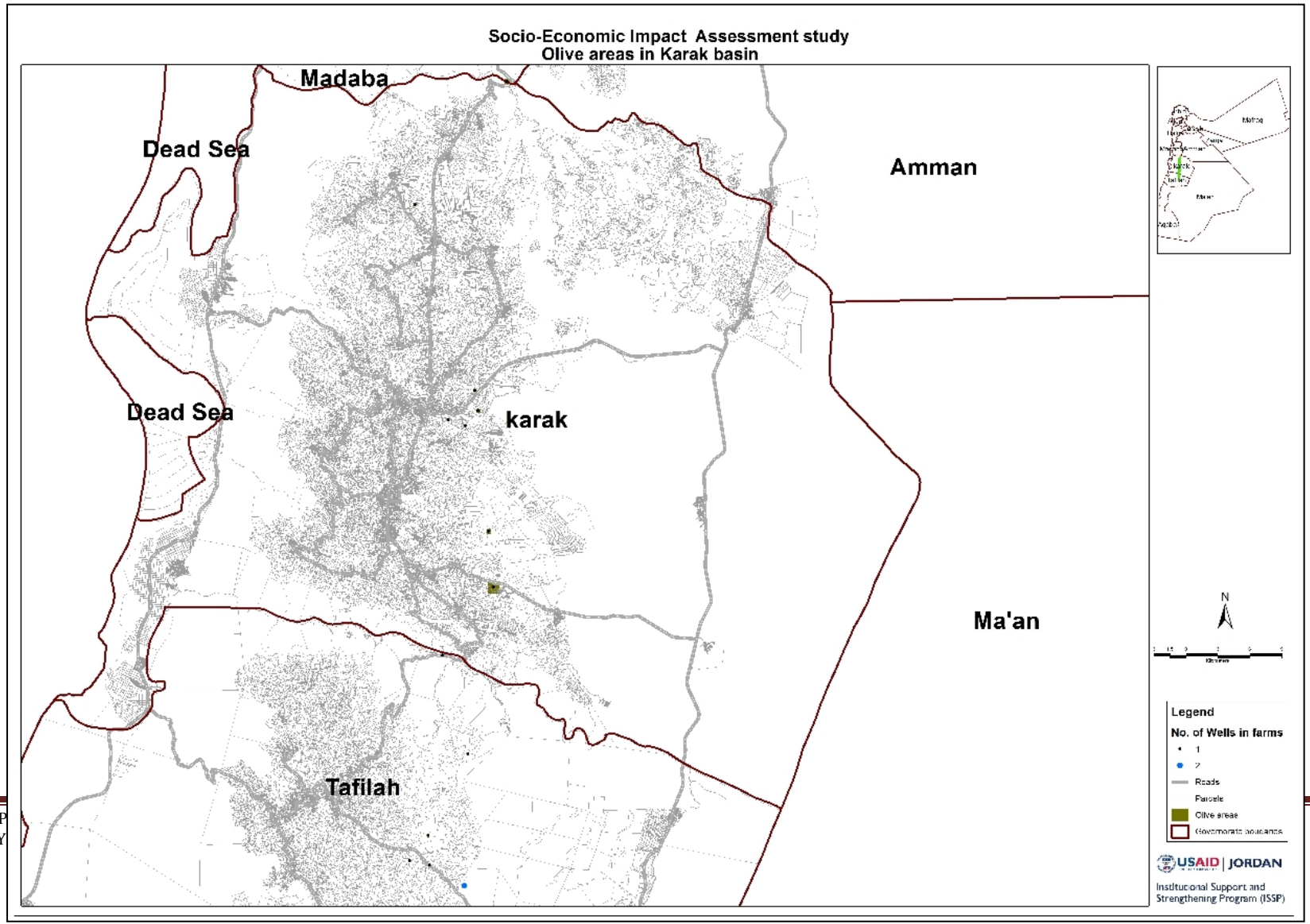
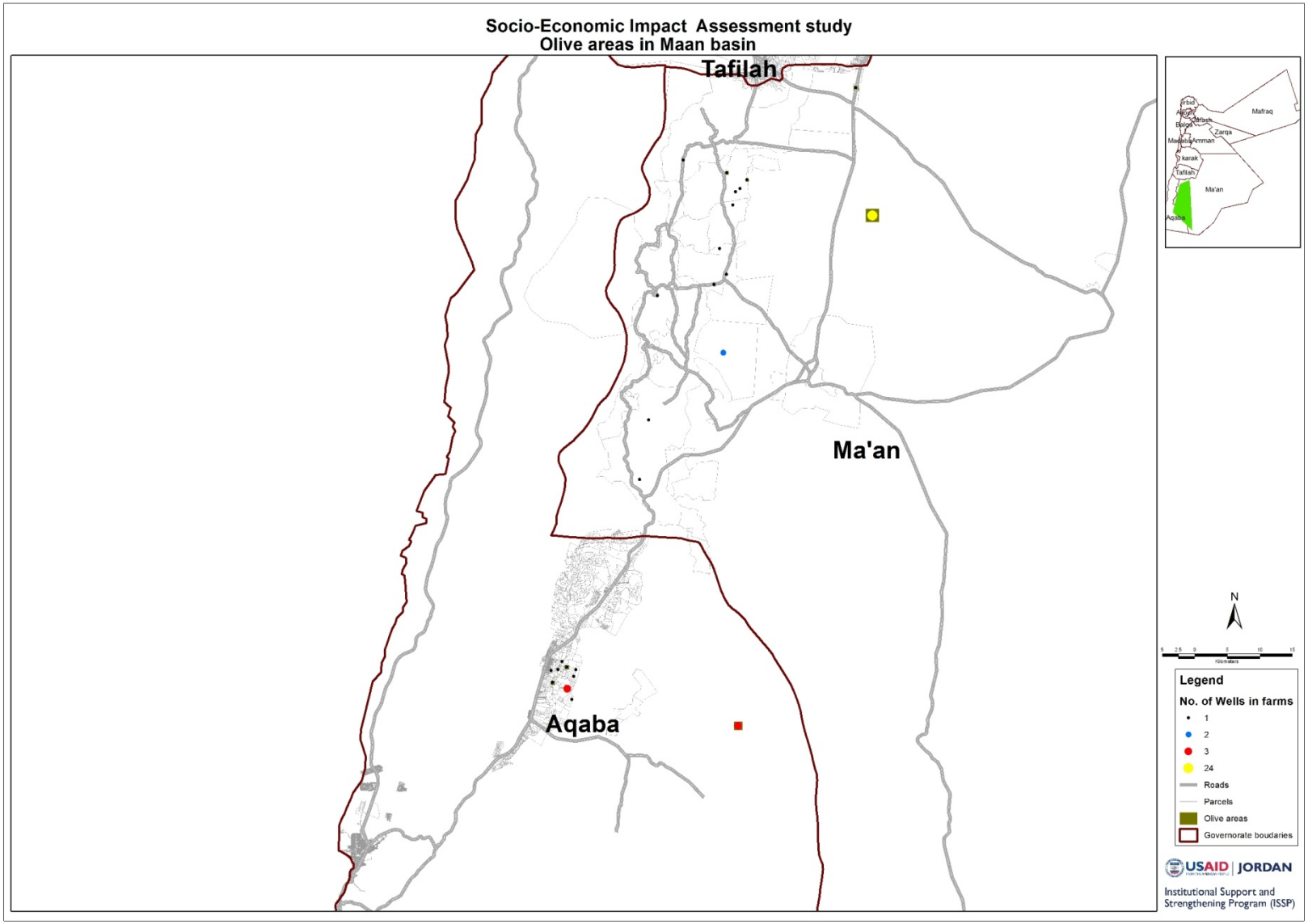

Socio-Economic Impact Assessment study
Olive areas in Amman/Zarqa basin
Ajloun
Jarash
Mafraq
Balqa
Zarqa
Amman
N
Legend
No. of Wells in farms
1
2
3
Roads
Parcels
Olive areas
Governorate boudaries
USAID | JORDAN
Institutional Support and Strengthening Program (ISSP)


Socio-Economic Impact Assessment study
Olive areas in Jezeh basin
Balqa
Zarqa
Amman
Madaba
karak
N
Legend
No. of Wells in farms
Roads
Parcels
Olive areas
Governorate boundaries
USAID | JORDAN
Institutional Support and Strengthening Program (ISSP)


Socio-Economic Impact Assessment study
Olive areas in Karak basin
Madaba
Dead Sea
Amman
Dead Sea
karak
Ma'an
Tafilah
N
Legend
No. of Wells in farms
1
2
Roads
Parcels
Olive areas
Governorate boundaries
USAID | JORDAN
Institutional Support and Strengthening Program (ISSP)


Socio-Economic Impact Assessment study
Olive areas in Maan basin
Tafilah
Ma'an
Aqaba
Mafraq
Zarqa
Amman
karak
Ma'an
Aqaba
N
Legend
No. of Wells in farms
1
2
3
24
Roads
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The Analysis supports updating the data available at the MoWI for the groundwater wells, such as, wells coordinates cultivated areas, crop pattern, water abstraction, ownership, wells operational status. Additionally, new information was collected that was not available before such as; socio-economic information, farmers needs and challenges, operational cost, labor, investment cost, irrigation system, selling destination (including exporting).

2 Background

To enable Jordan to better face its challenges in the water sector, USAID's ISSP project worked with the Ministry of Water and Irrigation (MWI), the Water Authority of Jordan (WAJ) and the Jordan Valley Authority (JVA) to develop and agree to carry out a comprehensive package of institutional reforms and restructuring activities, detailed below.

- *Activity 1: Support the Newly-Established National Water Policies Council* to improve transparency, accountability and shared responsibility for water policy.
- *Activity 2: Strengthen and Consolidate Authority for Water Resources Planning and Management in MWI* through capacity building, legal reforms and institutional restructuring to better execute its responsibilities for technical and strategic management of the water cycle, especially water resource management and planning.
- *Activity 3: Improve Water Delivery Management* through the following reform actions:
    - o Reorganize WAJ to Focus on Bulk Water Source Development and Supply to remove conflicts of interest between bulk water supply and utility oversight, prepare for future water supply needs and to improve operational efficiency.
    - o Continue the Process to More Fully Corporatize State-owned Water Utilities to improve management and fiscal and operational independence.
    - o Establish an Independent Water Utility Regulator to oversee the financial and technical performance of the corporatized water utilities.
- *Activity 4: Build and Empower Jordan Valley Water Users Associations (WUAs)* to move toward coverage of the entire irrigated area of the Jordan Valley and to determine whether they can function as independent irrigation utilities.
- *Activity 5: Enact a National Water Legislation* to institutionalize the improved structure of the water sector and resolve gaps and conflicts in the current legislative framework.

In addition, ISSP also provides key technical support to water sector organizations in order to enhance performance and support the development of the overall program.

This Socio-Economic Study directly supports the objectives and implementation of Activity 2. It is intended to significantly strengthen the capacity of MWI in water resource management and planning by providing the most comprehensive study to date on groundwater use. Socio-economic analysis

must be considered, in addition to technical water resources protection information, in the development of water sector policy and implementation of groundwater management.

3 Introduction

Groundwater management is considered to be a long-standing problem in the water sector. ISSP works to address key constraints in the better management of Jordan's threatened water resources which is directly relevant to this proposed activity.

This study was requested by the Ministry of Water and Irrigation to support its efforts to better address management issues for groundwater abstraction by completing a comprehensive socio-economic survey of groundwater wells across the Kingdom. Driven by recent developments in the political sphere in the region, the necessity to make well-informed and socially-acceptable policy decisions has become even more critical. The key to making such policy and management decisions regarding the groundwater situation is reliable information and analysis.

The ISSP engaged a multi-disciplinary study team to work together with the Ministry of Water and Irrigation (MWI) staff to execute the survey, analyze the information and present it in a format that would enhance and support the decision making process. The survey built on existing studies as well as current reliable data recently collected by various government authorities and donor programs, in particular the Highland Water Forum. This study depended heavily upon a high level of cooperation and coordination with the government of Jordan, in particular the MWI, the Water Authority of Jordan (WAJ), the Jordan Valley Authority (JVA), other Government Ministries and Governorate Authorities.

4 SUMMARY OF RESULTS

4.1 METHODOLOGY OF FIELD SURVEY

The survey conducted for the purpose of the study is considered to be the most comprehensive set of information on groundwater wells in Jordan. Since the survey combines technical and socio-economic information, it becomes essentially a data base describing the base case situation of groundwater wells in Jordan in year 2014.

A carefully designed methodology for data gathering and validation was followed for all the basins. A total of **1272** agriculture sites were visited covering **1376** private operating wells out of 2176 wells on record as being in operation. Wells coordinates, ownership and partnerships, operating conditions, legal status, abstraction amounts and metering, land area managed, crop patterns, irrigation techniques, marketing information, family involvement, educational level of farm managers, sources of finance in relation to facilities needed, energy source and consumption, temporary and permanent labor, relations between water users and other stakeholders, water quality and quantity, and the future of the farm (in the case of agriculture) as seen by the operators were all recorded while giving the users the opportunity to express the challenges they face and to identify their needs. Results of the survey are presented in the relevant report "Socio-economic Survey Results Reports" first in brief while the pages appended to that report show the details of the survey results for farms, industry as well as drinking water wells and those classified as tourism wells.

Survey results were used to harmonize with and validate data already in the MWI system. This data included well coordinates, cultivated areas, operating and non-operating wells, as well as legal and illegal wells. Due to the sensitivity of the well locations, well coordinates were read essentially two times to build confidence in the data and support the request that coordinates at the Ministry, not in harmony with survey readings be corrected accordingly. Furthermore, due to what appeared to be unreasonable abstraction quantities self-provided by the farmers in response to the questionnaire, cropping patterns were used in conjunction with cultivated areas to estimate water abstractions which were also compared with Ministry data.

4.2 KEY RESULTS OF FIELD SURVEY

Three separate summaries of the gathered data are presented as follows:

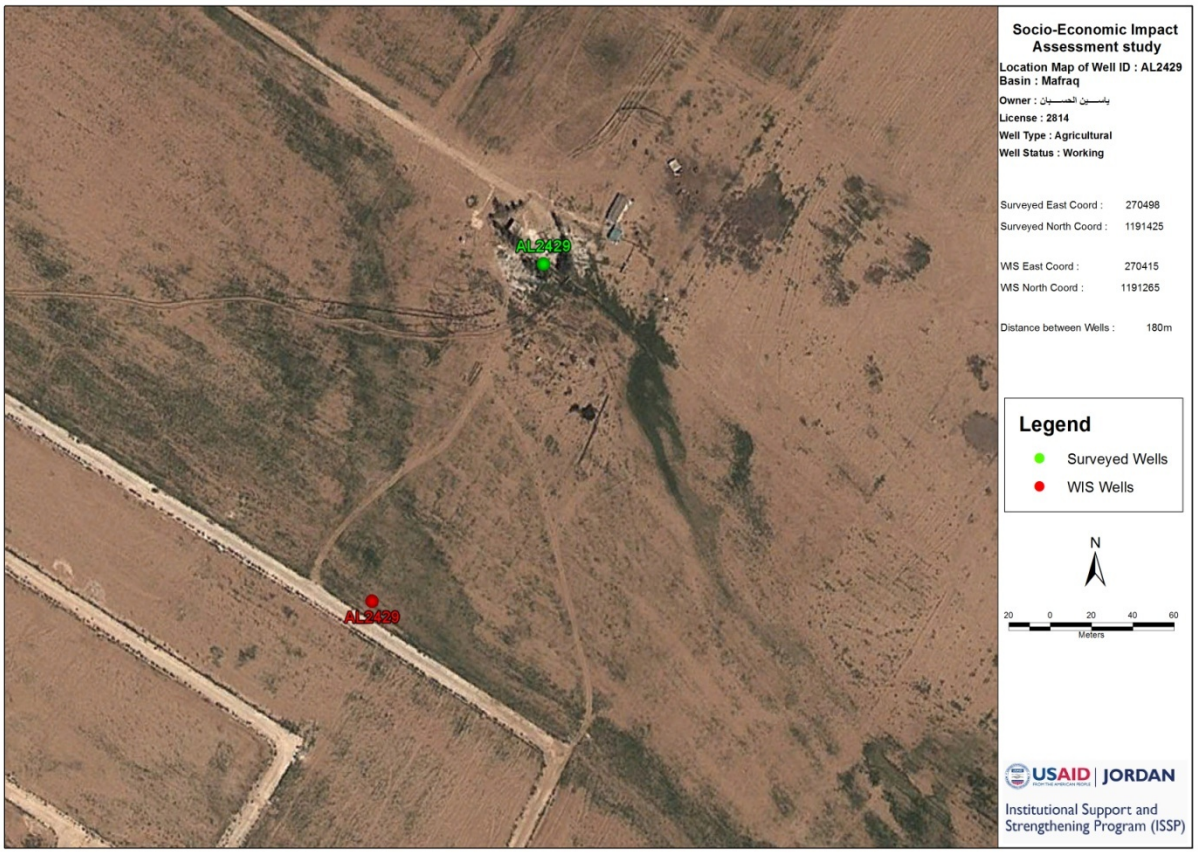
(1) The first summary pertains to well coordinates. These were compared randomly on the ground with MWI staff for data validation. Results were submitted on google maps for every individual visited well location. The maps show both coordinates identified by the survey team, and those in MWI records. They are too lengthy to be presented here, but were discussed repeatedly with the basins staff. These are given in the detailed report of the survey results which were reported separately in September 2014. It is our opinion that the survey results be incorporated in MWI data base. A sample presentation is given on the next page, the green point shows the new well coordinate and the red point is the old well coordinate.

Field basins staff have plenty of opportunity to keep checking on well locations; those included in our report as well as those that were not visited for reasons beyond the control of the surveyors. Table 6 summarizes the number of wells for each usage category in each of the basins. It shows that a substantial number of sites could not be visited during the survey, hence their coordinates are not validated. Of a total number of wells on record of 3779 including both legal (2615) and illegal wells (1164), a total of 2570, representing 68% of all wells, were visited. This represents 1997 legal and 573 illegal wells. Essentially, 32% of the wells of all use categories remain to be validated; a task left for the MWI to accomplish.

Table 6: INVENTORY OF WELLS VISITED IN THE SURVEY

Governorate		Total # of wells	Total visited wells	Total # of wells - by type: AGRICULTURAL	surveyed	refused	unvailable	INDUSTRIAL	surveyed	refused	unvailable	OTHER (drinking wells, etc.)	surveyed	refused	unvailable	NON-OPERATING	surveyed	refused	unvailable	Governm
Mafraq		**455**	**478**	**105.1%**																
	Legal-licensed	427	448	337	288	36	13	27	22	1	4	14	11	1	2	48	20	6	22	22
					85.5%	10.7%	3.9%		81.5%	3.7%	14.8%		78.6%	7.1%	14.3%		41.7%	12.5%	45.8%	
	Illegal-unlicensed	28	30	16	13	2	1						1			14	5		9	
					81.3%	12.5%	6.3%										35.7%		64.3%	
Azraq		**728**	**482**	**66.2%**																
	Legal-licensed	380	267	216	204	4	8	1	1			4	4			43	20		23	3
					94.4%	1.9%	3.7%		100.0%				100.0%				46.5%		53.5%	
	Illegal-unlicensed	348	222	184	157	6	21									38	17		21	
					85.3%	3.3%	11.4%										44.7%		55.3%	
Amman-Zarqa		**573**	**431**	**75.2%**																
	Legal-licensed	510	342	162	153	3	6	48	44	2	2	21	20		1	54	28	1	25	57
					94.4%	1.9%	3.7%		91.7%	4.2%	4.2%		95.2%		4.8%		51.9%	1.9%	46.3%	
	Illegal-unlicensed	63	89	41	38	1	2	2	1		1	0				42	20		22	4
					92.7%	2.4%	4.9%		50.0%		50.0%						47.6%		52.4%	
Aljezeh		**344**	**258**	**75.0%**																
	Legal-licensed	291	247	187	164	7	16	28	24		4	15	15			17	2		15	
					87.7%	3.7%	8.6%		85.7%		14.3%		100.0%				11.8%		88.2%	
	Illegal-unlicensed	53	11	4	3	1		0				0				7	2		5	
					75.0%	25.0%											28.6%		71.4%	
Ramtha		**185**	**159**	**85.9%**																
	Legal-licensed	185	159	139	108	15	16	2	2			5	5			13	5	1	7	
					77.7%	10.8%	11.5%		100.0%				100.0%				38.5%	7.7%	53.8%	
	Illegal-unlicensed	0	0	0				0				0				0				
Dier-Allah		**900**	**230**	**25.6%**																
	Legal-licensed	368	149	64	63	1		6	4		2	9	8		1	70	39		31	
					98.4%	1.6%			66.7%		33.3%		88.9%		11.1%		55.7%		44.3%	
	Illegal-unlicensed	532	81	59	52	7		0				1			1	21	17	1	3	
					88.1%	11.9%									100.0%		81.0%	4.8%	14.3%	
Karak		**126**	**124**	**98.4%**																
	Legal-licensed	126	124	34	32		2	38	36	1	1	5	3	2		28	19		9	19
					94.1%		5.9%		94.7%	2.6%	2.6%		60.0%	40.0%			67.9%		32.1%	
	Illegal-unlicensed	0	0	0				0				0				0				
Ma'an		**468**	**400**	**85.5%**																
	Legal-licensed	328	261	127	100	12	15	30	25		5	12	6		6	77	26	3	48	15
					78.7%	9.4%	11.8%		83.3%	0.0%	16.7%		50.0%		50.0%		33.8%	3.9%	62.3%	
	Illegal-unlicensed	140	139	54	1	52	1	0				0				85		85		
					1.9%	96.3%	1.9%											100.0%		
TOTAL RESULTS		**3779**	**2570**	**68.0%**																
Legal		2615	1997		1112	78	76		158	4	18		72	3	10		159	11	180	116
Illegal		1164	573		264	69	25		1	0	1		1	0	1		61	86	60	4


Socio-Economic Impact Assessment study
Location Map of Well ID : AL1076
Basin : Amman/Zarqa
Owner : سعيد قطيشات - 2 الشرقي
License : 253
Well Type : Agricultural
Well Status : Working
Surveyed East Coord : 268728
Surveyed North Coord : 1170939
WIS East Coord : 268550
WIS North Coord : 1170800
Distance between Wells : 226m
Legend
Surveyed Wells
WIS Wells
N
10 0 10 20 30
Meters
USAID | JORDAN
Institutional Support and Strengthening Program (ISSP)
al1076
al1076
© 2014 ORION-ME


Socio-Economic Impact Assessment study
Location Map of Well ID : AL2429
Basin : Mafraq
Owner : ياسين الحسبان
License : 2814
Well Type : Agricultural
Well Status : Working
Surveyed East Coord : 270498
Surveyed North Coord : 1191425
WIS East Coord : 270415
WIS North Coord : 1191265
Distance between Wells : 180m
Legend
Surveyed Wells
WIS Wells
N
20 0 20 40 60
Meters
USAID | JORDAN
Institutional Support and Strengthening Program (ISSP)
AL2429
AL2429

A standard procedure for the basins offices to follow in order to complete the data and ensure accuracy in coordinates readings would be: to take a GPS reading at a specific location (at the basin office, for example) and use this reading always as the reference point to confirm that all is in order before going to the field for other readings. The readings can always be put on google and GIS maps to verify correctness. Field offices were provided, through ISSP, with the needed computers and handheld GPS devices and trained on their use.

There are 2024 well coordinates provided for the visited wells of various uses. Table 7 below shows the difference in distance between the ISSP records and those of MWI. A sample of the locations of surveyed wells versus those on record, presented for coordinates of all visited wells in the detailed report on the subject, is shown on the opposite page.

Table 7: NUMBER OF WELL COORDINATES AND DIFFERENCE IN DISTANCE BETWEEN ISSP SURVEY & MWI RECORDS

No.	Wells coordinates	Distance difference between ISSP records and MWI
1	70	Were not compared
2	496	≤ 50 m
3	1458	50 m ≤
Total visited wells	2024	

However, the methodology to be followed at the basin level for continuous monitoring is the subject of another report. In that report, ISSP will address specific data quality, as well as data integration and management issues that were identified during the survey. These are expected to include ways to ensure better consistency between MWI and WAJ groundwater technical data and more frequent updates and syncs of the data between these entities. Accordingly, the study and its results, as well as the data collected, can be used to verify and update all information on wells through the newly created tools used in the Licensing, GIS, and the Field Departments as well as in the WIS, Billing and the Legal Database. These changes will reflect directly on the various entities within the MWI such as the Policy and Strategies Department, since water budgeting history affects water allocation, safe yields, and the water sector master plan. They will also affect Public Outreach who are responsible for generating annual reports based on the history of data that they receive.

(2) The second summary is related to water abstractions which are given in Table 8 and 9. Table 8 shows results of the survey in terms of abstractions for industrial, drinking, and

WAJ wells and prepares the ground for calculating overall abstractions which are presented in Table 9. Self-reported abstractions by farmers or information leading to estimating abstractions were not used in Table 9. The table utilizes information on the areas cultivated and associated crop patterns (detailed later in this report) to calculate the estimated water consumption for the visited agricultural wells. To arrive at total estimates, abstractions for visited wells, with crop patterns and cultivated areas, were also extrapolated for the wells on record that were not visited on order to reach an estimate of the total agricultural consumption, with an ever present reservation that these quantities are based on known or collected information.

For example, estimated abstraction at Azraq at 361 visited wells was calculated as 44 MCM. As 64 wells were not visited, abstraction at these wells was calculated as (64/361) x 44 MCM and the result added to 44 MCM making the likely abstraction in Azraq Basin for irrigation to be nearly 52 MCM, which when added to 0.2 MCM from industry and 0.021 MCM form drinking/tourism wells, and 15 MCM abstracted by WAJ for domestic uses, makes the overall abstraction in Azraq in the order of 67 MCM. The same exercise was made for the other basins, resulting in an overall abstraction of 504 MCM. .

Table 8: SUMMARY OF GROUNDWATER WELLS AND ABSTRACTIONS AS SURVEYED

	Agricultural Wells						Industrial Wells			Drinking Wells		WAJ Wells	
BASIN	Sites Visited	Operating	On Record	Illegal	On Record as Operating but NOT	On Record as Not Operating but YES	On Record	Operating	Abstract MCM	No.	Abstract MCM	No	Abstract MCM
Azraq	334	361	425	157	23	2	3	1	0.208	3	0.021	19	15
Mafraq	298	301	341	13	6	6	22	16	1.049	12	0.442	88	28
Amman-Zarqa	178	191	206	39	13	3	73	61	4.885	38	2.673	131	38
Deir Allah	110	115	496	49	29	10	7	4	0.021	8	0.138	78	35
Jezeh	159	167	213	1	3	2	30	21	0.800	13	0.435	22	2
Karak	29	32	51	0	2	1	52	36	14.446	3	0.251	102	16
Ma'an	65	101	292	55	25	6	30	22	0.471	5	0.384	140	31
Ramtha	101	108	152	2	4	2	2	2	0.078	4	0.069	80	32
TOTAL	1274	1376	2176	316	105	32	219	163	21.958	86	4.413	660	197

Table 9: SUMMARY OF GROUNDWATER ABSTRACTION AT ALL BASINS

BASIN	Visited Agriculture Sites	Visited Operating Wells	Wells On Record	Wells Not Visited	Abstraction Calculated from Crops at visited wells	Interpreted Abstraction of Wells Not Visited	Likely Agriculture Abstraction	Industrial Abstract MCM	Drinking Abstract MCM	WAJ Abstract MCM	TOTAL For BASIN
Azraq	334	361	425	64	44	7.8	51.8	0.208	0.021	15	66.929
Mafraq	298	301	341	40	52.9	7	59.9	1.049	0.442	28	89.149
Amman-Zarqa	178	191	206	15	17.5	1.4	18.9	4.885	2.673	38	64.396
Deir Allah	110	115	496	381	4.685	15.515	20.4	0.021	0.138	35	55.543
Jezeh	159	167	213	46	20.8	6.3	26.6	0.800	0.435	2	29.726
Karak	29	32	51	19	3	1.8	4.8	14.446	0.251	16	35.497
Ma'an	65	101	292	191	26	49.2	75.5	0.471	0.384	31	107.335
Ramtha	101	108	152	44	16.2	6.6	22.8	0.078	0.069	32	54.947
TOTAL	1274	1376	2176	800	185.085	95.615	280.7	21.358	4.413	197	504.071

(3) The third summary is a tabulation of gathered socio-economic and other data that may become of relevance when studying impacts of policy measures on socio-economic conditions. Such study will be conducted and reported separately. Table 10 shows a sample of the third summary applied to one basin only. This and results of other basins are given in a later section on survey results (Table 11, on page 25). Each tabulation tells a story and is significant to the specific analysis for which it is employed. The table indicates that the survey has produced a data base from which specific information for specific interests can be obtained. An example of how information from this table can be used is the socio-economic analysis made in subsequent sections of this report.

Table 10: SAMPLE OF DATA GATHERED FROM THE SOCIO ECONOMIC SURVEY

TOPIC	AZRAQ	TOPIC	AZRAQ
Owner operating own farm	39%	Extent of drip irrigation	mostly
Representative areas, Number of Farms	167		
Total area	63,594 Du	Crops for personal use	58%
Farmers irrigating only part of the land	61%	Sell at wholesale market (on farm)	35% (-)
Ownership of Farms: purchased,	88 %		
inherited,	12%		
tribal rights	Nil	Farms featuring livestock	7%
Partnership, ownership cases	9.9%		
Female share of partnerships	63.9%	Support to family members	95%
		% of farms w/Jordanian families	32%
		Jordanian families living on farm	107/334
		Jordanian owners living on farm	67/107
Farm managers hired full time	63%	% of farms w/Jordanian owner	20%
Education of operators, Tawjihi & above	59%		138
Illiterate	9%	Families supported by illegal wells	41%
Wells drilled before ownership legal:illegal:permit	132: 99: 0		
after ownership, legal:illegal:permitted	------- 61: 42: 0	Families living on farms w/ illegal wells	56 Families
		Financial dependency on the farm	
		80 -100% of income	37%
Wells drilled 1992 and after	149	less than 20% of income	42%
Water meters Working:	192		
Water meters not working:	6		Egypt
Water meters not installed	136	Permanent workers nationality	Jordan
Farmers: insufficient water	86%		
(numbers that buy)	(6)	Majority of Temporary workers	1/3 are local
		Frequency visits of MWI to farms:	
		More than 4 visits/month	222 sites
Cases of selling water	1	2-4 visits per month	112 sites
Wells operating hours, Total	717		
Summer+ Fall	246 + 194		
Winter+ Spring	152 + 125	Farmers needs: same as in all basins	
Noted water salinity & soil degradation	1/3 of farms	Farmers Challenges: same as in all basins	
		Farm viewed by farmers in 5 years	
Energy source	3% solar	Continue farm as is	46%
Farms w/elec company;	68%;	Expand farmed area	23%
cost in JD/m3,	0.09	Reduce farmed area	2%
and using generators	29%;	Stop farming altogether	24%
cost in JD/m3	0.20	Change crop pattern	Nil

4.3 METHODOLOGY OF SOCIO-ECONOMIC ANALYSIS

Having gathered a tremendous amount of data from the survey, it was necessary to analyze it to identify key economic and social variables related to different farming systems prevailing in the investigated basins. Whereas data can always be categorized according to specific interests, the farming system used here is one method of categorization. Cross tabulation can then be made to obtain an image of the interrelations between the variables selected to assess the interactions between them. For this report, the variables selected stem from the purpose of the study essentially aiming to provide a policy tool to help Jordan deal with groundwater abstractions. The key variable used in the analysis is the managed farm area at each farm. Three distinct clusters were then identified as farming systems, namely (a) managed areas less than 50 du, (b) managed areas between 50 du and 200 du, and (c) areas larger than 200 du. Analysis was then made for these clusters in relation to several indicators such as socio economic and demographic characteristics, farm and well characteristics, dominant crop patterns, financial indicators, labor and gender indicators, and economic efficiency.

4.4 KEY RESULTS OF SOCIO-ECONOMIC ANALYSIS

The key results of the socioeconomic analysis at the eight- basins level are as follows:

(1) The total owned and total cultivated areas by the interviewed well owners and farm operators in the eight groundwater basins are compared with the MWI records in the process of validation of essential data. Although comparable at the Amman-Zerka and Karak basins, the comparison shows big differences between MWI records and the reported areas by the farmers interviewed. Results show that the actual cultivated areas in the basins, where differences were noted, exceed what is reported in the records of MWI. The highest variations are in the basins of Azraq (48% vs 28%), Mafraq (76% vs 46%) and Ramtha (85% vs 63%). For the same crop patterns, this leads to significant variation in the estimated quantities of water abstracted at these basins. Table 11 below shows where the differences and their extent;

Table 11: Comparison of areas cultivated: Survey Results and MWI Records for the visited wells, excluding Deir Allah Basin*

	Survey Records				Comparison of Survey vs MWI for Same Wells				
Basin	**No. of Wells visited**	**Area Owned visited (du)**	**Area Cultivated visited (du)**	**% of Cultivated Area from total owned visited**	**No. of wells comparable with MWI records**	**Area Owned based on the survey (du)**	**Area Cultivated based on the survey (du)**	**Area Cultivated based on MWI records (du)**	**Cultivated Areas Percentage to the total comparison between Survey vs MWI**
Azraq	**332**	**130,584**	**63,599**	**48.7%**	**276**	**102,993**	**46,351**	**29,405**	**45% vs 28%**
Mafraq	**259**	**120,979**	**91,912**	**76%**	**263**	**109,502**	**83,089**	**50,660**	**76% vs 46%**
Amman-Zarqa	**167**	**63,771**	**26,711**	**42%**	**111**	**49,819**	**18,451**	**19,289**	**37% vs 39%**
Jezeh	**157**	**56,124**	**37,054**	**49%**	**130**	**48,769**	**32,322**	**27,635**	**67% vs 57%**
Karak	**27**	**9,539**	**6,369**	**67%**	**20**	**4,281**	**2,722**	**2,808**	**65% vs 66%**
Ma'an	**63**	**104,864**	**30,925**	**29%**	**50**	**100,768**	**29,214**	**19,878**	**29% vs 20%**
Ramtha	**99**	**33,644**	**27,751**	**82%**	**86**	**28,306**	**24,772**	**18,450**	**85% vs 63%**

- Deir Allah Basin MWI information was not available

(2) The "Crop Water Requirement" tables provided by the MoA for the eight basins were used as the basis for determining the total amounts of water abstracted by the surveyed 1249 farms where the survey questionnaire was completed and where the cultivated areas and crops are known. As indicated in the analysis reports appended to this report, the total estimated abstracted water at the 1249 surveyed farms in the 8 basins is **185 MCM**. This is far beyond what was reported by the farmers, though in harmony with that in MWI records, and when extended to all operating wells (as was done in Table 3, assuming the figure represents a representative sample) is also far beyond the safe yield of the aquifers, and certainly far beyond the quantity allocated in the MWI strategy for irrigation from highland aquifers;

(3) Mafraq is the leading basin in the total estimated abstracted water for agricultural uses followed by Azraq. The analysis shows that the abstracted amount of irrigation water in Mafraq basin represents 28% of the total water abstraction in all basins followed by Azraq basin at 23%, whereby both these basins are responsible for 51%; of the abstraction across the Kingdom.

(4) The analysis shows that **55%** of the total amount of abstracted water in the 8 basins was used to irrigate **olive trees** while the remaining 45% was used to irrigate other trees and vegetables. Mafraq is the leading basin in volume of water abstracted for olive trees by allocating a sum of 26 MCM (only in surveyed wells) representing 50% of the amount abstracted in this basin. Though less in absolute quantities, the analysis also shows **that 71% of the total abstracted water in Azraq was used for irrigating olive trees only.**

(5) Results show that **73% of the total abstracted water was used by large farmers** (380 farms) followed by medium farmers (492 farms) **at 23%** and the small farmers (377 farms) consumed **only 4%.** This excludes the Deir Allah basin, where the average farm size is smaller than farms in the uplands basins, and where no such large farmers exist. This sheds a light on how to address the management of abstractions where figures indicate, for example, that 8 farms of the large farm category in Azraq abstract more than 159 farms of the small category;

(6) The results of some **cross tabulation between** some of the selected socioeconomic indicators revealed the following:

   a. Family members of owners in 65.5% of the total 1268 respondents in all basins do not live on their farms. Even owners who depend on farming as a source of living, with farming income proportion to their total income between 80%-100%, representing, about 60 % of farmers, have no family members living on the farm.

   b. The total number of small farmers in the eight basins who do not live on their farms is 252 representing 67% of small farmers, while the overwhelming majority of those

farmers (96%) use less than 50,000 CM. These two factors are significant in that the majority of farmers are not subsistence farmers and that significant numbers are not charged at all for their abstractions; leaving room for unaccountable inefficiencies in the use of water;

c. The analysis shows that 37% of the small farmers (legal and illegal) earn less than 20% of their total income from farming. This, combined with the numbers that do not live on the farms (nearly 33%), raise doubts on both the economic and social significance of the small farms;

d. The overwhelming majority of small farmers use **less than 50,000 CM** of water on their farms. **Only one farmer** of 374 small farmers is abstracting more than 150,000 CM based on the crop water requirement. This implies that only one in the "small farmer" category is subject to being billed for the water used (where billing starts after the 150,000 CM threshold is exceeded);

e. The analysis shows that **333 out of 1240** respondents (based on the crop water requirement) are using **more than 150,000 CM** meters while representing only 27% of the total number of visited farms. A total of 7.2% of these farms produce only for export. This is significant in assessing the location of socio-political powers, and once addressed, might bring down the problem of over-abstraction to manageable levels;

f. The survey shows that 1077 farmers in the 8 basins employ one to five non-Jordanian laborers at an overall average of 3 laborers per farm. Out of the 1077 farmers employing non-Jordanians, only a total of 46 farmers, representing 96% of the total farmers hire more than 1 worker per 5 irrigated du, which is the number allocated by MoA regulations. ISSP suggested to MWI that one way to ensure farmers' compliance is through requests for non-Jordanian labor permits. Subsequently, in coordination between the ministries of labor and water, regulations required that farmers have to obtain clearance to their request for non-Jordanian labor from MWI. This has connected the two ministries and facilitated access of MWI to the farmers, thereby giving them a channel for enforcement of regulations, one of which is collecting outstanding payments where a long history of non-compliance persists;

g. Of the 725 respondents to the reason for not cultivating all of their land, 45% claimed it was due to the "non-availability" of water. Cross-referencing this response to farms selling water shows that 9 well owners of the 725 respondents to this question fall in this category.

h. Of the 791 farmers cultivating olive trees (which is considered as a high water demand and low value crop), 209 farmers representing 26.4% of farmers cultivating olive trees complained about insufficiency of allocated water. As more than 50% of highland farms cultivate olives, mitigating this demand is essential;
i. The results of the cross tabulation between big farms planning to expand the farm area in the future, have only one well and complaining that water is not enough, concluded that 64% of the total large farms fall within this category. This, if anything, indicates that education in the water situation in the country is lacking.

It should be noted that when specific policy decisions are to be made or current decisions are to be tested in terms of impact, different sets of appropriate variables available from the survey may be selected.

Like all studies of this nature, sustainability is in question. ISSP, within its broad mandate of institutional support, sees that an entity already exists within the Water sector that can take ownership of the files and data base formulated from the survey. The Basins Offices structure and management can be in charge of continuous validation and update of the field data. Since staff from these offices are already on the ground, the task should be manageable bearing in mind that farms in the major basins, such as those in Mafraq, Azraq and Amman Zarqa, where nearly 50% of the wells in the Kingdom are located, are already being visited by the Basins staff 2 to 4 times per month. A systematic approach will be developed and staff, assigned to this responsibility, will be trained to qualify. ISSP has contributed to the re-engineering of the Basins Offices with a GIS data base and links to the Water Information System (WIS) suitable to move the process forward. As part of ISSP activities to strengthen and Consolidate Authority for Water Resources Planning and Management, several tools and applications were developed to improve efficiency, and optimize performance and productivity. The tools, aiming to provide a better basis for decision making and to increase transparency as well as to improve data quality, include the following::

- **Licensing Database** to maintain the records and associated technical data for all current and historical groundwater wells licenses,
- **GIS Database**, a tool to cover licensing and monitoring functions as well as improving the abilities of the field employees who will apply this tool to benefit from it thus providing the MWI with an intelligent, spatially enabled database so that job planning, any equipment inventory, and workflow analysis become automated yet simple procedures integrated into one system, and
- **Meter Reading & Violation Management Applications,** to organize operations in the field, improve data flow and management within the offices and with the related departments at

central WAJ, as well as scrutiny of illegal wells. A link to the billing system will also enhance the collection process while the link to the legal department will enhance the prosecution process.

5 FIELD SURVEY

5.1 THE SURVEY OBJECTIVES

The primary objective of the field survey is to collect socio-economic as well as technical data associated with groundwater abstraction, and use, to be analyzed to identify key issues and impacts of groundwater use across sectors and regions.

The study also aims to better address the socio-economic situation of the farmers, the challenges and needs they face, and the management issues for groundwater abstraction.

The data collected through this study will provide the basis for building analytical and policy tools to manage groundwater resources and restore aquifers safe yield in ways that consider the implications of policy decisions on the users and on social and economic activities that depend on groundwater abstractions.

5.2 SURVEY METHODOLOGY AND PROCESS VALIDATION

The fieldwork was organized in close cooperation between ISSP staff, the Steering Committee appointed by MWI and the managers of the so-called "Basins Offices" which are 8 in number mandated to monitor all basins within the Kingdom. A special team received technical and communication training before starting the fieldwork in the eight basins. Basins staff contacted the farmers/owners and organized the visits, though ISSP had sent short message services (SMS) to the farmers' whose phone numbers were available, informing them about the study and its objectives and asking for their cooperation with the surveyors. The field team consisted of 18 interviewers and supervisors; 12 surveyors were divided into six teams, each with a supervisor to monitor the daily work. Each team was also accompanied by one staff member from the respective basin office. An overall Project Manager was responsible for the entire field work.

The validation and control process for the fieldwork and the data received from the field was as follows:

- ID numbers were given to all members who participated in the field work (interviewers, supervisors, editors, controllers and data entry team) in order to track the performance on daily basis of each member.

- Supervisors compared and completed questionnaires generated by the interviewers and investigated and reported any systematic inconsistencies.
- Supervisors accompanied each interviewer for a minimum of 10% of all interviews ensuring that all protocols and practices were followed.
- All questionnaires were visually checked each evening after a day of interviewing to verify that responses were recorded correctly.
- Telephone controllers also conducted in-person callbacks with interviewees for clarifications or confirmations for at least twenty percent (20%) of all interviews.
- The Field Project Manager made unannounced spot checks on the Supervisors to ensure that their duties are being carried out.
- Interviews were selected randomly for verification. If an interviewer was found to have improperly conducted or falsified an interview, one hundred percent (100%) of his/her work would be verified by the Editors and the Controllers.
- A minimum of 30% of the data uploaded from the questionnaires was checked to make sure that there are no entry mistakes. When a high rate of errors was found in any data file, the file would be 100% checked by another data entry specialist

5.3 FIELD SURVEY RESULTS OF AGRICULTURE USE

The following Table 12 is a condensed tabulation of most of the information collected in the survey. It revels the responses to the question of the survey and warrants careful scrutiny. It covers significant details in terms of how farms are owned, and managed, operated and cultivated, water related issues and implications on costs as well as economic and gender concerns.

Table 12: SUMMARY OF DATA GATHERED FROM THE SOCIO ECONOMIC SURVEY

TOPIC	AZRAQ	MAFRAQ	AMM-ZER	DEIR ALLA	JEEZEH	KARAK	MA'AN	RAMTHA
No. of surveyed agricultural wells analyzed	334	298	178	110	159	27	65	101
Owner operating own farm	39%	84%	45%	27%	35%	8%	17%	22%
Representative areas, Number of Farms Total area	167 63,594Du	298 91,912Du	167 26,710Du	110 6,410Du	159 37,054Du	27 6,370Du	61 29,675Du	100 27,751Du
Farmers irrigating only part of the land	61%	46%	57%	60%	60%	67%	80%	50%
Ownership of Farms: purchased, inherited, tribal rights	88.32% 11.7% Nil	93.2% 7% Nil	84.3% 15.2 % 0.5%	99.1% 0.9% Nil	93.7% 5.7% 0.6%	50% 50% Nil	94.3% 5.6% 0.1%	92.1% 7.9% Nil
Partnership in ownership cases Female share of partnerships	9.9% 63.9%	11.4% 82.8%	17.9% 29.6%	3.6% 40%	6.9% 34.1%	25.9% 59.3%	6.2% 61.5%	14.9% 47.4%
Farm managers hired full time	63%	44%	66%	71%	73%	70%	76%	81%
Education of operators, Tawjihi & above illiterate	59% 9%	58% 8%	54% 7%	59% 2%	58% 12%	74% 3%	66% 4%	63% 1%
Wells drilled before ownership, legal: illegal: permit after ownership, legal: illegal: permitted	132:99:0 61:42:0	252:11:0 33 :2:0	119:30:0 32:10:0	45:30:11 6:19:4	130:1:0 25:1:0	25:00:00 nil	90:1:0 9:0:0	95:0:0 0:0:13
Wells drilled 1992 and after	149	124	49	62	45	7	52	29
Water meters Working: Not working: Not installed	192:6:136	287:06:8	154:36:00	58:05:52	166:01:0	32:00:0	84:04:02	106:01:01
Farms claiming insufficient water (numbers that buy), or JVA	86% (6)	74% (13)	63% (10)	59% (37)29JVA	50% (7)	63% (7)	75% (33)	62% (3)
Cases of selling water	1	11	23	0	8	3	1	17
Wells operating hours, Total Summer+Fall Winter+Spring	717 246+ 194 152 + 125	1273 504+ 325 272 +172	752 286 + 192 152 + 122	991 307 + 274 225 + 185	717 246 +194 152+ 125		1141 466 +284 236 +155	1522 594 + 496 244 + 188

TOPIC	AZRAQ	MAFRAQ	AMM-ZER	DEIR ALLA	JEEZEH	KARAK	MA'AN	RAMTHA
Noted water salinity & soil degradation	one third	64 of 298	one third	>50%	one third	one half	3 of 65	3 of 101
Energy source Farms w/elec company; cost in JD/m^3, and using generators/cost in JD/m^3	3% solar 68%; 0.09 29%; 0.20	 98%;0.36 2%; 0.23	 81%; 0.26 19%; 0.41	 97%; 0.13 3%; 0.18	1 No. 90%;0.09 7%;0.20	 70%;0.09 30%;0.20	 86%;0.24 14%;0.54	 96%; 0.36 4%; 0.81
Extent of drip irrigation	mostly	34%	mostly	78%	Mostly	all	mostly	all
Crops for personal use	58%	10%	50%	22%	23%	22%	18%	13%
Sell at wholesale market (on farm)	35%	89%	100%	100%	77%	100%	34% (22)	most
Farms featuring livestock	6.89%	4%	8.42%	2.73%	9.43%		7..69%	6.93%
Support to family members	95%	92%	94%	98%	95%	96%	94%	95%
% of farms w/Jordanian families Jordanian families living on the farm Jordanian owners living on the farm % of farms w/Jordanian owner families	32% 107/334 67/107 20%	41% 122/298 59/122 20%	33% 56/167 39/56 23%	12% 13/110 3/13 3%	12% 18/151 11/18 7%	15% 4/26 3/4 12%	20% 13/65 4/13 6%	29% 29/101 14 /29 14%
Families supported by illegal wells	138, 41%	10, 3.4%	32, 18%	47, 43%	not known	nil	not known	not known
Families living on farms w/ illegal wells	56 fam	10 fam	14 fam	6 fam		nil		
Financial dependency on the farm 80 -100% of income from farm less than 20% of income from farm	 37% 42%	 80% 20%	 53% 13%	 6% 40%	 60% 36%	 41%	 51% 18%	 51% 12%
Permanent workers nationality	Egypt/Jor	Egypt	Egypt/Jor	Egypt/Jor	Egypt/Jor	Egypt/Jor	Egypt	Egypt
Majority of Temporary workers	1/3 local	>50% local	non-Jord	>50% local	most Egypt	most Syria	>50% local	>50% local
Frequency visits of MWI staff to farms: More than 4 visits per month 2-4 visits per month 1 visit per month	 222 sites 112 sites	 103 sites 150 sites	 144 sites 27 sites no sites	 67 sites 27 sites no sites	 136 sites 11 sites	 23 sites nil nil	 60 sites no sites no sites	 95 sites no sites no sites
Farmers needs	financial support for facilities, export access, and qualified extension workers							
Farmers Challenges	permits for new, replacement, cleaning wells. labor permits, low prices, competition							

TOPIC	AZRAQ	MAFRAQ	AMM-ZER	DEIR ALLA	JEEZEH	KARAK	MA'AN	RAMTHA
Farm viewed by farmers 5 years from now: Continue farm as is	46%	55%	55%	7%	72%	41%	62%	62%
Expand farmed area	23%	19%	21%	28%	13%	22%	20%	18%
Reduce farmed area	2%	4%	3%	63%	2%	nil	5%	5%
Stop farming altogether	24%	16%	19%	3%	12%	nil	12%	15%
Change crop pattern	nil	nil	nil	nil	2%	30%	nil	nil

6 SOCIOECONOMIC ANALYSIS OF SURVEY RESULTS

6.1 THE ANALYSIS OBJECTIVES

This section of the report complements the data gathered in this study covering a comprehensive statistical analysis of the collected socio-economic data for eight water basins in Jordan. This section provides additional detailed socioeconomic analysis based on establishing clusters of farming systems with similar characteristics.

According to FAO[2]: *a farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Depending on the scale of the analysis, a farming system can encompass a few dozen or many locations.*

This analysis aims at: 1) developing at least three farming systems (profiles) in each of the eight basins using the socioeconomic data collected by the survey tool; and 2) identifying and estimating a set of technical and economic efficiency indicators for each of the 8 basins.

6.2 ANALYSIS DESIGN AND METHODOLOGY

The analysis relied on collecting both primary and secondary data. The primary technical data was collected by completing a sum of 1376 questionnaires from the eight studied basins; Amman-Zarqa, Azraq, Mafraq, Jezeh, Ma'an, Karak, Ramtha and Deir Allah. The study relied also on other secondary data from different sources related to agricultural production, prices of horticultural products, trade data, groundwater abstraction, water use, and labor. The primary data was verified and validated. The verified primary data was then analyzed using the statistical package SPSS software and used to identify the key economic and social variables related to the different farming systems prevailing in the eight basins. At a later stage, the farming system analysis will be used to examine the impacts of groundwater use across sectors and agricultural production regions. These identified farming systems might also be used provide the basis for building selected analytical and policy tools to manage groundwater resources and restore aquifers safe yield in ways that consider

[2] http://www.fao.org/farmingsystems/description_en.htm

the implications of policy decisions on the users and on social and economic activities that depend on groundwater abstractions.

Descriptive statistical analysis tools were used to analyze the collected data to construct descriptions about the characteristics of the sets of quantitative data. Statistical summaries were estimated for the different numerical indicators that summarize the data sets. These summaries were used to identify the characteristics of the farm populations from the data gathered. The measures of central tendency and dispersion (arithmetic mean, range, variance and standard deviation) have been used in the statistical analysis. Visual binning was used for creating new variables, based on grouping contiguous values of existing variables, into a limited number of distinct categories. Visual binning was used to create many categorical variables from continuous scale to a new categorical variable that contains ranges such as income, well depth, year of establishing the farm, number of family members supported, number of laborers living on the farm, and many other variables.

Cross tabulation is another statistical analysis tool that was used in this study to provide an image of the interrelation between some of the variables and to help in finding interactions between them. This analysis is detailed in the attached appendices where each basin is analyzed separately (Appendices 1 through 8).

6.3 SELECTION OF FARMING SYSTEMS

6.3.1 EXTENT AND REPRESENTATION OF SURVEY

As indicated earlier, the socioeconomic analysis and the results are based on the farmers' direct answers to the survey questionnaire. A sum of 1376 interviews was conducted by the enumerators of the study team. Some of the interviewees did not fully respond to the enumerators in completing the study's questionnaire. Consequently, out of the 1376 interviews a sum of 1272 questionnaires was completed in the eight groundwater basins. However, 23 farmers did not report the cultivated area. Consequently, the number of analyzed questionnaires is 1249.

Table 13 shows the distribution of the interviews in the eight groundwater basins. The largest number of interviews took place in AL Azraq basin (26%) followed by Al Mafraq (22%). This was expected since these two basins have been the subject of many studies in the past and have been the targeted basins to scrutinize while others like Ramtha had not been given sufficient attention.

TABLE 13: RESPONSES TO THE FIELD SURVEY

Basin	Azraq	Mafraq	Amman Zarqa	Deir Allah	Jezeh	Karak	Ma'an	Ramtha	TOTAL

Responses to interview	**361**	**301**	**191**	**115**	**167**	**32**	**101**	**108**	**1376**
Percent	26.2%	21.9	13.9	8.4	12.1	2.3	7.3	7.8	100

6.3.2 FARMING SYSTEMS

The selection of the most appropriate farming systems in the eight basins was based on criteria that emanate mainly from the purpose of the study. The main purpose of this study is to develop a policy tool to help decision makers in the water sector in Jordan deal with problems related to water allocation and use in the eight groundwater basins. Water allocation and use are highly linked to the productivity of the resource whether used in agricultural production with associated over pumping, increasing salinity, etc. or to meet the escalating demand for water at the municipal sector ever increasing due to the growth in population on one side growth and the influx of refugees to Jordan in large numbers during the last few years.

Given the large number of interviewed farmers in the eight basins and large number of the socioeconomic variables included in the questionnaire, the "cross tabulation" tool was used to help in clustering the 1249 farms. The result of the analysis is portrayed by the matrix in Table 14. The matrix is constructed according to the key variable of "managed farm area" that is used here for ranking the 1249 farms.

Furthermore, the matrix in Table 14 shows the distribution of farms by the managed farm size in each of the basins and relates them to the overall situation in all the basins. Therefore it contains all the data pertaining to numbers and areas.

Table 14: Distribution of the completed questionnaire by farm size in the 8 Groundwater Basins

Water Basin	Description of indicators	Managed Farm Size in Dunum																Total
		<= 50.00	50.01 - 100.00	100.01 - 150.00	150.01 - 200.00	200.01 - 250.00	250.01 - 300.00	300.01 - 350.00	350.01 - 400.00	400.01 - 450.00	450.01 - 500.00	500.01 - 600.00	600.01 - 700.00	700.01 - 800.00	800.01 - 900.00	900.01 - 1000.00	1000.01 +	
Al-Azraq	Number of analyzed farms in the basin	159	54	28	21	15	9	7	7	6	4	5	2	6	2	0	8	333
	% of farm size within the groundwater basin	48%	16%	8%	6%	5%	3%	2%	2%	2%	1%	2%	1%	2%	1%	0%	2%	100%
	% of the farm size within all basins	40%	24%	20%	17%	22%	12%	21%	14%	19%	15%	24%	13%	30%	40%	0%	26%	26%
	% of Total sum of farms in all basins	13%	4%	2%	2%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	1%	26%
Al-Mafraq	Number of analyzed farms in the basin	26	51	42	49	21	25	13	20	15	9	7	7	5	2	0	6	298
	% of farm size within the groundwater basin	9%	17%	14%	16%	7%	8%	4%	7%	5%	3%	2%	2%	2%	1%	0%	2%	100%
	% of the farm size within all basins	7%	22%	29%	40%	31%	34%	38%	41%	47%	35%	33%	44%	25%	40%	0%	19%	23%
	% of Total sum of farms in all basins	2%	4%	3%	4%	2%	2%	1%	2%	1%	1%	1%	1%	0%	0%	0%	0%	23%
Amman/Zarqa	Number of analyzed farms in the basin	86	31	15	11	3	9	3	3	3	4	1	1	3	0	0	5	178
	% of farm size within the groundwater basin	48%	17%	8%	6%	2%	5%	2%	2%	2%	2%	1%	1%	2%	0%	0%	3%	100%
	% of the farm size within all basins	22%	14%	10%	9%	4%	12%	9%	6%	9%	15%	5%	6%	15%	0%	0%	16%	14%
	% of Total sum of farms in all basins	7%	2%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%
Deir Allah	Number of analyzed farms in the basin	74	22	6	6	0	1	0	1	0	0	0	0	0	0	0	0	110
	% of farm size within the groundwater basin	67%	20%	5%	5%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	100%
	% of the farm size within all basins	19%	10%	4%	5%	0%	1%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	9%
	% of Total sum of farms in all basins	6%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	9%
Jezeh	Number of analyzed farms in the basin	25	37	22	17	11	12	6	9	2	5	3	1	3	0	2	4	159
	% of farm size within the groundwater basin	16%	23%	14%	11%	7%	8%	4%	6%	1%	3%	2%	1%	2%	0%	1%	3%	100%
	% of the farm size within all basins	6%	16%	15%	14%	16%	16%	18%	18%	6%	19%	14%	6%	15%	0%	29%	13%	13%
	% of Total sum of farms in all basins	2%	3%	2%	1%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	13%
Karak	Number of analyzed farms in the basin	2	10	7	2	2	0	0	1	1	0	0	0	0	0	1	1	27
	% of farm size within the groundwater basin	7%	37%	26%	7%	7%	0%	0%	4%	4%	0%	0%	0%	0%	0%	4%	4%	100%
	% of the farm size within all basins	1%	4%	5%	2%	3%	0%	0%	2%	3%	0%	0%	0%	0%	0%	14%	3%	2%
	% of Total sum of farms in all basins	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
Ma'an	Number of analyzed farms in the basin	11	8	6	8	5	6	2	2	3	1	1	2	2	0	2	5	64
	% of farm size within the groundwater basin	17%	13%	9%	13%	8%	9%	3%	3%	5%	2%	2%	3%	3%	0%	3%	8%	100%
	% of the farm size within all basins	3%	4%	4%	7%	7%	8%	6%	4%	9%	4%	5%	13%	10%	0%	29%	16%	5%
	% of Total sum of farms in all basins	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%
Ramtha	Number of analyzed farms in the basin	13	14	17	8	10	12	3	6	2	3	4	3	1	1	2	2	101
	% of farm size within the groundwater basin	13%	14%	17%	8%	10%	12%	3%	6%	2%	3%	4%	3%	1%	1%	2%	2%	100%
	% of the farm size within all basins	3%	6%	12%	7%	15%	16%	9%	12%	6%	12%	19%	19%	5%	20%	29%	6%	8%
	% of Total sum of farms in all basins	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%
Total of all Basins	Number of analyzed farms	396	227	143	122	67	74	34	49	32	26	21	16	20	5	7	31	1270
	% of farm size within the all basins	31%	18%	11%	10%	5%	6%	3%	4%	3%	2%	2%	1%	2%	0%	1%	2%	100%
	% of the farm size in all basins	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	% of Total sum of farms in all basins	31%	18%	11%	10%	5%	6%	3%	4%	3%	2%	2%	1%	2%	0%	1%	2%	100%

The matrix clearly shows that there are THREE distinct clusters of farms in the eight basins:

1. Small farm size where the managed area is less than 50 du (System I);
2. Medium farm size where the managed area is between 50 and 200 du (System II); and
3. Large farm size where the managed area is greater than 200 du (System III).

Table 15 below, extrapolated from Table 14, gives the percentages of specific areas in each of the basins showing that, the larger farms are located in Ma'an Basin while the smaller are in Deir Allah Basin. However, what surfaces from the table is that Ma'an Basin is predominantly of the large farms category given the farms in Disi and the apple farms in Shobak.

Table 15: Farm area percentages in each basin based on the three farming systems

Farm area (Du)	Basin							
	Azraq	Mafraq	Amman-Zarqa	Deir Alla'	Jezeh	Karak	Ma'an	Ramtha
0-50 (Small)	7.9%	0.9%	8.2%	31%	1.8%	0.9%	0.1%	1.25%
50 – 200 (Medium)	22.3%	24.2%	23.4%	58%	24.5%	36.4%	13.6%	17.6%
200+ (Large)	69.6%	74.9%	68.2%	11%	73.8%	62.6%	85.3%	81.1%
	↓	↓	↓	↓	↓	↓	↓	↓
200 -500	30.2%	45.9%	32.2%	10.9%	41.3%	23%	29.3%	42.5%
500 - 1000	20.3%	19.1%	13.1%	0%	18.6%	17.5%	26%	29.4%
1000 +	19.1%	9.9%	22.9%	0%	13.9%	22.1%	30%	9.2%

Table 15 also gives a breakdown in the category of over 200 du. Farm areas between 200 and 500 du, except for Deir Allah and Karak, are the predominant size in all basins. Given the great number of farms, and the relatively small percentage that the small farm category represents in terms of the area

farmed (7%), it seems clear that large farms should be given due attention in monitoring and follow up. Taking Azraq, for example, 8 farms each in excess of 1000 du in area consumed, based on water crop requirements, an estimated total of 16,885,593 CM. If investment is made in sophisticated monitoring, these large farms should be given priority. Additionally, as the GIS system is now available at the Ministry, these wells can be closely monitored and mapped.

Based on of the 1249 farms across the Kingdom, Figure 1 shows that the dominant farm size (managed area) in the eight basins is between 50-200 du (System II) while the other two systems are almost equal in proportion. However, this proportion varies from one basin to another. For example, small constitute 49% of the total number of arms while in Deir Allah it forms 68% of the total.

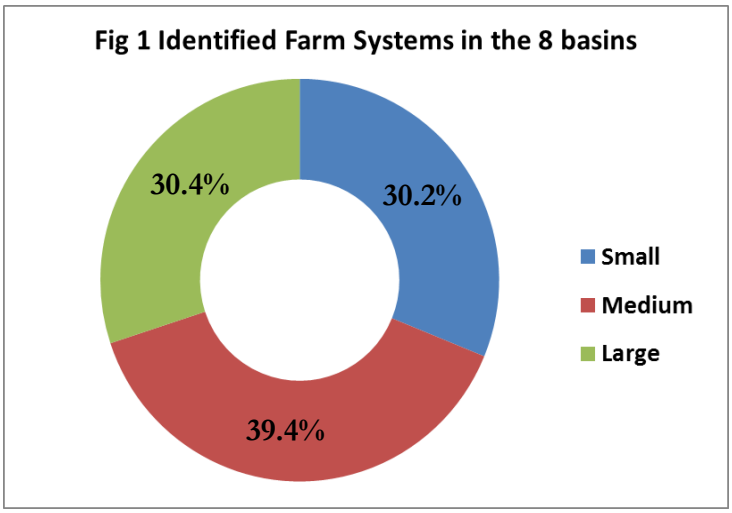
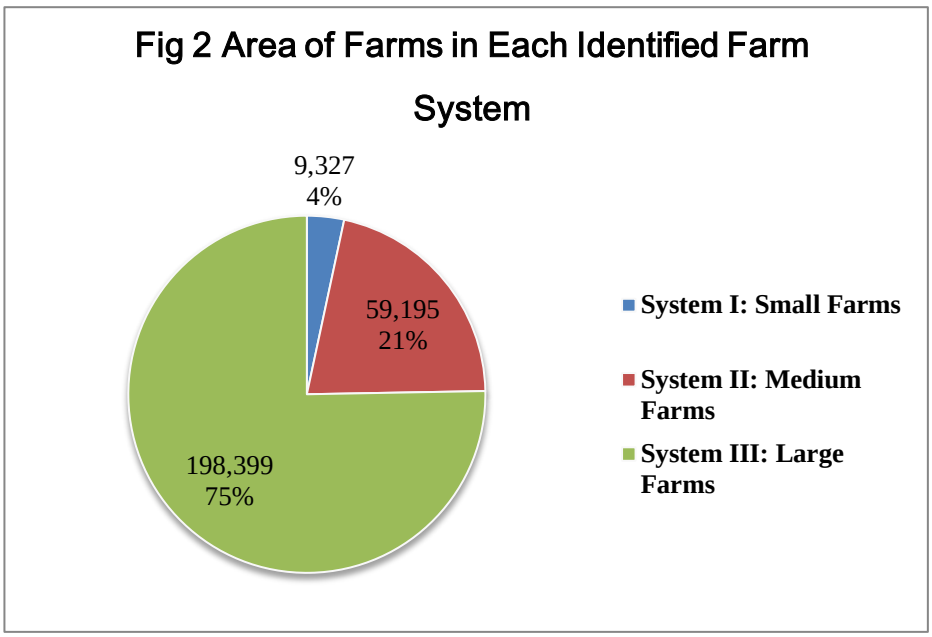


Figure 2 shows the areas in du of farms in the three identified faming systems. The 380 large farms occupy an area of 198,399 du, (30.4% of the farms comprise 75% of the area); and the medium size farms totaling 492 in number cover 59,195 du, (39.4% of the farms are on over 21% of the area), while 377 small size farms are 9,327 du in area (30.2% of the farms cultivate 4% of the areas) .



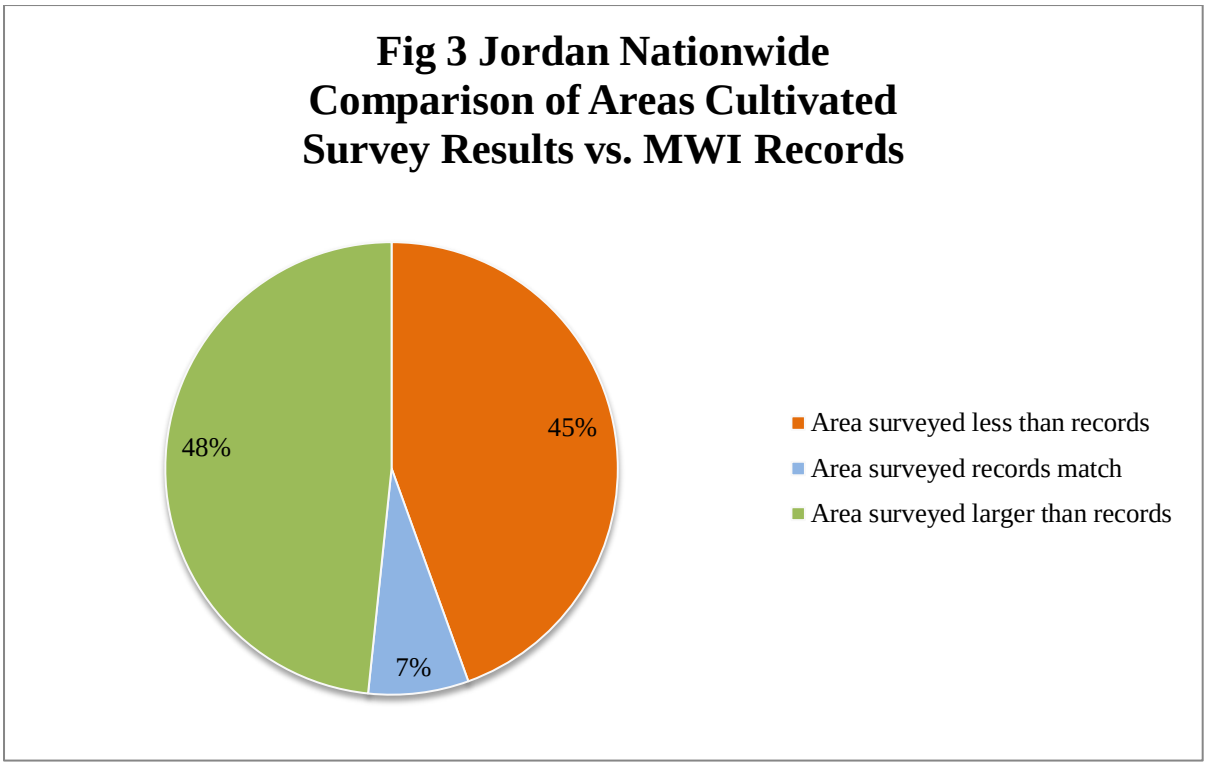
6.3.3 ANALYSIS RESULTS OF THE FARM AREAS IN THE EIGHT GROUNDWATER BASINS

This section presents the analysis results of the total owned areas and the total cultivated (managed areas) of the interviewed well owners and farm operators in the eight groundwater basins. Table 16 portrays the distribution of reported areas in the questionnaires against wells records at the MWI. The table and Figure 3 below show the differences between MWI records and the cultivated areas reported by the interviewees. Although comparable at the Amman-Zerqa and Karak basins, the comparison shows big differences between MWI records and the reported areas by the farmers interviewed. It is obvious from the results that the actual cultivated areas in the other basins exceed what is reported in the records of MWI. The highest variation is noted in the basins of Azraq (48% vs 28%), Mafraq (76% vs 46%) and Ramtha (85% vs 63%);

Table 16: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN THE 8 GROUNDWATER BASINS

#	Case at Jordan Nationwide – All visited wells	Area in Du	Percent of total area
1	Cultivated area in Deir Alla' Basin (109 wells) (was not found at MWI records)	6,410 out of 8,881	
2	Total area owned based on the survey (1249 wells)	504,129	
3	Cultivated area based on the survey (1249 wells)	266,921	52%
#	**Case at Jordan Nationwide – Wells in MWI Records**	**Area in Du**	**Percent of total area**
1	Total area owned based on the survey (935 wells)	441,110	
2	Cultivated area based on the survey (935 wells)	235,042	53%
3	Cultivated area based on the MWI records (935 wells)	168,125	38%
4	Difference between MWI records and Survey Results	66,917	

Whereas the suvey results indicate that nearly 55% of the owned areas are cultivated, as reported by the owners/operators of the farms, MWI records indicate that only 38% is cultivated. It is highly unlikely that farmers respond to the question by oversizing or undersizing the actual areas, it can be assumed that the survey figures represent the situation on the ground.



Tables 17 through 23 and Figures 4 through 10 show the results of the total owned areas and the total cultivated (managed) areas of the interviewed well owners and farm operators at the **basin level** compared to the records of the MWI.

Table 17: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN AZRAQ BASIN

#	Case – All visited wells	Area in Du	Percent of total area
1	total area owned based on the survey (332 wells)	119,828	
2	cultivated area based on the survey (332 wells)	52,838	44%
#	**Case – only wells in MWI records**	**Area in Du**	**Percent of total area**
1	total area owned based on the survey (275 wells)	98,670	
2	cultivated area based on the survey (275 wells)	42,027	43%
3	cultivated area based on the MWI records (275 wells)	29,405	30%
4	Difference between MWI records and Survey Results	12,622	

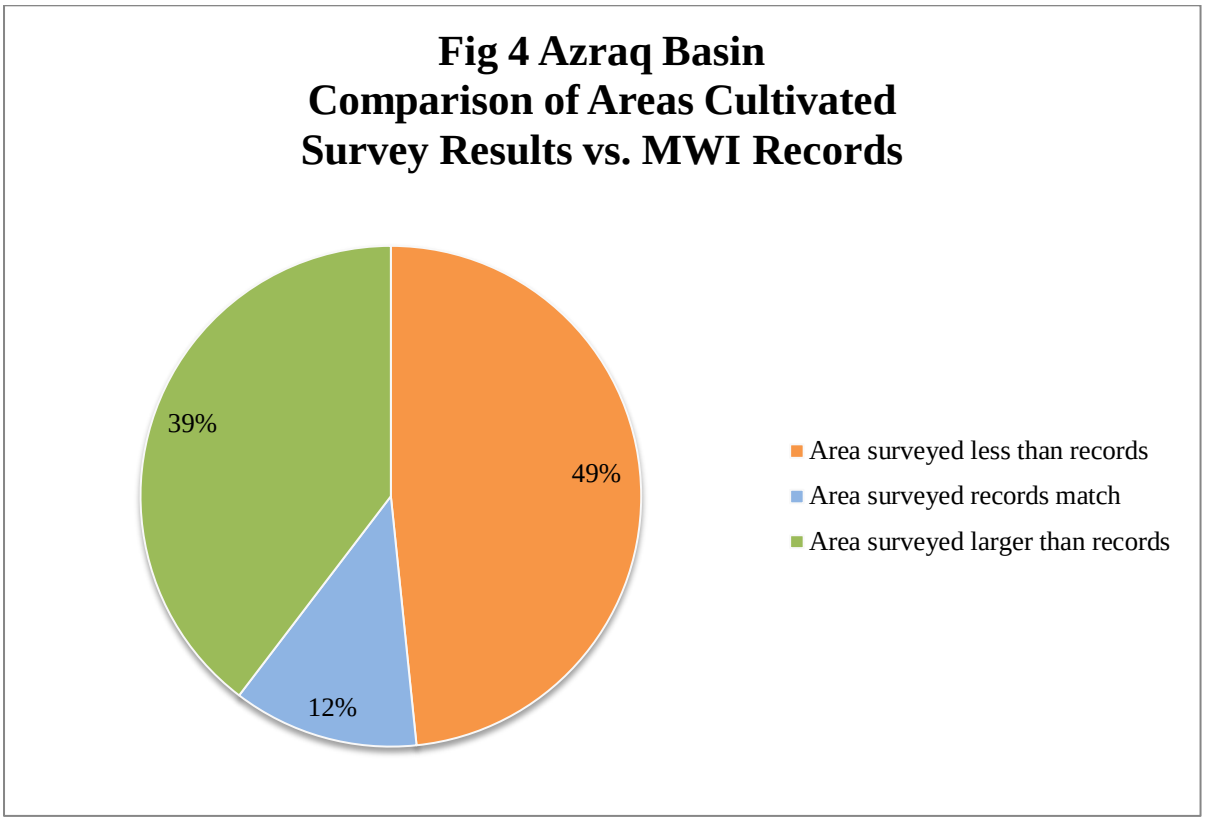


Table 18: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN MAFRAQ BASIN

#	Case – All visited wells	Area in Du	Percent of total area
1	total area owned based on the survey (295 wells)	107,479	
2	cultivated area based on the survey (295 wells)	76,964	72%
#	**Case – only wells in MWI records**	**Area in Du**	**Percent of total area**
1	total area owned based on the survey (263 wells)	95,902	
2	cultivated area based on the survey (263 wells)	69,539	73%
3	cultivated area based on the MWI records (263 wells)	50,510	53%
4	Difference between MWI records and Survey Results	19,029	

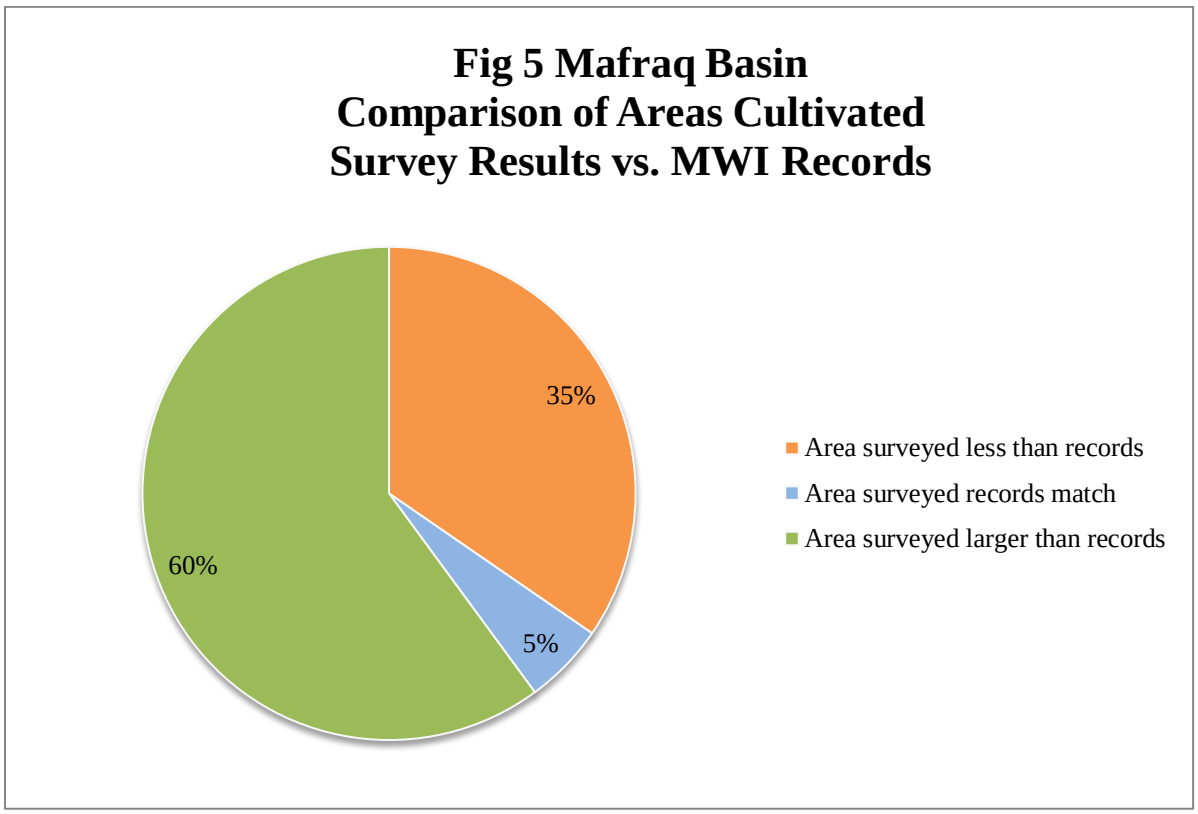


Table 19: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN AMMAN-ZARQA BASIN

#	Case – All visited wells	Area in Du	Percent of total area
1	total area owned based on the survey (167 wells)	63,771	
2	cultivated area based on the survey (167 wells)	26,711	42%
#	**Case – only wells in MWI records**	**Area in Du**	**Percent of total area**
1	total area owned based on the survey (111 wells)	49,819	
2	cultivated area based on the survey (111 wells)	18,451	37%
3	cultivated area based on the MWI records (111 wells)	19,289	39%
4	Difference between MWI records and Survey Results	-838	

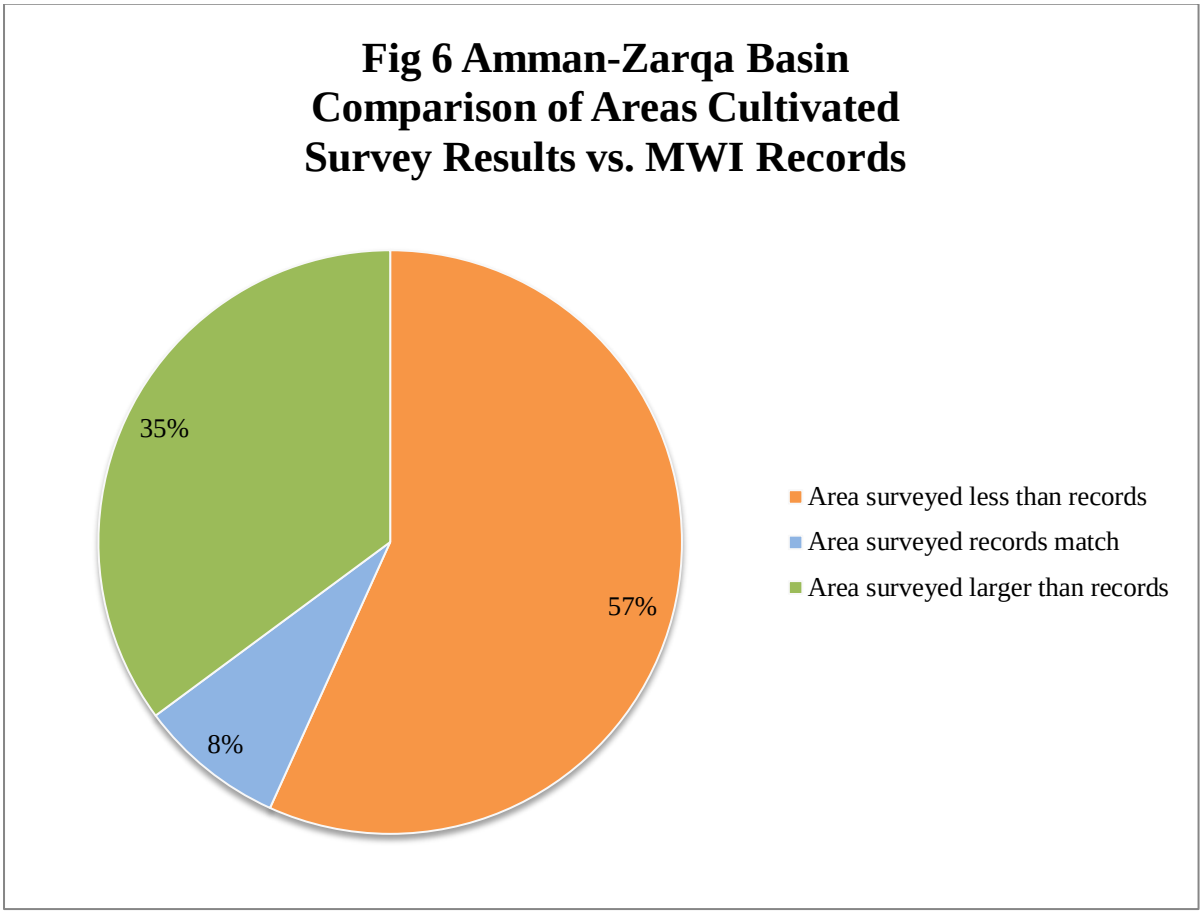


Table 20: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN JEZEH BASIN

#	Case – All visited wells	Area in Du	Percent of total area
1	total area owned based on the survey (157 wells)	56,124	
2	cultivated area based on the survey (157 wells)	37,054	66%
#	**Case – only wells in MWI records**	**Area in Du**	**Percent of total area**
1	total area owned based on the survey (130 wells)	48,769	
2	cultivated area based on the survey (130 wells)	32,822	67%
3	cultivated area based on the MWI records (130 wells)	27,635	57%
4	Difference between MWI records and Survey Results	5,187	

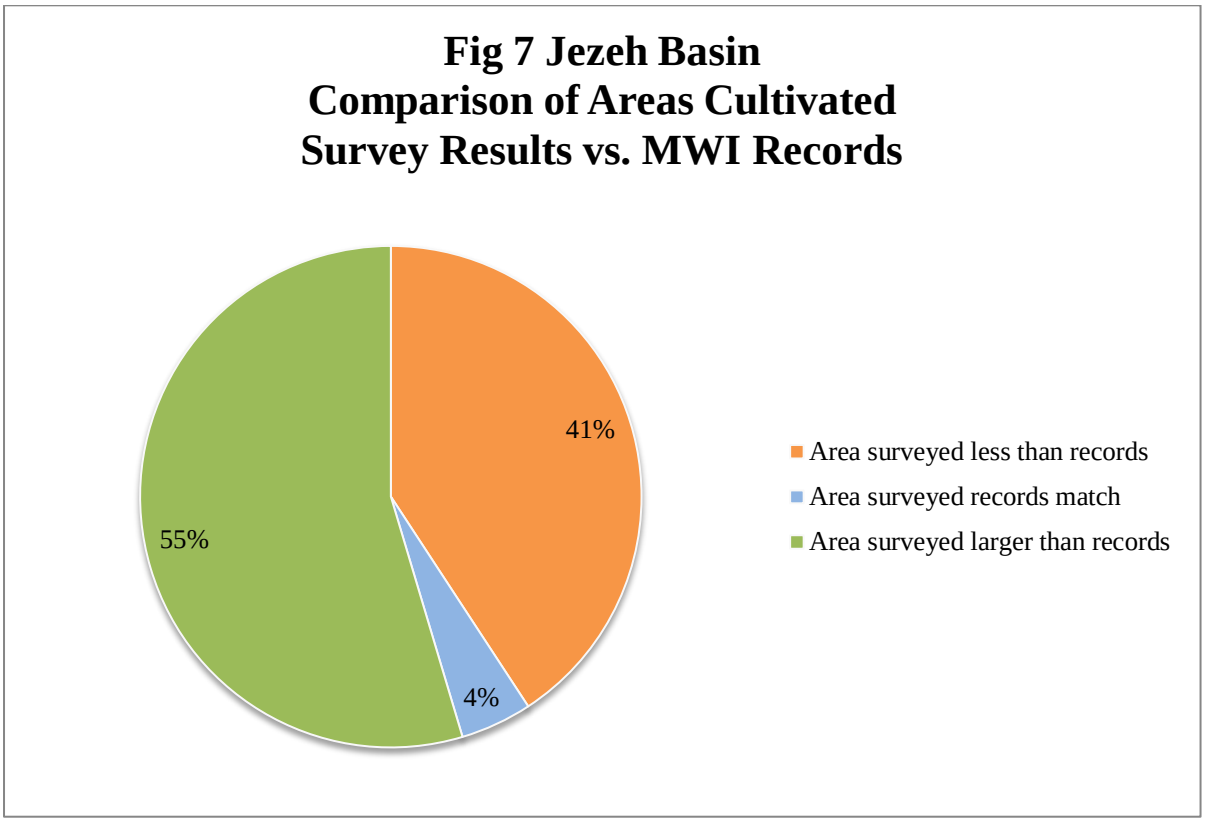


Table 21: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN KARAK BASIN

#	Case – All visited wells	Area in Du	Percent of total area
1	total area owned based on the survey (27 wells)	9,539	
2	cultivated area based on the survey (27 wells)	6,369	67%
#	**Case – only wells in MWI records**	**Area in Du**	**Percent of total area**
1	total area owned based on the survey (20 wells)	4,281	
2	cultivated area based on the survey (20 wells)	2,772	65%
3	cultivated area based on the MWI records (20 wells)	2,808	66%
4	Difference between MWI records and Survey Results	-36	

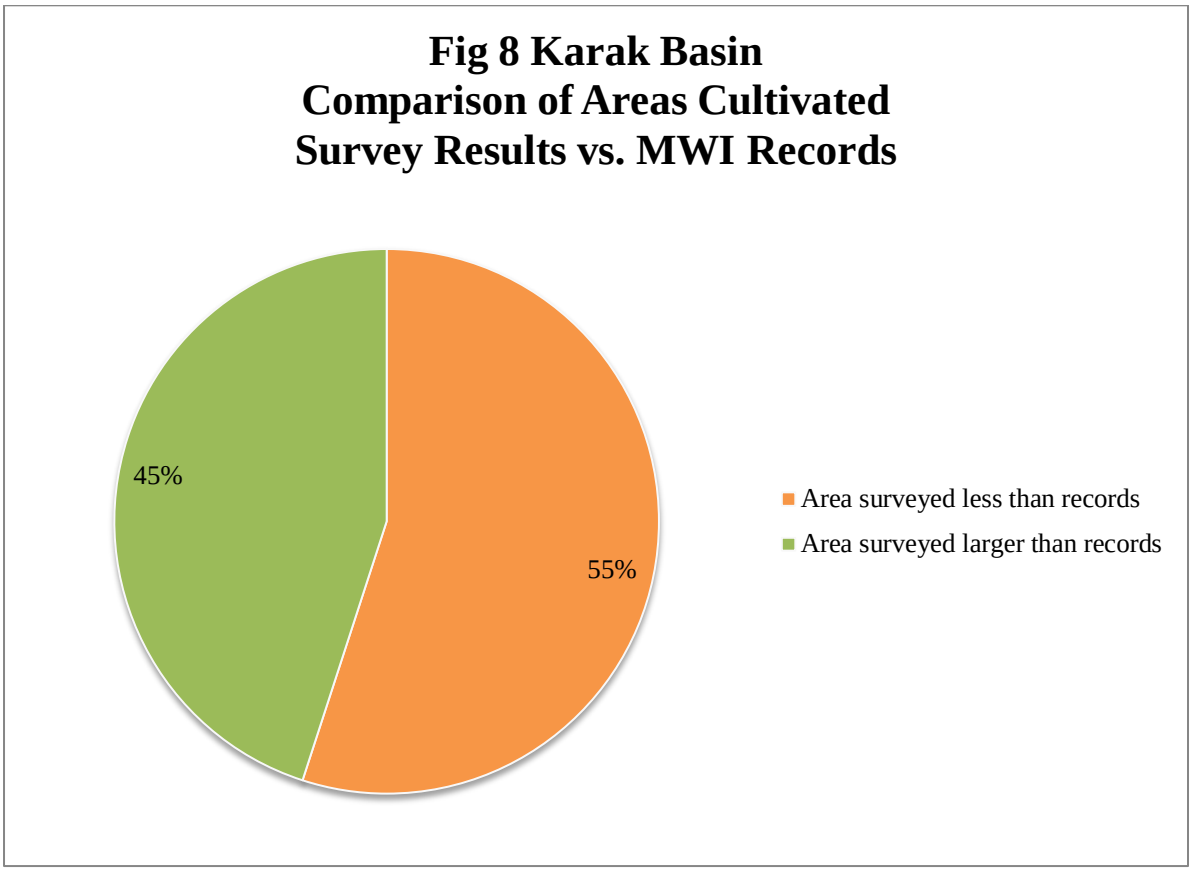


Table 22: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN MA'AN BASIN

#	Case – All visited wells	Area in Du	Percent of total area
1	total area owned based on the survey (63 wells)	104,864	
2	cultivated area based on the survey (63 wells)	32,825	31%
#	Case – only wells in MWI records	Area in Du	Percent of total area
1	total area owned based on the survey (50 wells)	100,768	
2	cultivated area based on the survey (50 wells)	31,114	30%
3	cultivated area based on the MWI records (50 wells)	19,878	20%
4	Difference between MWI records and Survey Results	11,236	

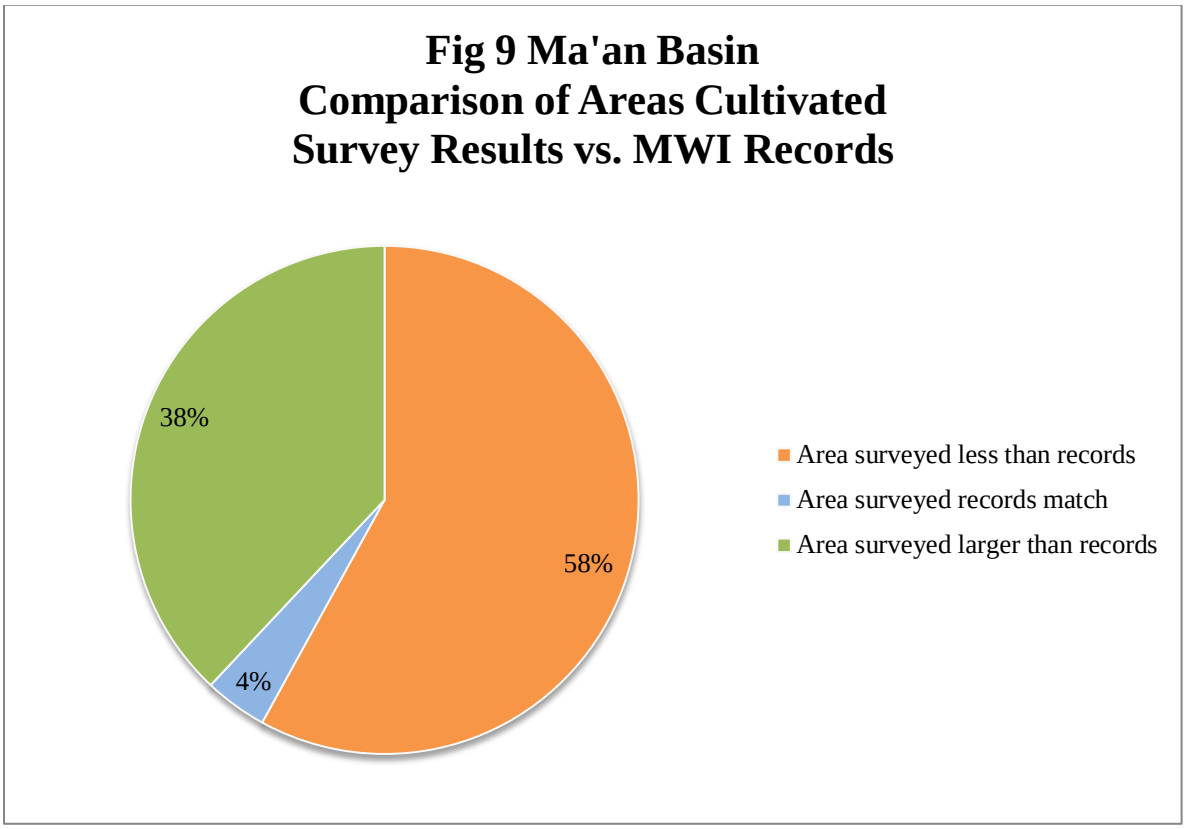
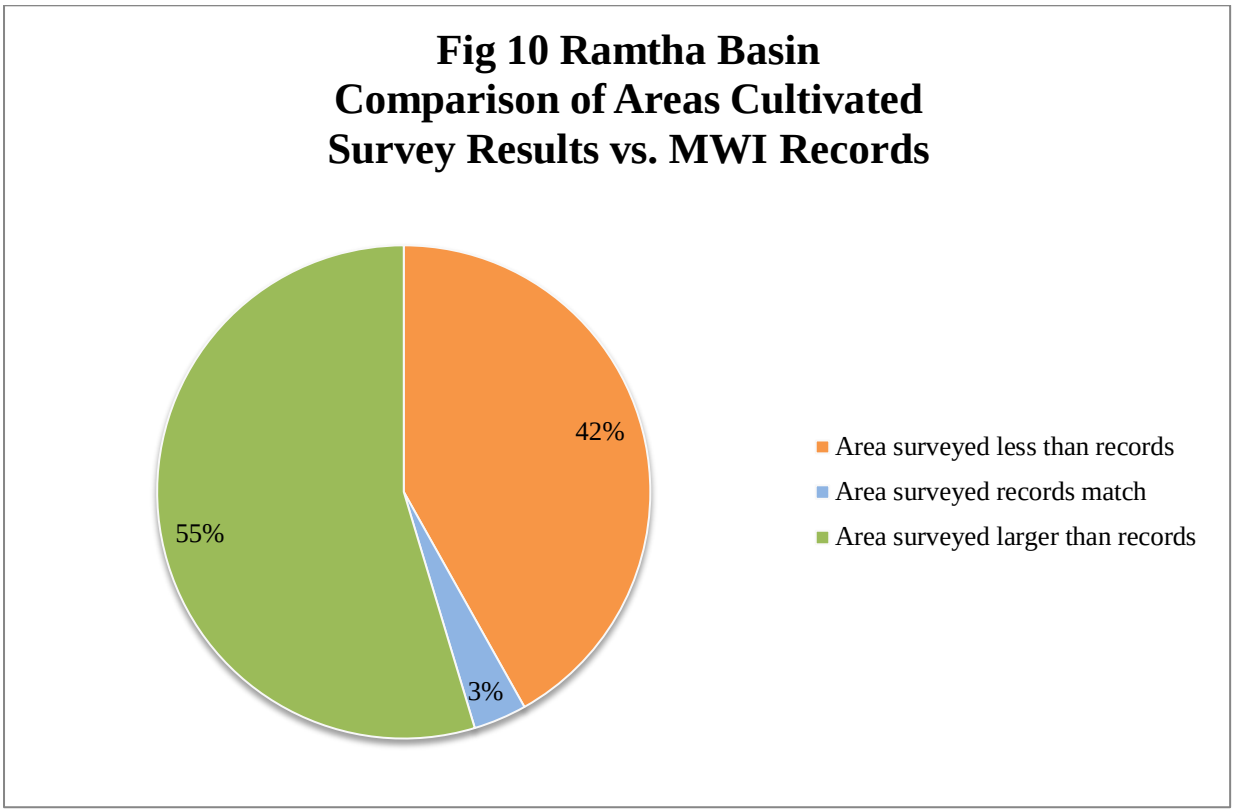


Table 23: TOTAL OWNED AND CULTIVATED AREA AS REPORTED IN THE COMPLETED QUESTIONNAIRE COMPARED TO MWI RECORDS IN RAMTHA BASIN

#	Case – All visited wells	Area in Du	Percent of total area
1	total area owned based on the survey (99 wells)	33,644	
2	cultivated area based on the survey (99 wells)	27,751	82%
#	**Case – only wells in MWI records**	**Area in Du**	**Percent of total area**
1	total area owned based on the survey (86 wells)	29,306	
2	cultivated area based on the survey (86 wells)	24,772	85%
3	cultivated area based on the MWI records (86 wells)	18,450	63%
4	Difference between MWI records and Survey Results	6,322	



7 FARMING SYSTEMS RESULTS SUMMARY FOR ALL BASINS

7.1 MAIN CULTIVATED CROPS AND ESTIMATED ABSTRACTED WATER IN ALL BASINS

Table 24 shows the detailed breakdown of crops in the cultivated areas in the 8 groundwater basins. It is clear that olive is the dominant crop type that occupies more than 126,000 du representing about one-half of the cultivated areas in the different basins. The table also shows that 83% of the cultivated area is planted with olive trees in the Large farms cluster while in Medium and Small farms olive trees respectively cover 14% and 3% of the area. Of the 280,000 du cultivated land in the visited farms in the 8 basins, 80% of the cultivated area is owned by large farmers. The table also shows that of the total cultivated area, trees occupy 71%.

The methodology for calculating water used for irrigation, once the crops are known, is that based on the crop water requirements provided by MoA, and the only method currently accepted at MWI. According to FORWARD report (2000)[3], *the irrigation water requirement for a crop is the consumptive crop water use, cumulative evapotranspiration, plus additional water to account for leaching and irrigation efficiency, minus the water from effective rainfall. To estimate the irrigation water requirement an irrigation efficiency of 80 percent for low-pressure systems, drip and micro-sprinkler, and 70 percent for surface irrigation systems such as furrow are assumed. By accounting for these efficiencies, the irrigation water requirement is adjusted upward to account for different leaching fractions. The average rainfall in each region was then subtracted from these adjusted values to derive the irrigation water requirement of the crop.* The FORWARD study, in full collaboration with the NCARE and JV Authority, used the above described methodology to determine the consumptive crop water for each of the major crops in each of the stage offices in the Jordan Valley. According to this definition of crop water requirement and the adopted methodology by NCARE (MoA), the "Crop Water Requirement" tables provided by the MoA for the eight basins were used to determine the total amount of abstracted water by the surveyed 1249 farms.

[3] FORWARD, a USAID Program, "Assessment of Water Quality Variations in the Jordan Valley, Volume I, Summary Report," prepared for the Jordan Valley Authority and the Water Authority of Jordan, Ministry of Water and Irrigation, Amman, June 2000, pp. 21-22 [emphasis added].

Table 24: DISTRIBUTION OF CULTIVATED AREAS BY CROP IN THE 8 GROUNDWATER BASINS

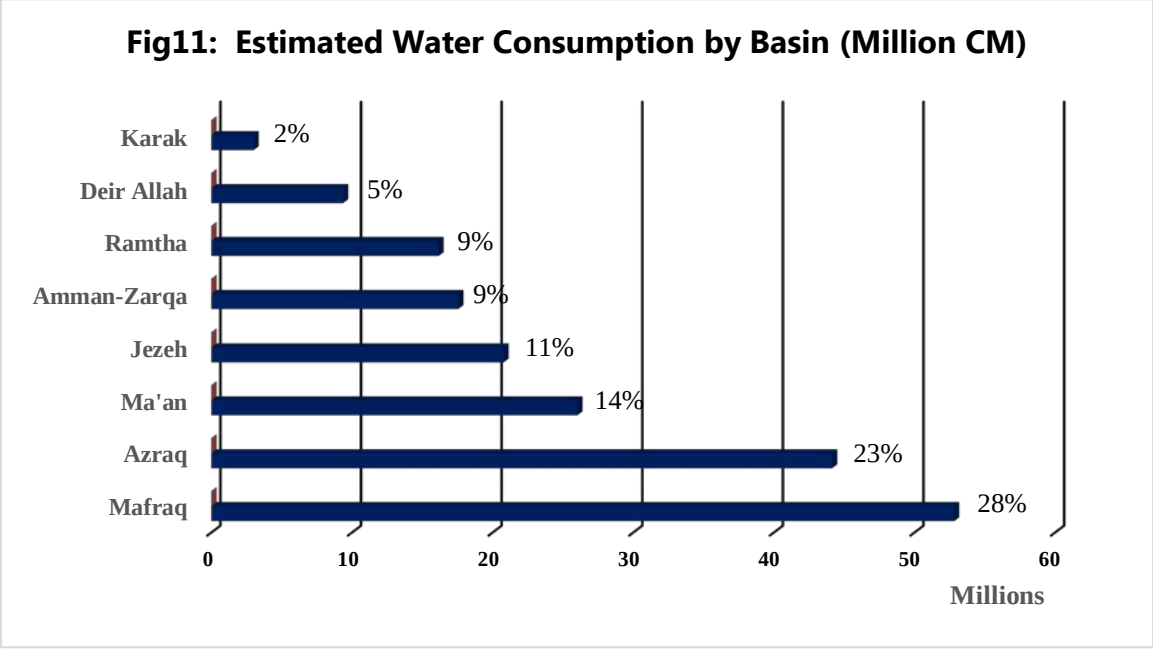
Crops	Small	Medium	Large	Total	% Crop
Olive	3,489	11,667	61,324	76,480	30%
Olive for pressing	1,408	7,338	41,393	50,139	18%
Tomato	508	6,348	10,851	17,707	6%
Peach	28	2,480	12,393	14,900	5%
Grape	374	2,008	9,900	12,282	4%
Alfalfa	295	1,228	6,572	8,095	3%
Apricot	16	1,045	6,761	7,822	3%
Corn	224	523	6,138	6,885	2%
Barley	111	1,903	4,391	6,405	2%
Apple	8	259	5,877	6,144	2%
Nectarine	1	561	5,076	5,638	2%
Arecaceae (Palm)	960	833	3,810	5,603	2%
Potato	165	425	4,410	5,000	2%
Cauliflower	328	2,204	1,783	4,315	1%
Watermelon		1,320	2,763	4,083	1%
Capsicum	77	921	2,738	3,736	1%
Peach (cake-like)		150	3,350	3,500	1%
Zucchini	197	814	2,176	3,187	1%
Eggplant	319	921	1,379	2,619	1%
Wheat	20	224	1,765	2,009	1%
Pear	21	259	1,339	1,619	1%
Lettuce	71	738	757	1,566	1%
Pomegranate	21	294	1,135	1,450	0%
Decoration trees	84	150	1,175	1,409	0%
Cabbage	66	515	807	1,388	0%
Cucumber	177	627	516	1,319	0%
Cupressus	4	180	1,100	1,284	0%
Stone Fruits	12		1,220	1,232	0%
Cantaloupe	11	516	680	1,207	0%
Blubank			1,175	1,175	0%
Lemon	57	308	705	1,070	0%
Other crops	280	1,639	17,152	19,071	7%
Total	**9,327**	**48,395**	**222,609**	**280,332**	**100%**

Table 25: MAIN CULTIVATED CROPS IN THE 8 GROUNDWATER BASINS

Main cultivated crop	Water Requirment (CM) in the eight basins								Total Per Crop	% of total
	Ramtha	Mafraq	Amman-Zarqa	Maan	Azraq	Deir Allah	Karak	Jezeh		
Olive	5,649,150	18,447,800	7,976,850	3,484,400	20,868,798	70,950	992,550	5,261,750	62,752,248	33.9%
Olive for pressing	3,296,150	7,498,400	4,034,800	3,998,600	11,108,980			9,198,150	39,135,080	21.1%
Tomato	960,750	7,243,500	758,625	1,927,800	459,200	238,700	358,680	990,000	12,937,255	7.0%
Peach	570,105	6,461,705	333,205	922,250	23,040		28,000	159,125	8,497,430	4.6%
Alfalfa		390,000	705,900	195,000	4,791,930	63,700	93,600	84,075	6,324,205	3.4%
Barley			1,000,065	225,150	1,608,750	2,861,950	25,662		5,721,577	3.1%
Grape	1,458,600	1,414,400	284,400	820,765	1,588,595	131,200	54,264	141,750	5,893,974	3.2%
Apricot	366,680	2,636,800	311,318	1,100,835	4,680		8,500		4,428,813	2.4%
Potato	87,100		113,240	3,352,500		19,800		181,424	3,754,064	2.0%
Apple	70,555	275,525	103,773	3,036,800	17,760		18,000		3,522,413	1.9%
Nectarine	180,765	2,871,640							3,052,405	1.6%
Beet			22,048		749,550		56,430	1,732,230	2,560,258	1.4%
Corn		63,800	55,836	1,879,600	221,760	74,892		21,120	2,317,008	1.2%
Watermelon		502,970	143,100	1,066,800	165,000		81,400	30,500	1,989,770	1.1%
Cauliflower	281,200	535,800	364,000	282,530	38,000	29,500	3,091	424,460	1,958,581	1.1%
Peach (cake-like)	77,250	1,812,800							1,890,050	1.0%
Other Crops (less than 1% of area)	3,154,988	2,661,875	1,598,686	3,708,399	2,494,210	1,194,053	1,278,747	2,550,100	18,641,058	10.1%
TOTAL	**16,153,293**	**52,817,015**	**17,805,845**	**26,001,429**	**44,140,253**	**4,684,745**	**2,998,924**	**20,774,684**	185,376,188	100.0%

As indicated in Table 25, the total estimated abstracted water of the **surveyed farms (1272 wells) in the 8 basins is 185 MCM, w**hile those in MWI records for 2,139 agricultural wells is 196 MCM. The quantity calculated for the 1272 wells, if used broadly as representative, can be used for estimating abstraction for the remaining wells which were either not visited due to denied access or, when visited, the questionnaire was not fully completed. Total operating wells on record in MWI files are 2,578. The inferred quantities (calculated basin by basin) add up to **281** million cubic meters for all operating agriculture wells in all the basins. Adding WAJ abstractions and other uses, the estimated abstracted water from all operating wells in the 8 basins, based on the study, is **503 MCM**. This is far in excess of the safe yield of aquifers of 275 MCM. Furthermore, Jordan's Water Strategy limits allowed water allocations to agriculture to 579 MCM (JVA irrigation + Highland irrigation, 2007). Deducting surface water sources from these allocations would leave 304 million cubic meters for abstraction from groundwater aquifers in the highlands. The quantities estimated from this study exceed all threshold values and are thus extremely alarming.

Figure 11 shows that Mafraq is the leading basin in the total estimated abstracted water for agricultural uses at the visited farms representing 28% of the total abstraction on a national level. This is followed by Azraq at 23%.



Figures indicates that 55% of the total amount of abstracted water in the 8 basins was used to irrigate olive trees while the remaining 45% was used to irrigate all other trees as well as vegetable crops.

Mafraq is a major basin in water abstraction for olive trees at 26 MCM representing 50% of the amount abstracted in this basin. However, 71% of the total abstracted water in Azraq is used to irrigate olive trees only.

7.2 DISTRIBUTION OF ESTIMATED ABSTRACTED WATER IN ALL BASINS BY FARMING SYSTEMS

Table 26 shows the distribution of the abstracted irrigation water in the 8 basins categorized by the farming cluster. The table shows that 74% of the total abstracted water was used by large farmers followed by medium farmers at 22% and the small farmers consuming only 4%. Much of the abstracted water by large farmers has been observed in all basins except in Deir Allah, where the average farm size is smaller than farms in the highland basins.

Table 26: Estimated Water Abstraction at the Surveyed Farms in the 8 Groundwater Basins

Basin	Estimated Abstraction Water (CM) by Cluster			
	Small	Medium	Large	Total - Basin
Mafraq	614,720	11,376,207	40,825,988	**52,816,915**
Azraq	2,636,437	8,354,511	33,152,305	**44,143,253**
Ma'an	178,530	5,557,541	20,288,458	**26,024,529**
Jezeh	468,388	4,675,743	15,630,553	**20,774,684**
Amman-Zarqa	735,325	4,261,946	12,562,849	**17,560,120**
Ramtha	208,799	3,013,281	12,931,213	**16,153,293**
Deir Allah	1,648,850	3,035,895	None	**4,684,745**
Karak	None	978,719	2,020,205	**2,998,924**
Total Basins by Cluster	**6,491,049**	**41,253,843**	**137,411,571**	**185,156,463**
% in numbers	31%	39%	30%	100%
% in abstraction	4%	22%	74%	100%
% in total area	3%	21%	75%	100%

7.3 ANALYSIS OF SELECTED SOCIOECONOMIC INDICATORS AT THE LEVEL OF THE EIGHT BASINS

Beyond the farm size, cropping patterns, and water abstractions other selected socioeconomic factors were analyzed for further classification of the farming systems within each of the three identified systems. A further sum of 20 combinations or farming systems (clusters) were identified when cross-referencing the farm size with the following factors gathered from the survey:

- Socioeconomic and Demographic Characteristics
- Farm and Well Characteristics
- Main Financial Indicators
- Main Labor and Gender Indicators
- Economic Efficiency Indicators

Cross tabulation analysis was used to examine different sets of relationships related to variables such as farm income, farm size, water abstraction and other socioeconomic indicators as follows:

- Relationship between the number of family members living on the farm and the farming income proportion to the total income can be established. Table 27 shows that 817 of the total 1254 respondents to this question have no family members living on the farm. This represents 65% of all farmers. The table also shows that about 60 % of farmers whose farming income proportion to their total income lies between 80%-100% have no family members living on the farm.

Table 27: RELATIONSHIP BETWEEN FAMILY MEMBERS LIVING ON FARM AND DEPENDANT ON FARM INCOME

		Farming income proportion to the total income				Total
		<20%	20% - 50%	51% - 80%	81% - 100%	
Family members living on the farm	None	174	101	66	476	817
	1 5	27	19	16	120	182
	>5	56	34	24	141	255
Total		**257**	**154**	**106**	**737**	**1254**

- Table 28 shows the percentage of farmers (legal and illegal) who do not live on the farm, have small farm, and the distribution of their farming income proportion to their total

income. The table shows that, from the sampled number of "small farmers" who do not live on the farm, 37% of the farmers earn less than 20% of their total income from farming, while an equal percentage depend heavily on the income from the farm (81%-100%).

Table 28: FARMING INCOME PROPORTION TO TOTAL INCOME OF SMALL FARMERS NOT LIVING ON FARM

	Income Distribution	Frequency	Percent	Valid Percent
Farming income proportion to the total income	< 20%	97	36.6	37.3
	20%- 50%	44	16.6	16.9
	51% - 80%	20	7.5	7.7
	81% - 100%	99	37.4	38.1
	Total	260	98.1	100

- Table 29 shows the distribution of estimated water needs of 302 small farms in the eight basins. The table shows that the overwhelming majority of small farmers use less than 50 thousand cubic meter of water on their farms. Only one farmer, of the 302 farmers who responded to the questionnaire, is abstracting more than 150 thousand cubic meters.

Table 29: DISTRIBUTION OF ESTIMATED WATER USED BY SMALL FARMERS (LEGAL AND ILLEGAL)

	Water Abstraction CM	# of wells	Percent
Estimated water needs of small farms (legal and illegal) **Self-reported**	zero	14	4.6
	0 - 50 K	266	88.1
	51 - 75 K	13	4.3
	76 - 100 K	7	2.3
	101 - 125 K	1	0.3
	<= Higher	1	0.3
	Total	302	100

	Water Abstraction CM	# of wells	Percent
Estimated water needs of small farms (legal and illegal) **Based on crop water requirement**	zero	1	0.27
	0 - 50 K	364	97.32
	51 - 75 K	8	2.14
	76 - 100 K	-	-
	101 - 125 K	-	-
	<= Higher	1	0.27
	Total	374	100

- Table 30 shows the cross relationships between the small farmers water needs and their farm income proportion to the total income. The table shows that the farming income proportion to the total income is less than 20% for all small farmers who use less than 100,000 CM.

Table 30: CROSS TABULATION RESULTS BETWEEN SMALL FARMERS WATER NEED AND FARM INCOME PROPORTION TO THE TOTAL INCOME (LEGAL AND ILLEGAL). (WATER ABSTRACTION IS AS SELF-REPORTED)

			Total ABSTRACTION (Binned)						
			Zero	0 - 50K	51 – 75 K	76 – 100 K	101 – 125 K	<= HIGH	Total
Farming income proportion to the total income?	<20%	# of farms	8	91	5	1	0	0	105
		% within Farming income proportion to the total income?	8%	87%	5%	1%	0%	0%	100%
		% within total ABSTRACTION (Binned)	57%	35%	38%	14%	0%	0%	35%
		% of Total	3%	31%	2%	0%	0%	0%	35%
	20% - 50%	# of farms	1	46	3	1	0	1	52
		% within Farming income proportion to the total income?	2%	88%	6%	2%	0%	2%	100%
		% within total ABSTRACTION (Binned)	7%	18%	23%	14%	0%	100%	18%
		% of Total	0%	16%	1%	0%	0%	0%	18%
	51% - 80%	# of farms	1	9	2	1	0	0	13
		% within Farming income proportion to the total income?	8%	69%	15%	8%	0%	0%	100%
		% within total ABSTRACTION (Binned)	7%	3%	15%	14%	0%	0%	4%
		% of Total	0%	3%	1%	0%	0%	0%	4%
	81% - 100%	# of farms	4	114	3	4	1	0	126
		% within Farming income proportion to the total income?	3%	90%	2%	3%	1%	0%	100%
		% within total ABSTRACTION (Binned)	29%	44%	23%	57%	100%	0%	43%
		% of Total	1%	39%	1%	1%	0%	0%	43%
Total		# of farms	14	260	13	7	1	1	296
		% within Farming income proportion to the total income?	5%	88%	4%	2%	0%	0%	100%
		% within total ABSTRACTION (Binned)	100%	100%	100%	100%	100%	100%	100%
		% of Total	5%	88%	4%	2%	0%	0%	100%

- Table 31 shows the cross relationships between small farmers (legal and illegal) who do not live on the farm and the total water use in cubic meters. The highlighted section of Table 31 shows that the total number of small farmers in the eight basins who do not live on their farm is 202 representing two thirds of small farmers. The highlighted area in the table also shows that the overwhelming majority of those farmers (93%) use less than 50,000 CM.

Table 31: CROSS TABULATION RESULTS BETWEEN SMALL FARMERS (LEGAL AND ILLEGAL) DO NOT LIVE ON THE FARM AND WATER USE IN CUBIC METERS. (WATER ABSTRACTION IS AS SELF-REPORTED)

			Total ABSTRACTION (Binned)						Total
			Zero	0- 50K	51 – 75 K	76 - 100 K	101–125 K	<= HIGH	
Number of family members living on the farm	No one	# of farms	10	178	8	5	1	0	202
		% within "How many family members live on the farm?"	5%	88%	4%	3%	1%	0%	100%
		% within "Total ABSTRACTION (Binned)	71%	67%	62%	71%	100%	0%	67%
		% of Total	3%	59%	3%	2%	0%	0%	67%
	1 To 5	# of farms	0	42	1	2	0	0	45
		% within "How many family members live on the farm?"	0%	93%	2%	4%	0%	0%	100%
		% within total ABSTRACTION (Binned)	0%	16%	8%	29%	0%	0%	15%
		% of Total	0%	14%	0%	1%	0%	0%	15%
	>5	# of farms	4	44	4	0	0	1	53
		% within "How many family members live on the farm?"	8%	83%	8%	0%	0%	2%	100%
		% within total ABSTRACTION (Binned)	29%	17%	31%	0%	0%	100%	18%
		% of Total	1%	15%	1%	0%	0%	0%	18%
Total		# of farms	14	264	13	7	1	1	300
		% within "How many family members live on the farm?"	5%	88%	4%	2%	0%	0%	100%
		% within total ABSTRACTION (Binned)	100%	100%	100%	100%	100%	100%	100%
		% of Total	5%	88%	4%	2%	0%	0%	100%

- Table 32 shows the cross relationships between small farmers (legal and illegal) who paid only cash for the farm investment and the crop water needs. The highlighted section in green of Table 32 indicates that the total number of small farmers in the eight basins who paid their farm investment in cash is 251 representing 91 % of the total small farmers. The highlighted area of the table also shows that the overwhelming majority of those farmers (93%) use less than 50,000 CM.

Table 32: CROSS TABULATION RESULTS OF 275 SURVEYED FARMERS (LEGAL AND ILLEGAL) WHO PAID IN CASH FOR THEIR FARM INVESTMENT, HAVE A SMALL FARM, AND THEIR CROP WATER NEEDS. (WATER ABSTRACTION IS AS SELF-REPORTED)

	Type of Finance	Tested variable	Total ABSTRACTION						Total
			Zero	0 - 50K	51 - 75K	76 - 100 K	101 125 K	<= HIGH	
Source of finance- In cash	Not Self-finance in cash	# of farms	1	19	1	3	0	0	24
		% within "What was your source of finance?"- Self-finance in cash	4%	79%	4%	13%	0%	0%	100%
		% within total abstraction (Binned)	8%	8%	8%	43%	0%	0%	9%
		% of Total	0%	7%	0%	1%	0%	0%	9%
	Self-finance in cash	# of farms	11	223	11	4	1	1	251
		% within . "What was your source of finance? - Self-finance in cash"	4%	89%	4%	2%	0%	0%	100%
		% within total abstraction (Binned)	92%	92%	92%	57%	100%	100%	91%
		% of Total	4%	81%	4%	1%	0%	0%	91%
Total		# of farms	12	242	12	7	1	1	275
		% within "What was your source of finance? - Self-finance in cash"	4%	88%	4%	3%	0%	0%	100%
		% within total abstraction (Binned)	100%	100%	100%	100%	100%	100%	100%
		% of Total	4%	88%	4%	3%	0%	0%	100%

- Table 33 shows the cross relationships between shallow wells (legal and illegal) that do not provide enough water and their farm income proportion. The table shows that there are 54 shallow wells in the 8 basins. Eighteen (18) farmers stated that the quantity of abstract water is enough while the remaining 35 said the contrary. The table also shows that 14 farmers representing 26% of the farmers who said that the water is not enough, fall within the category of farmers whose their farming income proportion to the total income is less than 20%.

Table 33: Cross tabulation results between shallow wells (legal and illegal) that do not provide versus farm income proportion

Are the water quantities enough	Answer	. Farming income as proportion of total Income				Total
		<20%	20% - 50%	51% - 80%	81% - 100%	
	Yes	7	5	0	6	18
	No	14	9	3	9	35
Total		21	14	3	15	53

- Table 34 shows that 1077 farmers (legal and illegal) in the 8 basins employ between one and five non Jordanian laborers at an overall average of 3 laborers per farm. Table 35 on the other hand shows that out of the 1077 farmers employing non Jordanians, only 46 farmers representing 4% of the total farmers having foreign labor exceeding 1 worker per 5 irrigated du. Generally, Labor Ministry allows 1 non Jordanian laborer per 5 du

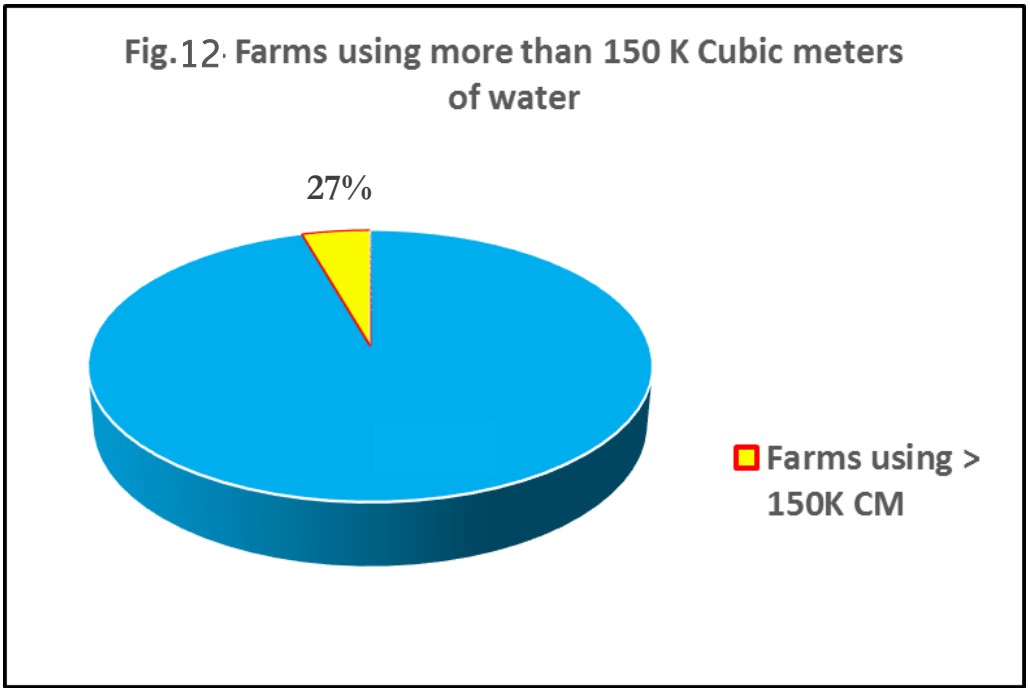
Table 34: Farmers (legal and illegal) employing non Jordanian labor in the 8 basins

	N	Minimum	Maximum	Sum
Non JOR Labor	1077	1	5	3151
Labor Ratio	1085	0	3750	91004.47

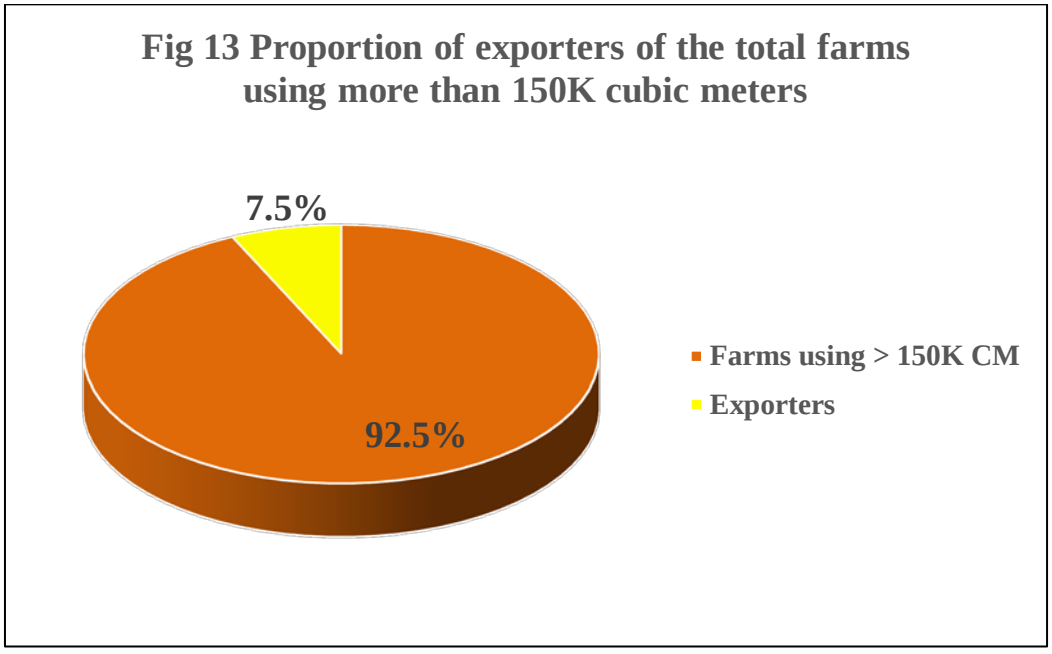
Table 35: Farmers (legal and illegal) with foreign labor exceeding 1 worker per 5 irrigated du

	N	Minimum	Maximum	Sum
Area Du	46	0.02	25	356.17
Non JOR Labor	46	1	5	110
Labor Ratio	46	0.01	5	146

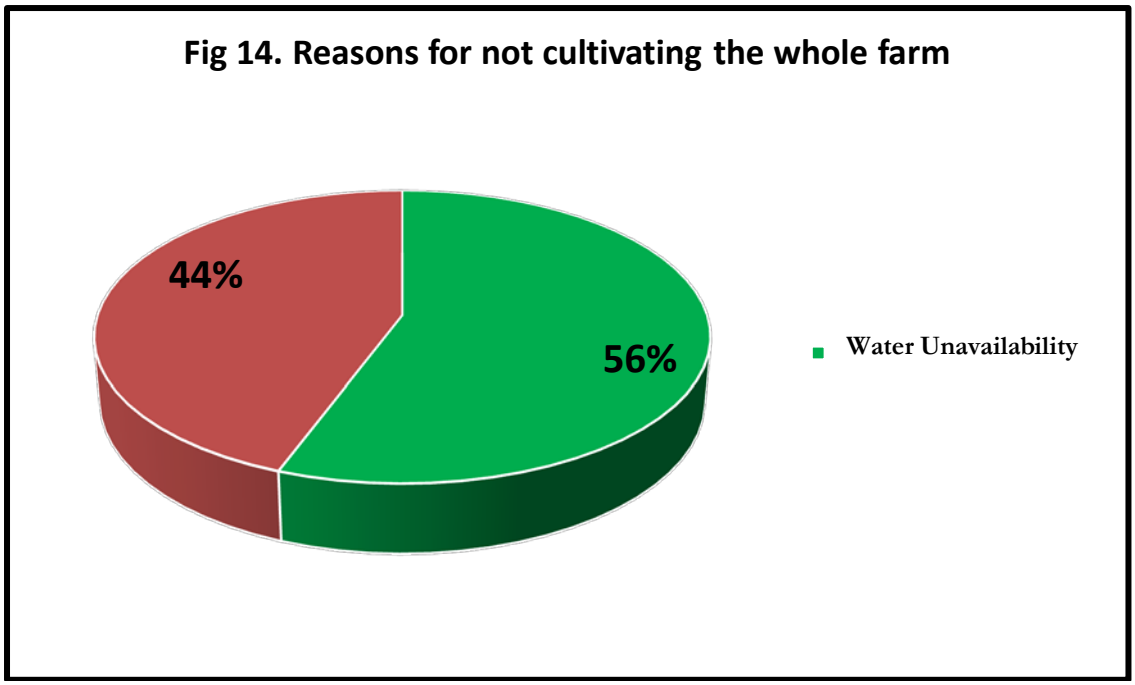
- Data shows that only 335 out of 1240 respondents claim that they use more than 150 thousand cubic meters based on the crop water requirement representing 27% (Figure 12) of the total number of visited farms.



- As indicated in Figure 13, the percentage of big farms that only export their products and use more than 150,000 M^3 is 7.5%.

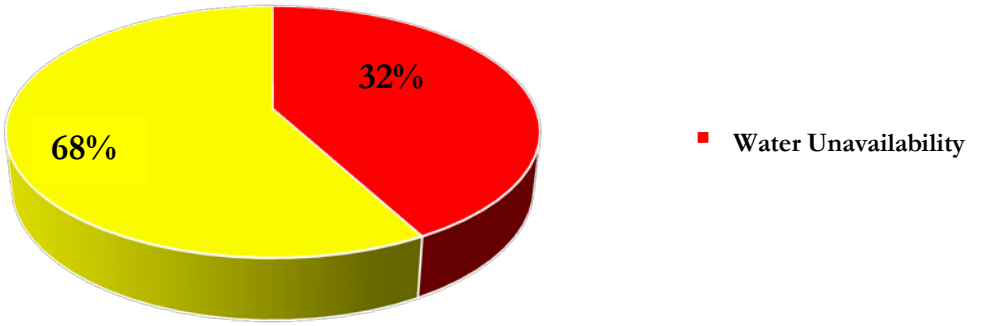


- 738 farmers responded to the question: "If the rest of the land is fallow, mention the reason". As indicted in Figure 14, 44% of the respondents claim that "Water availability" is the reason for not cultivating all of their land.



- Figure 15 shows the proportion of large farmers consuming more than 150 thousand cubic meters (based on the crop water requirement) and do not fully cultivate their farms because of water unavailability. A total of 102 farms out of the 321 large farmers responded to this question where 32% stated that they do not cultivate the whole farm area because of insufficient water.

Fig 15 Proportion of large framers consuming >150K CM and do not fully cultivate their farms because of water availability



- Table 36 shows the cross tabulation results between cultivating high water demand crops and complaints of water shortage. The table shows that of the 311 sampled farmers cultivating olive trees (high water demand crop), 168 farmers representing 54% of farmers cultivating olive trees complained about water shortage.

Table 36: FARMERS CULTIVATE CROPS THAT DEMAND LARGE AMOUNT OF WATER AND COMPLAINED THAT WATER IS NOT ENOUGH

			Crop type Olive		Total
			Not Olives	Olives	
If the rest of the land is fallow , mention the reason - Water availability	Not Water Availability	#of Respondents	243	168	411
		% within If the rest of the land is fallow the reason"Water availability "	59%	41%	100%
		% within Crop type Olives	57%	54%	56%
		% of Total	33%	23%	56%
	Water Availability	#of Respondents	184	143	327
		% within"If the rest of the land is fallow" the reason"Water availability"	56%	44%	100%
		% within Crop type Olives	43%	46%	44%
		% of Total	25%	19%	44%
Total		#of Respondents	427	311	738
		% within "If the rest of the land is fallow" the reason"Water availability"	58%	42%	100%
		% within Crop type Olives	100%	100%	100%
		% of Total	58%	42%	100%

- Table 37 shows the cross tabulation result between big farms planning to expand the farm area, have one well and complained that water is not enough. A total of 79 big farms are planning to expand the farm area in the future. The table shows that there are 39 big farms that own one well and 25 farms, representing 64% of the total large farms, with one well stated that they are planning to expand but the water is not enough.

Table 37: LARGE FARMS PLANNING TO EXPAND THE FARM AREA, HAVE ONE WELL AND COMPLAINED THAT WATER IS NOT ENOUGH.

			. If the rest of the land is fallow , the reason is - Water availability		
			Not Water availability	Water availability	Total
NUMBER OF WELL. Number of Well	1	Count	14	25	39
		% within NUMBER OF WELL. Number of Well	36%	64%	100%
		% within "If the rest of the land is fallow the reason - Water availability"	74%	83%	80%
		% of Total	29%	51%	80%
	2	Count	4	3	7
		% within NUMBER OF WELL. Number of Well	57%	43%	100%
		% within . "If the rest of the land is fallow the reason - Water availability"	21%	10%	14%
		% of Total	8%	6%	14%
	3	Count	1	2	3
		% within NUMBER OF WELL. Number of Well	33%	67%	100%
		% within . "If the rest of the land is fallow the reason - Water availability"	5%	7%	6%
		% of Total	2%	4%	6%
Total		Count	19	30	49
		% within NUMBER OF WELL. Number of Well	39%	61%	100%
		% within . "If the rest of the land is fallow the reason - Water availability"	100%	100%	100%
		% of Total	39%	61%	100%

- Table 38 shows the cross tabulation result between farmers claiming that they leave the rest of the land fallow because of the "water availability" and they do sell water at the same time. The results show that 32 well owners do sell water out of the 737 respondents to this question. Of the 32 well owners, 9 farmers claim that they leave part of their land fallow because water is not enough.

Table 38: FARMERS CLAIMING THAT THEY DO NOT HAVE ENOUGH WATER AND THEY SELL WATER

			Do you sell water		Total
			Yes	No	
If the rest of the land is fallow , mention the reason - Water availability	Not Water availability	Count	23	388	411
		% within"If the rest of the land is fallow, the reason Water availability"	6%	94%	100%
		% within Do you.sell water	72%	55%	56%
		% of Total	3%	53%	56%
	Water availability	Count	9	317	326
		% within"If the rest of the land is fallow, the reason Water availability"	3%	97%	100%
		% within"Do you sell water"	28%	45%	44%
		% of Total	1%	43%	44%
Total		Count	32	705	737
		% within"If the rest of the land is fallow, the reason Water availability"	4%	96%	100%
		% within"Do you sell water"	100%	100%	100%
		% of Total	4%	96%	100%

8 Appendix I:Azraq Basin

8.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 333 respondents in the Al Azraq Basin out of the visited 361 farms. Figure 2 indicates that the size of the average managed area of almost one half of the interviewed farms is less than 50 du. The Figure also shows that the medium farm size represents 31 percent and the large farms represent 21% of the total surveyed farms.

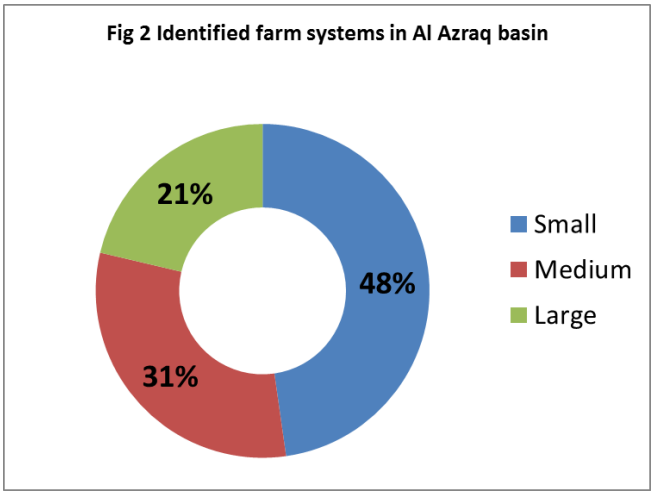


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Amman/Zarqa) basin

Water Basin	Al-Azraq				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	%of farm size within the groundwater basin	%of the farm size within all basins	%of Total sum of farms in all basins	Number of farms in all basins	%of farm size within all basins	%of the farm size in all basins	%of Total sum of farms in all basins
<= 50.00	159	48%	40%	13%	396	31%	100%	31%
50.01 - 100.00	54	16%	24%	4%	227	18%	100%	18%
100.01 - 150.00	28	8%	20%	2%	143	11%	100%	11%
150.01 - 200.00	21	6%	17%	2%	122	10%	100%	10%
200.01 - 250.00	15	5%	22%	1%	67	5%	100%	5%
250.01 - 300.00	9	3%	12%	1%	74	6%	100%	6%
300.01 - 350.00	7	2%	21%	1%	34	3%	100%	3%
350.01 - 400.00	7	2%	14%	1%	49	4%	100%	4%
400.01 - 450.00	6	2%	19%	0%	32	3%	100%	3%
450.01 - 500.00	4	1%	15%	0%	26	2%	100%	2%
500.01 - 600.00	5	2%	24%	0%	21	2%	100%	2%
600.01 - 700.00	2	1%	13%	0%	16	1%	100%	1%
700.01 - 800.00	6	2%	30%	0%	20	2%	100%	2%
800.01 - 900.00	2	1%	40%	0%	5	0%	100%	0%
900.01 - 1000.00	0	0%	0%	0%	7	1%	100%	1%
1000.01+	8	2%	26%	1%	31	2%	100%	2%
	333	100%	26%	26%	1270	100%	100%	100%

8.2 DESCRIPTION OF FARMING SYSTEMS

8.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the three identified farm sizes.

- **Farming system I (small size holdings):** the majority of the managers are older than 46 years of age (59%), their level of education is high school or less (73%), there are only 3 female managers, about one-fourth of the managers are non-Jordanians (mainly Egyptians), 65% of these farms have no family members living on-farm and only one-fourth rely heavily on farming income.
- **Farming system II (medium size holdings):** 90% of the managers are older than 31 years, the level of education of 71% is Tawjihi or less, no female farm manager, non-Jordanian managers represents close to one fourth (22%), the majority of these farms support on average 1-5 family members, and about one fourth of the owners rely heavily on farming income.
- **Farming system III (large size holdings):** 93% of the managers are older than 31 years, the level of education of 59% is Tawjihi or less, no female farm managers, almost one-fourth of the managers are non-Jordanian, 95% of these farms support on average 1-5 family members, and 58% of the owners rely heavily on farming income.

Concluding remarks: The analysis of the socioeconomic characteristics of the three clusters in Al Azraq Basin indicates that as the farm size increases, the farms in this basin tend to be more agribusiness oriented, support more family members and higher reliance on the farming income while smaller farms tend to be more as hobby farms.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the three identified farming systems in Azraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	**103 Farms (31%)**	**71 Farms (21%)**
Age	• 10% < 30 year • 31% 31-45 year • 39% 46 – 60 year • 20% > 60	• 10% < 30 year • 34% 31-45 year • 36% 46 – 60 year • 20% > 60	• 7% < 30 year • 34% 31-45 year • 36% 46 – 60 year • 23% > 60
Education	• 47% < Tawjihi • 26% Tawjihi • 25% University • 2% > University	• 45% < Tawjihi • 26% Tawjihi • 28% University • 1% > University	• 45% < High school • 14% High school • 27% college • 14% > college
Gender	• 156 males • 3 females	• 103 males • 0 female	• 71 males • 0 female
Nationality	• 123 Jordanian • 33 Egyptian • 3 Syrian	• 81 Jordanian • 21 Egyptian • 1 Syrian	• 55 Jordanian • 14 Egyptian • 2 Palestinian
Number of family members supported	• 79% support 3-5 • 21% support less than 3	• 94% support 1-5 • 06% support none	• 31% support 1-5 • 64% support >5 • 5 % support None
Farming income proportion	• 26% > 80% of total income • 23% 20-80% of T. income • 51% < 20% of T. income	• 23% > 80% of total income • 25% 20-80% of T. income • 52% < 20% of T. income	• 58% > 80% of total income • 20% 20-80% of T. income • 22% < 20% of T. income

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	**103 Farms (31%)**	**71 Farms (21%)**
Number of family members live on the farm	• 65% No one • 19% 1-5 • 16% 3-5	• 61% No one • 20% 1-5 • 19% 3-5	• 65 % No one • 18% 1-5 • 17% >5

8.2.2 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the three identified clusters of farms in Al Azraq basin. Table 3 shows the frequency distributions of the related indicators for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** more than 75% of the farms were owned before the year 2002, 46% of the farms managed by licensed owners, only 9% of the farms' wells are shallow, all of the wells were installed after 1960, the well capacity of 82% of the farms is less than 30 CM/hr, the level of salinity of 38% of the wells is less than 1000, the depth of 82% of the wells was less than 30 meters when installed, the total annual abstraction of the 159 farms under this farm system is estimated at 1.401 million CM, and the average annual abstraction is 12.2 thousand CM/well;
- **Farming system II (medium size holdings):** more than 78% of the farms were owned before the year 2002, 38% of the farms managed by licensed owners while 58% are managed by operators, 98% of the farms' wells are artesian, only 1% of the wells were installed before 1960, the well's capacity of 75% of the farms is the range of 11-50 CM/hr, the level of salinity of 49% of the wells is less than 1000, the depth of the wells when installed at 85% of the farms was more than 30 meters, the total annual abstraction under this farm system is estimated at 2.5 million CM, and the average annual abstraction is 30.6 thousand CM/well;
- **Farming system III (large size holdings):** The majority of the farms (86%) were owned before the year 2002, 58% of the farms managed by licensed owners while 42% are managed by operators, 94% of the farms' wells are artesian, only 1% of the wells were installed before 1960, the well's capacity of 24% of the farms is more than 50 CM/hr, the level of salinity of 48% of the wells is less than 1000, the depth of the wells at the time of installment for 81% of the wells was in the range of 31-150, the total annual abstraction at the farms under this farm system is estimated at 2.6 MCM, and the average annual abstraction is 46.3 thousand CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the three identified clusters of farms indicates that as the farm size increases, dependence on artesian wells expands, the majority of the farms are managed by operators, the capacity of the well increases, the depth of the wells also increases and ultimately the volume of abstraction increases. This conclusion supports the remark of the previous section that as the size of the farm increases, farms in Al Azraq and Amman Zarqa basins tends to be more agribusiness oriented, support more family members and exhibit higher reliance on farming income.
- According to the completed questionnaires, the total annual abstraction of water by the three farm systems amounts to 6.434 million cubic meters. This amount of water was used by 331 farmers to irrigate a sum of 61,117 du of which 48,978 is allocated for fruit trees and the remaining 12,140 du for vegetables and annual crops. This means that the average volume of water used per du is 105 CM.

Table 3 Frequency distribution of the farm and well characteristics for the three identified farming systems in Azraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	103 Farms (31%)	71 Farms (20%)
Years of ownership of the well/Farm	• 25% < 10 year • 52% 11-25 year • 11% 26 – 40 year • 12% > 40	• 22 % < 10 year • 41% 11-25 year • 25% 26 – 40 year • 12% > 40	• 16 % < 10 year • 52 % 26 – 40 year • 13% 26 – 40 year • 19% > 40
Farm Operator Status	• 46% License owner • 2% Renter • 52% Operator	• 38% License owner • 4 % Renter • 58 % Operator	• 42% License owner • 0 % Renter • 58 % Operator
Type of the wells	• 9% Shallow • 89% Artesian • 1% Don't know	• 2 % Shallow • 98% Artesian	• 6 % Shallow • 94% Artesian
Year of well installation	• 0% before 1960 • 40% 1960-1990 • 60% after 1990	• 1% before 1960 • 51% 1960-1990 • 48% after 1990	• 4 % before 1960 • 54% 1960-1990 • 42% after 1990
Well capacity (m3/hr)	• 20% Less than 10 • 62% 11-30 • 13% 31-50 • 5% more than 50	• 6 % Less than 10 • 47 % 11-30 • 28% 31-50 • 19% more than 50	• 2 % Less than 10 • 32 % 11-30 • 42% 31-50 • 24% more than 50
Level of water salinity once installed (EC)	• 19% <= 500 • 19% 501 - 1000 • 21% 1001 – 1500 • 41% > 1500	• 23% <= 500 • 26% 501 - 1000 • 27% 1001 – 1500 • 24% > 1500	• 20 % <= 500 • 28 % 501 - 1000 • 22 % 1001 – 1500 • 30 % > 1500
Well depth when installed (m)	• 50% <= 30 • 32% 30-50 • 16% 50 - 150 • 2% >150	• 15% <= 30 • 77% 31 - 150 • 08% >150	• 9 % <= 30 • 81% 31 - 150 • 2 % >150
Total Abstraction CM	• 1,401,270	• 2,449,370	• 2,589,149
Average Abstraction CM/Farm	• 12,185	• 30,617	• 46,235

8.2.3 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Al Azraq basin. The total cultivated area reported by the 331 respondents is 61,117 du of which 48,978 is allocated for fruit trees and the remaining 12,140 du for vegetables and annual crops. This section deals with the analysis of the dominant cropping pattern prevailing at the three identified clusters of farms in this basin. Table 4 shows the distribution of the cultivated area among different crops for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** the dominant cultivated tree is olive for both pickling and for pressing purposes. 85% of the total farm area is cultivated with olive trees of which 63% is devoted for pickling and 22% for pressing. Other cultivated fruit trees are grape and pears which jointly form 4% of the farm size. The rest of the farm is devoted to alfalfa and corn.
- **Farming system II (medium size holdings):** As in the case of farming system I, the dominant cultivated tree is also olive for both pickling and for pressing purposes. However, the share of olive trees here is slightly lower at 67% of the total farm area of which 47% is devoted for pickling and 20% for pressing. Area devoted to grapes is 8% and 2% for pears. The rest of the farm is devoted to field crops and vegetables. Alfalfa is the dominant annual

crop occupying 11% of the farm size. The remaining area is devoted to tomato and cantaloupe.

- **Farming system III (large size holdings):** The dominant cropping pattern in this cluster is a similar to the previous two systems. The dominant cultivated tree is also olive for both pickling and for pressing purposes. The devoted area for olive trees is 64% of the total farm area of which 41% is for pickling and 24% for pressing. Area devoted to grapes, pears and palm is 12%. The rest of the farm is devoted to alfalfa (10%) barley (3%), and 2% for wheat.

Concluding remarks: The analysis of the cropping pattern characteristics of the three identified clusters of farms indicates that as the farm size increases, the allocated area for olive production slightly decreases. Large farms tend to diversify crops production especially grapes which is high-value product. This conclusion supports the remark in the previous two sections that as the farm size increases, farms become more business oriented.

Table 4 Dominant cropping patterns for the three identified farming systems in Azraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	**103 Farms (31%)**	**71 Farms (21%)**
Main fruit trees (% of the total cultivated area in du)	• 63% Olive • 22% Olive for pressing • 3% Grape • 1% Pears	• 47% Olive • 20% Olive for pressing • 8 % Grape • 2 % Pears	• 41% Olive • 24% Olive for pressing • 7 % Grape • 3 % Palm • 2% Pears • 1% Pomegranate
Main vegetables and field crops (% of the total cultivated area in du)	• 4% Alfalfa • 2% Corn	• 11 % Alfalfa • 2 % Cantaloupe • 2% Tomato	• 10 % Alfalfa • 3 % Barley • 2 % Wheat • 1% tomato

8.2.4 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the three identified clusters of farms. Table 5 shows the results of the analysis for the three farm categories. The table shows the following:

- **Farming system I (small size holdings):** The total amount of investment in the 159 farms is 7.5 million JD of which 98% are investments by the well owners and the remaining 2% are invested by the renters. The average investment per farm is 70 thousand JD. The sum of the annual total operational cost for all farms of this category is 133 thousand JD while the

average operational cost per du is 97 JD. The average gross margin per du for this cluster is 106 JD; As in the case of the other basins, there is a huge variance in the operational costs among the 159 farmers.

- **Farming system II (medium size holdings):** The total amount of investment in the 103 medium size farms is 8.7 million JD of which 96% are investments by the well owners and the remaining 4% are invested by the renters. The average investment per farm is 91.5 thousand JD. The sum of the annual total operational cost for all farms of this category is 3.2 million JD while the average operational cost per du is 271 JD. The average gross margin per du for this cluster is 133 JD. It should be noted here that most of the financial indicators for system 2 are higher than those of system 1.
- **Farming system III (large size holdings):** The total amount of investment in the 71 large size farms is 15.6 million JD all are investments by the well owners since there are no renters in this farming system in Al Azraq basin. The average investment per farm is 255.3 thousand JD. The sum of the annual total operational cost for all farms of this category is 12.7 million JD while the average operational cost per du is 275 JD. The average gross margin per du for this cluster is 167 JD;

Concluding remarks:

Figure 3 shows comparison between the main three financial parameters used in the financial analysis. The figure shows that as the farm size increases, the operational costs per du increases and the gross margin increases too. These results are actually in line with the economy of scale principles that says the larger farmers should be more efficient and their gross margins should be also higher, up to a certain level.

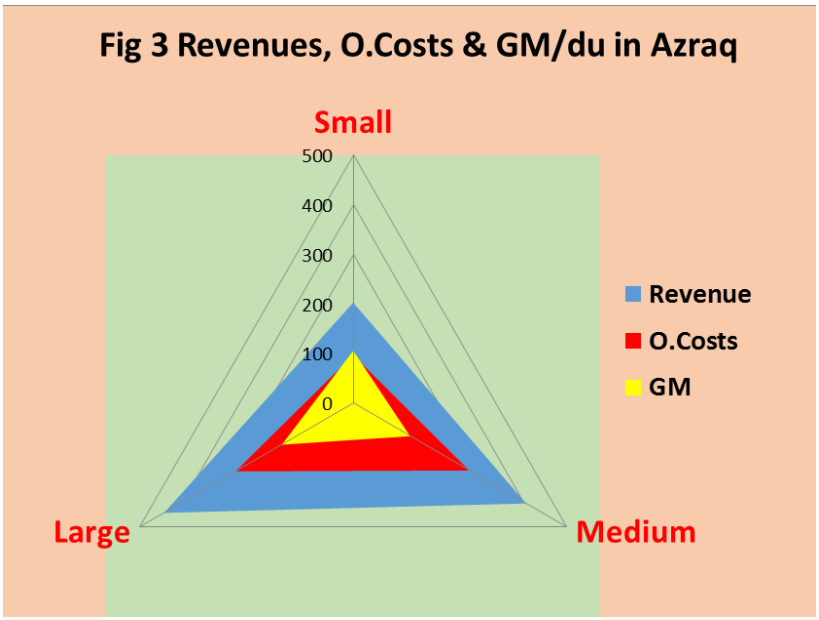


Table 5 Main Financial Indicators for the three identified farming systems in Azraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	103 Farms (31%)	71 Farms (21%)

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	103 Farms (31%)	71 Farms (21%)
Total Investment Costs in JD – Wells' Owners and Renters	• 7,484,385	• 8,636,030	• 15,569,850
Total Investment Costs in JD – Wells' Owners	• 7,396,485	• 8,321,530	• 15,569,850
Total Investment Costs in JD – Wells' Renters	• 87,900	• 314,500	• 0
Average Investment Costs in JD/Farm	• 69,918	• 91,446	• 255,243
Total Operational Costs in JD	• 132,753	• 3,163,001	• 12,652,223
Average Operational Costs in JD/du	• 97	• 271	• 275
Total Revenues in JDs for all farms	• 276,986	• 4,706,386	• 20,329,291
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for all farms	• 144,206	• 1,548,495	• 7,677,068
Average Gross Margin in JD/du for all farms	• 106	• 133	• 167

8.2.5 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the three farming systems. The table shows the following:

- **Farming system I (small size holdings):** The total number of hired labor of both permanent and daily categories in the 159 farms amounted to 52,584 work days/year. The farms under this system hire both Jordanians and non-Jordanians. The hired permanent laborers include both males and females. Permanent females represent 13% of the total permanent labor. Average monthly wage to Jordanian permanent labor is 199 JD while the paid wage for non-Jordanian is 223 JD. The majority of permanent laborers (more than 78%) are non-Jordanian. The total number of hired daily labor under this is system amounted to 884 of which 13% are females.. However, the daily wage of females (Jordanians and non-Jordanians) is lower by more than 40% of wage paid to males.
- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 103 farms amounted to 58,531 work days/year. The farms under this system hire both Jordanians and non-Jordanians. Hired permanent laborers included both males and females. Average monthly wage for Jordanian labor is 243 JD while the paid wage for non-Jordanian is 288 JD. The majority of permanent labor are non-Jordanians (72%). The number of hired female daily labor is about one-fourth of the total hired daily labor. However, the female daily wage is lower by 66% from that of male labor.

- **Farming system III (large size holdings):** The total number of hired labor of both permanent and daily categories in the 71 farms amounted to 95,129 work days/year. The farms under this system hire both Jordanians and non-Jordanians. However, non-Jordanian permanent labor represents the majority (82%). The overwhelming majority of the hired permanent laborers are males. Average monthly wage paid to Jordanian labor is 295 JD while the paid wage for non-Jordanian is 281 JD. About 25% of the total numbers of daily laborers are females. However, their daily wage is lower by 30% of what is paid to males;

Concluding remarks:

- The majority of the permanent laborers are males (both Jordanians and non-Jordanians). The three framing systems rely heavily on non-Jordanian daily labor, however system 1 employs more of permanent labor compared to the other two systems.
- Wages paid to non-Jordanian laborers are higher than what is paid to Jordanians.
- Female daily wage is lower than male wage across the three farming systems.

Table 6 Main labor and Gender Indicators for the three identified farming systems in Azraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	103 Farms (31%)	71 Farms (21%)
Permanent Jordanian (laborers No.) • **Male** • **Female**	 • 57 • 9	 • 50 • 7	 • 42 • 4
Wages of Permanent Jordanian (JD/Month) • **Male** • **Female**	 • 199 • N/A	 • 243 • N/A	 • 295 • N/A
Permanent Non-Jordanian (laborers No.) • **Male** • **Female**	 • 103 • 0	 • 130 • 0	 • 190 • 0
Wages of Permanent Non-Jordanian (JD/Month) • **Male** • **Female**	 • 223 • N/A	 • 288 • N/A	 • 281 • N/A
Daily Jordanian laborers (No.) • **Male**	 • 171	 • 277	 • 306

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	103 Farms (31%)	71 Farms (21%)
• Female	• 93	• 125	• 189
Wages of Daily Jordanian (JD/day) • Male • Female	 • 10 • 6.0	 • 12 • 4.14	 • 11 • 5.5
Daily Non-Jordanian laborers (No.) • Male • Female	 • 713 • 22	 • 891 • 12	 • 562 • 62
Daily wage of Non-Jordanian (JD/day) • Male • Female	 • 15 • 4.4	 • 15.5 • 6.0	 • 12.22 • 8.86
Total number of working days /year	• 52,584	• 58,531	• 95,129

8.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

According to the completed questionnaires, the total annual abstraction of water by the three farm systems amounts to 6.434 million cubic meters. This amount of water was used by 333 farmers to irrigate a sum of 61,067 du of which 48,978 is allocated for fruit trees and the remaining 12,140 du for vegetables and annual crops. This means that the average volume of water used per du is 105 cubic meters. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 333 farms that completed the questionnaire distributed by clusters. The table also shows the crop water requirement per du in Azraq basin as estimated by the MOA (due to the unavailability of the crop water requirement for some of the crops, the researcher used the minimum water requirement for the same or similar crops cultivated in other basins in the uplands). As estimated in the table, the total amount of water required to irrigate the sum of the 61,067 du cultivated by the 333 farms is 44 million cubic meters which exceeds the total amounts of water reported by the farmers in the questionnaire by more than seven times.

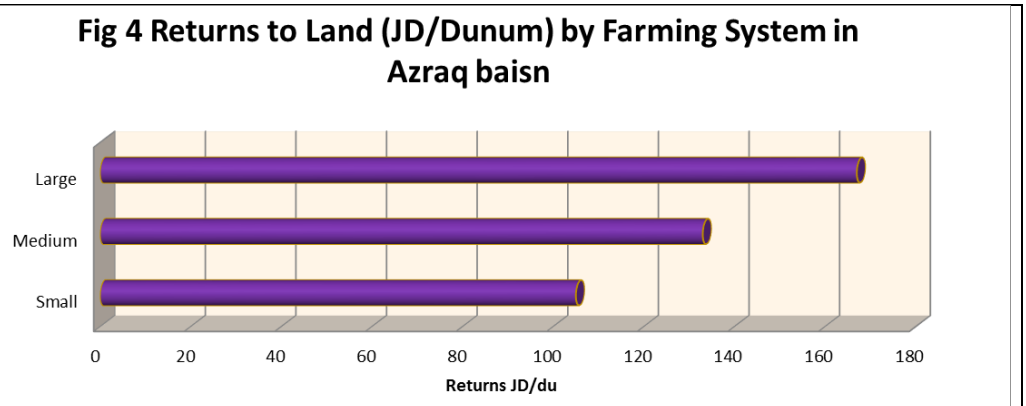
Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Azraq basin

Main cultivated crop	Area by Cluster			Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Small	Medium	Large			
Olive	2211	5465	18740	26,416	790	20,868,798
Olive for pressing	758	2310	10994	14,062	790	11,108,980
Alfalfa	145	1237	4762	6,144	780	4,791,930
Grape	113	947	3234	4,294	370	1,588,595
Arecaceae (Palm)	86	241	1461	1,788	900	1,608,750
Barley			1315	1,315	570	749,550
Wheat		50	1125	1,175	650	763,750
Pear	20	205	726	951	480	456,480
Corn	65	100	675	840	264	221,760
Pomegranate	16	163	651	830	450	373,500
Tomato		235	585	820	560	459,200
Cantaloupe		255	350	605	500	302,500
Eggplant		47	449	496	575	285,200
Watermelon		160	170	330	500	165,000
Pistachio	20	10	135	165	480	79,200
Apricot	6	21	136	163	480	78,240
Cauliflower			100	100	380	38,000
Cactus		85		85	100	8,500
Broad bean			80	80	444	35,520
Lemon			80	80	480	38,400
Crops can not identified	16	50		66	400	26,400
Peach	1	11	36	48	480	23,040
Decoration trees	6	40		46	400	18,400
Beans			40	40	228	9,120
Cautery			40	40	100	4,000
Almonds		7	30	37	480	17,760
Apple	6		20	26	180	4,680
Onion		25		25	600	15,000
Lettuce	10			10	300	-
Total	**3,477**	**11,664**	**45,934**	**61,076**		**44,140,253**

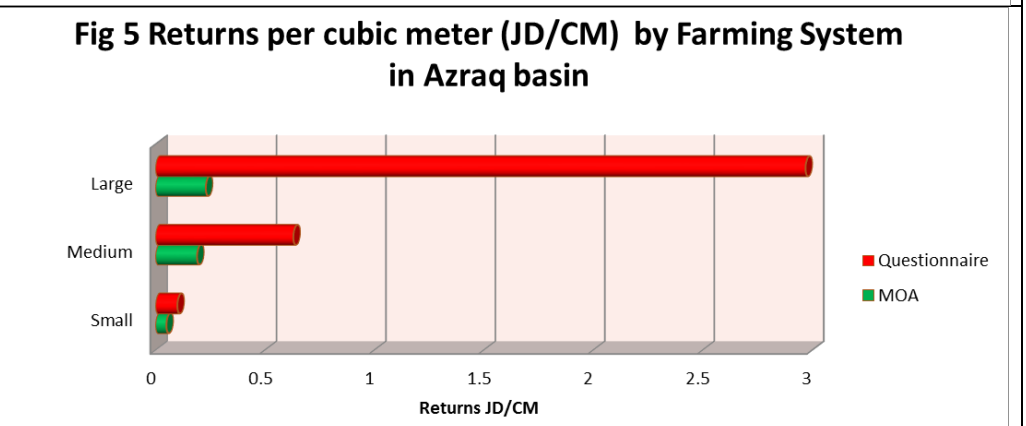
8.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the three farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

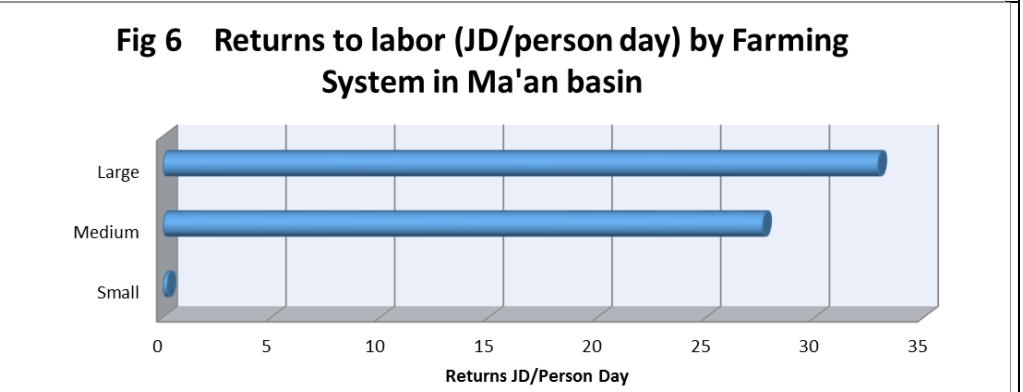
Farming system I is the most efficient in terms of returns to land resource.



Farming system III (large farms) is the most efficient in terms of economic water use efficiency .



Farming system II (medium farms) is the most efficient in terms of economic returns to labor.



Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, the average return per cubic meter of water in the highlands ranged between 0.48 – 0.05 JD for fruit trees while it ranged between 1.33-0.33 for vegetables. It is clear from the above Figure 5 that the estimated return to water indicator for the three farming systems falls within the ranges estimated by the water valuation study.

Table 7 Main economic efficiency indicators for the three identified farming systems in Azraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	159 Farms (48%)	103 Farms (31%)	71 Farms (21%)
• Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)	105	133	167
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)	0.10	0.63	2.97
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water requirement as per MOA in CM)	0.05	0.19	0.23
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	2.6	21	80

9 Appendix II: Mafraq Basin

9.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 298 respondents in the Al Mafraq Basin out of the visited 301 farms. Figure 2 indicates that almost one-half of the surveyed farms in Al Mafraq are of the size of 50-200 du (System II). The Figure also shows that the small farm size (System 1) represents only 9% while the large farms represent 43% of the total surveyed farms.

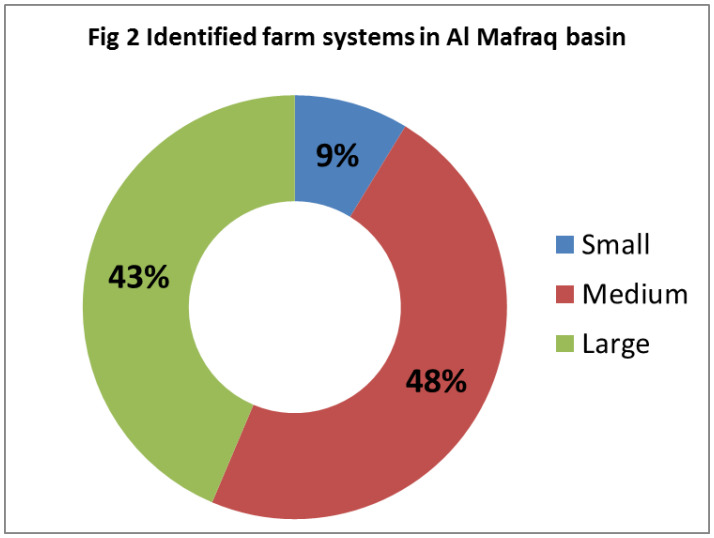


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Mafraq) basin

Water Basin	Al-Mafraq				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	% of farm size within the groundwater basin	% of the farm size within all basins	% of Total sum of farms in all basins	Number of farms in all basins	% of farm size within all basins	% of the farm size in all basins	% of Total sum of farms in all basins
<= 50.00	26	9%	7%	2%	396	31%	100%	31%
50.01 - 100.00	51	17%	22%	4%	227	18%	100%	18%
100.01 - 150.00	42	14%	29%	3%	143	11%	100%	11%
150.01 - 200.00	49	16%	40%	4%	122	10%	100%	10%
200.01 - 250.00	21	7%	31%	2%	67	5%	100%	5%
250.01 - 300.00	25	8%	34%	2%	74	6%	100%	6%
300.01 - 350.00	13	4%	38%	1%	34	3%	100%	3%
350.01 - 400.00	20	7%	41%	2%	49	4%	100%	4%
400.01 - 450.00	15	5%	47%	1%	32	3%	100%	3%
450.01 - 500.00	9	3%	35%	1%	26	2%	100%	2%
500.01 - 600.00	7	2%	33%	1%	21	2%	100%	2%
600.01 - 700.00	7	2%	44%	1%	16	1%	100%	1%
700.01 - 800.00	5	2%	25%	0%	20	2%	100%	2%
800.01 - 900.00	2	1%	40%	0%	5	0%	100%	0%
900.01 - 1000.00	0	0%	0%	0%	7	1%	100%	1%
1000.01+	6	2%	19%	0%	31	2%	100%	2%
Total	298	100%	23%	23%	1270	100%	100%	100%

9.2 DESCRIPTION OF FARMING SYSTEMS

9.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the three identified farm sizes.

- **Farming system I (small size holdings):** the majority of the farm managers are older than 46 years of age (77%), their level of education is high school or more (61%), there are no female managers, only two of the 26 farm managers are non-Jordanians (an Egyptian and a Pakistani), 39% of these farms have no family members living on-farm and more than one-half (56%) of the farmers rely heavily on farming income.
- **Farming system II (medium size holdings):** 89% of the farm managers are older than 31 years, the level of education of 71% is Tawjihi or less, no female farm manager, non-Jordanian managers represents 10%, the overwhelming majority of these farms (94%) support on average 1-5 family members, and more than two thirds (72%) of the owners rely heavily on farming income.
- **Farming system III (large size holdings):** 92% of the managers are older than 31 years, the level of education of 56% of them is Tawjihi or less, there is one female farm manager, almost one-fifth (21%) of the managers are non-Jordanian (mainly Egyptians), 90% of these farms support on average 1-5 family members, and 75% of the owners rely heavily on farming income.

Concluding remarks: As in the case of Amman Al-Zarqa and Al Azraq basins, the analysis of the socioeconomic characteristics of the three clusters in Al Mafraq Basin indicates that as the farm size increases, the farms in this basin tend to be more agribusiness oriented, support more family members and higher reliance on the farming income while smaller farms tend to be more as hobby farms. Only one female manager is found in the whole basin managing a farm of system III. The age of the farm managers of farming system I tends to be higher than the other two systems which might be an indication that much of the small farms are hobby farms.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the three identified farming systems in Mafraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	26 Farms (9%)	142 Farms (43%)	157 Farms (48%)
Age	• 11% < 30 year • 31% 31-45 year • 35% 46 – 60 year • 23% > 60	• 11% < 30 year • 44% 31-45 year • 31% 46 – 60 year • 14% > 60	• 8% < 30 year • 52% 31-45 year • 27% 46 – 60 year • 13% > 60
Education	• 39% < Tawjihi • 29% Tawjihi • 20% University • 2% > University	• 51% < Tawjihi • 20% Tawjihi • 25% University • 4% > University	• 34% < Tawjihi • 22% Tawjihi • 38% University • 6% > University
Gender	• 26 males • 0 females	• 142 males • 0 female	• 156 males • 1 female
Nationality	• 24 Jordanian • 1 Egyptian • 1 Pakistani	• 128 Jordanian • 12 Egyptian • 1 Palestinian • 1 Sudanese	• 124 Jordanian • 27 Egyptian • 3 Palestinian • 2 Syrian • 1 Pakistani
Number of family members supported	• 77% support 3-5 • 23% support less than 3	• 76% > 5 • 18% support 1-5 • 06% support none	• 31% support 1-5 • 59% support >5 • 10 % support None
Farming income proportion	• 56% > 80% of total income • 28% 20-80% of T. income • 16% < 20% of T. income	• 72% > 80% of total income • 20% 20-80% of T. income • 8% < 20% of T. income	• 74% > 80% of total income • 18% 20-80% of T. income • 8% < 20% of T. income
Number of family members live on the farm	• 39% No one • 7% 1-5 • 54% > 5	• 47% No one • 16% 1-5 • 37% >5	• 63 % No one • 12% 1-5 • 25% >5

9.2.2 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the three identified clusters of farms in Al Mafarq basin. Table 3 shows the frequency distributions of the related indicators for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** All of the farms of this system were owned before the year 2002, 58% of the farms are managed by licensed owners, 88% of the farms' wells are artesian, all of the wells were installed after 1960 of which 52% were installed during the period 1960-90, the well capacity of 64% of the farms is less than 30 CM/hr, the level of salinity of 82% of the wells is less than 1000, the depth of 72% of the wells is more than 150 meters when installed, the total annual abstraction of the 26 farms under this farm system is estimated at 389 thousand CM, and the average annual abstraction is 17.7 thousand CM/well;
- **Farming system II (medium size holdings):** more than 68% of the farms were owned before the year 2002, 32% of the farms managed by licensed owners while 44% are managed by operators, 91% of the farms' wells are artesian, all wells were installed after 1960, the well's capacity of 55% of the farms is in the range of 11-50 CM/hr, the level of salinity of 92% of the wells is less than 1000, the depth of the wells when installed at 92% of the farms was more than 150 meters, the total annual abstraction under this farm system is estimated at 8.7 million CM, and the average annual abstraction of the 142 farms is 63.6 thousand CM/well;
- **Farming system III (large size holdings):** The majority of the farms (72%) were owned before the year 2002, 32% of the farms managed by licensed owners while 55% are managed by operators, 90% of the farms' wells are artesian, all of the wells were installed after 1960, the well's capacity of 90% of the farms is more than 30 CM/hr, the level of salinity of 87% of the wells is less than 1000, the depth of the wells at the time of installment for 99% of the wells was greater than 150m, the total annual abstraction at the farms under this farm system is estimated at 11.1 million CM, and the average annual abstraction is 75.8 thousand CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the three identified clusters of farms indicates that as the farm size increases, dependence on artesian wells expands, the majority of the farms are managed by operators, the capacity of the well increases, the depth of the wells also increases and ultimately the volume of abstraction increases. This conclusion supports the remark of the previous section that as the size of the farm increases, farms in Al Azraq, Amman Zarqa and Mafraq basins tend to be more agribusiness oriented, support more family members and exhibit higher reliance on farming income.
- According to the completed questionnaires, the total annual abstraction of water by the three farm systems amounts to 20.240 million cubic meters. This amount of water was used by 298 farmers to irrigate a sum of 81,941 du of which 66,161is allocated for fruit trees and the remaining 15,780 du for vegetables and annual crops. This means that the average volume of water used per du is 247 cubic meters. However, studies on crop water requirement in the desert areas shows that the average water requirement per du of fruit trees is 307 cubic meter and 471 cubic meters for vegetables. Some studies on the Yarmouk basin estimated the water crop requirement for olives at 600 CM/du. If the lower bound crop water requirement is used, then the actual amount of water to irrigate the cultivated area in Al Mafraq basin is 27.7 million cubic meters which way lower than reported by the respondents.
- Water salinity of the overwhelming majority of the wells under the 3 farming system is lower than 1000.

Table 3 Frequency distribution of the farm and well characteristics for the three identified farming systems in Mafraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	26 Farms (9%)	142 Farms (43%)	157 Farms (48%)
Years of ownership of the well/Farm	• 0% < 10 year • 43% 11-25 year • 43% 26 – 40 year • 14% > 40	• 32 % < 10 year • 29% 11-25 year • 29% 26 – 40 year • 10% > 40	• 28 % < 10 year • 35% 11-25 year • 31% 26 – 40 year • 6% > 40
Farm Operator Status	• 58% License owner • 8% Renter • 34% Operator	• 32% License owner • 24 % Renter • 44 % Operator	• 32% License owner • 13 % Renter • 55% Operator
Type of the wells	• 0% Shallow • 88% Artesian • 12% Don't know	• 1% Shallow • 91% Artesian • 8% Don't know	• 0% Shallow • 90% Artesian • 10 % Don't know
Year of well installation	• 0% before 1960 • 52% 1960-1990 • 43% 1991- 2000 • 5% after 2001	• 0% before 1960 • 51% 1960-1990 • 49% after 1990	• 0 % before 1960 • 49% 1960-1990 • 51% after 1990
Well capacity (m3/hr)	• 24% Less than 10 • 40% 11-30 • 28% 31-50 • 8% more than 50	• 7 % Less than 10 • 13 % 11-30 • 42% 31-50 • 38% more than 50	• 1 % Less than 10 • 9 % 11-30 • 30 % 31-50 • 42 % 51-70 • 18 % more than 70
Level of water salinity once installed (EC)	• 46% <= 500 • 38% 501 - 1000 • 8% 1001 – 1500 • 8% > 1500	• 55% <= 500 • 39% 501 - 1000 • 4% 1001 – 1500 • 2% > 1500	• 45 % <= 500 • 42 % 501 - 1000 • 8 % 1001 – 1500 • 5 % > 1500
Well depth when installed (m)	• 0% <= 30 • 0% 30-50 • 28% 50 - 150 • 72% >150	• 1% <= 30 • 7% 31 - 150 • 92% >150	• 0 % <= 30 • 1 % 31 - 150 • 99 % >150
Total Abstraction CM	• 389,281	• 8,710,320	• 11,140,530
Average Abstraction CM/Farm	• 17,695	• 63,578.	• 75,785

9.2.3 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Al Mafraq basin. The total cultivated area reported by the 298 respondents is 81,941 du of which 66,161 du are allocated for trees and the remaining 12,140 du for vegetables and annual crops. This section deals with the analysis of the dominant cropping pattern prevailing at the three identified clusters of farms in this basin. Table 4 shows the distribution of the cultivated area among different crops for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** the dominant cultivated tree is olive for both pickling and for pressing purposes. 50% of the total farm area is cultivated with olive trees of which 42% is devoted for pickling and 8% for pressing. Other cultivated fruit trees include

grape 7% and peach 2% of the farms size. The rest of the farm is devoted to tomato at 11%, cauliflower at 6% , eggplant 4%, zucchini 4%, and cabbage 4%.;

- **Farming system II (medium size holdings):** The allocated land for olive trees is much lower than system 1. The dominant crop in this system is tomato at 28% followed by olive trees for pickling at 19% of the total area. The third dominant crop is peach that occupies 14% of the area. The rest of the farm is devoted to other vegetables crops and fruit trees.
- **Farming system III (large size holdings):** The dominant cropping pattern in this cluster of large farms is olive trees which occupies around one-half of the total area. The other fruit trees include peach, nectarine, apricot and grape. The dominant vegetable crop is tomato at 6% of the total cultivate area under this system.

Concluding remarks: The analysis of the cropping pattern characteristics of the three identified clusters of farms indicates that olive is still the dominant tree in this basin especially in systems 1 and III. However, in relative terms olive trees are less important in Al Mafraq. The dominant fruit trees following olive are peach, nectarine, grape and apricots. Fruits produced in this basin are considered export-oriented products of high quality and high value.

Table 4 Dominant cropping patterns for the three identified farming systems in Mafraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	26 Farms (9%)	142 Farms (43%)	157 Farms (48%)
Main fruit trees (% of the total cultivated area in du)	• 42% Olive • 8% Olive for pressing • 7% Grape • 2% Peach	• 19% Olive • 14% Peach • 5% Apricots • 5% Olive for pressing • 4% Nectarine • 3% Grape	• 33% Olive • 15% Peach • 14% Olive for pressing • 7 % Nectarine • 6 % Apricot • 5% Peach (cake) • 4% Grape
Main vegetables and field crops (% of the total cultivated area in du)	• 11% Tomato • 6% Cauliflower • 4% Eggplants • 4% Zucchini • 4% Cabbage	• 28% Tomato • 4 % Watermelon • 2% Eggplants • 2% Cauliflower • 2% Capsicum • 2% Cabbage • 6% others	• 6 % Tomato • 1 % Cauliflower • 1 % Spinach • 1 % Cabbage • 4 % others

9.2.4 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the three identified clusters of farms. Table 5 shows the results of the analysis for the three farm categories. The table shows the following:

- **Farming system I (small size holdings):** The total amount of investment in the 26 farms is 2.8 million JD of which 96% are investments by the well owners and the remaining 4% are invested by the renters. The average investment per farm is 119 thousand JD. The sum of the annual total operational costs for all farms of this category is 204 thousand JD while the average operational costs per du is 149 JD. The average gross margin per du for this cluster is 410 JD. As in the case of the other basins, there is a variance in the operational costs among the 26 farmers.

- **Farming system II (medium size holdings):** The total amount of investment in the 142 medium size farms is 16.6 million JD of which 65% are investments by the well owners and the remaining 35% are invested by the renters. The investment by the renters is the highest among the three different farming systems. The average investment per farm is 173 thousand JD. The sum of the annual total operational cost for all farms of this category is 9.7 million JD while the average operational cost per du is 518 JD. The average gross margin per du for this cluster is 235 JD. It should be noted here that most of the financial indicators for system 2 are higher than those of system 1 especially the operational costs. This could be mainly due to growing high value crops that requires higher investments and running costs too.
- **Farming system III (large size holdings):** The total amount of investment in the 157 large size farms is 40.4 million JD of which 6% of the investments are by renters. The average investment per farm is 364 thousand JD. The sum of the annual total operational cost for all farms of this category is 39.6 million JD while the average operational cost per du is 589 JD. The average gross margin per du for this cluster is 306 JD. All financial indicators in this farming system are higher than those in the previous two systems.

Concluding remarks:

The total invested capital in Al Mafraq basin is estimated at 60 million JD while the annual total operational costs amounted to 50 million JD. Figure 3 shows comparison between the main three financial parameters used in the financial analysis. The figure shows that as the farm size increases, the operational costs per du increases and the gross margin increases too. These results are actually in line with the economy of scale principles that says the larger farmers should be more efficient and their gross margins should be also higher, up to a certain level.

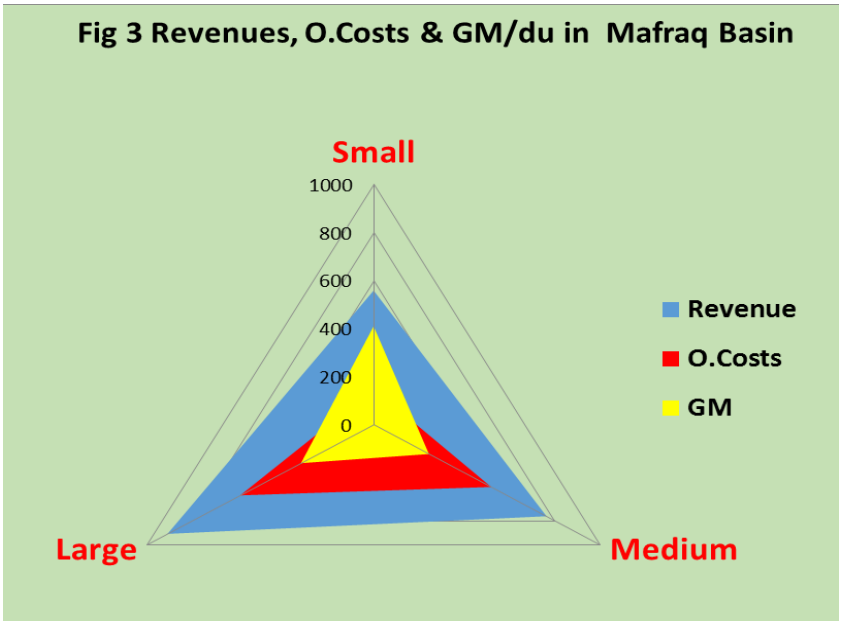


Table 5 Main Financial Indicators for the three identified farming systems in Mafraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	26 Farms (9%)	142 Farms (43%)	157 Farms (48%)
Total Investment Costs in JD – Wells' Owners and Renters	• 2,738,850	• 16,650,525	• 40,403,950

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	26 Farms (9%)	**142 Farms (43%)**	**157 Farms (48%)**
Total Investment Costs in JD – Wells' Owners	• 2,623,850	10,759,250	• 37,693,525
Total Investment Costs in JD – Wells' Renters	• 115,000	• 5,891,275	• 2,710,425
Average Investment Costs in JD/Farm	• 119,080	• 173,443	• 364,000
Total Operational Costs in JD	• 203,493	• 9,740,028	• 39,644,859
Average Operational Costs in JD/du	• 149	• 518	• 589
Total Revenues in JDs for all farms	• 763,447	• 14,321,724	• 61,242,226
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for all farms	• 559,953	• 4,411,799	• 20,652,108
Average Gross Margin in JD/du for all farms	• 410	• 235	• 306

9.2.5 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the three farming systems. The table concludes the following:

- **Farming system I (small size holdings):** The total number of hired labor of both permanent and daily categories in the 26 farms amounted to 25,404 work days/year. The farms under this system hire both Jordanians and non-Jordanians. The hired permanent laborers include both males and females. Permanent females represent about one-fourth of the total permanent labor. Average monthly wage to Jordanian permanent labor is 212 JD while the paid wage for non-Jordanian is 259 JD. More than one-half of the permanent labor is non-Jordanian. The total number of hired daily labor under this system amounted to 76 laborers of which 11% are females. However, the daily wage of females (Jordanians and non-Jordanians) under this farming system is almost equal to wages paid to males.
- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 142 farms amounted to 377,328 work days/year. The farms under this system hire also both Jordanians and non-Jordanians. Hired permanent laborers included both males and females. Female permanent labor represents more than one-fourth of the total permanent labor. Average monthly wage for Jordanian labor is 243 JD while the paid wage for non-Jordanian is 247 JD. The majority of permanent labor are non-Jordanians (56%). The number of hired female daily labor represents 38% of total hired daily labor. However, the wage paid to Jordanian female daily laborers is lower by 66% of that of Jordanian male labor. However, the wage paid to non-Jordanian female labor is almost three times of the Jordanian females.
- **Farming system III (large size holdings):** The total number of hired labor of both permanent and daily categories in the 157 farms amounted to 647,817 work days/year. The farms under this system hire both Jordanians and non-Jordanians. However, non-Jordanian permanent labor represents the majority (71%). The overwhelming majority of the hired permanent laborers are males. Average monthly wage paid to Jordanian labor is 290 JD while the paid wage for non-Jordanian is 253 JD. About 34% of the total numbers of daily laborers are females. Female daily wage under this system is very close to wages paid to males.

Concluding remarks:

- The majority of the permanent laborers are males (both Jordanians and non-Jordanians). The three framing systems rely heavily on non-Jordanian daily labor, however system 3 employs more of permanent labor compared to the other two systems.
- Wages paid to daily non-Jordanian female and male laborers are higher than what is paid to Jordanians.
- In general, the female daily wage is lower than male wage across the three farming systems.

Table 6 Main labor and Gender Indicators for the three identified farming systems in Mafraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	26 Farms (9%)	142 Farms (43%)	157 Farms (48%)
Permanent Jordanian (laborers No.)			
• **Male**	• 27	• 283	• 393
• **Female**	• 8	• 115	• 28
Wages of Permanent Jordanian (JD/Month)			
• **Male**	• 212	• 243	• 290
• **Female**	• N/A	• N/A	• N/A
Permanent Non-Jordanian (laborers No.)			
• **Male**	• 41	• 512	• 1034
• **Female**	• 0	• 0	• 0
Wages of Permanent Non-Jordanian (JD/Month)			
• **Male**	• 259	• 247	• 253
• **Female**	• N/A	• N/A	• N/A
Daily Jordanian laborers (No.)			
• **Male**	• 64	• 1,199	• 2,105
• **Female**	• 59	• 819	• 1,315
Wages of Daily Jordanian (JD/day)			
• **Male**	• 7.8	• 9.2	• 7.4
• **Female**	• 8.0	• 3.9	• 4.95
Daily Non-Jordanian laborers (No.)			
• **Male**	• 97	• 1,002	• 1,402
• **Female**	• 0	• 538	• 523
Daily wage of Non-Jordanian (JD/day)			
• **Male**	• 10	• 10.7	• 9.5
• **Female**	• 0	• 9.4	• 8.9
Total number of working days /year	• 25,404	• 377,328	• 647,817

9.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

According to the completed questionnaires, the total annual abstraction of water by the 298 farms of the three farm clusters amounted to 20,240,131 cubic meters. This amount of water was used by only 298 farms in the basin to irrigate a sum of 87,342 du. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 298 farms that completed the questionnaire distributed by clusters. The table also shows the crop water requirement per du in Mafraq basin as estimated by the MOA (due to the unavailability of the crop water requirement for some of the crops, the researcher used the minimum water requirement for the same or similar crops cultivated in other basins in the uplands). As estimated in the table, the total amount of water required to irrigate the sum of the 87,342 du cultivated by the 298 farms is 52.9 million cubic meters which exceeds the total amounts of water reported by the farmers in the questionnaire by more than two and half times.

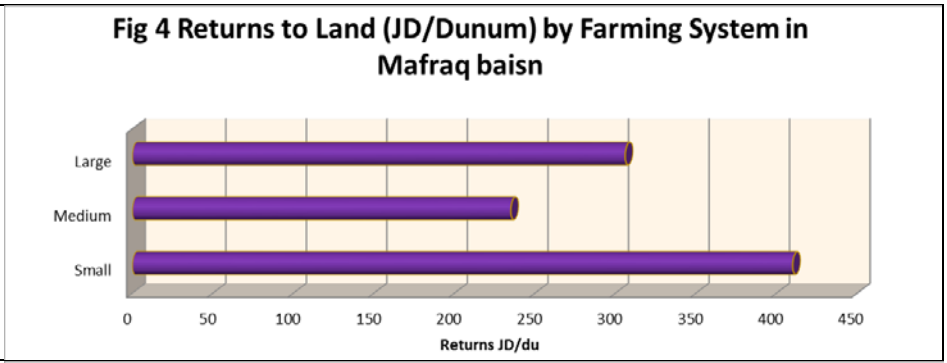
Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Mafraq basin

Main cultivated crop	Area by Cluster			Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Small	Medium	Large			
Olive	449	3647	22258	26,354	700	18,447,800
Peach	20	2715	9812	12,547	515	6,461,705
Olive for pressing	82	990	9640	10,712	700	7,498,400
Tomato	114	5251	4293	9,658	750	7,243,500
Nectarine		800	4776	5,576	515	2,871,640
Apricot		1010	4110	5,120	515	2,636,800
Peach (cake-like)		235	3285	3,520	515	1,812,800
Grape	80	620	2628	3,328	425	1,414,400
Cauliflower	67	366	907	1,340	400	535,800
Watermelon		719	230	949	530	502,970
Stone Fruits		50	760	810	515	417,150
Cabbage	42	310	450	802	450	360,900
Eggplant	48	387	275	710	575	408,250
Spinach		150	535	685	208	142,480
Capsicum	20	337	228	585	526	307,710
Apple			535	535	515	275,525
Alfalfa			500	500	780	390,000
Pear		35	348	383	515	197,245
Crops can not identified			328	328	300	98,400
Corn	1	178	140	319	200	63,800
Pomegranate		145	161	306	400	122,400
Parsley	1	101	153	255	200	51,000
Blubank			250	250	156	39,000
Cantaloupe		165	67	232	520	120,640
Lettuce	7	50	112	169	200	33,800
Plum		35	125	160	515	82,400
Rucola		50	100	150	208	31,200
Rhodes			125	125	500	62,500
Other veg and Fruits	138	487	309	934	200	186,800
	1,069	**18,833**	**67,439**	**87,342**		**52,817,015**

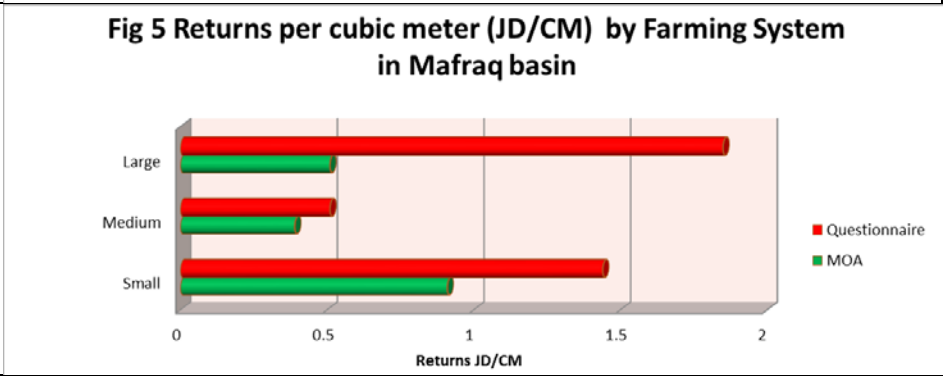
9.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the three farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

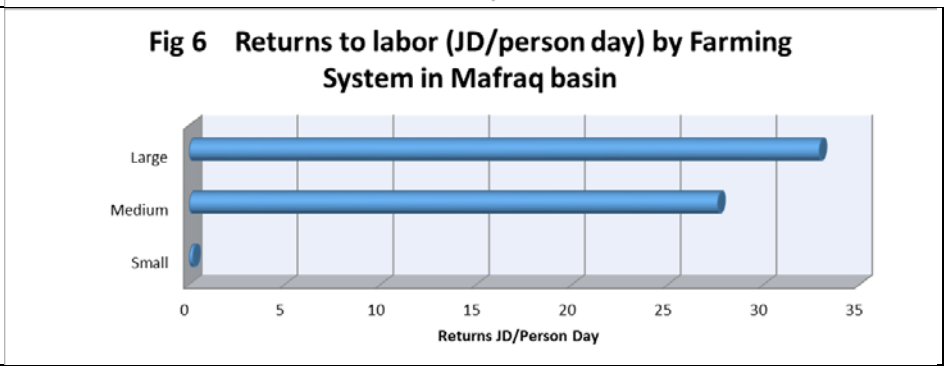
Farming system I is the most efficient in terms of returns to land resource.



Farming system III (large farms) is the most efficient in terms of economic water use efficiency. However, when actual water requirements are used, small farms becomes the most efficient.



Farming system III (large farms) is the most efficient in terms of economic returns to labor.



Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, the average return per cubic meter of water in the highlands ranged between 0.48 – 0.05 JD for fruit trees while it ranged between 1.33-0.33 for vegetables. It is clear from the above Figure 5 and table 8 that the estimated return to water indicator for farming systems I and III are higher than the ranges estimated by the water valuation study while the returns to water for farming system II falls within the range of the study. However, when actual crop water requirements are used (MOA figures), the returns per cubic meter of water decrease dramatically.

Table 8 Main economic efficiency indicators for the three identified farming systems in Mafraq basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	26 Farms (9%)	142 Farms (43%)	157 Farms (48%)
• Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)	410	235	306
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)	1.44	0.51	1.85
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water requirement as per MOA in CM)	0.91	0.39	0.51
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	22	11.7	31.9

10 Appendix III: Amman-Zarqa Basin

10.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 178 respondents in the Amman Zarqa Basin out of the visited 191 farms. Figure 2 indicates that the size of the average managed area of one half of the interviewed farms is less than 50 du. The Figure also shows that the medium farm size represents 32 percent and the large farms represent 20% of the total surveyed farms.

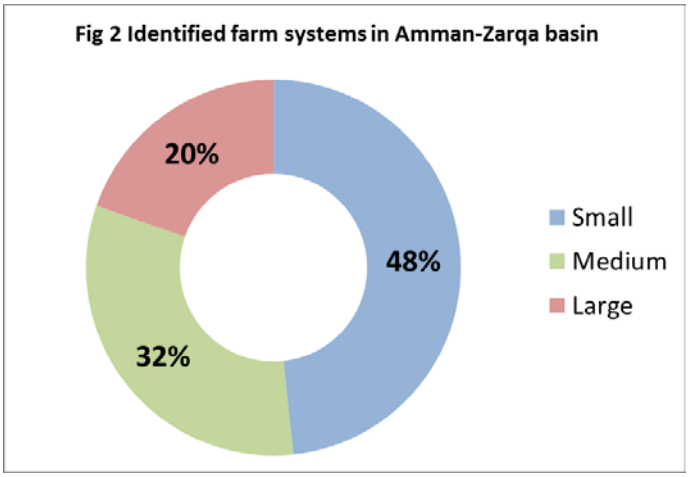


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Amman/Zarqa) basin

Water Basin	Amman/Zarqa				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	% of farm size within the groundwater basin	% of the farm size within all basins	% of Total sum of farms in all basins	Number of farms in all basins	% of farm size within all basins	% of the farm size in all basins	% of Total sum of farms in all basins
<= 50.00	86	48%	22%	7%	396	31%	100%	31%
50.01 - 100.00	31	17%	14%	2%	227	18%	100%	18%
100.01 - 150.00	15	8%	10%	1%	143	11%	100%	11%
150.01 - 200.00	11	6%	9%	1%	122	10%	100%	10%
200.01 - 250.00	3	2%	4%	0%	67	5%	100%	5%
250.01 - 300.00	9	5%	12%	1%	74	6%	100%	6%
300.01 - 350.00	3	2%	9%	0%	34	3%	100%	3%
350.01 - 400.00	3	2%	6%	0%	49	4%	100%	4%
400.01 - 450.00	3	2%	9%	0%	32	3%	100%	3%
450.01 - 500.00	4	2%	15%	0%	26	2%	100%	2%
500.01 - 600.00	1	1%	5%	0%	21	2%	100%	2%
600.01 - 700.00	1	1%	6%	0%	16	1%	100%	1%
700.01 - 800.00	3	2%	15%	0%	20	2%	100%	2%
800.01 - 900.00	0	0%	0%	0%	5	0%	100%	0%
900.01 - 1000.00	0	0%	0%	0%	7	1%	100%	1%
1000.01+	5	3%	16%	0%	31	2%	100%	2%
	178	100%	14%	14%	**1270**	**100%**	**100%**	**100%**

10.2 DESCRIPTION OF FARMING SYSTEMS

10.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the three identified farm sizes.

- **Farming system I (small size holdings):** the majority of the managers are older than 46 years of age (90%), their level of education is high school or less (72%), no female managers, less than 1% of the managers are non-Jordanians, 60% of these farms have no family members living on-farm and only one-third rely heavily on farming income.
- **Farming system II (medium size holdings):** 96% of the managers are older than 31 years, the level of education of 72% is Tawjihi or less, only one female farm manager, more non-Jordanian managers (8%), the majority of these farms support on average 3-5 family members, and about one half of the owners rely on farming income.
- **Farming system III (large size holdings):** 89% of the managers are older than 31 years, the level of education of 53% is Tawjihi or less, no female farm managers, almost one-fourth of the managers are non-Jordanian, 90% of these farms support on average 1-5 family members, and 70 of the owners rely on farming income.

Concluding remarks: The analysis of the socioeconomic characteristics of the three clusters indicates that as the farm size increases, the farms in AZ basin tend to be more agribusiness oriented, support more family members and higher reliance on the farming income while smaller farms tend to be more as hobby farms.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the three identified farming systems in AZ basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)
Age	• 10% < 30 year • 27% 31-45 year • 47% 46 – 60 year • 16% > 60	• 4% < 30 year • 31% 31-45 year • 37% 46 – 60 year • 28% > 60	• 11% < 30 year • 42% 31-45 year • 42% 46 – 60 year • 5% > 60
Education	• 48% < Tawjihi • 26% Tawjihi • 24% University • 2% > University	• 50% < Tawjihi • 23% Tawjihi • 26% University • 1% > University	• 32% < High school • 21% High school • 44% college • 3% > college
Gender	• 86 males	• 56 males • 1 female	• 38 males
Nationality	• 84 Jordanian • 2 Egyptian	• 53 Jordanian • 4 Egyptian	• 31 Jordanian • 7 Egyptian
Number of family members supported	• 79% support 3-5 • 21% support less than 3	• 80% support 3-5 • 20% support less than 3	• 90% support 1-5 • 10% support None
Farming income proportion	• 37% > 80% of total income • 23% 20-80% of T. income • 40% < 20% of T. income	• 48% > 80% of total income • 40% 20-80% of T. income • 12% < 20% of T. income	• 70% > 80% of total income • 14% 20-80% of T. income • 16% < 20% of T. income
Number of family members live on the farm	• 60% No one • 12% 1-5 • 28% 3-5	• 70% No one • 12% 1-5 • 18% 3-5	• 73% No one • 11% 1-5 • 16% 3-5

10.2.2 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the three identified clusters of farms in Amman Zarqa basin. Table 3 shows the frequency distributions of the related indicators for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** more than 75% of the farms were owned before the year 2002, less than one-half of the farms managed by licensed owners, more than one-third of the farms' wells are shallow, more than one-third of the wells were installed before 1960, the well capacity of more than two thirds of the farms is less than 30 CM/hr, the level of salinity of 58% of the wells is less than 1000, the depth of more than one half of the wells was less than 30 meters when installed, the total annual abstraction of the farms under this farm system is estimated at 1.027 million CM, and the average annual abstraction is 17.1 thousand CM/well;
- **Farming system II (medium size holdings):** more than 9% of the farms were owned before the year 2002, 35% of the farms managed by licensed owners while 60% are managed by operators, 97% of the farms' wells are artesian, only 10% of the wells were installed before 1960, the well's capacity of 64% of the farms is the range of 11-50 CM/hr, the level of salinity of 67% of the wells is less than 1000, the depth of the wells when installed at 87% of the farms was more than 30 meters, the total annual abstraction under this farm system is estimated at 2.014 million CM, and the average annual abstraction is 36700 CM/well;
- **Farming system III (large size holdings):** One half of the farms were owned before the year 2002, only 11% of the farms managed by licensed owners while 81% are managed by operators, 100% of the farms' wells are artesian, only 5% of the wells were installed before 1960, the well's capacity of 44% of the farms is more than 50 CM/hr, the level of salinity of 68% of the wells is less than 1000, the depth of the wells at the time of installment for 65% of the wells was more than 150 meters, the total annual abstraction at the farms under this farm system is estimated at 1.918 million CM, and the average annual abstraction is 53300 CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the three identified clusters of farms indicates that as the farm size increases, dependence on artesian wells expands, the majority of the farms are managed by operators, the capacity of the well increases, the depth of the wells also increases and ultimately the volume of abstraction increases. This conclusion supports the remark of the previous section that as the size of the farm increases, farms in AZ basin tend to be more agribusiness oriented, support more family members and exhibit higher reliance on farming income.
- As reported in the completed questionnaires, the total annual abstraction of water by the three farm systems amounts to 4.960 million cubic meters. This amount of water was used by 178 farmers to irrigate a sum of 27,964 du of which 20,113 in fruit trees and 7,851 in annual crops. This means that the average volume of water used per du is 177 cubic meters. However, studies on crop water requirement in the desert areas shows that the average water requirement per du of fruit trees is 307 cubic meter and 471 cubic meters for vegetables. Some studies on the Yarmouk basin estimated the water crop requirement for olives at 600 CM/du. If the lower bound crop water requirement is used, then the actual amount of water to irrigate the cultivated area in Amman Zarqa basin is 9.865 million cubic meters which is close to double the amount reported by the respondents.

Table 3 Frequency distribution of the farm and well characteristics for the three identified farming systems in AZ basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)
Years of ownership of the well/Farm	• 25% < 10 year • 26% 11-25 year • 37% 26 – 40 year • 12% > 40	• 5 % < 10 year • 37% 11-25 year • 47% 26 – 40 year • 11% > 40	• 50 % < 10 year • 33 % 26 – 40 year • 17% > 40
Farm Operator Status	• 41% License owner • 11% Renter • 48% Operator	• 35% License owner • 5 % Renter • 60 % Operator	• 11% License owner • 8 % Renter • 81 % Operator
Type of the wells	• 33% Shallow • 67% Artesian	• 7 % Shallow • 93% Artesian	• 100% Artesian
Year of well installation	• 36% before 1960 • 39% 1960-1990 • 35% after 1990	• 10% before 1960 • 62% 1960-1990 • 18% after 1990	• 6 % before 1960 • 57% 1960-1990 • 37% after 1990
Well capacity (m3/hr)	• 21% Less than 10 • 48% 11-30 • 20% 31-50 • 11% more than 50	• 9 % Less than 10 • 30 % 11-30 • 34% 31-50 • 27% more than 50	• 6 % Less than 10 • 22 % 11-30 • 28% 31-50 • 44% more than 50
Level of water salinity once installed (EC)	• 31% <= 500 • 27% 501 - 1000 • 17% 1001 – 1500 • 25% > 1500	• 30% <= 500 • 37% 501 - 1000 • 13% 1001 – 1500 • 20% > 1500	• 36% <= 500 • 32% 501 - 1000 • 16% 1001 – 1500 • 16% > 1500
Well depth when installed (m)	• 52% <= 30 • 28% 31 - 150 • 20% >150	• 13% <= 30 • 41% 31 - 150 • 46% >150	• 0 % <= 30 • 35% 31 - 150 • 65% >150
Total Abstraction CM	• 1,026,658	• 2,013,997	• 1,918,430
Average Abstraction CM/Farm	• 17,111	• 36,618	• 53,290

10.2.3 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Amman Zarqa basin. The total cultivated area reported by the 178 respondents is 27,964 du of which 20,113 is allocated for fruit trees and the remaining 7,851 du for annual crops. This section deals with the analysis of the dominant cropping pattern prevailing at the three identified clusters of farms in this basin. Table 4 shows the distribution of the cultivated area among different crops for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** the dominant cultivated tree is olive for both pickling and for pressing purposes. 35% of the total farm area is cultivated with olive trees of which 26% is devoted for pickling and 9% for pressing. Other cultivated fruit trees are grape and lemon which jointly form 5% of the farm size. The rest of the farm is devoted to vegetable crops. The dominant annual crops in descending order include cauliflower, alfalfa, barley, potato, tomato and eggplant;
- **Farming system II (medium size holdings):** As in the case of farming system I, the dominant cultivated tree is also olive for both pickling and for pressing purposes. However, the share of olive trees here is slightly higher at 39% of the total farm area of which 20% is devoted for pickling and 19% for pressing. Area devoted to peaches is only 3%. The rest of the farm is devoted to field crops and vegetables. Barley is the dominant annual crop occupying 18% of the farm size. The remaining area is devoted to vegetable crops which in descending order include cauliflower, tomato, alfalfa, cucumber, eggplant and zucchini;
- **Farming system III (large size holdings):** The dominant cropping pattern in this cluster is a bit different from the previous two. Although the dominant cultivated tree is olive for both pickling and for pressing purposes but its share is much higher. The devoted area for olive trees is 70% of the total farm area of which 49% is for pickling and 21% for pressing. Area devoted to peaches and apricots is only 5%. The rest of the farm is devoted to barley (2%), alfalfa (3%) and 20% for other vegetable crops.

Concluding remarks: The analysis of the cropping pattern characteristics of the three identified clusters of farms indicates that as the farm size increases, the allocated area for olive production increases. Large farms tend to be specialized in olive production while the smaller sizes farms tend have a more diverse cropping pattern. This conclusion supports the remark in the previous two sections that as the farm size increases, farms become more business oriented.

Table 4 Dominant cropping patterns for the three identified farming systems in AZ basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	**57 Farms (32%)**	**35 Farms (20%)**
Main ruit trees (% of the total cultivated area in du)	• 26% Olive • 9% Olive for pressing • 3% Grape • 2% Lemon	• 20% Olive • 19% Olive for pressing • 3 % Peach	• 49% Olive • 21% Olive for pressing • 3 % Apricot • 2 % Peach
Main vegetables and field crops (% of the total cultivated area in du)	• 9% Cauliflower • 7% Alfalfa • 6% Barley • 5% Potato • 4% Tomato	• 18% Barley • 8 % Cauliflower • 4% Tomato • 3 % Alfalfa • 2% Cucumber	• 2 % Barley • 3 % Alfalfa • 20% other vegetables

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)
	• 3% Eggplant	• 2% Eggplant • 2% Zucchini	

10.2.4 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the three identified clusters of farms. Table 5 shows the results of the analysis for the three farm categories. The table shows the following:

- **Farming system I (small size holdings):** The total amount of investment in the 86 farms is 5.3 million JD of which 96% are investments by the well owners and the remaining 4% are invested by the renters. The average investment per farm is 65.5 thousand JD. The sum of the annual total operational cost for all farms of this category is 321 thousand JD while the average operational cost per du is 218 JD. The average gross margin per du for this cluster is 176 JD;
- **Farming system II (medium size holdings):** The total amount of investment in the 27 medium size farms is 7.056 million JD of which 95% are investments by the well owners and the remaining 5% are invested by the renters. The average investment per farm is 96.3 thousand JD. The sum of the annual total operational cost for all farms of this category is 1.875 million JD while the average operational cost per du is 244 JD. The average gross margin per du for this cluster is 126 JD
- **Farming system III (large size holdings):** The total amount of investment in the 33 large size farms is 16.3 million JD of which 97% are investments by the well owners and the remaining 3% are invested by the renters. The average investment per farm is 430 thousand JD. The sum of the annual total operational cost for all farms of this category is 4.778 million JD while the average operational cost per du is 246 JD. The average gross margin per du for this cluster is 69 JD;

Concluding remarks:

Figure 3 shows comparison between the main three financial parameters used in the financial analysis. The figure shows that as the farm size increases, the operational costs per du increases and the gross margin decreases. If the reported data by large farmers is correct, then these results are actually against the economy of scale principles. According to economies of scale, the larger farmers should be more efficient and their gross margins should be also higher.

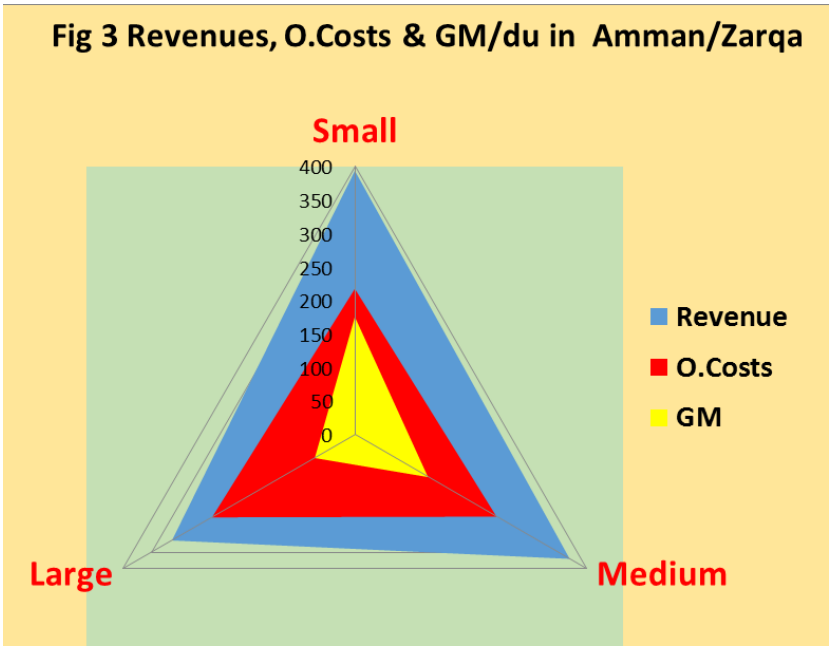


Table 5 Main Financial Indicators for the three identified farming systems in AZ basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)
Total Investment Costs in JD – Wells' Owners and Renters	• 5,299,600	• 7,056,050	• 16,328,100
Total Investment Costs in JD – Wells' Owners	• 5,125,600	• 6,687,550	• 15,898,100
Total Investment Costs in JD – Wells' Renters	• 174,000	• 368,500	• 430,000
Average Investment Costs in JD/Farm	• 65,427	• 96,273	• 429,687
Total Operational Costs in JD	• 321,036	• 1,874,595	• 4,778,223
Average Operational Costs in JD/du	• 218	• 244	• 246
Total Revenues in JDs for all farms	• 580,658	• 2,848,455	• 6,117,644
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for	• 259,622	• 973,860	• 1,339,421

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)
all farms			
Average Gross Margin in JD/du for all farms	• 176	• 126	• 69

10.2.5 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the three farming systems. The table shows the following:

- **Farming system I (small size holdings):** The total number of hired labor of both permanent and daily categories in the 86 farms amounted to 3,485 work days/year. The farms under this system hire both Jordanians and non-Jordanians. All of the hired permanent laborers are males. Average monthly wage to Jordanian labor is 241 JD while the paid wage for non-Jordanian is 249 JD. The majority of permanent laborers (more than 70%) are non-Jordanian. The number of hired female daily labor is higher than male labor. However, their daily wage is lower by 1.00 JD/day.
- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 57 farms amounted to 5,205 work days/year. The farms under this system hire both Jordanians and non-Jordanians. All of the hired permanent laborers are males. Average monthly wage for Jordanian labor is 227 JD while the paid wage for non-Jordanian is 249 JD. The majority of permanent labor are Jordanians. The number of hired female daily labor is lower than male labor. However, the female daily wage is lower by 50% from that of male labor.
- **Farming system III (large size holdings):** The total number of hired labor of both permanent and daily categories in the 33 farms amounted to 3,365 work days/year. The farms under this system hire both Jordanians and non-Jordanians. However, non-Jordanian permanent labor represents the majority. All of the hired permanent laborers are males. Average monthly wage paid to Jordanian labor is 304 JD while the paid wage for non-Jordanian is 292 JD. About 40% of the total numbers of daily laborers are females. However, their daily wage is lower by 30% of what is paid to males;

Concluding remarks:

- All permanent laborers are males (both Jordanians and non-Jordanians). Large farms rely heavily on non-Jordanian permanent labor compared to the other two systems.
- Female daily wage is lower than male wage across the three farming systems.

Table 6 Main labor and Gender Indicators for the three identified farming systems in AZ basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)
Permanent Jordanian (laborers No.) • **Male** • **Female**	 • 33 • 0	 • 226 • 0	 • 84 • 0
Wages of Permanent Jordanian (JD/Month) • **Male** • **Female**	 • 241 • N/A	 • 227 • N/A	 • 304 • N/A
Permanent Non-Jordanian (laborers No.) • **Male** • **Female**	 • 105 • 0	 • 166 • 0	 • 1169 • 0
Wages of Permanent Non- Jordanian (JD/Month) • **Male** • **Female**	 • 249 • N/A	 • 237 • N/A	 • 292 • N/A
Daily Jordanian laborers (No.) • **Male** • **Female**	 • 62 • 78	 • 232 • 126	 • 212 • 136
Wages of Daily Jordanian (JD/day) • **Male** • **Female**	 • 7.32 • 6.32	 • 8.28 • 3.41	 • 9.38 • 6.31
Daily Non-Jordanian laborers (No.) • **Male** • **Female**	 • 136 • 15	 • 237 • 85	 • 679 • 104
Daily wage of Non-Jordanian (JD/day) • **Male** • **Female**	 • 10.4 • 5	 • 10.11 • 5.30	 • 12.18 • 8.55
Total number of working days /year	• 3485	• 5205	• 3365

10.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

According to the completed questionnaires, the total annual abstraction of water by the 178 farms of the three farm clusters amounted to 4,959,085 cubic meters. This amount of water was used by only 178 farms in the basin to irrigate a sum of 28,564 du. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 178 farms that completed the questionnaire distributed by the three clusters. The table also shows the crop water requirement per du in Amman-Zarqa basin as estimated by the MOA (due to the unavailability of the crop water requirement for some of the crops, the researcher used the minimum water requirement for the same or similar crops cultivated in other basins in the uplands). As estimated in the table, the total amount of water required to irrigate the sum of the 28,564 du cultivated by the 178 farms is 17.5 million cubic meters which exceeds the total amounts of water reported by the farmers in the questionnaire by more than three times.

Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Amman-Zarqa basin

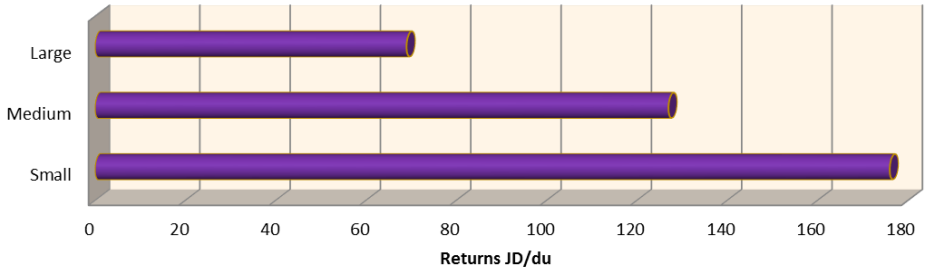
Main cultivated crop	Area by Cluster			Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Small	Medium	Large			
Olive	391	1507	9498	11,396	700	7,976,850
Olive for pressing	128	1493	4143	5,764	700	4,034,800
Barley	91	1351	313	1,755	570	1,000,065
Tomato	58	290	664	1,012	750	758,625
Cauliflower	136	604	170	910	400	364,000
Alfalfa	99	206	600	905	780	705,900
Peach	7	216	425	647	515	333,205
Apricot	9	41	555	605	515	311,318
Eggplant	38	158	175	371	575	213,325
Different Vegetables	30	50	260	340	450	153,000
Cucumber	7	172	150	329	293	96,397
Cabbage	10	77	240	327	450	147,150
Lemon	35	56	225	316	900	284,400
Fruite trees - Unsepcified			300	300	515	154,500
Potato	68	80	150	298	380	113,240
Corn	14	100	183	297	188	55,836
Watermelon		120	150	270	530	143,100
different Seedings types		130	130	260	515	133,900
Lettuce	14	68	140	222	208	46,176
Apple	2		200	202	515	103,773
Spinach	25	40	130	195	208	40,456
Cantaloupe		40	150	190	520	98,800
Zucchini	34	137		171	156	26,676
Wheat		94	40	134	650	86,775
Decoration trees		50	75	125	515	64,375
Beet	3	43	60	106	208	22,048
Parsley	12	20	70	102	208	21,216
Capsicum		90	5	95	332	31,540
Grape	44	42	5	91	425	-
Total	**1,253**	**7,273**	**19,206**	**27,732**		**17,521,445**

10.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the three farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

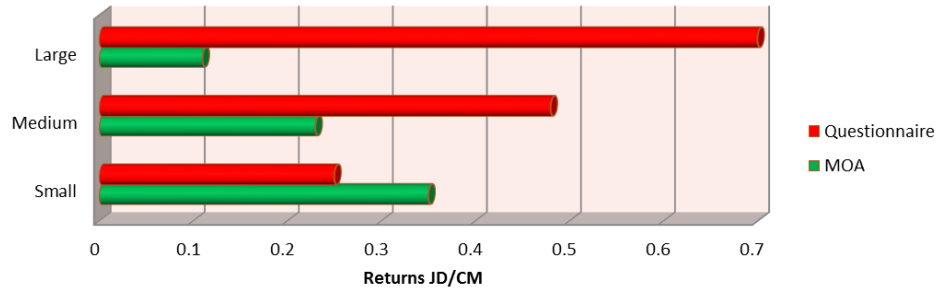
Farming system I is the most efficient in terms of returns to land resource.

Fig 4 Returns to Land (JD/Dunum) by Farming System in Amman-Zarqa baisn



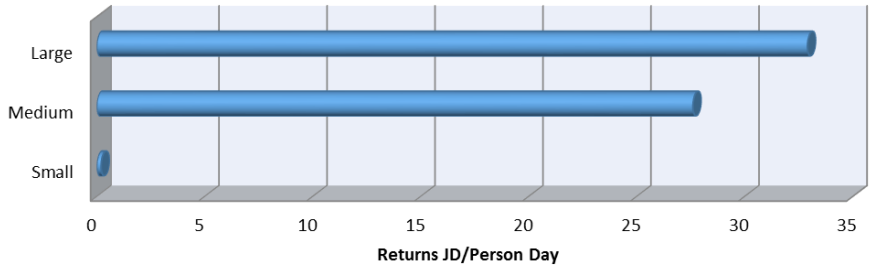
Farming system III (large farms) is the most efficient in terms of economic water use efficiency .

Fig 5 Returns per cubic meter (JD/CM) by Farming System in Amman-Zarqa basin



Farming system II (medium farms) is the most efficient in terms of economic returns to labor.

Fig 6 Returns to labor (JD/person day) by Farming System in Amman-Zarqa basin



Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, the average return per cubic meter of water in the highlands ranged between 0.48 – 0.05 JD for fruit trees while it ranged between 1.33-0.33 for vegetables. It is clear from the above Figure 5 and table 13 that the estimated returns to water indicator for farming systems II and III are within the ranges estimated by the water valuation study while the returns to water for farming system I is close lower. These estimates should be lower if the actual volumes of abstracted water are used in estimating these indicators. As indicated above, the stated water abstraction rates by the respondents are only one-third of the actual water requirements of the cultivated crops. For instance, in case of system III, if we re-estimate the return to water using the actual water requirements, the ratio goes down to JD 0.11 per cubic meter of water which is way below the rate given the reported amounts of abstraction.

Table 8 Main economic efficiency indicators for the three identified farming systems in AZ basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	86 Farms (48%)	57 Farms (32%)	35 Farms (20%)
• Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)	176	127	69
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)	0.25	0.48	0.70
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water requirement as per MOA in CM)	0.35	0.23	0.11
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	5.8	7.6	3.4

11 Appendix IV: Ramtha Basin

11.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 101 respondents in the Al Ramtha Basin out of the visited 108 farms. Figure 2 indicates that almost one-half of the surveyed farms in Al Ramtha are of the size of larger than 200 du (System III). The Figure also shows that the small farm size (System 1) represents only 13% while the medium farms represent (System II) 43% of the total surveyed farms.

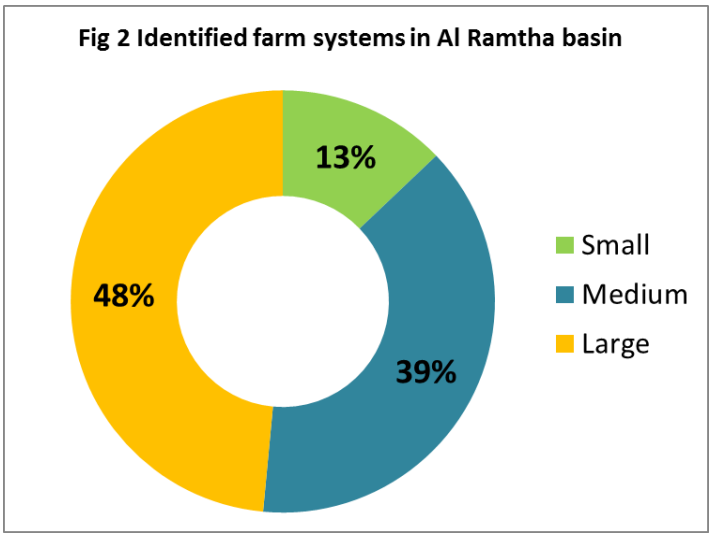


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Ramtha) basin

Water Basin	Al-Mafraq				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	% of farm size within the groundwater basin	% of the farm size within all basins	% of Total sum of farms in all basins	Number of farms in all basins	% of farm size within all basins	% of the farm size in all basins	% of Total sum of farms in all basins
<= 50.00	13	13%	3%	1%	396	31%	100%	31%
50.01 - 100.00	14	14%	6%	1%	227	18%	100%	18%
100.01 - 150.00	17	17%	12%	1%	143	11%	100%	11%
150.01 - 200.00	8	8%	7%	1%	122	10%	100%	10%
200.01 - 250.00	10	10%	15%	1%	67	5%	100%	5%
250.01 - 300.00	12	12%	16%	1%	74	6%	100%	6%
300.01 - 350.00	3	3%	9%	0%	34	3%	100%	3%
350.01 - 400.00	6	6%	12%	0%	49	4%	100%	4%
400.01 - 450.00	2	2%	6%	0%	32	3%	100%	3%
450.01 - 500.00	3	3%	12%	0%	26	2%	100%	2%
500.01 - 600.00	4	4%	19%	0%	21	2%	100%	2%
600.01 - 700.00	3	3%	19%	0%	16	1%	100%	1%
700.01 - 800.00	1	1%	5%	0%	20	2%	100%	2%
800.01 - 900.00	1	1%	20%	0%	5	0%	100%	0%
900.01 - 1000.00	2	2%	29%	0%	7	1%	100%	1%
1000.01+	2	2%	6%	0%	31	2%	100%	2%
Total	101	100%	8%	8%	1270	100%	100%	100%

11.2 DESCRIPTION OF FARMING SYSTEMS

11.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the three identified farm sizes.

- **Farming system I (small size holdings):** the majority of the farm managers are younger than 46 years of age (55%), their level of education is high school or more (61%), there are no female managers, two of the 13 farm managers are non-Jordanians (Egyptians), 77% of these farms have no family members living on-farm and the majority (70%) of the farmers rely heavily on farming income.
- **Farming system II (medium size holdings):** 91% of the farm managers are older than 31 years, the level of education of 64% is Tawjihi or less, no female farm manager, non-Jordanian managers represents 16% (all are Egyptians), the overwhelming majority of these farms (90%) support on average 1-5 family members, and more than two thirds (72%) of the owners rely heavily on farming income.
- **Farming system III (large size holdings):** 96% of the managers are older than 31 years, the level of education of 72% of them is Tawjihi or less, there is one female farm manager, 10% of the managers are non-Jordanian (Egyptians), 41% of these farms support on average 1-5 family members, and 74% of the owners rely heavily on farming income.

Concluding remarks: As in the case of Amman Al-Zarqa, Al Azraq and Mafraq basins, the analysis of the socioeconomic characteristics of the three clusters in Al Ramtha Basin indicates that as the farm size increases, the farms in this basin tend to be more agribusiness oriented, and higher reliance on the farming income while smaller farms tend to be more as hobby farms. No female managers were found in the whole basin. The age above 60 years of the farm managers of farming system I tends to be higher than the other two systems which might be an indication that much of the small farms are hobby farms.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the three identified farming systems in Ramtha basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	13 Farms (13%)	39 Farms (39%)	49 Farms (48%)
Age	• 15% < 30 year • 40% 31-45 year • 31% 46 – 60 year • 14% > 60	• 8% < 30 year • 39% 31-45 year • 39% 46 – 60 year • 14% > 60	• 4% < 30 year • 47% 31-45 year • 37% 46 – 60 year • 12% > 60
Education	• 39% < Tawjihi • 31% Tawjihi • 30% University • 0% > University	• 41% < Tawjihi • 23% Tawjihi • 28% University • 8% > University	• 33% < Tawjihi • 39% Tawjihi • 18% University • 10% > University
Gender	• 13 males • 0 females	• 39 males • 0 female	• 49 males • 0 female
Nationality	• 11 Jordanian • 2 Egyptian	• 33 Jordanian • 6 Egyptian	• 43 Jordanian • 6 Egyptian
Number of family members supported	• 23% support 3-5 • 77% support >5	• 64% > 5 • 26% support 1-5 • 10% support none	• 25% support 1-5 • 73% support >5 • 2 % support None
Farming income proportion	• 70% > 80% of total income • 23% 20-80% of T. income • 7% < 20% of T. income	• 72% > 80% of total income • 12% 20-80% of T. income • 16% < 20% of T. income	• 74% > 80% of total income • 22% 20-80% of T. income • 4% < 20% of T. income
Number of family members live on the farm	• 77% No one • 8% 1-5 • 15% > 5	• 74% No one • 21% 1-5 • 5% >5	• 59 % No one • 25% 1-5 • 16% >5

11.2.2 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the three identified clusters of farms in Al Ramtha basin. Table 3 shows the frequency distributions of the related indicators for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** All of the farms of this system were owned before the year 2002, 46% of the farms are managed by licensed owners, all of the farms' wells are artesian, all of the wells were installed after 1960 of which 60% were installed during the period 1960-90, the well capacity of 62% of the farms is less than 30 CM/hr, the level of salinity of 80% of the wells is less than 500 while the salinity of the rest is below 1000, the depth of 77% of the wells is more than 150 meters when installed, the total annual abstraction of the 26 farms under this farm system is estimated at 410 thousand CM, and the average annual abstraction is 31.6 thousand CM/well;
- **Farming system II (medium size holdings):** All of the farms were owned before the year 2002, 41% of the farms managed by licensed owners while 56% are managed by operators, all of the farms' wells are artesian, 97% ofl wells were installed after 1960, the well's capacity of 70% of the farms is in the range of 11-50 CM/hr, the level of salinity of 81% of the wells is less than 500 while the salinity of the rest is below 1000, the depth of the wells when installed at 89% of the farms was more than 150 meters, the total annual abstraction under this farm system is estimated at 1.8 million CM, and the average annual abstraction of the farms is 63.6 thousand CM/well;
- **Farming system III (large size holdings):** The majority of the farms 39 (89%) were owned before the year 2002, 29% of the farms managed by licensed owners while 61% are managed by operators, all of the farms' wells are artesian, 95% of the wells were installed after 1960, the well's capacity of 79% of the farms is more than 30 CM/hr, the level of salinity of 88% of the wells is less than 1000, the depth of the wells at the time of installment for 88% of the wells was greater than 150 m, the total annual abstraction at the farms under this farm system is estimated at 3.9 million CM, and the average annual abstraction is 80.3 thousand CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the three identified clusters of farms indicates that as the farm size increases, dependence on artesian wells expands, the majority of the farms are managed by operators, the capacity of the well increases, the depth of the wells also increases and ultimately the volume of abstraction increases. This conclusion supports the remark of the previous section that as the size of the farm increases, farms in Al Azraq, Amman-Zarqa, Mafraq and Ramtha basins tend to be more agribusiness oriented, support more family members and exhibit higher reliance on farming income.
- According to the completed questionnaires, the total annual abstraction of water by the three farm systems amounts to 6.1 million cubic meters. This amount of water was used by 101 farmers to irrigate a sum of 28,966 du of which 21,215 is allocated for fruit trees and the remaining 7, 751 du for vegetables and annual crops. This means that the average volume of water used per du is 209 cubic meters. However, studies on crop water requirement in the desert areas shows that the average water requirement per du of fruit trees is 307 cubic meter and 471 cubic meters for vegetables. Some studies on the Yarmouk basin estimated the water crop requirement for olives at 600 CM/du. If the lower bound crop water requirement is used, then the actual amount of water to irrigate the cultivated area in Al Ramtha basin is 10.2 million cubic meters which way lower than reported by the respondents.

- Water salinity of the overwhelming majority of the wells under the 3 farming system is lower than 1000. This is an indication that the water quality of this basin is better than in the Azraq, Mafraq and Amman-Zarqa basins.

Table 3 Frequency distribution of the farm and well characteristics for the three identified farming systems in Ramtha basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	13 Farms (13%)	39 Farms (39%)	49 Farms (48%)
Years of ownership of the well/Farm	• 0% < 10 year • 75% 11-25 year • 25% 26 – 40 year • 0 % > 40	• 0 % < 10 year • 13 % 11-25 year • 75 % 26 – 40 year • 12 % > 40	• 11 % < 10 year • 11 % 11-25 year • 56 % 26 – 40 year • 22 % > 40
Farm Operator Status	• 46% License owner • 15% Renter • 39% Operator	• 41% License owner • 3 % Renter • 56 % Operator	• 29% License owner • 10 % Renter • 61 % Operator
Type of the wells	• 0% Shallow • 100 % Artesian	• 0 % Shallow • 100 % Artesian	• 0% Shallow • 100% Artesian
Year of well installation	• 0% before 1960 • 60% 1960-1990 • 20% 1991- 2000 • 20% after 2001	• 3% before 1960 • 63% 1960-1990 • 11% 1991- 2000 • 23% after 2001	• 5% before 1960 • 71% 1960-1990 • 5% 1991- 2000 • 19% after 2001
Well capacity (m3/hr)	• 39% Less than 10 • 23% 11-30 • 15% 31-50 • 23% more than 50	• 10 % Less than 10 • 39 % 11-30 • 31% 31-50 • 20% more than 50	• 2 % Less than 10 • 19 % 11-30 • 40 % 31-50 • 25 % 51-70 • 14 % more than 70
Level of water salinity once installed (EC)	• 80% <= 500 • 20% 501 - 1000	• 81% <= 500 • 19% 501 - 1000	• 56 % <= 500 • 32 % 501 - 1000 • 10 % 1001 – 1500 • 2 % > 1500
Well depth when installed (m)	• 8% 51 - 70 • 15% 71 - 90 • 77% >150	• 3 % 51 - 70 • 8 % 71 - 149 • 89% >150	• 2 % <= 30 • 10 % 91 - 150 • 88 % >150
Total Abstraction CM	• 410,375	• 1,794,860	• 3,852,487
Average Abstraction CM/Farm	• 31,567	• 46,022	• 80,260

11.2.3 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Al Ramtha basin. The total cultivated area reported by the 101 farmers is 28,966 du of which 21,215 is cultivated with fruit trees and the remaining 7, 751 du with vegetables and annual crops. This section deals with the analysis of the dominant cropping pattern prevailing at the three identified clusters of farms in this basin. Table 4 shows the distribution of the cultivated area among different crops for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** the dominant cultivated tree is olive for both pickling and for pressing purposes. 49% of the total farms area is cultivated with olive trees of which 38% is devoted for pressing and 11% for pickling. The rest of the farms' area is devoted to tomato at parsley 9%, corn 9%, flowers 8%, tomato 7%, cucumber 5%, lettuce 4% and the remaining area of 10% is cultivated with other a variety of vegetables.
- **Farming system II (medium size holdings):** The allocated land for olive trees is much lower than system I. The dominant crop in this system is capsicum at 25% followed by olive trees for pickling at 17% of the total area. The third dominant crop is grape that occupies 7% of the area. The rest of the farm is devoted to other vegetables crops and fruit trees including apricot, peach, lemon, cauliflower, tomato, common beans, etc.
- **Farming system III (large size holdings):** The dominant cropping pattern in this cluster of large farms is olive trees which occupies around more than one-half of the total area (54%) followed with grape at 13%. The other fruit trees include peach, apricot and other stone fruits. . The dominant vegetable crop is tomato at 4% of the total cultivate area under this system.

Concluding remarks: The analysis of the cropping pattern characteristics of the three identified clusters of farms indicates that olive is still the dominant tree in this basin especially in systems I and III. However, in relative terms olive trees are less important in Al Ramtha. The dominant fruit trees following olive are grape peach, and apricots. It should be noted here that the cropping pattern in this basin is more diversified. The data shows a large variety of vegetable crops produced in this basin compared to the other basins in the highlands areas.

Table 4 Dominant cropping patterns for the three identified farming systems in Ramtha basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)

	13 Farms (13%)	39 Farms (39%)	49 Farms (48%)
Main fruit trees (% of the total cultivated area in du)	• 38 % Olive for pressing • 11 % Olive	• 17% Olive • 7 % Grape • 6 % Olive for pressing • 6 % Peach • 4 % Apricots • 3 % Lemon	• 34% Olive • 20% Olive for pressing • 13% Grape • 3 % Peach • 2 % Apricot • 2% Stone fruits • 1% Nectarine
Main vegetables and field crops (% of the total cultivated area in du)	• 9% Parsley • 9% Corn • 8% flowers • 7% Tomato • 5% Cucumber • 4% lettuce • 10% other vegetables	• 25 % Capsicum • 7 % Cauliflower • 6 % Tomato • 2 % Common bean • 1% Eggplants • 1% Cabbage • 1% wheat • 11 % others	• 4 % Tomato • 4% Capsicum • 2% Wheat • 1 % Cauliflower • 13 % others

11.2.4 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the three identified clusters of farms. Table 5 shows the results of the analysis for the three farm categories. The table shows the following:

- **Farming system I (small size holdings):** The total amount of investment in the 13 farms is 1.9 million JD of which 96% are investments by the well owners and the remaining 4% are invested by the renters. The average investment per farm is 172 thousand JD. The sum of the annual total operational costs for all farms of this category is 114 thousand JD while the average operational cost per du is 318 JD. The average gross margin per du for this cluster is 300 JD. As in the case of the other basins, there is a variance in the operational costs among the 13 farmers.
- **Farming system II (medium size holdings):** The total amount of investment in the 39 medium size farms is 15.3 million JD of which 98% are investments by the well owners and the remaining 2% are invested by the renters. The average investment per farm is 430 thousand JD. The sum of the annual total operational cost for all farms of this category is 1.3 million JD while the average operational cost per du is 220 JD. The average gross margin per du for this cluster is 259 JD.
- **Farming system III (large size holdings):** The total amount of investment in the 49 large size farms is 11.4 million JD of which 95% of the investments are by wells' owners. The average investment per farm is 271 thousand JD. The sum of the annual total operational cost for all farms of this category is 4.1 million JD while the average operational cost per du is 182 JD. The average gross margin per du for this cluster is 399 JD.

Concluding remarks:

The total invested capital in Al Ramtha basin is estimated at 28.7 million JD while the annual total operational costs amounted to 5.5 million JD. Figure 3 shows a comparison between the main three financial parameters used in the financial analysis among the three farming systems. The figure shows that the operational costs of system 1 (small farm size) is the highest among the three systems while the gross margins are the highest for system 3. The three systems make positive gross margins but system 3 makes the highest which is mainly due to the low operational costs compared to the other two systems.

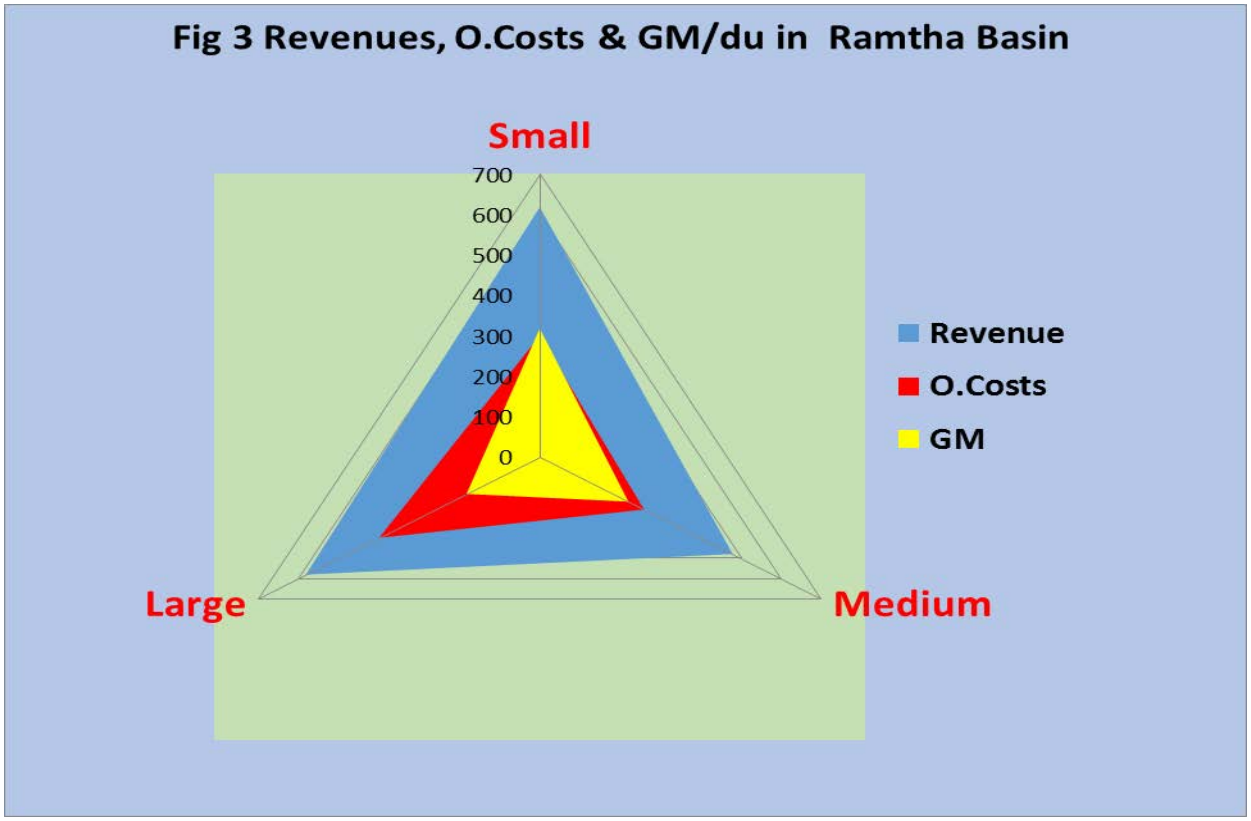


Table 5 Main Financial Indicators for the three identified farming systems in Ramtha basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	13 Farms (13%)	39 Farms (39%)	49 Farms (48%)
Total Investment Costs in JD – Wells' Owners and Renters	• 1,901,900	• 15,479,900	• 11,359,400
Total Investment Costs in JD – Wells' Owners	• 1,815,900	• 15,256,400	• 10,751,900
Total Investment Costs	• 86,000	• 223,500	• 607,500

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	13 Farms (13%)	39 Farms (39%)	49 Farms (48%)
in JD – Wells' Renters			
Average Investment Costs in JD/Farm	• 172,900	• 429,997	• 270,462
Total Operational Costs in JD	• 113,956	• 1,323,287	• 4,105,564
Average Operational Costs in JD/du	• 318	• 220	• 182
Total Revenues in JDs for all farms	• 221,409	• 3,003,124	• 13,122,710
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for all farms	• 107,453	• 1,557,678	• 9,017,146
Average Gross Margin in JD/du for all farms	• 300	• 259	• 399

11.2.5 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the three farming systems. The table concludes the following:

- **Farming system I (small size holdings):** The total number of hired labor of both permanent and daily categories in the 13 farms amounted to 19,807work days/year. The farms under this system hire both Jordanians and non-Jordanians. The hired permanent laborers are only males. Average monthly wage to Jordanian permanent labor is 217 JD while the paid wage for non-Jordanian is 279 JD. More than one-half of the permanent labor is non-Jordanian. The total number of hired daily labor under this system amounted to 134 laborers. The daily rates of the Jordanian labor (both males and females) arelower than non-Jordanian.
- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 39 farms amounted to 70,913work days/year. The farms under this system hire also both Jordanians and non-Jordanians. Hired permanent laborers include only males. Average monthly wage for Jordanian labor is 280 JD while the paid wage for non-Jordanian is 246 JD. The majority of permanent labor are non-Jordanians (68%). The hired Jordanian female daily labor is more than one-half of total hired daily labor. The wage paid to Jordanian female daily laborers is almost equal to that of Jordanian male labor. However, the wage paid to non-Jordanian female labor is lower than the wage paid to the Jordanian females.
- **Farming system III (large size holdings):** The total number of hired labor of both permanent and daily categories in the 49 farms amounted to 89,700 work days/year. As in the case of the other two farming systems, the farms under this system hire both Jordanians and non-Jordanians. However, non-Jordanian permanent labor represents the majority (92%). All of the hired permanent laborers are males. Average monthly wage paid to Jordanian labor is 276 JD while the paid wage for non-Jordanian is 255 JD. The number of Jordanian female daily laborers exceeds the number of Jordanian males but their daily rates are lower by almost one-fourth of what paid to male labor. On the contrary, the number of male non-Jordanian laborers is more than three folds of the female non-Jordanian labor. Daily rates paid to non-Jordanian female labor are lower by 25% of what paid to non-Jordanian males.

Concluding remarks:

- All permanent laborers in Al Ramtha basin are males (both Jordanians and non-Jordanians). The three framing systems rely heavily on non-Jordanian daily labor, however system III employs more of permanent non-Jordanian labor compared to the other two systems.
- Wages paid to daily non-Jordanian female and male laborers are higher than what is paid to Jordanians.
- In general, the female daily wage is lower than male wage across the three farming systems.

Table 6 Main labor and Gender Indicators for the three identified farming systems in Ramtha basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	13 Farms (13%)	39 Farms (39%)	49 Farms (48%)
Permanent Jordanian (laborers No.) • **Male** • **Female**	 • 23 • 0	 • 47 • 0	 • 26 • 0
Wages of Permanent Jordanian (JD/Month) • **Male** • **Female**	 • 217 • N/A	 • 280 • N/A	 • 276 • N/A
Permanent Non-Jordanian (laborers No.) • **Male** • **Female**	 • 36 • 0	 • 104 • 0	 • 282 • 0
Wages of Permanent Non- Jordanian (JD/Month) • **Male** • **Female**	 • 279 • N/A	 • 246 • N/A	 • 255 • N/A
Daily Jordanian laborers (No.) • **Male** • **Female**	 • 55 • 48	 • 136 • 209	 • 470 • 493
Wages of Daily Jordanian (JD/day) • **Male** • **Female**	 • 7.4 • 6.4	 • 7.1 • 7.0	 • 8.2 • 6.4
Daily Non-Jordanian laborers (No.) • **Male** • **Female**	 • 21 • 10	 • 544 • 57	 • 817 • 170
Daily wage of Non-Jordanian (JD/day) • **Male** • **Female**	 • 10.3 • 10	 • 10 • 6.3	 • 10.2 • 8.1
Total number of working days /year	• 19,807	• 70,913	• 89,700

11.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

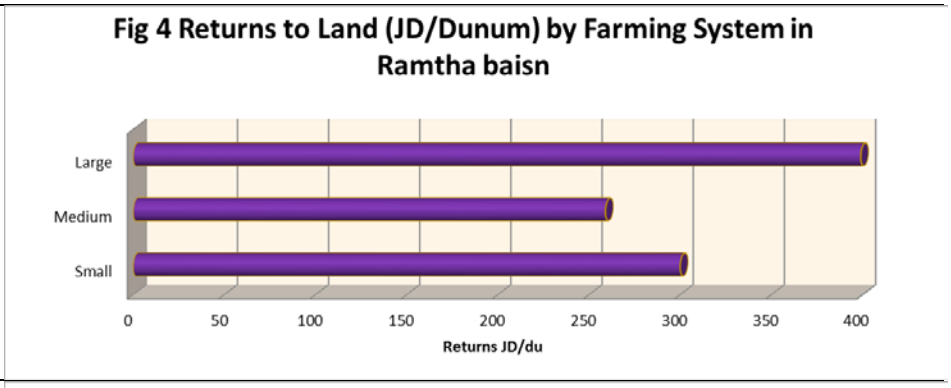
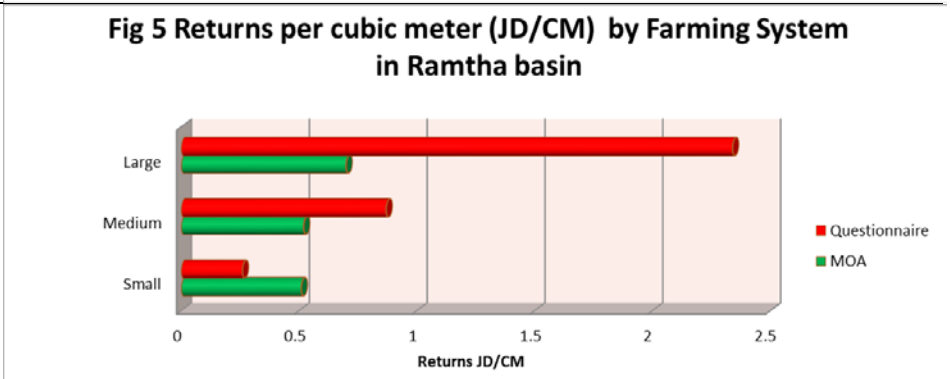
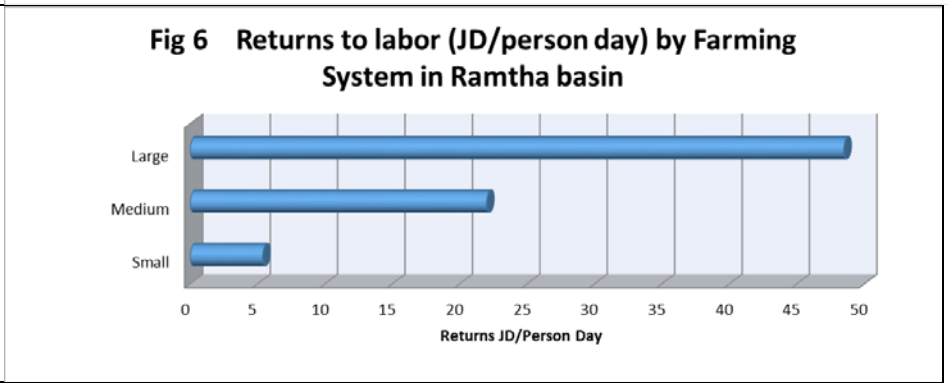
According to the completed questionnaires, the total annual abstraction of water by the 101 farms of the three farm clusters amounted to 6,057,722 cubic meters. This amount of water was used by only 101 farms in the basin to irrigate a sum of 29,016 du. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 101 farms that completed the questionnaire distributed by clusters. The table also shows the crop water requirement per du in Ramtha basin as estimated by the MOA (due to the unavailability of the crop water requirement for some of the crops, the researcher used the minimum water requirement for the same or similar crops cultivated in other basins in the uplands). As estimated in the table, the total amount of water required to irrigate the sum of the 29,016 du cultivated by the 101 farms is 16.2 million cubic meters which exceeds the total amounts of water reported by the farmers in the questionnaire by more than two and half times.

Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Ramtha basin

Main cultivated crop	Area by Cluster			Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Small	Medium	Large			
Olive	42	1006	7643	8,691	650	5,649,150
Olive for pressing	146	365	4560	5,071	650	3,296,150
Grape		427	3005	3,432	425	1,458,600
Capsicum	10	1490	795	2,295	332	761,940
Tomato	28	378	875	1,281	750	960,750
Peach		357	750	1,107	515	570,105
Apricot		247	465	712	515	366,680
Cauliflower	10	428	265	703	400	281,200
Wheat		90	400	490	400	196,000
Stone Fruits			460	460	515	236,900
Lemon		176	200	376	900	338,400
Nectarine		71	280	351	515	180,765
Different Vegetables			300	300	400	120,000
Citrus			300	300	900	270,000
Potato			260	260	335	87,100
Eggplant	4	90	165	259	436	112,924
Pear		61	170	231	515	118,965
Vegetables			200	200	400	80,000
Common bean	5	150	30	185	635	117,475
Broccoli		15	150	165	400	66,000
Loquat			150	150	400	60,000
Peach (cake-like)		85	65	150	515	77,250
Cabbage		70	75	145	450	65,250
Apple		30	107	137	515	70,555
Zucchini			135	135	200	27,000
Onion		15	115	130	675	87,750
Cucumber	20	87	16	123	208	25,584
Sage		60	50	110	400	44,000
Other veg and Fruits	123	336	608	1,067	400	426,800
	388	**6,034**	**22,594**	**29,016**		**16,153,293**

11.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the three farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

Farming system III is the most efficient in terms of returns to land resource followed by System I.	
Farming system III (large farms) is the most efficient in terms of economic water use efficiency.	
Farming system III (large farms) is the most efficient in terms of economic returns to labor.	

Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, the average return per cubic meter of water in the highlands ranged between 0.48 – 0.05 JD for fruit trees while it ranged between 1.33-0.33 for vegetables. It is clear from the above Figure 5 and table 13 that the estimated return to water indicator for farming systems III is higher than the ranges estimated by the water valuation study while the returns to water for farming system II and I fall within the range of the study. The returns per cubic meter of water changes dramatically when the actual crop water requirements are used especially for large and medium farms clusters.

Table 8 Main economic efficiency indicators for the three identified farming systems in Ramtha basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	13 Farms (13%)	39 Farms (39%)	49 Farms (48%)
• Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)	300	259	399
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)	0.26	0.87	2.34
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water requirement as per MOA in CM)	0.51	0.52	0.70
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	5.4	22	48.5

12 Appendix V: Deir-Allah Basin

12.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 110 respondents in Deir Allah Basin out of the visited 115 farms. Figure 2 indicates that almost two thirds of the surveyed farms in Deir Allah are of the small size (System I: smaller than 50 du). However, it should be stated here that Deir Allah basin is different from the other basins in terms of the large number of small farms and very small number of large farms that exceeds 200 du in size, consequently, the analysis of this basin was limited to size I and size II clusters.

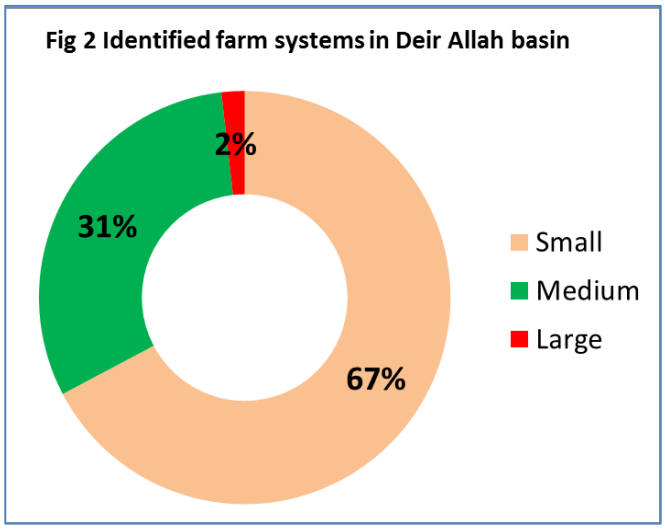


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Deir Allah) basin

Water Basin	Deir Allah				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	% of farm size within the groundwater basin	% of the farm size within all basins	% of Total sum of farms in all basins	Number of farms in all basins	% of farm size within all basins	% of the farm size in all basins	% of Total sum of farms in all basins
<= 50.00	74	67%	19%	6%	396	31%	100%	31%
50.01 - 100.00	22	20%	10%	2%	227	18%	100%	18%
100.01 - 150.00	6	5%	4%	0%	143	11%	100%	11%
150.01 - 200.00	6	5%	5%	0%	122	10%	100%	10%
200.01 - 250.00	0	0%	0%	0%	67	5%	100%	5%
250.01 - 300.00	1	1%	1%	0%	74	6%	100%	6%
300.01 - 350.00	0	0%	0%	0%	34	3%	100%	3%
350.01 - 400.00	1	1%	2%	0%	49	4%	100%	4%
400.01 - 450.00	0	0%	0%	0%	32	3%	100%	3%
450.01 - 500.00	0	0%	0%	0%	26	2%	100%	2%
500.01 - 600.00	0	0%	0%	0%	21	2%	100%	2%
600.01 - 700.00	0	0%	0%	0%	16	1%	100%	1%
700.01 - 800.00	0	0%	0%	0%	20	2%	100%	2%
800.01 - 900.00	0	0%	0%	0%	5	0%	100%	0%
900.01 - 1000.00	0	0%	0%	0%	7	1%	100%	1%
1000.01+	0	0%	0%	0%	31	2%	100%	2%
Total	110	100%	9%	9%	1270	100%	100%	100%

12.2 DESCRIPTION OF FARMING SYSTEMS

12.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the major two identified farm sizes.

- **Farming system I (small size holdings):** about two thirds of the farm managers are younger than 46 years of age, the level of education of the majority of the managers is high school or less (73%), there are no female managers, almost one-half of the farm managers are non-Jordanians, 78% of the farms have no family members living on the farm and only 55% of the farmers rely heavily on farming income (80% of the total income).
- **Farming system II (medium size holdings):** 78% of the farm managers are within the age group of 31-60 years, the level of education of 61% of them is Tawjihi or less, only one female farm manager, non-Jordanian managers represents 47% (25% are Egyptians), the majority of these farms (70%) support more than 5 family members, and more than two thirds (77%) of the owners rely heavily on farming income.

Concluding remarks: The farming systems in Deir Allah basin are different in two matters: 1) the size of the farms is much smaller compared to other basins and 2) as explained later the cropping patters are also different. As in the case of other farms in the uplands, the analysis of the socioeconomic characteristics of the two clusters in Deir Allah Basin indicates that as the farm size increases, the farms in this basin tend to be more agribusiness oriented, and higher reliance on the farming income. Only one female manager was found in the whole basin. The age of the overwhelming majority of all farm managers across the three clusters is less than 60 years.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the three identified farming systems in Deir Allah basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	**36 Farms (33%)**
Age	• 26% < 30 year • 38% 31-45 year • 28% 46 – 60 year • 8 % > 60	• 19% < 30 year • 39% 31-45 year • 39% 46 – 60 year • 3% > 60
Education	• 45% < Tawjihi • 28% Tawjihi • 25% University • 2% > University	• 47% < Tawjihi • 14% Tawjihi • 37% University • 2% > University
Gender	• 74 males • 0 females	• 35 males • 1 female
Nationality	• 39 Jordanian • 31 Egyptian • 2 Pakistani • 1 Palestinian • 1 Syrian	• 19 Jordanian • 9 Egyptian • 6 Pakistani • 2 Iraqi

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
Number of family members supported	• 64% > support >5 • 36% support 1-5	• 70% > 5 • 25% support 1-5 • 6% None
Farming income proportion	• 55% > 80% of total income • 25% 20-80% of T. income • 20% < 20% of T. income	• 77% > 80% of total income • 6% 20-80% of T. income • 17% < 20% of T. income
Number of family members live on the farm	• 78% No one • 14% 1-5 • 8% > 3-5	• 72% No one • 17% 1-5 • 11% > 3-5

12.2.2 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the two identified clusters of farms in Deir Allah basin. Table 3 shows the frequency distributions of the related indicators for the two farm categories. The table reveals the following:

- **Farming system I (small size holdings):** 57% of the farms of this system were owned before the year 2002, 56% of the farms are managed by operators, all of the farms' wells are artesian, 11% of the wells were installed before 1960 while the overwhelming majority was installed after 1991, 86% of the wells capacity is within the range of 11-50CM/hr, the level of salinity of 70% of the wells is more than 2000 while 27% of the well's the salinity is within the range of 1000-2000, the depth of 78% of the wells is within the range of 31-90 meters when installed, the total annual abstraction of the 74 farms under this farm system is estimated at 1.156 million CM, and the average annual abstraction is 20.6 thousand CM/well;
- **Farming system II (medium size holdings):** 50% of the farms were owned before the year 2002 (only 4 respondents out of 36 answered this question), 78% of the farms are managed by operators, all of the farms' wells are artesian, the majority of the wells (90%) were installed after 1991, the well capacity of 82% of the farms is within the range of 11-50 CM/hr, the level of salinity of 87% of the wells is more than 2000 while the remaining 13% of the well's the salinity is within the range of 1000-2000, the depth of 65% of the wells is within the range of 71-150 meters when installed, the total annual abstraction of the 36 farms under this farm system is estimated at 1.11 million CM, and the average annual abstraction is 39.6 thousand CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the two identified clusters of farms indicates all wells in this basin are artesian; the majority of the farms are managed by operators. The salinity of most of the wells is higher than 2000, especially the large farms.

Table 3 Frequency distribution of the farm and well characteristics for the three identified farming systems in Deir Allah basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
Years of ownership of the well/Farm	• 57% < 10 year • 14% 11-25 year • 29% 26 – 40 year • 50% > 40	• 50 % < 10 year • 50 % 11-25 year • * Only 4 respondents
Farm Operator Status	• 11% License owner • 7 % Renter • 56% Operator	• 11% License owner • 11 % Renter • 78 % Operator
Type of the wells	• 0% Shallow • 100 % Artesian	• 0 % Shallow • 100 % Artesian
Year of well installation	• 11% before 1960 • 6% 1960-1990 • 26% 1991- 2000 • 57% after 2001	• 5% before 1960 • 5% 1960-1990 • 14% 1991- 2000 • 76% after 2001
Well capacity (m3/hr)	• 4% Less than 10 • 56% 11-30 • 30% 31-50 • 10% more than 50	• 4 % Less than 10 • 46 % 11-30 • 36% 31-50 • 14% more than 50
Level of water salinity once installed (EC)	• 3 % 501 - 1000 • 27 % 1001 – 2000 • 70 % > 2000	• 3 % 501 - 1000 • 10 % 1001 – 2000 • 87 % > 2000
Well depth when installed (m)	• 6 % <= 30 • 78 % 31 - 90 • 16 % > 91	• 29 % 31 – 70 • 35 % 71 – 90 • 30% 91 -150 • 6 % > 150
Total Abstraction CM	• 1,154,615	• 1,109,560
Average Abstraction CM/Farm	• 20,618	• 39,627

12.2.3 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Deir Allah basin. The total cultivated area reported by the 110 farms (respondents) in the basin is 6,447 du of which 2,900 du is allocated for fruit trees and the remaining 3,459 du for vegetables and annual crops. Table 4 shows the distribution of the cultivated area among different crops for the two farm categories. The table reveals the following:

- **Farming system I (small size holdings):** the total cultivated area in this cluster is 2,226 du. The dominant cultivated tree is date palm followed by orange and grape. The rest of the farms' area is devoted to vegetables mainly tomato (11%), eggplants (10%), zucchini and cucumber.
- **Farming system II (medium size holdings):** The allocated land under this cluster is 4,221 du of which 43% is cultivated with fruit trees and the remaining area is cultivated with vegetables. Date palm trees are also the dominant fruit trees occupying 33% of the total cultivated area. The table shows that there is a large number of vegetables cultivated in this cluster of which the three main vegetable crops cultivated are tomato at 10%, followed by capsicum7% and eggplants 5%.

Concluding remarks: The analysis of the cropping pattern characteristics of the two identified clusters of farms indicates that date palm are the dominant crops in Deir Allah which is most probably linked to water saliently. Date palm are salt tolerant trees and also a high value crop. Jordan production of dates has increased by ten folds during the last two decades from 892 tons in 1994 to 10,417 tons in 2012 (DOS, 2014). Also the planted number of date palm trees increased from 20.5 thousand in 1994 to 297 thousand in 2012. The cropping pattern in Deir Allah is also characterized by the wide variety of cultivated vegetable crops which are dominated by potato, tomato, corn and watermelon.

Table 4 Dominant cropping patterns for the three identified farming systems in Deir Allah basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
Main fruit trees (% of the total cultivated area in du)	• 37 % Palm • 3 % Orange • 3 % Grape • 3% Decoration trees • 2% Banana	• 33 % Palm • 3 % Orange • 3 % Olive • 2 % Grape • 2% Banana
Main vegetables and field crops (% of the total cultivated area in du)	• 11% Tomato • 10% Eggplant • 5% Zucchini • 5% Corn • 5% Cucumber • 13% other vegetables	• 10% Tomato • 7%Capcicum • 6% Eggplant • 5% Cucumber • 5% Zucchini • 5% Corn • 5% Cucumber • 3% Strawberry • 2% Parsley • 2% Pototo • 7% other vegetables

12.2.4 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the two identified clusters of farms. Table 5 shows the results of the analysis for the two farm categories. The table shows the following:

- **Farming system I (small size holdings):** The total amount of investment in the 74 farms is 5.12 million JD by the well owners and renters. The average investment per farm is 98.5 thousand JD. The sum of the annual total operational costs for all farms of this category is 5.98 million JD while the average operational cost per du is 535 JD. The average gross margin per du for this cluster is 400 JD.
- **Farming system II (medium size holdings):** The total amount of investment in the 36 farms is 5.98 million JD invested all by the wells' owners and renters. The average investment per farm is 259 thousand JD. The sum of the annual total operational cost for all farms of this category is 1.61 million JD while the average operational cost per du is 381 JD. The average gross margin per du for this cluster is 633 JD.

Concluding remarks:

The total invested capital in Deir Allah basin (of the 110 respondents) is estimated at 12.17 million JD while the annual total operational costs amounted to 7.6 million JD. Figure 3 shows a comparison between the main three financial parameters used in the financial analysis among the two farming

systems. The figure shows that the operational cost of system I (small farm size) is the highest among the two systems. The gross margins are the highest for system II which is clearly due to the lower operational costs compared to system I. The two systems make positive gross margins but system 2 makes the highest margins.

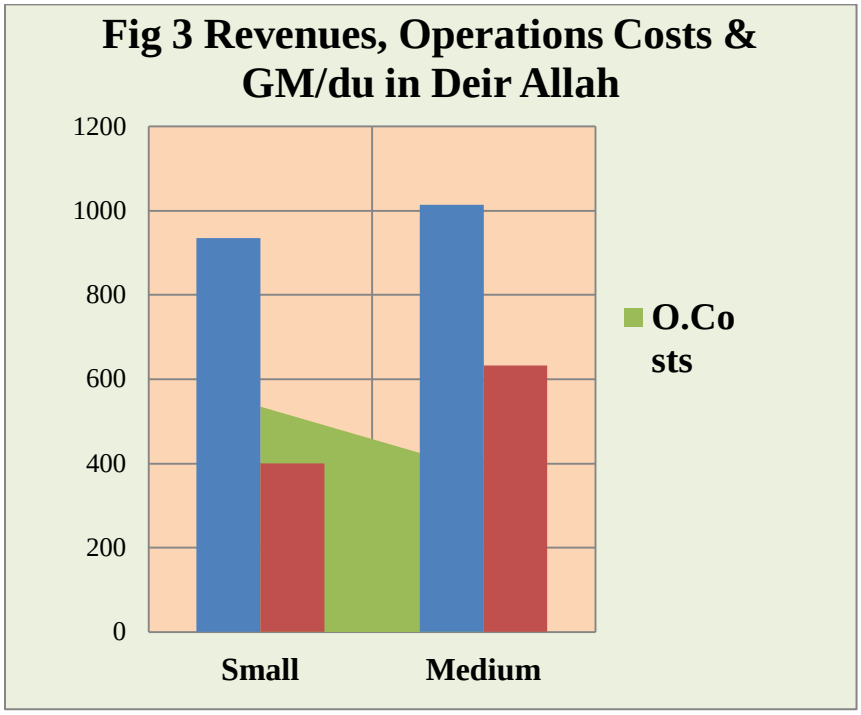


Table 5 Main Financial Indicators for the three identified farming systems in Deir Allah basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
Total Investment Costs in JD – Wells' Owners and Renters	• 5,123,218	• 6,997,900
Total Investment Costs in JD – Wells' Owners	• 4,823,568	• 6,680,150
Total Investment Costs in JD –	• 299,650	• 317,750

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
Wells' Renters		
Average Investment Costs in JD/Farm	• 98,523	• 259,182
Total Operational Costs in JD	• 5,976,656	• 1,607,384
Average Operational Costs in JD/du	• 535	• 381
Total Revenues in JDs for all farms	• 10,420,820	• 4,280,266
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for all farms	• 4,477,898	• 2,672,882
Average Gross Margin in JD/du for all farms	• 400	• 633

12.2.5 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the two farming systems. The table concludes the following:

- **Farming system I (small size holdings):** The total number of hired labor of both permanent and daily categories in the 74 farms amounted to 91,420 work days/year. The farms under this system hire both Jordanians and non-Jordanians. The hired Jordanian permanent laborers includes both males and females. Average monthly wage to Jordanian male permanent labor is 260 JD while the paid wage for non-Jordanian is 227 JD. More than 81% of the permanent labor is non-Jordanian. The total number of hired daily labor under this system amounted to 540 laborers (male and female). The daily rates of the Jordanian labor of both males and females are lower than non-Jordanian.
- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 36 farms amounted to 110,783 work days/year. The farms under this system hire also both Jordanians and non-Jordanians. Hired permanent laborers include both males and females. Average monthly wage for Jordanian labor is 247 JD while the paid wage for non-Jordanian is 304 JD. The majority of permanent labor are non-Jordanians (90%). The total hired Jordanian female daily labor is almost triple the number of hired daily Jordanian male labor. The wage paid to Jordanian female daily laborers is higher than what is paid for Jordanian male but at the same time, it is much lower than the wage paid to non-Jordanian labor.

Concluding remarks:

- Permanent laborers in Deir Allah basin include both males and females (only Jordanian females). The two framing systems rely heavily on non-Jordanian daily labor; however system 2 employs more of permanent non-Jordanian labor compared to system 1.

- Wages paid to daily non-Jordanian female and male laborers are higher than what is paid to Jordanians.

Table 6 Main labor and Gender Indicators for the three identified farming systems in Deir Allah basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
Permanent Jordanian (laborers No.)		
• **Male**	• 45	• 31
• **Female**	• 8	• 0
Wages of Permanent Jordanian (JD/Month)		
• **Male**	• 260	• 247
• **Female**	• 0	• 0
Permanent Non-Jordanian (laborers No.)		
• **Male**	• 227	• 304
• **Female**	• 0	• 0
Wages of Permanent Non- Jordanian (JD/Month)		
• **Male**	• 253	• 253
• **Female**	• 0	• 0
Daily Jordanian laborers (No.)		
• **Male**	• 58	• 65
• **Female**	• 62	• 182
Wages of Daily Jordanian (JD/day)		
• **Male**	• 7.3	• 4.7
• **Female**	• 2.3	• 4.9
Daily Non-Jordanian laborers (No.)		
• **Male**	• 398	• 186
• **Female**	• 22	• 23
Daily wage of Non-Jordanian (JD/day)		
• **Male**	• 9.9	• 8.6
• **Female**	• 2.2	• 7.7
Total number of working days /year	• 91,420	• 110,783

12.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

According to the completed questionnaires, the total annual abstraction of water by the two farm systems amounts to 2.265 million cubic meters. This amount of water was used by only 110 farms in the basin to irrigate a sum of 6,447 du. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 110 farms who completed the questionnaire. The table also shows the crop water requirement per du in Deir Allah basin as estimated by the MOA. As estimated in the table, the total amount of water required to irrigate a sum of 6,073 du is 4.685 million cubic meters which is almost double of the amount reported by the farmers in the questionnaire.

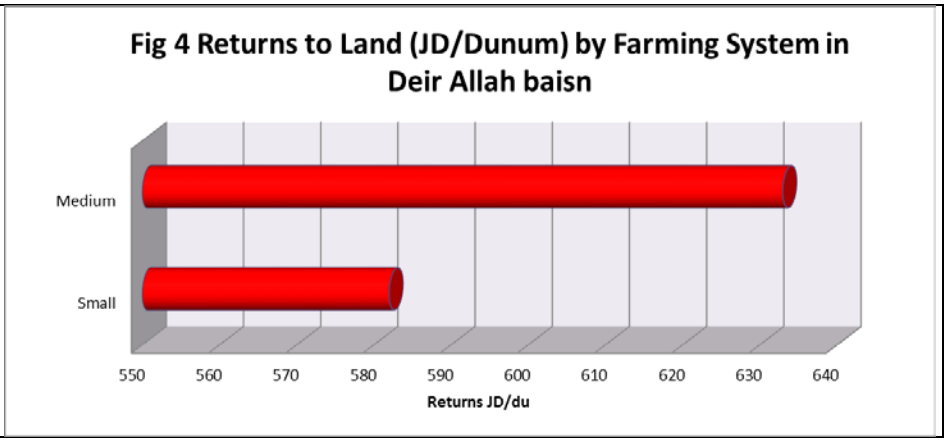
Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Deir Allah basin

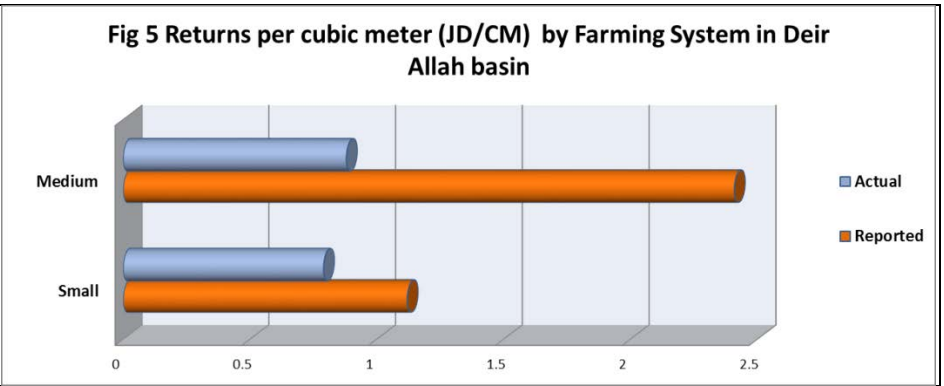
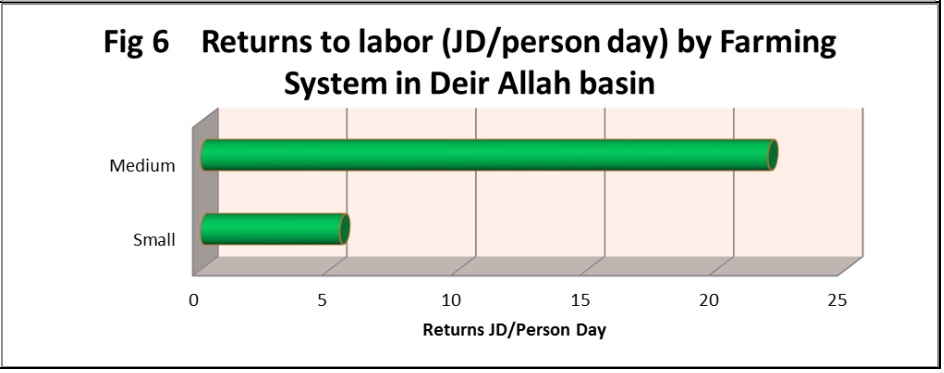
Main cultivated crop	Area in Dunum		Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Cluster 1	Cluster 2			
Arecaceae (Palm)	829	1373	2202	1300	2,861,950
Tomato	243	440	682	350	238,700
Capsicum	47	296	343	450	154,125
Eggplant	219	260	479	430	205,970
Cucumber	104	214	317	290	91,930
Corn	111	205	316	237	74,892
Zucchini	116	197	313	180	56,340
Orange	75	140	215	990	212,850
Strawberry		115	115	600	69,000
Olive	19	110	129	550	70,950
Grape	72	92	164	800	131,200
Banana	35	75	110	1450	159,500
Clementina		72	72	990	71,280
Parsley		70	70	500	35,000
Potato	29	70	99	200	19,800
Cauliflower	50	68	118	250	29,500
Lettuce	8	55	63	200	12,600
Cabbage	9	50	59	387	22,833
Lemon	22	46	68	990	66,825
Alfalfa	51	40	91	700	63,700
Pomelo	18	11	29	990	28,215
Cantaloupe	11	10	21	370	7,585
Total	2,065	4,008	6,073		4,684,745

12.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the three farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

Farming system II is the most efficient in terms of returns to land resource followed by System I.



Farming system II (large farms) is the most efficient in terms of economic water use efficiency. But it is almost equal to system I when actual water requirements are uses.	
Farming system II (large farms) is the most efficient in terms of return to labor followed by system I.	

Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, water values in Middle Jordan Valley have the highest value of about (JD 1.1/m^3), Safi, and northern governorates are among the highest value of about (JD 1/m^3). Northern Jordan Valley is half of MJV with about JD 0.79/m^3. This conclusion is supported by the findings of this study as indicated in figure 5 above and in table 8. The figure and the table show that even when the actual water requirements are used, the economic returns to water for both clusters are around JD 0.88/CM. As indicated in the water valuation report this might be because of the dominance of citrus fruits in NJV and the date palm trees which have been on an increasing pace for the last two decades.

Table 8 Main economic efficiency indicators for the three identified farming systems in Deir Allah basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
• **Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)**	582	633
• **Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)**	1.12	2.41
• **Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water**	0.79	0.88

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)
	74 Farms (67%)	36 Farms (33%)
requirement as per MOA in CM)		
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	14.2	24.1

13 Appendix VI: Jezeh Basin

13.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 159 respondents in the Al Jezeh Basin out of the visited 159 farms. Figure 2 indicates that almost one-half of the surveyed farms in Al Jezeh are of the size of the medium size (System II: larger than 50 and less than or equal 200 du). The Figure also shows that the small farm size (System 1) represents only 16% while the large farms represent (System III) 36% of the total surveyed farms.

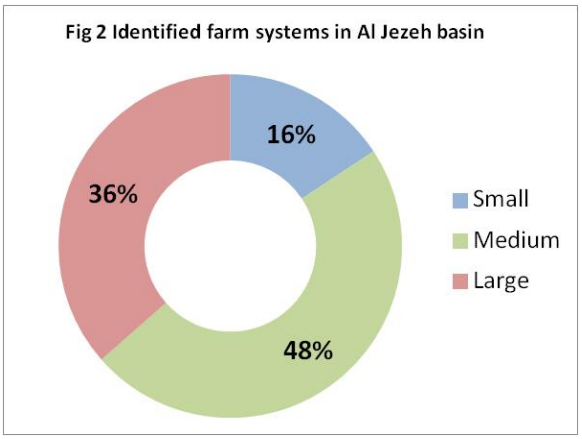


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Jezeh) basin

Water Basin	Al-Jezeh				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	% of farm size within the groundwater basin	% of the farm size within all basins	% of Total sum of farms in all basins	Number of farms in all basins	% of farm size within all basins	% of the farm size in all basins	% of Total sum of farms in all basins
<= 50.00	25	16%	6%	2%	396	31%	100%	31%
50.01 - 100.00	37	23%	16%	3%	227	18%	100%	18%
100.01 - 150.00	22	14%	15%	2%	143	11%	100%	11%
150.01 - 200.00	17	11%	14%	1%	122	10%	100%	10%
200.01 - 250.00	11	7%	16%	1%	67	5%	100%	5%
250.01 - 300.00	12	8%	16%	1%	74	6%	100%	6%
300.01 - 350.00	6	4%	18%	0%	34	3%	100%	3%
350.01 - 400.00	9	6%	18%	1%	49	4%	100%	4%
400.01 - 450.00	2	1%	6%	0%	32	3%	100%	3%
450.01 - 500.00	5	3%	19%	0%	26	2%	100%	2%
500.01 - 600.00	3	2%	14%	0%	21	2%	100%	2%
600.01 - 700.00	1	1%	6%	0%	16	1%	100%	1%
700.01 - 800.00	3	2%	15%	0%	20	2%	100%	2%
800.01 - 900.00	0	0%	0%	0%	5	0%	100%	0%
900.01 - 1000.00	2	1%	29%	0%	7	1%	100%	1%
1000.01+	4	3%	13%	0%	31	2%	100%	2%
Total	159	100%	13%	13%	1270	100%	100%	100%

13.2 DESCRIPTION OF FARMING SYSTEMS

13.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the three identified farm sizes.

- **Farming system I (small size holdings):** more than one-half of the farm managers are younger than 46 years of age (56%), their level of education is high school or more (72%), there are no female managers, eight of the 25 farm managers are non-Jordanians (6 Egyptians, 1 Sudanese and 1 Syrian), 88% of these farms have no family members living on-farm and the majority (68%) of the farmers rely heavily on farming income.
- **Farming system II (medium size holdings):** 89% of the farm managers are older than 31 years, the level of education of 75% is Tawjihi or less, no female farm manager, non-Jordanian managers represents 23% (Egyptians, Sudanese, Pakistani, and Iraqi), the overwhelming majority of these farms (99%) support on average 1-5 family members, and more than two thirds (69%) of the owners rely heavily on farming income.
- **Farming system III (large size holdings):** 88% of the managers are older than 31 years, the level of education of 57% of them is Tawjihi or less, there are no female farm manager, 50% of the managers are non-Jordanian (Egyptians, Syrian, Pakistani, Iraqi, and Sudanese), 93% of these farms support on average 1-5 family members, and 85% of the owners rely heavily on farming income.

Concluding remarks: As in the case of Amman Al-Zarqa, Al Azraq, Mafraq basins and Ramtha, the analysis of the socioeconomic characteristics of the three clusters in Al Jezeh Basin indicates that as the farm size increases, the farms in this basin tend to be more agribusiness oriented, and higher reliance on the farming income. No female managers were found in the whole basin. The age of the overwhelming majority of all farm managers across the three clusters is less than 60 years.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the three identified farming systems in Jezeh basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	25 Farms (16%)	76 Farms (48%)	58 Farms (36%)
Age	• 20% < 30 year • 36% 31-45 year • 36% 46 – 60 year • 8% > 60	• 11% < 30 year • 25% 31-45 year • 33% 46 – 60 year • 11% > 60	• 12% < 30 year • 53% 31-45 year • 26% 46 – 60 year • 9% > 60
Education	• 36% < Tawjihi • 36% Tawjihi • 20% University • 8% > University	• 43% < Tawjihi • 32% Tawjihi • 24% University • 1% > University	• 41% < Tawjihi • 16% Tawjihi • 40% University • 3% > University
Gender	• 25 males • 0 females	• 76 males • 0 female	• 58 males • 0 female
Nationality	• 17 Jordanian • 6 Egyptian • 1 Sudanese • 1 Syrian	• 52 Jordanian • 15 Egyptian • 1 Sudanese • 1 Pakistani • 1 Iraqi	• 31 Jordanian • 22 Egyptian • 1 Sudanese • 1 Syrian • 1 Iraqi • 1Pakistani
Number of family members supported	• 56% > support 3-5 • 36% support 1-5 • 8% support none	• 54% > 5 • 45% support 1-5 • 1% support none	• 36% support 1-5 • 57% support >5 • 7 % support None
Farming income proportion	• 68% > 80% of total income • 16% 20-80% of T. income • 16% < 20% of T. income	• 69% > 80% of total income • 21% 20-80% of T. income • 10% < 20% of T. income	• 85% > 80% of total income • 10% 20-80% of T. income • 5% < 20% of T. income
Number of family members live on the farm	• 88% No one • 12 % 3-5	• 75% No one • 7% 1-5 • 18% > 3-5	• 85 % No one • 3% 1-5 • 12% >5

13.2.2 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the three identified clusters of farms in Al Jezeh basin. Table 3 shows the frequency distributions of the related indicators for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** All of the farms of this system were owned before the year 2002 (only four farmers responded to this question), 72% of the farms are managed by operators, all of the farms' wells are artesian, all of the wells were installed after 1960 of which 61% were installed during the period 1960-90, the well capacity of 79% of the farms is less than 30 CM/hr, the level of salinity of 53% of the wells is less than 500 while 37% of the well's the salinity is within the range of 500-1000, the depth of 94% of the wells is more than 150 meters when installed, the total annual abstraction of the 25 farms under this farm system is estimated at 427 thousand CM, and the average annual abstraction is 18.7 thousand CM/well;
- **Farming system II (medium size holdings):** 83% of the farms were owned before the year 2002, only 22% of the farms managed by licensed owners while 60% are managed by operators, all of the farms' wells are artesian, all of the wells were installed after 1960, the well's capacity of 88% of the farms is in the range of 11-50 CM/hr, the level of salinity of 31% of the wells is less than 500 while the salinity of 59% of the wells is within the range of 500-1000, the depth of the wells when installed of all farms was more than 150 meters, the total annual abstraction under this farm system is estimated at 2.14 million CM, and the average annual abstraction of the farms is 28.9 thousand CM/well;
- **Farming system III (large size holdings):** All of the 25 farms were owned before the year 2002, 19% of the farms managed by licensed owners while 77% are managed by operators, all of the farms' wells are artesian, all wells in this cluster were installed after 1960, the well's capacity of 96% of the farms is within the range of 11-70 CM/hr, the level of salinity of 65% of the wells is less than 1000, the depth of the wells at the time of installment for 98% of the wells was greater than 150m, the total annual abstraction at the farms under this farm system is estimated at 2.14 million CM, and the average annual abstraction is 37 thousand CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the three identified clusters of farms indicates all wells in this basin are artesian, the majority of the farms are managed by operators, as the farm size increases the capacity of the well increases, the depth of the wells also increases and ultimately the volume of abstraction increases. This conclusion supports the remark of the previous section that as the size of the farm increases, farms in Al Azraq, AZ, Mafraq and Ramtha basins tend to be more agribusiness oriented, support more family members and exhibit higher reliance on farming income.
- According to the completed questionnaires, the total annual abstraction of water by the three farm systems amounts to 4.71 million cubic meters. This amount of water was used by 159 farmers to irrigate a sum of 37,421 du of which 23,802 is allocated for fruit trees and the remaining 13,619 du for vegetables and annual crops. This means that the average volume of water used per du is 126 cubic meters. However, studies on crop water requirement in the desert areas shows that the average water requirement per du of fruit trees is 307 cubic meter and 471 cubic meters for vegetables. Some studies on the Yarmouk basin estimated the water crop requirement for olives at 600 CM/du. If the lower bound crop water requirement is used, then the actual amount of water to irrigate the cultivated area in Al Jezeh basin is 13.7 million cubic meters which is almost three times higher than reported by the respondents.

- Water salinity of the overwhelming majority of the wells under the 3 farming system is lower than 1000. This is an indication that the water quality of this basin is better than in the Azraq, Mafraq and Amman-Zarqa basins.

Table 3 Frequency distribution of the farm and well characteristics for the three identified farming systems in Jezeh basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	25 Farms (16%)	76 Farms (48%)	58 Farms (36%)
Years of ownership of the well/Farm	• 0% < 10 year • 40% 11-25 year • 25% 26 – 40 year • 25 % > 40 *only 4 respondents	• 27 % < 10 year • 27 % 11-25 year • 18 % 26 – 40 year • 28 % > 40	• 0 % < 10 year • 25 % 11-25 year • 75 % 26 – 40 year • 0 % > 40
Farm Operator Status	• 16% License owner • 4% Renter • 72% Operator • 8% Others	• 22% License owner • 18 % Renter • 60 % Operator	• 19% License owner • 4% Renter • 77% Operator
Type of the wells	• 0% Shallow • 100 % Artesian	• 0 % Shallow • 100 % Artesian	• 0% Shallow • 100% Artesian
Year of well installation	• 0% before 1960 • 61% 1960-1990 • 26% 1991- 2000 • 13% after 2001	• 0% before 1960 • 75% 1960-1990 • 13% 1991- 2000 • 12% after 2001	• 0% before 1960 • 72% 1960-1990 • 22% 1991- 2000 • 6% after 2001
Well capacity (m3/hr)	• 25% Less than 10 • 54% 11-30 • 13% 31-50 • 8% more than 50	• 7 % Less than 10 • 46 % 11-30 • 42% 31-50 • 5% more than 50	• 2 % Less than 10 • 29 % 11-30 • 55 % 31-50 • 12 % 51-70 • 2 % more than 70
Level of water salinity once installed (EC)	• 53 % <= 500 • 26 % 501 - 1000 • 11 % 1001 – 1500 • 11 % > 1500	• 31 % <= 500 • 31 % 501 - 1000 • 28 % 1001 – 1500 • 10 % > 1500	• 36 % <= 500 • 29 % 501 - 1000 • 30 % 1001 – 1500 • 5 % > 1500
Well depth when installed (m)	• 4% 131 - 150 • 96% >150	• 100% >150	• 2 % 91 - 150 • 98 % >150
Total Abstraction CM	• 426,870	• 2,137,547	• 2,144,210
Average Abstraction CM/Farm	• 18,560	• 28,885	• 36,969

13.2.3 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Al Jezeh basin. The total cultivated area reported by the 159 farmers is 37,421 du of which 23,802 is cultivated with fruit trees and the remaining 13,619 du is cultivated with vegetables and annual crops. This section deals with the analysis of the dominant cropping pattern prevailing at the three identified clusters of farms in

this basin. Table 4 shows the distribution of the cultivated area among different crops for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** the dominant cultivated tree is olive for both pickling and for pressing purposes. 71% of the total farms area is cultivated with olive trees of which 31% is devoted for pressing and 41% for pickling. The rest of the farms' area is devoted to cauliflower 8%, tomato 5%, cucumber 3%, potato 2%, lettuce 2% and the remaining area of 6% is cultivated with other a variety of vegetables.
- **Farming system II (medium size holdings):** The allocated land for olive trees is much lower than system 1. Total olive trees area represents 45% of the total cultivated area of which 38% devoted to olive for pressing and 7% of picking olive. The table shows that there is a wide variety of cultivated vegetable crops dominated by tomato at 9%, followed by cauliflower at 8%, lettuce 6%, zucchini 5%, barley 4%, onion 4% and other crops 9%.
- **Farming system III (large size holdings):** The dominant cropping pattern in this cluster of large farms is olive trees which occupies around 64% of the total area. Other types of fruit trees represents only 4% of the total area. The remaining 32% of the cultivated area is allocated to vegetables and field crops of which barley occupies 10% followed by zucchini at 7%.

Concluding remarks: The analysis of the cropping pattern characteristics of the three identified clusters of farms indicates that olive is still the dominant tree in this basin especially in systems 1 and III. The area devoted to other fruit trees is negligible. There is a wide variety of cultivated vegetable crops and barley.

Table 4 Dominant cropping patterns for the three identified farming systems in Jezeh basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	25 Farms (16%)	**76 Farms (48%)**	**58 Farms (36%)**
Main fruit trees (% of the total cultivated area in du)	• 41 % Olive • 31 % Olive for pressing • 2% Grape	• 38% Olive for pressing • 7% Olive • 3 % Grape • 1 % Cactus • 1 % Peach	• 38 %Olive for pressing • 26 % Olive • 1 % Grape • 1% Apricot • 1% Apple • 1% Peach
Main vegetables and field crops (% of the total cultivated area in du)	• 8% Cauliflower • 5% Tomato • 3% Cucumber • 2% Pototo • 2% lettuce • 2% flowers • 4% other vegetables	• 9 % Tomato • 8 % Cauliflower • 6% Lettuce • 5% Zucchini • 4% Barley • 4% Onion • 1 % Capsicum • 1% Cucumber • 1% Cabbage • 1% Strawberry • 5 % others	• 10% Barley • 7 % Zucchini • 2 % Cupressus • 2 % Lettuce • 1% Capsicum • 1% Potato • 1% Cauliflower • 1% Eggplant • 4 % others

13.2.4 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the three identified clusters of farms. Table 5 shows the results of the analysis for the three farm categories. The table shows the following:

- **Farming system I (small size holdings):** The total amount of investment in the 25 farms is 4.4 million JD of which 99% are investments by the well owners and only 1% is invested by the renters. The average investment per farm is 191 thousand JD. The sum of the annual total operational costs for all farms of this category is 184 thousand JD while the average operational cost per du is 228 JD. The average gross margin per du for this cluster is 341 JD. As in the case of the other basins, there is a variance in the operational costs among the 25 farmers.
- **Farming system II (medium size holdings):** The total amount of investment in the 76 medium size farms is 13.5 million JD of which 88% are investments by the well owners and the remaining 12% are invested by the renters. The average investment per farm is 229 thousand JD. The sum of the annual total operational cost for all farms of this category is 2.2 million JD while the average operational cost per du is 242 JD. The average gross margin per du for this cluster is 446 JD.
- **Farming system III (large size holdings):** The total amount of investment in the 58 large size farms is 19.3 million JD of which 99% of the investments are by wells' owners. The average investment per farm is 357 thousand JD. The sum of the annual total operational cost for all farms of this category is 4.5 million JD while the average operational cost per du is 164 JD. The average gross margin per du for this cluster is 408 JD.

Concluding remarks:

The total invested capital in Al Jezeh basin is estimated at 37.2 million JD while the annual total operational costs amounted to 6.9 million JD. Figure 3 shows a comparison between the main three financial parameters used in the financial analysis among the three farming systems. The figure shows that the operational costs of system II (medium farm size) is the highest among the three systems. The gross margins are also the highest for system II. The three systems make positive gross margins but system 2 makes the highest which is also has the highest operational costs compared to the other two systems.

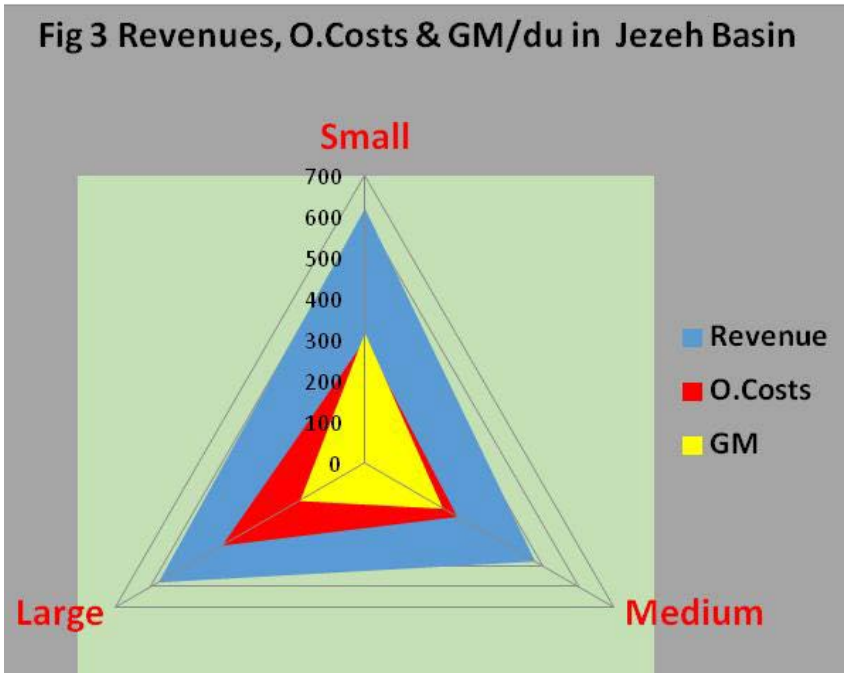


Table 5 Main Financial Indicators for the three identified farming systems in Jezeh basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	25 Farms (16%)	76 Farms (48%)	58 Farms (36%)
Total Investment Costs in JD – Wells' Owners and Renters	• 4,390,000	• 13,497,050	• 19,264,000
Total Investment Costs in JD – Wells' Owners	• 4,348,000	• 11,935,450	• 19,189,000
Total Investment Costs in JD – Wells' Renters	• 42,000	• 1,561,600	• 75,000
Average Investment Costs in JD/Farm	• 190,870	• 228,764	• 356,741
Total Operational Costs in JD	• 183,757	• 2,198,471	• 4,506,752
Average Operational Costs in JD/du	• 228	• 242	• 164
Total Revenues in JDs for all farms	• 470,002	• 6,249,323	• 15,695,671
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for all farms	• 274,575	• 4,056,851	• 11,233,918
Average Gross Margin in JD/du for all farms	• 341	• 446	• 408

13.2.5 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the three farming systems. The table concludes the following:

- **Farming system I (small size holdings):** The total number of hired labor of both permanent and daily categories in the 25 farms amounted to 29,900 work days/year. The farms under this system hire both Jordanians and non-Jordanians. The hired permanent laborers are only males. Average monthly wage to Jordanian permanent labor is 125 JD while the paid wage for non-Jordanian is 251 JD. More than 90% of the permanent labor is non-Jordanian. The total number of hired daily labor under this system amounted to 184 laborers (male and female). The daily rates of the Jordanian labor (both males and females) are lower than non-Jordanian.
- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 76 farms amounted to 85,136 work days/year. The farms under this system hire also both Jordanians and non-Jordanians. Hired permanent laborers include only males. Average monthly wage for Jordanian labor is 250 JD while the paid wage for non-Jordanian is 268 JD. The majority of permanent labor are non-Jordanians (90%). The hired Jordanian female daily labor is more than one-half of total hired daily female labor. The wage paid to Jordanian female daily laborers is much lower than what is paid for both Jordanian male and non-Jordanian labor.

- **Farming system III (large size holdings):** The total number of hired labor of both permanent and daily categories in the 58 farms amounted to 177,784 work days/year. As in the case of the other two farming systems, the farms under this system hire both Jordanians and non-Jordanians. However, non-Jordanian permanent labor represents the majority (95%). All of the hired permanent laborers are males. Average monthly wage paid to Jordanian labor is 276 JD while the paid wage for non-Jordanian is 254 JD. The number of Jordanian female daily laborers exceeds the number of Jordanian males but their daily rates are lower by almost 40% of what paid to male labor. On the contrary, the number of male non-Jordanian laborers is more than five folds of the female non-Jordanian labor. Daily rates paid to non-Jordanian female labor are equal to what paid to non-Jordanian males.

Concluding remarks:

- All permanent laborers in Al Jezeh basin are males (both Jordanians and non-Jordanians). The three framing systems rely heavily on non-Jordanian daily labor, however system 3 employs more of permanent non-Jordanian labor compared to the other two systems.
- Wages paid to daily non-Jordanian female and male laborers are higher than what is paid to Jordanians by an average of 30%.

Table 6 Main labor and Gender Indicators for the three identified farming systems in Jezeh basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	25 Farms (16%)	76 Farms (48%)	58 Farms (36%)
Permanent Jordanian (laborers No.) • **Male** • **Female**	 • 10 • 0	 • 28 • 0	 • 31 • 0
Wages of Permanent Jordanian (JD/Month) • **Male** • **Female**	 • 125 • 0	 • 250 • N/A	 • 275 • N/A
Permanent Non-Jordanian (laborers No.) • **Male** • **Female**	 • 82 • 0	 • 244 • 0	 • 537 • 0
Wages of Permanent Non- Jordanian (JD/Month) • **Male** • **Female**	 • 251 • 0	 • 268 • N/A	 • 254 • N/A
Daily Jordanian laborers (No.) • **Male** • **Female**	 • 95 • 15	 • 305 • 149	 • 441 • 496
Wages of Daily Jordanian (JD/day) • **Male** • **Female**	 • 12.1 • 1.11	 • 11.2 • 3.9	 • 10.4 • 6.4
Daily Non-Jordanian laborers (No.) • **Male** • **Female**	 • 74 • 0	 • 552 • 135	 • 865 • 147
Daily wage of Non-Jordanian (JD/day) • **Male** • **Female**	 • 14.2 • 0	 • 10.4 • 7.5	 • 9.6 • 9.8
Total number of working days /year	• 29,900	• 85,136	• 177,784

13.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

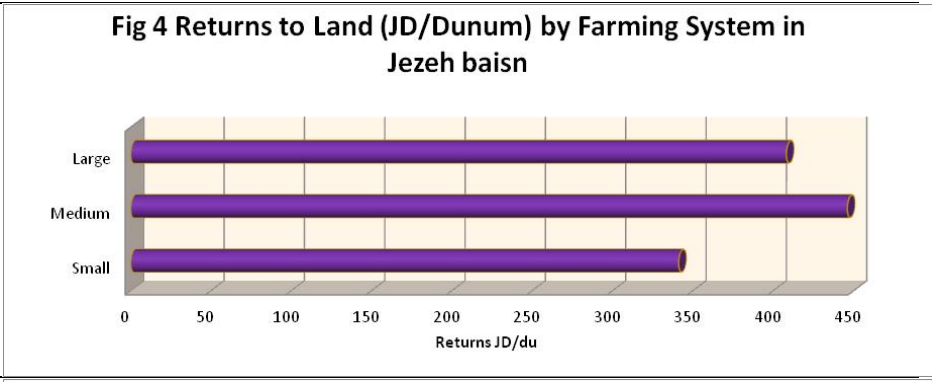
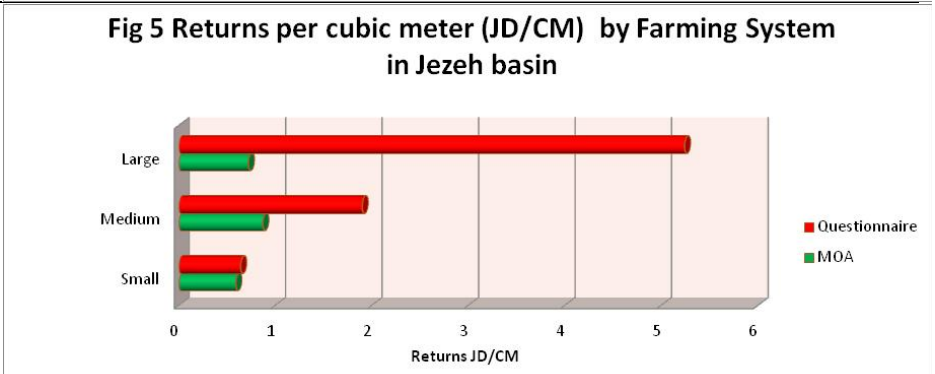
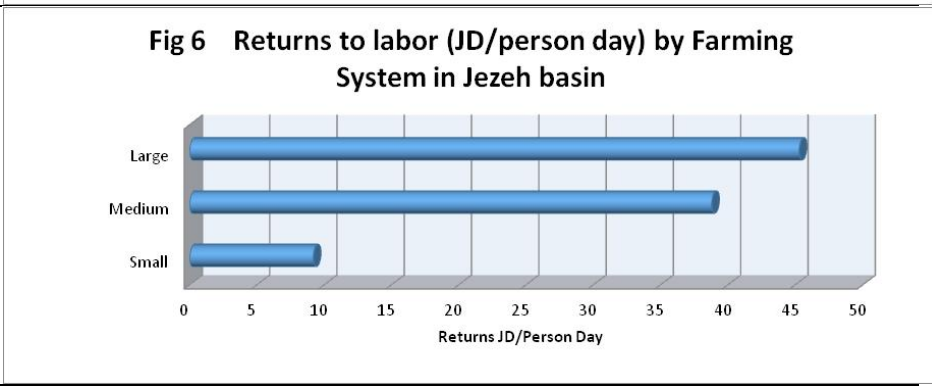
According to the completed questionnaires, the total annual abstraction of water by the 159 farms of the three farm clusters amounted to 4,708,627 cubic meters. This amount of water was used by only 159 farms in the basin to irrigate a sum of 37,421 du. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 159 farms that completed the questionnaire distributed by clusters. The table also shows the crop water requirement per du in Jezeh basin as estimated by the MOA (due to the unavailability of the crop water requirement for some of the crops, the researcher used the minimum water requirement for the same or similar crops cultivated in other basins in the uplands). As estimated in the table, the total amount of water required to irrigate the sum of the 37,421 du cultivated by the 64 farms is 20.8 million cubic meters which exceeds the total amounts of water reported by the farmers in the questionnaire by **more than four times.**

Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Jezeh basin

Main cultivated crop	Area by Cluster			Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Small	Medium	Large			
Olive for pressing	251	3475	10425	14,151	650	9,198,150
Olive	327	655	7113	8,095	650	5,261,750
Barley		395	2644	3,039	570	1,732,230
Zucchini		485	1968	2,453	236	578,908
Tomato	43	831	926	1,800	550	990,000
Cauliflower	65	727	325	1,117	380	424,460
Lettuce	17	568	445	1,030	208	214,240
Cupressus			500	500	400	200,000
Capsicum		97	400	497	332	165,004
Potato	18	75	400	493	368	181,424
Cucumber	21	135	305	461	293	135,073
Grape	15	236	154	405	350	141,750
Eggplant		39	315	354	575	203,550
Strawberry		100	250	350	500	175,000
Peach		75	260	335	475	159,125
Apricot	1	50	240	291	475	138,225
Onion	8	251		259	600	155,400
Flowers	15	30	150	195	500	97,500
Apple		17	160	177	475	84,075
different Seedings types			150	150	400	60,000
Cabbage	5	108	25	138	400	55,200
Cactus		100	2	102	100	10,200
Pomegranate			100	100	400	40,000
Corn		80		80	264	21,120
Different Vegetables		75		75	250	18,750
Plum		45	25	70	475	33,250
Garlic		63		63	600	37,800
Watermelon		61		61	500	30,500
Other veg and Fruits	20	325	235	580	400	232,000
	806	**9,098**	**27,517**	**37,421**		**20,774,684**

13.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the three farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

Farming system II (medium farms) is the most efficient in terms of returns to land resource followed by System III.	
Farming system III (large farms) is the most efficient in terms of economic water use efficiency followed by system II. However, when MOA figures are used the coefficients changes dramatically especially for large farms	
Farming system III (large farms) is the most efficient in terms of economic returns to labor followed by system II.	

Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, the average return per cubic meter of water in the highlands ranged between 0.48 – 0.05 JD for fruit trees while it ranged between 1.33-0.33 for vegetables. It is clear from the above Figure 5 and table 8 that the estimated returns to water indicator for farming systems II and III are higher than the ranges estimated by the water valuation study while the returns to water for farming system I falls within the range of the study. These estimates become much lower when the

actual crop water requirements are used to estimate the volumes of abstracted water, especially in large farms.

Table 8 Main economic efficiency indicators for the three identified farming systems in Jezeh basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	25 Farms (16%)	76 Farms (48%)	58 Farms (36%)
• Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)	341	446	408
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)	0.64	1.9	5.24
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water requirement as per MOA in CM)	0.59	0.87	0.72
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	9.2	38.8	45.3

14 Appendix VII: Karak Basin

14.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 27 respondents in Karak Basin out of the visited 32 operating wells. Figure 2 indicates that more than two thirds of the surveyed farms in Karak are of the medium size (System II: more than 50 du and smaller than 200 du). However, it should be stated here that Karak basin is different from the other basins in terms of the little number of small farms and almost one-fifth are large farms that exceeds 200 du in size, consequently, the analysis of this basin was limited to size II and size III clusters.

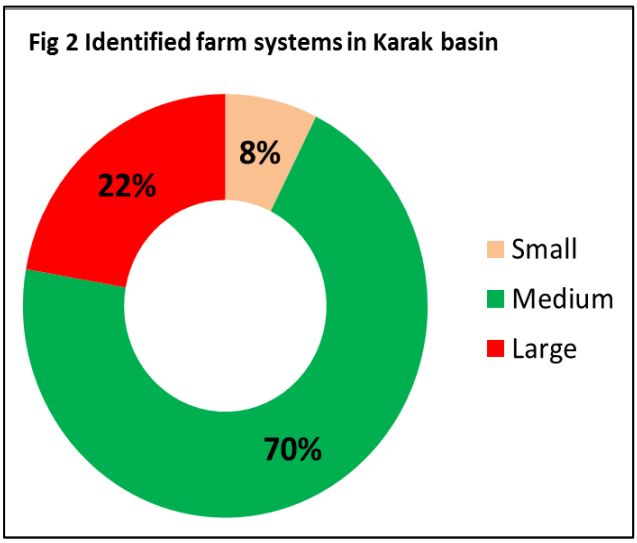


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Karak) basin

Water Basin	Karak				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	% of farm size within the groundwater basin	% of the farm size within all basins	% of Total sum of farms in all basins	Number of farms in all basins	% of farm size within all basins	% of the farm size in all basins	% of Total sum of farms in all basins
<= 50.00	2	7%	1%	0%	396	31%	100%	31%
50.01 - 100.00	10	37%	4%	1%	227	18%	100%	18%
100.01 - 150.00	7	26%	5%	1%	143	11%	100%	11%
150.01 - 200.00	2	7%	2%	0%	122	10%	100%	10%
200.01 - 250.00	2	7%	3%	0%	67	5%	100%	5%
250.01 - 300.00	0	0%	0%	0%	74	6%	100%	6%
300.01 - 350.00	0	0%	0%	0%	34	3%	100%	3%
350.01 - 400.00	1	4%	2%	0%	49	4%	100%	4%
400.01 - 450.00	1	4%	3%	0%	32	3%	100%	3%
450.01 - 500.00	0	0%	0%	0%	26	2%	100%	2%
500.01 - 600.00	0	0%	0%	0%	21	2%	100%	2%
600.01 - 700.00	0	0%	0%	0%	16	1%	100%	1%
700.01 - 800.00	0	0%	0%	0%	20	2%	100%	2%
800.01 - 900.00	0	0%	0%	0%	5	0%	100%	0%
900.01 - 1000.00	1	4%	14%	0%	7	1%	100%	1%
1000.01+	1	4%	3%	0%	31	2%	100%	2%
Total	27	100%	2%	2%	1270	100%	100%	100%

14.2 DESCRIPTION OF FARMING SYSTEMS

14.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the major two identified farm sizes.

- **Farming system II (medium size holdings):** about one-half of the farm managers are younger than 46 years of age, the level of education of 52% of the managers is high school or less, there are no female managers, about one-fourth of the farm managers are non-Jordanians, 76% of the farms have no family members living on the farm and only 38% of the farmers rely heavily on farming income (80% of the total income).
- **Farming system III (large size holdings):** 66% of the farm managers are within the age group of 31-60 years, the level of education of 83% of them is Tawjihi or less, no female farm managers, only one farm is managed by a non-Jordanian, the majority of these farms (83%) support more than 5 family members, and only one farm out of the 6 farms in this cluster relies heavily on farming income.

Concluding remarks: Despite the fact that the majority of the farms falls within system II (medium size), the analysis of the socioeconomic characteristics of the two clusters in Karak basin indicates that as the majority of the 27 farmers do not heavily rely on the farming income. No female manager was found in the whole basin. The age of the overwhelming majority of all farm managers across the two clusters is less than 60 years.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the two identified farming systems in Karak basin

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)
	21 Farms (78%)	6 Farms (22%)
Age	• 14% < 30 year • 29% 31-45 year • 33% 46 – 60 year • 24 % > 60	• 33% 31-45 year • 33% 46 – 60 year • 33% > 60
Education	• 28% < Tawjihi • 24% Tawjihi • 48% University • 0 % > University	• 17% < Tawjihi • 66% Tawjihi • 17% University
Gender	• 21 males • 0 females	• 6 males • 0 female
Nationality	• 17 Jordanian • 2 Egyptian • 2 Pakistani	• 5 Jordanian • 1 Egyptian
Number of family members supported	• 90% > support >5 • 5% support 1-5 • 5% None	• 83% > 5 • 17% support 1-5
Farming income proportion	• 38% > 80% of total income	• 20% > 80% of total income

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)
	21 Farms (78%)	6 Farms (22%)
	• 14% 20-80% of T. income • 48% < 20% of T. income	• 60% 20-80% of T. income • 20% < 20% of T. income
Number of family members live on the farm	• 76 % No one • 5 % 1-5 • 19 % > 3-5	• 83% No one • 17% >5

14.2.2

14.2.3 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the two identified clusters of farms in Karak basin. Table 3 shows the frequency distributions of the related indicators for the two farm categories. The table reveals the following:

- **Farming system II (medium size holdings):** almost one-half of the farms are managed by operators, all of the farms' wells are artesian, three fourths of the wells were installed during 1960-1990, 85% of the wells capacity is within the range of 11-50 CM/hr, the level of salinity of 27% of the well's is below 500 while the salinity of 45% is within the range of 501-1500, the depth of 85% of the wells is within the range of 31-110 meters when installed, the total annual abstraction of the 21 farms under this farm system is estimated at 643 thousand CM, and the average annual abstraction is 33.8 thousand CM/well;
- **Farming system III (large size holdings):** 67% of the farms are managed by operators, all of the farms' wells are artesian, the majority of the wells (67%) were installed before 1990, the well capacity of 83% of the farms is within the range of 31-70 CM/hr, the level of salinity of one-half of the wells is less than 500, the depth of 64% of the wells is more than 150 meters when installed, the total annual abstraction of the 6 farms under this farm system is estimated at 218 thousand CM, and the average annual abstraction is 36.4 thousand CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the two identified clusters of farms indicates that all wells in this basin are artesian; the majority of the farms are managed by operators. A large portion of the wells' salinity is less than 500 which indicates that the water quality in this basin in good.

Table 3 Frequency distribution of the farm and well characteristics for the two identified farming systems in Karak basin

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)

	21 Farms (78%)	6 Farms (22%)
Years of ownership of the well/Farm	• 5% > 40 • (only 1 respondent)	• 17 % > 11-25 (only 1 respondent)
Farm Operator Status	• 33% License owner • 19 % Renter • 43 % Operator • 5% MOA	• 33% License owner • 67 % Operator
Type of the wells	• 0% Shallow • 100 % Artesian	• 0 % Shallow • 100 % Artesian
Year of well installation	• 6% before 1960 • 75% 1960-1990 • 12% 1991- 2000 • 7% after 2001	• 17% 1960-1970 • 50% 1970- 1990 • 33% after 1991
Well capacity (m3/hr)	• 5% Less than 10 • 40% 11-30 • 45% 31-50 • 10% more than 50	• 17 % 11-30 • 50% 31-50 • 33% 51 - 70
Level of water salinity once installed (EC)	• 27% <= 500 • 27 % 501 - 1000 • 18 % 1001- 1500 • 28 % 1001 – 2000	• 50% <= 500 • 25 % 1500- 2000 • 25 % > 2000
Well depth when installed (m)	• 15 % <= 30 • 30 % 31 - 110 • 55 % > 110	• 17 % 31 – 50 • 17 % 90 - 110 • 64 % > 150
Total Abstraction CM	• 642,515	• 218,220
Average Abstraction CM/Farm	• 33,816.	• 36,370

14.2.4 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Karak basin. The total cultivated area reported by the 27 farms (respondents) in the basin is 6,198 du of which 4,079 du is allocated for trees and the remaining 2,119 du for vegetables and annual crops. Out of the 4,079 du of trees a sum of 1,881 du are planted with Cupressus and Pine trees. Table 4 shows the distribution of the cultivated area among different crops for the two farm categories. The table reveals the following:

- **Farming system II (medium size holdings):** the total cultivated area in this cluster is 2,057 du. The dominant cultivated tree is olive for pickling and pressing (27%) followed by grape and banana. The rest of the farms' area is devoted to vegetables mainly tomato (35%), watermelon (8%), cucumber (3%) and other crops (9%).
- **Farming system III (large size holdings):** The allocated land under this cluster is 4,141 du of which 1700 du are cultivated with Cupressus and Pine trees. Olive trees are the dominant fruit trees occupying 29% followed by decoration trees (27%) and Cupressus (14%) of the total cultivated area. The table shows that there are large number of vegetables cultivated in this cluster of which tomato is the dominant crop at 13% of the total area followed by alfalfa 3%.

Concluding remarks: The analysis of the cropping pattern characteristics of the two identified clusters of farms indicates that Cupressus , Pine and Olive trees occupies more than one half of the

total cultivated area in Karak basin. It is not clear if Cuperessus and Pine trees are cultivated under full irrigation or supplemental irrigation. Tomato is the major vegetable crop which occupies 21% of the total cultivated in the two clusters.

Table 4 Dominant cropping patterns for the two identified farming systems in Karak basin

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)
	21 Farms (78%)	6 Farms (22%)
Main fruit trees (% of the total cultivated area in du)	• 16 % Olive • 11 % Olive for pressing • 3 % Grape • 3 % Banana • 3 % Peach • 2 % Pistachio • 2 % Almond • 5 % Other	• 29 % Olive • 27% Decoration trees • 14% Cupressus • 4 % Olive for pressing • 1% Banana
Main vegetables and field crops (% of the total cultivated area in du)	• 35% Tomato • 8% Watermelon • 3% Cucumber • 2% Barley • 2% zucchini • 5% other vegetables	• 13% Tomato • 3% Alfalfa • 2% Cautery • 1 % Barley • 1 % Cantaloupe • 1% Watermelon • 1% Wheat • 13% other vegetables

14.2.5 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the two identified clusters of farms. Table 5 shows the results of the analysis for the two farm categories. The table shows the following:

- **Farming system II (medium size holdings):** The total amount of investment in the 21 farms is 3.33 million JD by the well owners and renters. The average investment per farm is 234 thousand JD. The sum of the annual total operational costs for all farms of this category is 525.4 thousand JD while the average operational cost per du is 255 JD. The average gross margin per du for this cluster is 445 JD.
- **Farming system III (large size holdings):** The total amount of investment in the 6 farms is 945 thousand JD invested all by the wells' owners and renters. The average investment per farm is 189 thousand JD. The sum of the annual total operational cost for all farms of this category is 548.2 thousand JD while the average operational cost per du is 224 JD. The average gross margin per du for this cluster is 383 JD.

Concluding remarks:

The total invested capital in Karak basin (of the 27 respondents) is estimated at 4.3 million JD while the annual total operational costs amounted to 1.074 million JD. Figure 3 shows a comparison between the main three financial parameters used in the financial analysis among the two farming systems. The figure shows that the operational costs of both systems are almost the same. However, the gross margins are the highest for system II which is clearly due to the high revenues compared to

system III. The two systems make positive gross margins but system 2 makes the highest margins. It should be noted here that the costs and revenues of the pine and the Cupressus trees were not considered in the analysis since the respondents did not provide any data on this two types of threes which represent 41% of the total cultivated area of cluster II farms.

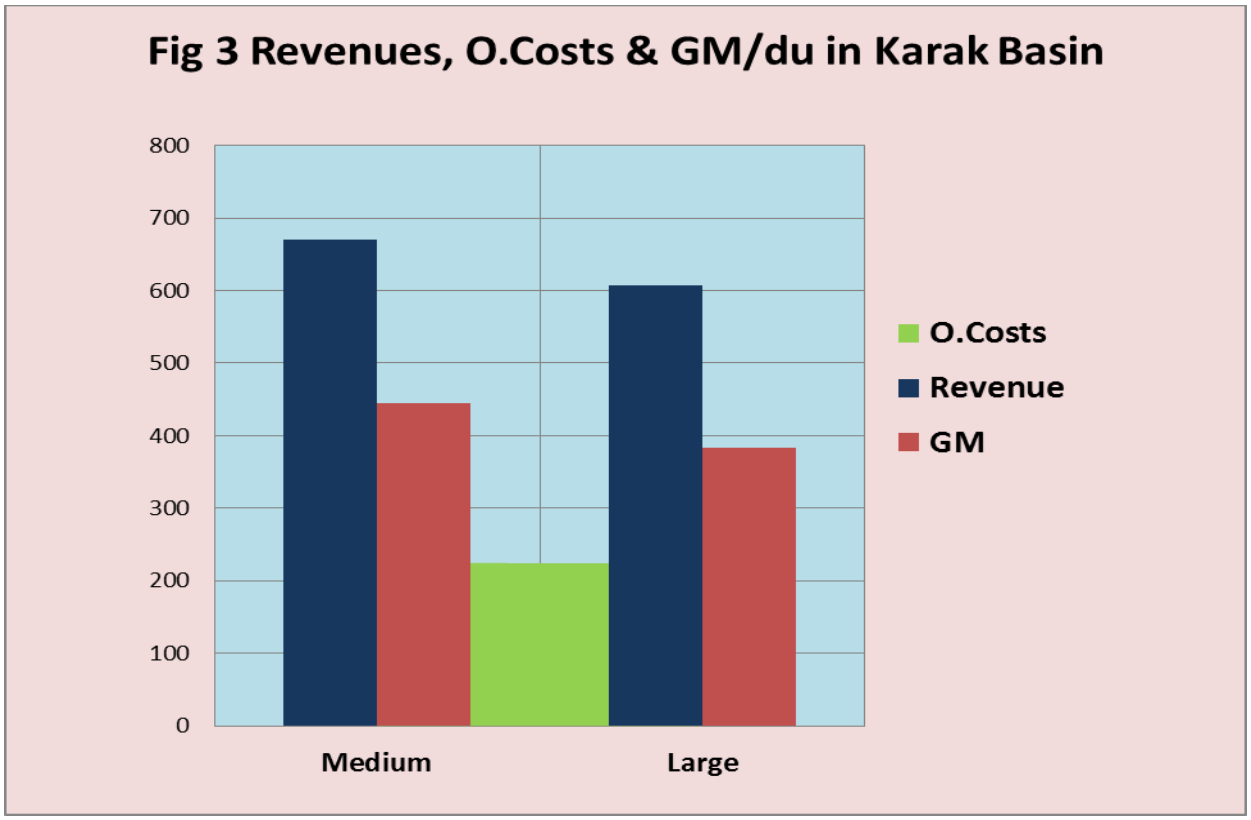


Table 5 Main Financial Indicators for the two identified farming systems in Karak basin

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)
	21 Farms (78%)	6 Farms (22%)
Total Investment Costs in JD – Wells' Owners and Renters	• 3,331,500	• 945,000
Total Investment Costs in JD – Wells' Owners	• 3,175,500	• 945,000
Total Investment Costs in JD – Wells' Renters	• 156,000	
Average Investment Costs in	• 237,964	• 189,000

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)
	21 Farms (78%)	6 Farms (22%)
JD/Farm		
Total Operational Costs in JD	• 525,400	• 548,237
Average Operational Costs in JD/du	• 255	• 224
Total Revenues in JDs for all farms	• 1,442,536	• 1,484,180
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for all farms	• 917,135	• 935,943
Average Gross Margin in JD/du for all farms	• 445	• 383

14.2.6 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the two farming systems. The table concludes the following:

- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 26 farms amounted to 34,262 work days/year. The farms under this system hire both Jordanians and non-Jordanians. The hired Jordanian permanent laborers include both males and females. Average monthly wage to Jordanian male permanent labor is 260 JD while the paid wage for non-Jordanian is 287 JD. The hired permanent Jordanian laborers are equal to the hired non-Jordanian. The total number of hired daily labor under this system amounted to 215 male laborers and 86 female laborers. The daily rates of the Jordanian laborers of both males and females are lower than non-Jordanian.
- **Farming system III (large size holdings):** The total number of hired labor of both permanent and daily categories in the 6 farms amounted to 55,124 work days/year. The farms under this system hire also both Jordanians and non-Jordanians. Hired permanent laborers include only males. Average monthly wage for Jordanian labor is 250 JD while the paid wage for non-Jordanian is 300 JD. The majority of permanent labors are non-Jordanians. More than 85% of the hired Jordanian daily labor is non-Jordanian. All of the female daily labor is non-Jordanian. The wage paid to Jordanian daily laborers is higher than what is paid for non- Jordanian.

Concluding remarks:

- Permanent laborers in Karak basin include only males. The two framing systems rely heavily on non-Jordanian daily labor; however system II employs more of permanent Jordanian labor compared to system III.
- Wages paid to daily non-Jordanian male laborers in System II is lower than what is paid by System III.

Table 6 Main labor and Gender Indicators for the two identified farming systems in Karak

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)
	21 Farms (78%)	6 Farms (22%)
Permanent Jordanian (laborers No.) • **Male** • **Female**	 • 48 • 0	 • 15 • 0
Wages of Permanent Jordanian (JD/Month) • **Male** • **Female**	 • 260 • 0	 • 250 • 0
Permanent Non-Jordanian (laborers No.) • **Male** • **Female**	 • 48 • 0	 • 26 • 0
Wages of Permanent Non- Jordanian (JD/Month) • **Male** • **Female**	 • 287 • 0	 • 300 • 0
Daily Jordanian laborers (No.) • **Male** • **Female**	 • 112 • 71	 • 55 • 0
Wages of Daily Jordanian (JD/day) • **Male** • **Female**	 • 9.4 • 5.1	 • 12.7 • 4.9
Daily Non-Jordanian laborers (No.) • **Male** • **Female**	 • 103 • 15	 • 308 • 18
Daily wage of Non-Jordanian (JD/day) • **Male** • **Female**	 • 11.4 • 5.0	 • 9.0 • 9.0
Total number of working days /year	• 34,262	• 55,124

14.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

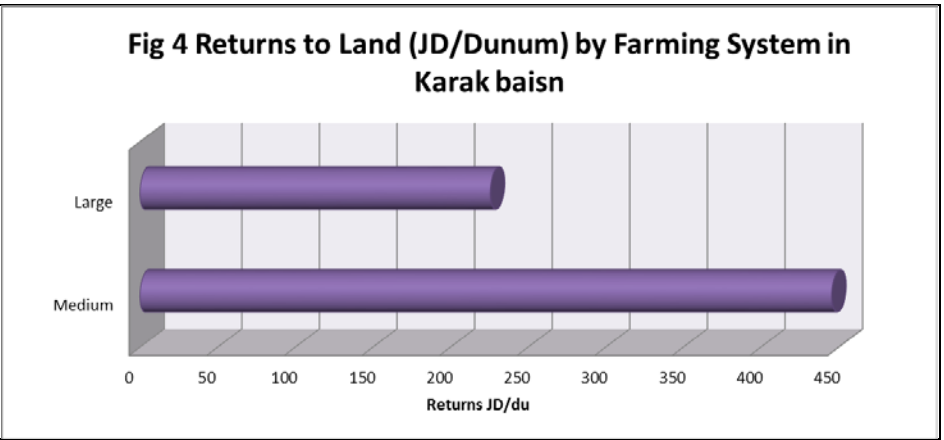
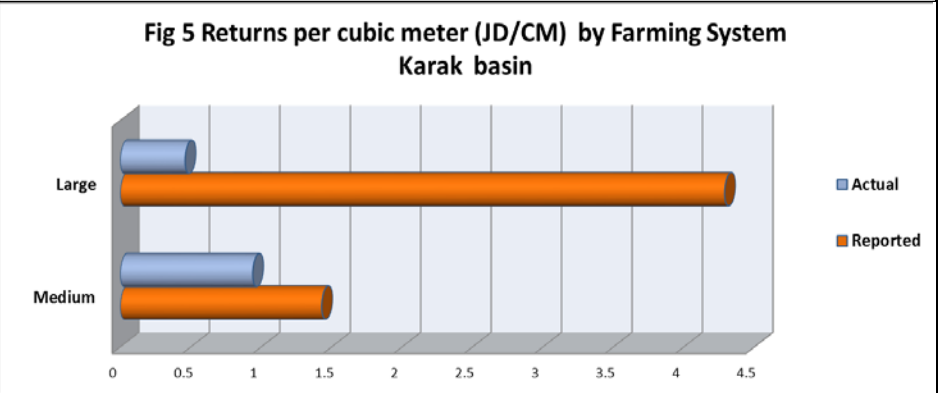
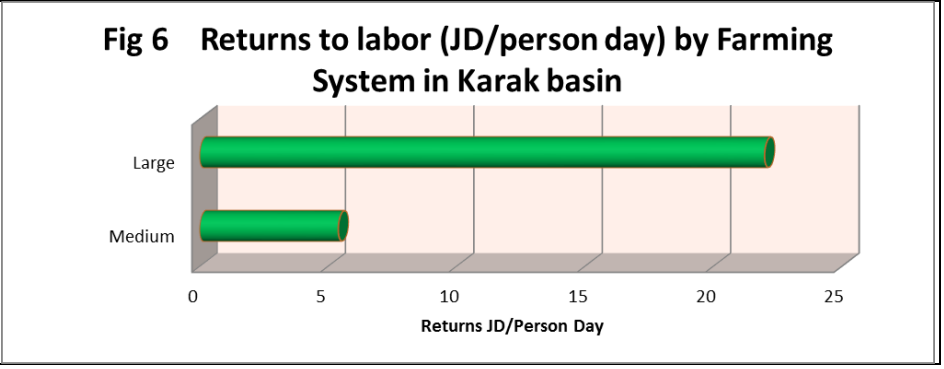
According to the completed questionnaires, the total annual abstraction of water by the 27 farms of the two farm clusters amounted to 860,735 cubic meters. This amount of water was used by only 27 farms in the basin to irrigate a sum of 6,167 du. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 27 farms that completed the questionnaire. The table also shows the crop water requirement per du in Karak basin as estimated by the MOA (due to the unavailability of the crop water requirement for Decoration/ornamental trees and cupressus trees, the researcher used the minimum water requirement for the trees in the region). As estimated in the table, the total amount of water required to irrigate the sum of the 6,167 du cultivated by the 27 farms is 3 MCM which exceeds the total amounts of water reported by the farmers in the questionnaire by more than three folds.

Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Karak basin

Main cultivated crop	Area in Dunum		Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Medium	Large			
Olive	331	1196	1527	650	992,550
Tomato	726	555	1281	280	358,680
Decoration trees	0	1100	1100	400	440,000
Cupressus	0	600	600	400	240,000
Olive for pressing	225	170	395	650	256,750
Watermelon	170	50	220	370	81,400
Alfalfa		120	120	780	93,600
Cautery		100	100	300	30,000
Barley	45	54	99	570	56,430
Banana	57	30	87	1454	126,498
Grape	64	4	68	798	54,264
Cantaloupe	15	50	65	370	24,050
Cucumber	59	5	64	293	18,752
Peach	56		56	500	28,000
Wheat		50	50	650	32,500
Pistachio	45		45	500	22,500
Almonds	36		36	500	18,000
Zucchini	35		35	156	5,460
Apricot	31		31	500	15,500
Lemon	30		30	918	27,540
Common bean	3	22	25	19	475
Arecaceae (Palm)	6	15	21	1222	25,662
Capsicum	21		21	332	6,972
Onion	20		20	675	13,500
Corchorus		20	20	300	6,000
Apple	17		17	500	8,500
Pomegranate	13		13	500	6,500
Cauliflower	11		11	281	3,091
Eggplant	10		10	575	5,750
Total	**2,026**	**4,141**	**6,167**		**2,998,924**

14.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the two farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

Farming system II is more efficient in terms of returns to land resource than System III.	
Farming system III (large farms) is the more efficient in terms of economic water use efficiency. However, when actual water requirements (MOA) are used, System III become less efficient than system II	
Farming system III (large farms) is the most efficient in terms of return to labor followed by system II (medium).	

Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, water values in Middle Jordan Valley have the highest value of about (JD 1.1/m^3), Safi, and northern governorates are among the highest value of about (JD 1/m^3). This conclusion is correct when the stated amounts of abstracted water in the questionnaire are used in the analysis as indicated in figure 5 above and in table 8. However, when the actual water requirements are used, the economic returns to water for cluster II and III become 0.94 JD/CM and 0.46 JD/CM, respectively.

Table 8 Main economic efficiency indicators for the two identified farming systems in Karak basin

Indicator	Farm System II (40 - 200 du)	Farm System II (>200 du)
	21 Farms (78%)	6 Farms (22%)
• Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)	446	383
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)	1.43	4.29
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water requirement as per MOA in CM)	0.94	0.46
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	26.8	17.0

15 Appendix VIII: Ma'an Basin

15.1 PROPERTIES OF FARM SIZE

Table 1 shows the detailed breakdown of the visually binned "managed farm size" variable. The distribution is based on the ranges of the farm sizes of the 64 respondents in Ma'an Basin out of the visited 101 farms. Figure 2 indicates that almost one-half of the surveyed farms in Ma'an are of the size of the large size (System III: larger than 200 du). However, it should be stated here that Ma'an basin is different from the other basins in terms of the large-scale commercial farms that use deep wells for irrigating a variety of vegetables, forage crops and fruit trees. As indicated in table 1, the size of the cultivated area of a significant proportion of the large farms cluster exceeds 600 du. The table shows that farms exceed 900 du in size represent a sum of 45% of the total surveyed farms. The Figure also shows that the small farm size (System 1) represents only 17% while the medium farms represent (System II) 34% of the total surveyed farms.

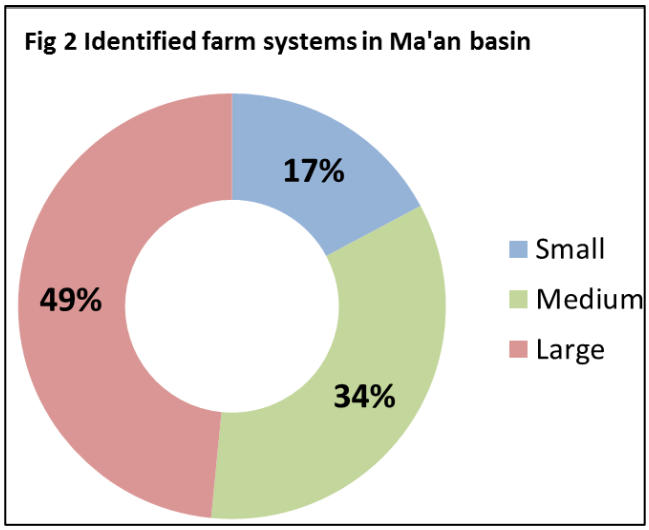


Table 1 Distribution of the completed questionnaire by Groundwater Basin (Ma'an) basin

Water Basin	Ma'an				Total of all Basins			
Managed Farm Size in Dunum	Number of farms in the basin	% of farm size within the groundwater basin	% of the farm size within all basins	% of Total sum of farms in all basins	Number of farms in all basins	% of farm size within all basins	% of the farm size in all basins	% of Total sum of farms in all basins
<= 50.00	11	17%	3%	1%	396	31%	100%	31%
50.01 - 100.00	8	13%	4%	1%	227	18%	100%	18%
100.01 - 150.00	6	9%	4%	0%	143	11%	100%	11%
150.01 - 200.00	8	13%	7%	1%	122	10%	100%	10%
200.01 - 250.00	5	8%	7%	0%	67	5%	100%	5%
250.01 - 300.00	6	9%	8%	0%	74	6%	100%	6%
300.01 - 350.00	2	3%	6%	0%	34	3%	100%	3%
350.01 - 400.00	2	3%	4%	0%	49	4%	100%	4%
400.01 - 450.00	3	5%	9%	0%	32	3%	100%	3%
450.01 - 500.00	1	2%	4%	0%	26	2%	100%	2%
500.01 - 600.00	1	2%	5%	0%	21	2%	100%	2%
600.01 - 700.00	2	3%	13%	0%	16	1%	100%	1%
700.01 - 800.00	2	3%	10%	0%	20	2%	100%	2%
800.01 - 900.00	0	0%	0%	0%	5	0%	100%	0%
900.01 - 1000.00	2	3%	29%	0%	7	1%	100%	1%
1000.01+	5	8%	16%	0%	31	2%	100%	2%
Total	64	100%	5%	5%	**1270**	**100%**	**100%**	**100%**

15.2 DESCRIPTION OF FARMING SYSTEMS

15.2.1 SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

This section deals with the analysis of the most frequently used socioeconomic indicators in this type of analysis. Table 2 shows the frequency distributions of the following indicators for the three identified farm sizes.

- **Farming system I (small size holdings):** more than one-half of the farm managers are younger than 46 years of age (70%), their level of education is high school or more (70%), there are no female managers, all of the 11 farm managers are Jordanians, none of these farms have family members living on-farm and only 25% of the farmers rely heavily on farming income.
- **Farming system II (medium size holdings):** 82% of the farm managers are older than 31 years, the level of education of 60% is Tawjihi or less, no female farm manager, non-Jordanian managers represents 25% (4 Egyptians and 1 Syrian), the majority of these farms (77%) support more than 5 family members, and more than two thirds (73%) of the owners rely heavily on farming income.
- **Farming system III (large size holdings):** 87% of the managers are older than 31 years, the level of education of 64% of them is more than Tawjihi, there are no female farm manager, more than 40% of the managers are non-Jordanian (Egyptians, Syrian, and Palestinian), 90% of these farms support on average 1-5 family members, and 73% of the owners rely heavily on farming income.

Concluding remarks: The farming systems in this Ma'an basin are different in two matters: 1) the size of the large farms compared to other basins and 2) as explained later the cropping patters. As in the case of other farms in the uplands, , the analysis of the socioeconomic characteristics of the three clusters in Ma'an Basin indicates that as the farm size increases, the farms in this basin tend to be more agribusiness oriented (especially in cluster III), and higher reliance on the farming income. No female managers were found in the whole basin. The age of the overwhelming majority of all farm managers across the three clusters is less than 60 years.

Table 2 Frequency distribution of socioeconomic and demographic characteristics for the three identified farming systems in Ma'an basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
Age	• 10% < 30 year • 60% 31-45 year • 10% 46 – 60 year • 20% > 60	• 18% < 30 year • 23% 31-45 year • 41% 46 – 60 year • 18% > 60	• 13% < 30 year • 48% 31-45 year • 29% 46 – 60 year • 10% > 60
Education	• 40% < Tawjihi • 10% Tawjihi • 50% University • 10% > University	• 32% < Tawjihi • 27% Tawjihi • 41% University • 0% > University	• 36% < Tawjihi • 10% Tawjihi • 54% University • 0% > University
Gender	• 10 males • 0 females	• 22 males • 0 female	• 58 males • 0 female
Nationality	• 10 Jordanian	• 17 Jordanian • 4 Egyptian • 1 Syrian	• 22 Jordanian • 6 Egyptian • 2 Syrian • 1 Palestinian
Number of family members supported	• 67% > support >5 • 33% support 1-5	• 77% > 5 • 23% support 1-5	• 32% support 1-5 • 58% support >5 • 10% support None
Farming income proportion	• 25% > 80% of total income • 38% 20-80% of T. income • 37% < 20% of T. income	• 73% > 80% of total income • 22% 20-80% of T. income • 5% < 20% of T. income	• 73% > 80% of total income • 14% 20-80% of T. income • 13 % < 20% of T. income
Number of family members live on the farm	• 100% No one	• 73% No one • 14% 1-5 • 13% > 3-5	• 52 % No one • 29 % 1-5 • 19 % >5

15.2.2 FARM AND WELL CHARACTERISTICS

This section deals with the analysis of the farm and well characteristics of the three identified clusters of farms in Ma'an basin. Table 3 shows the frequency distributions of the related indicators for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** 50% of the farms of this system were owned before the year 2002 (only two farmers responded to this question), 78% of the farms are managed by operators, all of the farms' wells are artesian, all of the wells were installed after 1960 of which 50% were installed during the period 1960-90, the well capacity of 30% of the farms is less than 10 CM/hr while the remaining 70% of the farms the capacity is within the range of 11-50 CM/hr, the level of salinity of 50% of the wells is less than 500 while 34% of the well's the salinity is within the range of 500-1000, the depth of 60% of the wells is more than 150 meters when installed, the total annual abstraction of the 10 farms under this farm system is estimated at 197.4 thousand CM, and the average annual abstraction is 19.7 thousand CM/well;
- **Farming system II (medium size holdings):** 50% of the farms were owned before the year 2002, 68% of the farms are managed by operators, all of the farms' wells are artesian, all of the wells were installed after 1960 of which 60% were installed during the period 1960-90, the well capacity of 73% of the farms is within the range of 11-50 CM/hr, the level of salinity of 73% of the wells is less than 500 while the remaining 27% of the well's the salinity is within the range of 500-1000, the depth of 73% of the wells is more than 150 meters when installed, the total annual abstraction of the 20 farms under this farm system is estimated at 749.4 thousand CM, and the average annual abstraction is 34.1 thousand CM/well;
- **Farming system III (large size holdings):** 75% of the farms of this cluster were owned before the year 2002, 13% of the farms managed by licensed owners while 77% are managed by operators, all of the farms' wells are artesian, 96% of the wells in this cluster were installed after 1960, the well's capacity of 90% of the farms is more than 30 CM/hr, the level of salinity of 77% of the wells is less than 500, the depth of wells at the time of installment of 94% of the wells was greater than 150 m, the total annual abstraction at the farms under this farm system is estimated at 2.17 million CM, and the average annual abstraction is 75 thousand CM/well;

Concluding remarks:

- The analysis of the farm and well characteristics of the three identified clusters of farms indicates all wells in this basin are artesian; the majority of the farms are managed by operators, as the farm size increases the capacity of the well increases, the depth of the wells also increases and ultimately the volume of abstraction increases. The large-scale farms which represent about one-half of the respondents in this basin are business-oriented farms that use deep wells for cultivating vegetable crops, field crops and fruits.
- According to the completed questionnaires, the total annual abstraction of water by the three farm systems amounts to 3.12 million cubic meters. This amount of water was used by only 64 farms in the basin to irrigate a sum of 38,327 du of which 19,440 is allocated for fruit trees and the remaining 18,887 du for vegetables and annual crops. This means that the average volume of water used per du is 81.4 cubic meters.
- Water salinity of the overwhelming majority of the wells under the 3 farming system is lower than 500. This is an indication that the water quality of this basin is better than in the Azraq, Mafraq and Amman-Zarqa basins.

Table 3 Frequency distribution of the farm and well characteristics for the three identified farming systems in Ma'an basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
Years of ownership of the well/Farm	• 50% < 10 year • 0% 11-25 year • 0% 26 – 40 year • 50% > 40 *only 2 respondents	• 50 % < 10 year • 25 % 11-25 year • 25 % 26 – 40 year • 0 % > 40	• 25 % < 10 year • 50 % 11-25 year • 25 % 26 – 40 year • 0 % > 40
Farm Operator Status	• 22% License owner • 0% Renter • 78% Operator	• 32% License owner • 0 % Renter • 68 % Operator	• 13% License owner • 10% Renter • 77% Operator
Type of the wells	• 0% Shallow • 100 % Artesian	• 0 % Shallow • 100 % Artesian	• 0% Shallow • 100% Artesian
Year of well installation	• 0% before 1960 • 50% 1960-1990 • 30% 1991- 2000 • 20% after 2001	• 0% before 1960 • 60% 1960-1990 • 30% 1991- 2000 • 10% after 2001	• 4% before 1960 • 50% 1960-1990 • 29% 1991- 2000 • 17% after 2001
Well capacity (m3/hr)	• 30% Less than 10 • 40% 11-30 • 30% 31-50 • 0% more than 50	• 14 % Less than 10 • 41 % 11-30 • 32% 31-50 • 13% more than 50	• 0 % Less than 10 • 10 % 11-30 • 38 % 31-50 • 28 % 51-70 • 24 % more than 70
Level of water salinity once installed (EC)	• 50 % <= 500 • 17 % 501 - 1000 • 17 % 1001 – 1500 • 16 % > 1500	• 73 % <= 500 • 18 % 501 - 1000 • 9 % 1001 – 1500 • 0 % > 1500	• 77 % <= 500 • 18 % 501 - 1000 • 5 % > 1500
Well depth when installed (m)	• 10% <= 30 • 40% 51 - 150 • 60% >150	• 27% <= 31-150 • 73% >150	• 3% <= 31-50 • 3% 51 -90 • 94% >150
Total Abstraction CM	• 197,400	• 749,400	• 2,173,970
Average Abstraction CM/Farm	• 19,740	• 34,064	• 74,965

15.2.3 DOMINANT CROP PATTERN

A large number of crops have been cultivated under irrigation in the Ma'an basin. The total cultivated area reported by the 64 farms (respondents) in the basin is 38,327 du of which 19,440 is allocated for fruit trees and the remaining 18,887 du for vegetables and annual crops. This section deals with the analysis of the dominant cropping pattern prevailing at the three identified clusters of farms in this basin. Table 4 shows the distribution of the cultivated area among different crops for the three farm categories. The table reveals the following:

- **Farming system I (small size holdings):** the total cultivated area in this cluster is only 217 which is considered very small compared to the other two clusters. The dominant cultivated tree is grape followed by olive for pressing purposes and palm. The rest of the farms' area is devoted to vegetables mainly potato (23%) followed by tomato 7%.

- **Farming system II (medium size holdings):** The allocated land under this cluster is 9, 098 of divided almost 50:50 between fruit trees and vegetables. Olive and apple trees are the dominant fruit trees occupying 35% of the total cultivated area. The table shows that there is a three main vegetable crops cultivated in this cluster dominated by tomato at 25%, followed by watermelon 23% and potato 6%.
- **Farming system III (large size holdings):** This cluster is the largest in terms of cultivated area and the size of farms. The total cultivated area of the 33 farms in this cluster is 29,012 du of which is also divided almost 50:50 between vegetables and fruit trees. The dominant fruit trees in this cluster are apple and olive trees which occupy around 34% of the total area. Other types of fruit trees represent only 12% of the total area. The remaining cultivated area is allocated to vegetables and field crops of which corn occupies 17% followed by potato 12%, tomato 7% , watermelon 5% and other crops at 10%.

Concluding remarks: The analysis of the cropping pattern characteristics of the three identified clusters of farms indicates that olive, apple and grape are the dominant trees in this basin. The area devoted to other fruit trees is negligible. There is a wide variety of cultivated vegetable crops which are dominated by potato, tomato, corn and watermelon.

Table 4 Dominant cropping patterns for the three identified farming systems in Ma'an basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	**20 Farms (49%)**	**33 Farms (34%)**
Main fruit trees (% of the total cultivated area in du)	• 23 % Grape • 20 % Olive for pressing • 17% Palm	• 16% Olive • 11% Apple • 8% Olive for pressing • 2 % Grape • 2 % Peach • 1% Apricot	• 16 %Apple • 13 % Olive • 5% Olive for pressing • 4% Apricot • 3% Peach • 2% Grape • 1% Pistachio
Main vegetables and field crops (% of the total cultivated area in du)	• 23 % Potato • 7% Tomato • 5% Eggplant • 2% Zucchini • 3% other vegetables	• 25% Tomato • 23% Watermelon • 6% Potato	• 17% Corn • 12% Potato • 7% Tomato • 5% Watermelon • 3% Rhodes • 7 % others

15.2.4 MAIN FINANCIAL INDICATORS

Standard financial indicators were estimated from the collected data and were analyzed for the three identified clusters of farms. Table 5 shows the results of the analysis for the three farm categories. The table shows the following:

- **Farming system I (small size holdings):** The total amount of investment in the 11 farms is 619 thousand JD by the well owners. The average investment per farm is 77 thousand JD. The sum of the annual total operational costs for all farms of this category is 48 thousand JD

while the average operational cost per du is 225 JD. The average gross margin per du for this cluster is 60 JD.

- **Farming system II (medium size holdings):** The total amount of investment in the 20 medium size farms is 3.2 million JD invested all by the wells' owners. The average investment per farm is 148 thousand JD. The sum of the annual total operational cost for all farms of this category is 807 thousand JD while the average operational cost per du is 234 JD. The average gross margin per du for this cluster is 356 JD.
- **Farming system III (large size holdings):** The total amount of investment in the 33 large size farms is 13.8 million JD of which 90% of the investments are by wells' owners. The average investment per farm is 656 thousand JD. The sum of the annual total operational cost for all farms of this category is 4.3 million JD while the average operational cost per du is 147 JD. The average gross margin per du for this cluster is 402 JD.

Concluding remarks:

The total invested capital in Ma'an basin (of the 64 respondents) is estimated at 17.5 million JD while the annual total operational costs amounted to 5.1 million JD. Figure 3 shows a comparison between the main three financial parameters used in the financial analysis among the three farming systems. The figure shows that the operational costs of system II (medium farm size) is the highest among the three systems while the lowest is cluster III of the large-scale farms. The gross margins are the highest for system III. The three systems make positive gross margins but system 3 makes the highest followed by system 2.

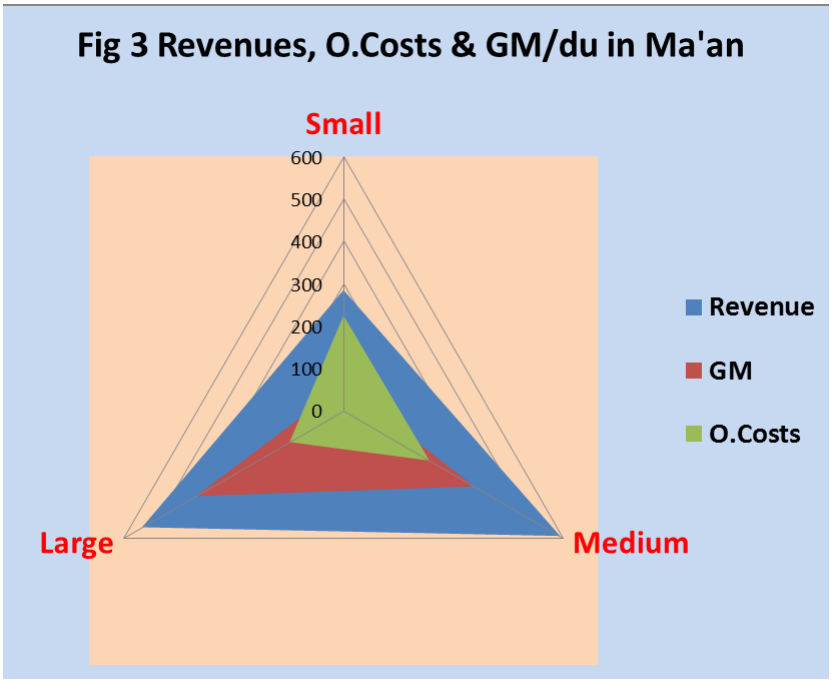


Table 5 Main Financial Indicators for the three identified farming systems in Ma'an basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
Total Investment Costs	• 619,150	• 3,107,050	• 13,781,745

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
in JD – Wells' Owners and Renters			
Total Investment Costs in JD – Wells' Owners	• 619,150	• 3,107,050	• 12,556,245
Total Investment Costs in JD – Wells' Renters	• 0	• 0	• 1,225,500
Average Investment Costs in JD/Farm	• 77,394	• 147,955	• 656,274
Total Operational Costs in JD	• 48,843	• 806,872	• 4,267,971
Average Operational Costs in JD/du	• 225	• 234	• 147
Total Revenues in JDs for all farms	• 61,121	• 2,034,236	• 15,930,744
Total Gross Margins (Total Revenue-Total Operational Costs) in JDs for all farms	• 13,038	• 1,227,364	• 11,662,773
Average Gross Margin in JD/du for all farms	• 60	• 356	• 402

15.2.5 MAIN LABOR AND GENDER INDICATORS

The questionnaire contained detailed data on labor and gender aspects. Table 6 includes the main results of the labor and gender analysis for the three farming systems. The table concludes the following:

- **Farming system I (small size holdings):** The total number of hired labor of both permanent and daily categories in the 11 farms amounted to 76,264 work days/year. The farms under this system hire both Jordanians and non-Jordanians. The hired permanent laborers are only males. Average monthly wage to Jordanian permanent labor is 220 JD while the paid wage for non-Jordanian is 227 JD. More than 56% of the permanent labor is non-Jordanian. The total number of hired daily labor under this system amounted to 41 laborers (male and female). The daily rates of the Jordanian labor are lower than non-Jordanian.
- **Farming system II (medium size holdings):** The total number of hired labor of both permanent and daily categories in the 20 farms amounted to 44,393 work days/year. The farms under this system hire also both Jordanians and non-Jordanians. Hired permanent laborers include both males and females. Average monthly wage for Jordanian labor is 215 JD while the paid wage for non-Jordanian is 255 JD. The majority of permanent labor are non-Jordanians (70%). The hired Jordanian female daily labor is almost double the number of hired daily male labor. The wage paid to Jordanian female daily laborers is higher than what is paid for Jordanian male but at the same time, lower than the wage of non-Jordanian labor.
- **Farming system III (large size holdings):** The total number of hired labor of both permanent and daily categories in the 33 farms amounted to 354,986 work days/year. As in

the case of the other two farming systems, the farms under this system hire both Jordanians and non-Jordanians. However, non-Jordanian permanent labor represents the 60% of the total labor. About one-third of the Jordanian permanent laborers are females. Average monthly wage paid to Jordanian labor is 257 JD while the paid wage for non-Jordanian is 243 JD. The number of Jordanian female daily laborers exceeds the number of Jordanian males by three folds and their daily rates are higher by almost 37% of what paid to male labor. Daily rates paid to non-Jordanian female labor are almost equal to what paid to non-Jordanian males.

Concluding remarks:

- Permanent laborers in Ma'an basin include both males and females (only Jordanian females). The three framing systems rely heavily on non-Jordanian daily labor; however system 3 employs more of permanent non-Jordanian labor compared to the other two systems.
- Wages paid to daily non-Jordanian female and male laborers are higher than what is paid to Jordanians.

Table 6 Main labor and Gender Indicators for the three identified farming systems in Ma'an basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
Permanent Jordanian (laborers No.) • **Male** • **Female**	 • 172 • 0	 • 27 • 13	 • 309 • 110
Wages of Permanent Jordanian (JD/Month) • **Male** • **Female**	 • 220 • 0	 • 215 • N/A	 • 257 • N/A
Permanent Non-Jordanian (laborers No.) • **Male** • **Female**	 • 71 • 0	 • 67 • 0	 • 473 • 0
Wages of Permanent Non- Jordanian (JD/Month) • **Male** • **Female**	 • 227 • 0	 • 255 • N/A	 • 243 • N/A
Daily Jordanian laborers (No.) • **Male**	 • 11 • 18	 • 123 • 260	 • 150 • 474

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
• Female			
Wages of Daily Jordanian (JD/day) • Male • Female	 • 7.7 • 6.0	 • 7.6 • 8.4	 • 5.6 • 8.9
Daily Non-Jordanian laborers (No.) • Male • Female	 • 12 • 0	 • 85 • 6.0	 • 753 • 53
Daily wage of Non-Jordanian (JD/day) • Male • Female	 • 11.7 • 0	 • 9.3 • 6.0	 • 11.2 • 10.6
Total number of working days /year	• 76,264	• 44,393	• 354,986

15.3 A COMPARISON BETWEEN REPORTED WATER USE AND ACTUAL CROP WATER REQUIREMENTS

According to the completed questionnaires, the total annual abstraction of water by the 64 farms of the three farm clusters amounted to 3,120,770 cubic meters. This amount of water was used by only 64 farms in the basin to irrigate a sum of 37,739 du. Table 7 shows the cultivated area of the main vegetable crops and fruit trees in the 64 farms that completed the questionnaire distributed by clusters. The table also shows the crop water requirement per du in Ma'an basin as estimated by the MOA (due to the unavailability of the crop water requirement for some of the crops, the researcher used the minimum water requirement for the same or similar crops cultivated in other basins in the uplands). As estimated in the table, the total amount of water required to irrigate the sum of the 37,739 du cultivated by the 64 farms is 26 million cubic meters which exceeds the total amounts of water reported by the farmers in the questionnaire by more than eight times.

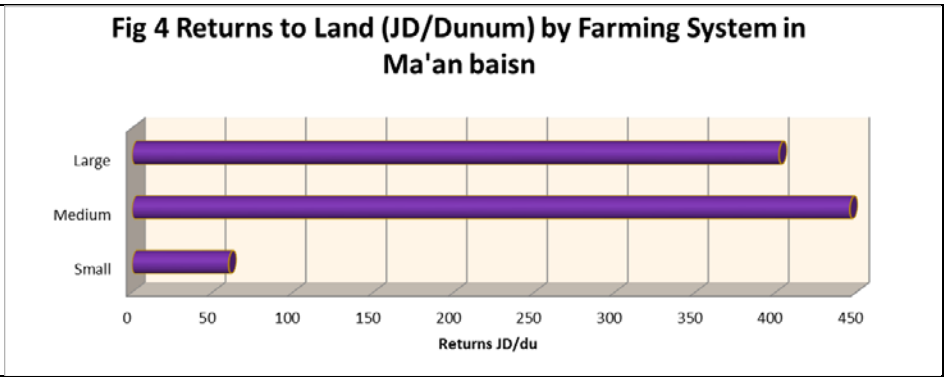
Table 7 Estimated actual volume of water required for irrigating the cultivated areas in Ma'an basin

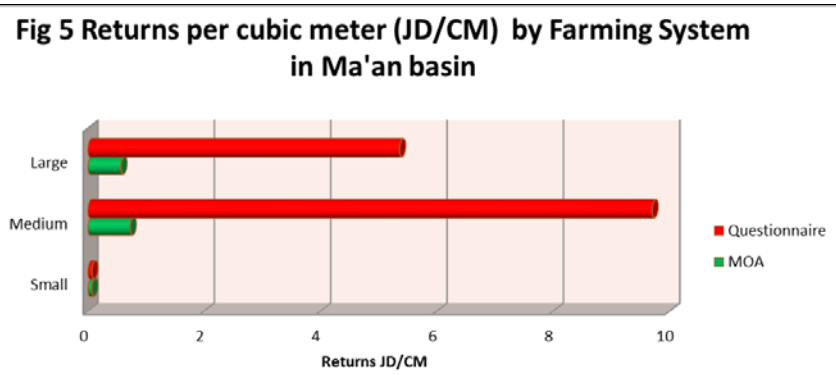
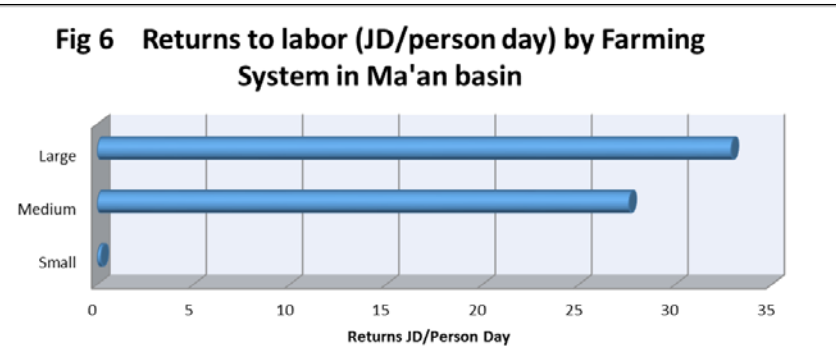
Main cultivated crop	Area by Cluster			Total Area Du	Water Req CM/Du	Total Water Req (CM)
	Small	Medium	Large			
Corn		80	5,000	5,080	370	1,879,600
Olive for pressing	43	3,475	1,481	4,998	800	3,998,600
Apple		17	4,655	4,672	650	3,036,800
Olive		655	3,701	4,356	800	3,484,400
Potato	50	75	3,600	3,725	900	3,352,500
Tomato	15	831	1,908	2,754	700	1,927,800
Arecaceae (Palm)	36		1,519	1,555	900	1,399,500
Watermelon		61	1,463	1,524	700	1,066,800
Apricot	0	50	1,245	1,295	850	1,100,835
Peach		75	1,010	1,085	850	922,250
Blubank			825	825	798	658,350
Rhodes			750	750	370	277,500
Grape	50	236	460	746	1100	820,765
Cauliflower		727	17	744	380	282,530
Lettuce		568		568	208	118,144
Onion		251	280	531	600	318,600
Zucchini	5	485	33	523	236	123,428
Barley		395		395	570	225,150
Pistachio			280	280	850	238,000
Alfalfa			250	250	780	195,000
Lemon			200	200	1000	200,000
Wheat		40	100	140	650	91,000
Cucumber		135		135	293	39,555
Cabbage		108	17	125	400	49,800
Plum		45	65	110	850	93,500
Cactus		100		100	100	10,000
Strawberry		100		100	400	40,000
Capsicum		97		97	526	51,022
Different Vegetables		75	2	77	300	-
Total	**199**	**8,681**	**28,859**	**37,739**		**26,001,429**

15.4 MAIN ECONOMIC EFFICIENCY INDICATORS

Three main economic efficiency indicators were calculated from the analysis of the data collected through the questionnaire. Table 8 shows a summary of the economic indicators for the three farming systems. Figures 4, 5 and 6 provide a comparison of the three indicators under the three farming systems.

Farming system II is the most efficient in terms of returns to land resource followed by System III.



Farming system II (large farms) is the most efficient in terms of economic water use efficiency followed by system III.	
Farming system III (large farms) is the most efficient in terms of economic returns to labor followed by system II.	

Concluding remarks:

- According to the water valuation study that was conducted by ISSP in 2012, the average return per cubic meter of water in the highlands ranged between 0.48 – 0.05 JD for fruit trees while it ranged between 1.33 - 0.33 for vegetables. It is clear from the above Figure 5 and table 8 that the estimated returns to water indicator for farming systems II and III are higher than the ranges estimated by the water valuation study while the returns to water for farming system I is close to zero. These estimates should be lower if the actual volumes of abstracted water are used in estimating these indicators. As indicated above, the stated water abstraction rates by the respondents are only one-fourth of the actual water requirements of the cultivated crops. For instance, in case of system III, if we re-estimate the return to water using the actual water requirements, the ratio goes down to JD 1.04 per cubic meter of water which is way below the rate given the reported amounts of abstraction.

Table 8 Main economic efficiency indicators for the three identified farming systems in Ma'an basin

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
• **Returns to Land (JD/du) average of all crops in the cluster (Total Gross Margin in JD / Total Cultivated Area in du)**	60	446	402

Indicator	Farm System I (<50 du)	Farm System II (50-200 du)	Farm System III (> 200 du)
	11 Farms (17%)	20 Farms (49%)	33 Farms (34%)
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total abstracted water CM)	0.07	9.7	5.36
• Returns per cubic meter (JD/CM) average of all crops in the cluster (Total Gross Margin in JD / Total actual water requirement as per MOA in CM)	0.07	0.73	0.57
• Returns to labor (JD/person day) average of all crops in the cluster (Total Gross Margin in JD / Total hired labor)	0.2	27.6	32.9

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