Integrated Water Resources Management in the Lower Jordan Rift Valley

Sustainable Management of Available Water Resources with Innovative Technologies

Work package 7, Deliverable D 703
Report Assessing the impacts of different water qualities and quantities on farmer income and their economic situation

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Contents

List of Tables

List of figures

Chapter one

Assessing the impacts of different water qualities and quantities on farmer income and their economic situation

Introduction

As in most of the countries in the region water resources in Palestine are scarce. Overexploitation of groundwater aquifers, which are the only source of water for Palestinians, beyond the annual potential replenishment quantities has and will contribute significantly to the degradation of groundwater quality in the exploited aquifers, and endangers the sustainability of the resources for future use. In addition to the fact that many of the residents of the rural areas are forced to rely on water tankers as their main water supplier. The expense entailed in purchasing water from these sources places a heavy financial burden on Palestinians in particular for marginalized areas which are generally poor.

Agriculture is the largest sector of the Palestinian economy, generating over 22% of the Gross Domestic Product of the West Bank and Gaza. In times of difficulty, the agricultural sector has acted as a buffer that absorbs large scores of unemployed people who lost their jobs in Israel or other local sectors of the economy. Various statistical data indicated that agriculture's contribution to employment rose from 12.7% in 1995 to 16% in 2004. The agricultural sector also plays a central role in achieving food security for Palestinian families as quite a good number of families depend on this sector in answering their needs by means of family and domestic products. Unfortunately, agricultural production is faced by a number of constraints including water management, feasibility of agricultural production, lack of infrastructure, production inputs and soil salinity. Marketing of farm products and their distribution to local and external markets is also one of the major obstacles facing Palestinian farmers. Selling Palestinian agricultural products within Israel requires special permits to be issued by the Israeli authorities. Transporting products from/to north to south in the West Bank has become difficult as well and introduces an additional cost. Movement of agricultural products between the West Bank and Gaza Strip is also subject to Israeli control. Competitiveness with Israeli produce in the local markets is also a challenge.

Agricultural development and dependency is especially noticed in the Jordan Valley. These areas have the potential for developing and improving its agricultural activities as it is rich in available agricultural lands and water and benefits from special weather conditions. An estimated 50,000 dunums are cultivated in the Palestinian Jordan Valley. Vegetables rank first in growing area and production followed by fruit trees then field crops and forages. The value of the annual production in the Jordan Valley in 2003/2004 was US$ 60.1 million forming 8.6% of that of the West Bank.

Conducting a survey formulated in the collection of information and data related to the prevailing socio-economic, agricultural and different quality water related conditions and then analyzing it will help integrate all relevant dimensions and form a basis to promote a better situation in terms of modifying, developing, and implementing actions which will significantly

help overcome problems regarding the improvement of the standard of living in the targeted locations. This report presents the outcome of the survey targeting several Palestinian localities it includes the main results obtained from analyzing the data collected and is divided into main sections including: Introduction, Targeted communities, Methodology, Obstacles, Data Analysis Results, Conclusions and Recommendations in addition to an Annex at the end of the report.

Objectives

The survey aims **to** carry assessment for different types of water quality and (b) for different water quantities, using the Water Allocation Model (WAM) in different pilot areas representing different water qualities (fresh-water, blended water, pure treated wastewater, brackish water). An investigation of the economic situation of farmers will be carried out regarding their costs of water abstraction, fertilizing and other production costs which may be reduced through the reuse of wastewater. In addition farmers' income situation will be analysed which depends on the production costs, yields and sales revenues. Thus, the evaluation of benefits of improved water availability will focus also on potential changes of farmers' income and their economic situation

Targeted communities

In order to assess the existing practices of using different water qualities and its impacts on farmers socioeconomic conditions 15 communities in the Jordan Rift Valley/West Bank as shown in Figure have been surveyed.

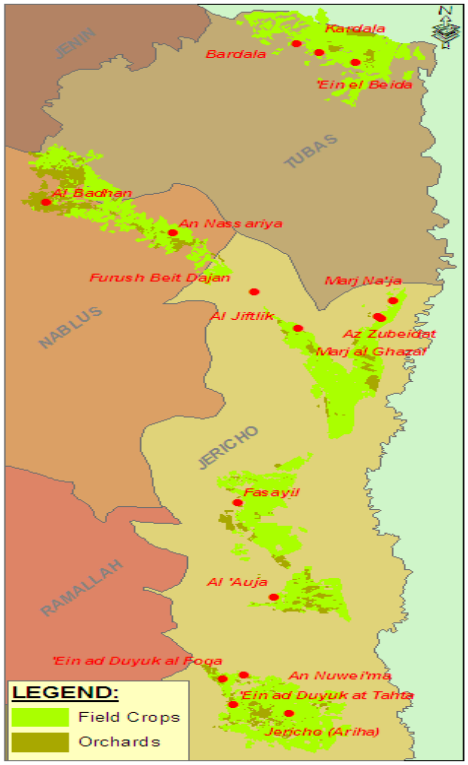

Figure 1.Areas targeted by Survey.

Methodology

This survey was conducted in the 15 targeted communities. In each of the localities respondents were randomly selected to generate both quantitative and qualitative data on selected parameters and indicators. The prepared questionnaire was distributed in the targeted areas. Fieldwork was carried out by field engineers in PHG. Two teams were formed from the Nablus and Ramallah offices including specialists from various disciplines (social economical environmental and water resources specialists).

Before launching the actual survey activity the following was done:

a) Translate questionnaire prepared by Study Team in English to Arabic
b) Train enumerators to make them understand how to interview farmers
c) Conduct a pilot survey to test and modify the questionnaire under the supervision of the Study Team

A total of 207 representative questionnaires were distributed (Table 1, Figure 2). The respondents were either full time farmers or at least partially involved in agricultural activities.

Table 1.Sample Distribution

Name of community	No. of samples
'Ein el Beida	**20**
Ad Duyuk	**14**
Al 'Auja	**11**
Al Badhan	**13**
Al Jiftlik	**13**
An Nassariya	**18**
An Nuwei'ma	**13**
Az Zubeidat	**13**
Bardala	**20**
Fasayil	**6**
Furush Beit Dajan	**13**
Jericho City	**13**
Kardala	**14**
Marj Na'ja	**13**
Marj al Ghazal	**13**
Total	**207**

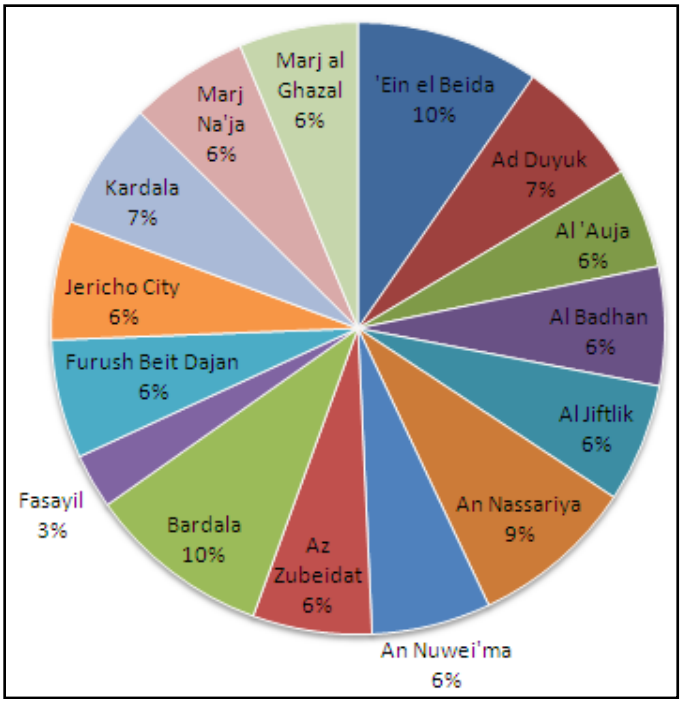

Figure 2.Samples Distribution

The collected data was then analyzed within the framework of the study objectives using Microsoft Excel, the Statistical Program for Social Sciences (SPSS) and the Geographic Information System program (GIS). Quality control was ensured during the whole collection and analysis process; more than 50% of the data entered was cross checked.

1. **Obstacles**

- Movement from one respondent to another was time consuming especially since the surveyor had to explain the questionnaire and its objectives every time.
- At times it was difficult to travel from one locality to another due to the harsh Israeli restrictions and checkpoints.
- It was also difficult for some of the respondents that depend on free lance work or agriculture to estimate their income and some could not estimate their monthly expenditure.
- Some did exaggerate in describing some of the data given.

2. **Data Analysis Results**

   a. Data has been validated , processed and displayed by several excel sheets and SPSS statistical Package,

The output of data analysis categorized as Following

- socioeconomic conditions of the farmers
- usage of different water quality

Chapter Two

Section one :Socioeconomic Profiles of the Farmers

1. **Percentage of family members participating in agricultural activities**

   Table 2 shows that a considerable percentage of the surveyed families' members are fully involved in agriculture which reflects the dependence on the sector.

Table 2. Percentage of surveyed families members are fully involved in agriculture

Community	Average percentage of people permanently participating in agriculture	Average percentage of people temporarily participating in agriculture
'Ein el Beida	37.9	23.9
Ad Duyuk	52.3	7.4
Al 'Auja	43.5	22.1
Al Badhan	32.7	27.0
Al Jiftlik	58.7	27.3
An Nassariya	41.4	14.7
An Nuwei'ma	34.4	3.6
Az Zubeidat	41.1	26.3
Bardala	39.7	15.2
Fasayil	9.8	9.3
Furush Beit Dajan	52.9	13.0
Jericho City	29.8	15.4
Kardala	44.2	9.2
Marj Na'ja	45.7	25.9
Marj al Ghazal	59.4	11.0
Overall:	**42.5**	**17.0**

2. Income generated by family males:

Table 3 Agriculture land area used by the family (dunum)

Community Name	Average agricultural land area used by the family (dunum)			
	Irrigated land-Open field	Irrigated land-Green house	Un-irrigated/Rainfed land	Pasture/Grazing land
'Ein el Beida	62.9	5.6	30.0	0.0
Ad Duyuk	23.7	0.1	0.0	0.0
Al 'Auja	128.7	0.7	0.0	0.0
Al Badhan	3.1	0.4	5.4	0.2
Al Jiftlik	29.1	4.7	28.5	0.0
An Nassariya	19.7	0.2	1.8	0.8
An Nuwei'ma	38.5	0.8	0.0	0.0
Az Zubeidat	43.4	1.2	24.2	22.8
Bardala	48.8	4.7	15.7	0.0
Fasayil	46.7	1.5	50.0	0.0
Furush Beit Dajan	27.8	5.9	0.0	0.0
Jericho City	103.1	2.1	0.0	0.0
Kardala	37.5	7.2	8.6	0.0
Marj al Ghazal	26.0	0.2	0.0	0.0
Marj Na'ja	20.1	0.2	0.8	0.0
Overall:	**43.1**	**2.6**	**10.3**	**1.5**

i. Agricultural land area owned by the family

Community Name	Average agricultural land area owned by the family (dunum)				
	Irrigated land-Open field	Irrigated land-Green house	Un-irrigated/Rainfed land	Pasture/Grazing land	Unused farm land
'Ein el Beida	9.8	2.6	4.8	0.0	2.8
Ad Duyuk	8.2	0.3	0.0	0.0	0.0
Al 'Auja	35.0	0.5	0.0	0.0	14.0
Al Badhan	3.1	0.4	5.8	0.2	0.2
Al Jiftlik	8.4	1.5	0.0	0.0	0.0
An Nassariya	4.8	0.1	1.1	0.0	0.4
An Nuwei'ma	8.5	0.4	0.9	0.0	0.0
Az Zubeidat	11.1	1.1	24.2	7.7	3.6

Bardala	16.8	2.9	10.3	0.1	0.1
Fasayil	30.0	0.0	50.0	0.0	220.0
Furush Beit Dajan	26.3	5.8	0.0	0.0	0.0
Jericho City	0.0	0.0	0.0	0.0	0.0
Kardala	13.6	4.7	3.2	0.0	0.0
Marj al Ghazal	18.9	0.2	0.0	0.0	0.0
Marj Na'ja	11.0	0.2	0.8	0.0	0.0
Overall:	**12.7**	**1.5**	**5.2**	**0.5**	**7.7**

ii. Total agricultural land area used by the family

Community Name	Total agricultural land area used by the family (dunum)			
	Mean	Minimum	Maximum	Standard deviation
'Ein el Beida	98.4	11.0	450.0	103.4
Ad Duyuk	23.9	7.0	50.0	13.0
Al 'Auja	129.5	43.0	300.0	73.1
Al Badhan	9.0	0.0	21.0	7.0
Al Jiftlik	62.2	11.0	344.0	90.3
An Nassariya	22.5	0.0	150.0	32.9
An Nuwei'ma	39.4	15.0	70.0	19.3
Az Zubeidat	91.7	30.0	305.0	93.0
Bardala	69.2	15.0	185.0	43.9
Fasayil	98.2	2.0	160.0	72.3
Furush Beit Dajan	33.8	10.0	140.0	39.7
Jericho City	105.2	23.0	500.0	134.0
Kardala	53.3	9.0	165.0	58.6
Marj al Ghazal	26.2	7.0	80.0	21.7
Marj Na'ja	21.0	8.0	30.0	7.7
Overall:	**57.5**	**0.0**	**500.0**	**72.8**

Table 3 shows very interesting results which reflect the importance of agriculture in the area. When the percetages exceed 100% this indicates that the family uses other rented or leased land area. It is worthy to note that in Al Jiftlik, An Nassariya, An Nuwei’ma, Az Zubeidat, Furush Beit Dajan, Kardala, Marj Na’ja and Marj al Ghazal all the respndents cultivate all the land they own and more while in Jericho the land owners do not cultivate the land themselves but lease it to others as in Tables 6.2.6.

Table 4.Irrigation systems

Community Name	Percentage of respondents that use the irrigation system			
	Drip irrigation	Sprinkler irrigation	Furrow irrigation	Rainfed
Ad Duyuk	85.7%	0.0%	0.0%	0.0%
Al 'Auja	100.0%	0.0%	0.0%	0.0%
Al Badhan	7.7%	0.0%	84.6%	76.9%
Al Jiftlik	100.0%	0.0%	7.7%	15.4%
An Nassariya	88.9%	44.4%	55.6%	33.3%
An Nuwei'ma	100.0%	0.0%	0.0%	0.0%
Az Zubeidat	100.0%	7.7%	0.0%	15.4%
Bardala	100.0%	85.0%	0.0%	5.0%
'Ein el Beida	100.0%	25.0%	30.0%	40.0%
Fasayil	100.0%	50.0%	0.0%	66.7%
Furush Beit Dajan	100.0%	0.0%	0.0%	7.7%
Jericho City	92.3%	0.0%	0.0%	0.0%
Kardala	100.0%	28.6%	0.0%	14.3%
Marj al Ghazal	100.0%	0.0%	0.0%	0.0%
Marj Na'ja	100.0%	0.0%	0.0%	15.4%
Overall:	**91.8%**	**18.4%**	**13.5%**	**18.4%**

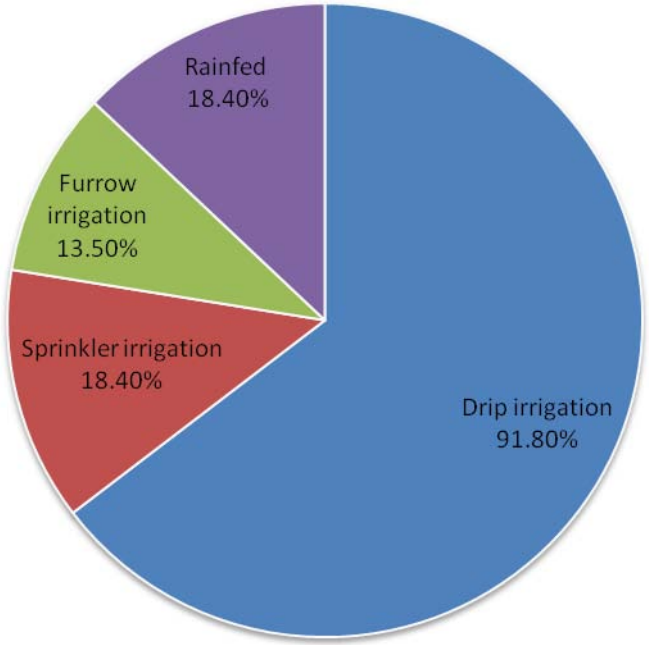

Figure 3.% of respondents using irrigation networks

Table 4 and Figure 3, show that drip irrigation is the most commonly used irrigation source in the targeted areas and is the only irrigaton method used in many. It is also important to keep in

mind that some respondents use more than one irrigation method. Another important note is that rainfed irrigation is somewhat limited due to the limited rainfall quantities in the area.

Table 5.Average land area cultivated with grains

Grain	Mean	Minmum	Location	Maximum	Location
Wheat	7.5	0.0	Ad Duyuk, Al 'Auja, An Nuwei'ma, Jericho City , Marj al Ghazal	25.8	'Ein el Beida
Barley	2.0	0.0	Ad Duyuk, Al 'Auja, Al Jiftlik, An Nassariya, An Nuwei'ma, Jericho City, Kardala, Marj al Ghazal, Marj Na'ja	25.0	Fasayil
Green Forage	0.3	0.0	All except Al 'Auja and Al Badhan	4.5	Al 'Auja
Groundnut	0.5	0.0	All except Al Badhan and Jiftlik	7.7	Al Jiftlik

Table 6.Area cultivated with fruits

Community Name	Average agricultural land area cultivated with fruits (dunum)				
	Citrus	Banana	Dates	Olives	Grapes
'Ein el Beida	0.3	0.0	0.1	0.3	0.0
Ad Duyuk	0.0	3.1	0.4	0.0	0.0
Al 'Auja	0.0	39.5	2.3	0.0	0.7
Al Badhan	0.6	0.0	0.0	5.2	0.2
Al Jiftlik	0.0	0.0	0.7	0.0	0.0
An Nassariya	0.4	0.0	0.0	0.4	0.0
An Nuwei'ma	0.0	7.2	0.0	0.0	0.0
Az Zubeidat	3.8	0.0	1.0	0.7	0.1
Bardala	0.6	0.0	0.4	0.1	0.0
Fasayil	0.0	14.7	1.0	0.0	10.0
Furush Beit Dajan	16.8	0.0	0.0	0.0	0.0
Jericho City	0.0	0.0	21.9	0.0	4.6
Kardala	0.4	0.0	0.0	0.0	0.0
Marj al Ghazal	0.0	0.0	1.2	0.0	0.0
Marj Na'ja	0.0	0.0	0.7	0.2	0.0
Overall:	**1.5**	**3.2**	**1.8**	**0.4**	**0.6**

Table 7. land area cultivated with vegetables

Community Name	Average agricultural land area cultivated with vegetables (dunum)								
	Squash	**Tomato**	**Watermelon**	**Green Beans**	**Eggplant**	**Chili pepper**	**Sweet melon**	**Cucumber**	**Pumpkin**
'Ein el Beida	17.5	5.4	0.5	2.4	12.0	2.4	0.4	4.3	0.2
Ad Duyuk	6.6	4.6	0.0	0.5	4.5	0.0	0.4	0.2	0.0
Al 'Auja	25.9	6.4	0.0	0.8	10.6	1.6	0.0	1.2	0.0
Al Badhan	0.7	0.2	0.0	0.0	0.7	0.3	0.0	0.2	0.0
Al Jiftlik	7.5	6.6	0.3	0.9	4.2	2.6	1.0	1.7	0.3
An Nassariya	1.4	1.1	0.0	0.2	2.4	0.5	0.0	5.3	0.2
An Nuwei'ma	11.9	7.0	0.0	0.1	5.2	2.2	0.0	1.3	0.0
Az Zubeidat	10.9	6.8	0.6	0.0	5.2	1.8	0.8	2.0	1.6
Bardala	17.2	5.7	0.0	3.9	6.1	2.2	0.3	5.3	0.0
Fasayil	16.2	0.0	0.0	1.2	1.2	5.8	0.0	0.0	0.0
Furush Beit Dajan	2.8	4.0	0.0	0.0	1.1	0.8	0.0	1.8	0.5
Jericho City	10.5	9.8	0.0	1.5	8.7	1.3	0.8	0.9	0.0
Kardala	13.0	3.4	0.0	2.3	5.8	2.3	0.3	3.9	0.2
Marj al Ghazal	3.9	4.5	0.0	0.0	3.5	0.2	0.0	1.7	0.2
Marj Na'ja	6.4	4.5	0.8	0.0	3.8	0.4	0.0	0.9	0.5
Overall:	**10.08**	**4.77**	**0.16**	**1.05**	**5.27**	**1.50**	**0.28**	**2.39**	**0.25**

Cont. average land area cultivated with vegetables (dunums)

Community Name	Average agricultural land area cultivated with vegetables (dunum)								
	Cowpea	**Sweet pepper**	**Yellow bean**	**Potato**	**Cauliflower**	**Corn**	**Jew's mallow**	**Dry onion**	**Cabbage**

'Ein el Beida	0.1	2.7	2.3	1.1	9.2	12.9	0.3	0.7	2.2
Ad Duyuk	0.0	0.3	0.0	0.6	4.2	4.1	2.1	0.0	0.0
Al 'Auja	0.4	1.1	0.2	0.0	1.8	36.4	8.9	0.2	0.0
Al Badhan	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Al Jiftlik	0.3	1.5	1.2	0.4	0.0	0.0	1.2	0.0	0.0
An Nassariya	0.0	0.1	0.1	1.4	0.3	0.3	0.5	4.1	0.0
An Nuwei'ma	0.5	0.3	0.2	0.6	2.2	2.0	5.1	1.5	1.1
Az Zubeidat	0.4	0.5	0.0	0.8	0.8	3.8	0.2	0.2	0.0
Bardala	0.7	0.5	4.3	0.2	2.4	1.9	0.5	0.7	0.7
Fasayil	0.0	2.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Furush Beit Dajan	0.0	0.8	0.0	0.0	0.0	0.4	0.0	0.0	0.0
Jericho City	0.0	1.3	0.7	0.2	3.1	4.8	5.5	.6	1.4
Kardala	0.7	0.6	1.5	0.0	1.1	1.8	0.0	0.0	1.4
Marj al Ghazal	0.2	0.0	0.0	0.0	0.0	0.8	0.6	0.0	0.0
Marj Na'ja	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0
Overall:	**0.24**	**0.77**	**0.90**	**0.43**	**2.00**	**4.54**	**1.52**	**0.64**	**0.52**

Cont. average land area cultivated with vegetables (dunums)

Community Name	**Average agricultural land area cultivated with vegetables (dunum)**								
	Turnip	**Green onion**	**Carrot**	**Spinach**	**Snake cucumber**	**Radish**	**Okra**	**Thyme**	**Onion set**
'Ein el Beida	0.0	0.1	0.5	0.6	0.0	0.1	0.1	0.1	0.0
Ad Duyuk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Al 'Auja	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Al Badhan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Al Jiftlik	0.0	0.0	0.0	0.2	4.5	0.0	0.0	0.0	0.0
An Nassariya	0.0	0.0	0.0	0.0	0.4	0.0	0.7	0.0	0.5
An Nuwei'ma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Az Zubeidat	0.0	0.6	0.0	0.5	2.0	0.0	3.5	0.0	0.0

Bardala	0.1	0.0	0.0	0.0	1.0	0.0	0.3	0.0	0.0
Fasayil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Furush Beit Dajan	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0
Jericho City	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kardala	0.0	0.0	0.0	0.2	1.1	0.0	0.0	0.1	0.0
Marj al Ghazal	0.0	0.0	0.0	0.0	3.8	0.0	5.6	0.0	0.0
Marj Na'ja	0.0	0.0	0.0	0.0	0.4	0.0	0.8	0.0	0.0
Overall:	**0.01**	**0.05**	**0.05**	**0.12**	**1.10**	**0.01**	**0.72**	**0.02**	**0.04**

Tables from 5 to 7 show that the most commonly cultivated crops are: wheat, squash, eggplant, tomato, corn, banana, cucumber, cauliflower and dates in descending order.

Section Two: Usage of different quality water

Table 8.water supply types

Community Name	Percentage of respondents relying on family groundwater well for agricultural water supply			Percentage of respondents relying on company (Mekorot) for agricultural water supply		
	No use	Sub-sidiary	Main	No use	Sub-sidiary	Main
Ad Duyuk	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Al 'Auja	100.0%	0.0%	0.0%	90.9%	0.0%	9.1%
Al Badhan	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Al Jiftlik	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
An Nassariya	100.0%	0.0%	0.0%	94.4%	0.0%	5.6%
An Nuwei'ma	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Az Zubeidat	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Bardala	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
'Ein el Beida	100.0%	0.0%	0.0%	25.0%	0.0%	75.0%
Fasayil	50.0%	0.0%	50.0%	100.0%	0.0%	0.0%
Furush Beit Dajan	84.6%	15.4%	0.0%	92.3%	0.0%	7.7%
Jericho City	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Kardala	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Marj al Ghazal	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Marj Na'ja	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Overall:	**97.6%**	**1.0%**	**1.4%**	**74.9%**	**0.0%**	**25.1%**

Cont. Water supply sources for agricultural purposes

Community Name	Percentage of respondents relying on private groundwater well for agricultural water supply			Percentage of respondents relying on public groundwater well for agricultural water supply		
	No use	Sub-sidiary	Main	No use	Sub-sidiary	Main
Ad Duyuk	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Al 'Auja	27.3%	72.7%		100.0%	0.0%	0.0%
Al Badhan	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Al Jiftlik	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%
An Nassariya	77.8%	0.0%	22.2%	100.0%	0.0%	0.0%
An Nuwei'ma	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Az Zubeidat	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Bardala	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%

'Ein el Beida	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Fasayil	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Furush Beit Dajan	84.6%	15.4%	0.0%	100.0%	0.0%	0.0%
Jericho City	30.8%	0.0%	69.2%	100.0%	0.0%	0.0%
Kardala	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Marj al Ghazal	7.7%	0.0%	92.3%	100.0%	0.0%	0.0%
Marj Na'ja	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Overall:	**77.8%**	**3.9%**	**18.4%**	**87.4%**	**0.0%**	**12.6%**

Cont. Water supply sources for agricultural purposes

Community Name	**Percentage of respondents relying on springs for agricultural water supply**			**Percentage of respondents relying on rainwater harvesting for agricultural water supply**		
	No use	Sub-sidiary	Main	No use	Sub-sidiary	Main
Ad Duyuk	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%
Al 'Auja	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%
Al Badhan	23.1%	7.7%	69.2%	92.3%	7.7%	0.0%
Al Jiftlik	76.9%	0.0%	23.1%	100.0%	0.0%	0.0%
An Nassariya	27.8%	0.0%	72.2%	100.0%	0.0%	0.0%
An Nuwei'ma	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%
Az Zubeidat	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Bardala	100.0%	0.0%	0.0%	90.0%	10.0%	0.0%
'Ein el Beida	55.0%	0.0%	45.0%	100.0%	0.0%	0.0%
Fasayil	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%
Furush Beit Dajan	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%
Jericho City	61.5%	0.0%	38.5%	100.0%	0.0%	0.0%
Kardala	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Marj al Ghazal	92.3%	0.0%	7.7%	100.0%	0.0%	0.0%
Marj Na'ja	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Overall:	**52.7%**	**0.5%**	**46.9%**	**98.6%**	**1.4%**	**0.0%**

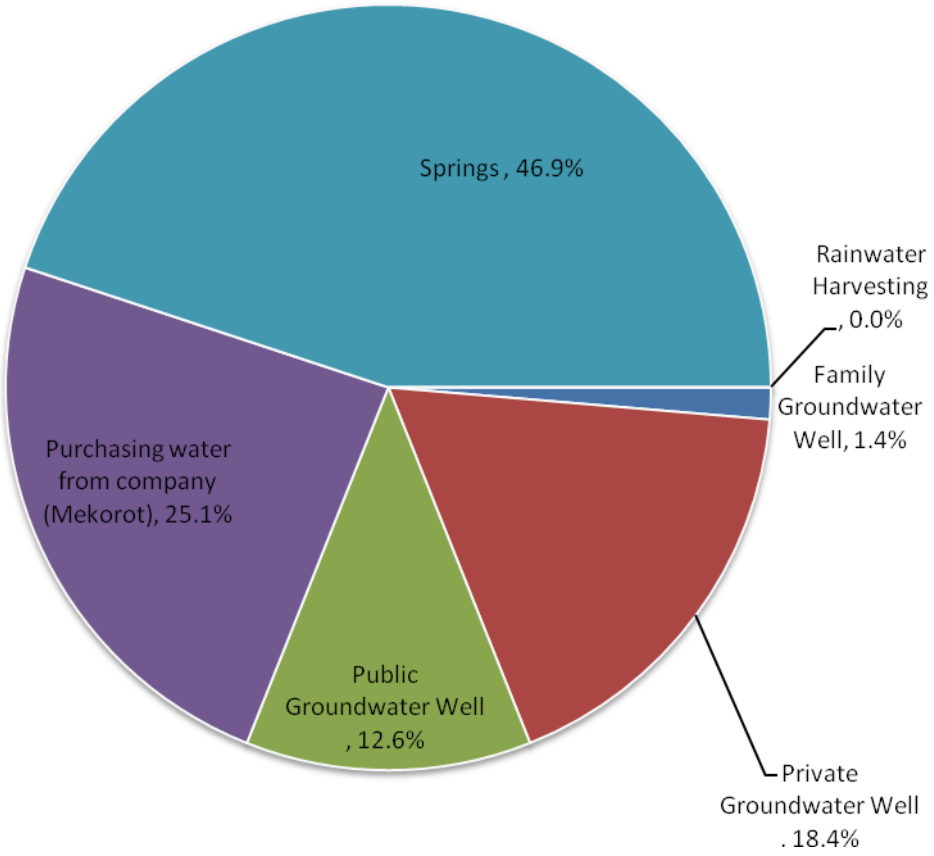

Figure 4.Main water sources for agricultural purposes

The results show that almost half of the respondents rely on springs for agricultural water supply. It was also clear that rainwater is not used for water supply mainly due to the limited amounts in the area. Most of the respondents use more than one source but mianly rely on springs and groundwater wells.

Table 9.Annual expenditure on agricultural water supply

Community Name	Annual expenditure on agricultural water supply only			
	Mean (NIS)	Maximum (NIS)	Minimum (NIS)	Standard deviation (NIS)
'Ein el Beida	8165	80000	0	18977
Ad Duyuk	3964	6000	2000	1134
Al 'Auja	5636	9000	3000	2461
Al Badhan	0	0	0	0
Al Jiftlik	32231	60000	8000	18611
An Nassariya	11917	200000	0	46976
An Nuwei'ma	2462	8000	0	2666
Az Zubeidat	33346	47000	20000	8668

Bardala	35	700	0	157
Fasayil	3300	6000	0	2982
Furush Beit Dajan	34077	150000	10000	40438
Jericho City	16731	70000	0	19034
Kardala	1550	5000	0	2146
Marj al Ghazal	23308	70000	5000	19512
Marj Na'ja	4769	17000	0	6623
Overall:	**11881**	**200000**	**0**	**22991**

It is important to note that some take water supply from springs or groundwater wells without paying. Others also take their supply from Mekorot and do not pay their bills which are ultimately deducted by Israel from the Palestinian tax revenues.

Replies of the respondents varied when asked about their satisfaction with the management of water quality. This is mainly due to the lack of knowledge about water quality and the fact that they judge it only by the salinity.

Table 10.satisfaction with water resources quantity

Community Name	**Satisfaction with water resources quantity management**				
	Dissatisfied	**Partially satisfied**	**Can't evaluate**	**Satisfied**	**Very satisfied**
Ad Duyuk	71.4%	14.3%	7.1%	7.1%	0.0%
Al 'Auja	63.6%	18.2%	18.2%	0.0%	0.0%
Al Badhan	33.3%	33.3%	0.0%	33.3%	0.0%
Al Jiftlik	38.5%	38.5%	0.0%	15.4%	7.7%
An Nassariya	22.2%	50.0%	0.0%	27.8%	0.0%
An Nuwei'ma	38.5%	46.2%	0.0%	15.4%	0.0%
Az Zubeidat	7.7%	69.2%	0.0%	7.7%	15.4%
Bardala	85.0%	10.0%	0.0%	5.0%	0.0%
'Ein el Beida	100.0%	0.0%	0.0%	0.0%	0.0%
Fasayil	66.7%	33.3%	0.0%	0.0%	0.0%
Furush Beit Dajan	23.1%	69.2%	0.0%	7.7%	0.0%
Jericho City	84.6%	7.7%	7.7%	0.0%	0.0%
Kardala	85.7%	14.3%	0.0%	0.0%	0.0%
Marj al Ghazal	7.7%	69.2%	0.0%	23.1%	0.0%
Marj Na'ja	23.1%	23.1%	0.0%	53.8%	0.0%
Overall:	**51.9%**	**31.6%**	**1.9%**	**13.1%**	**1.5%**

More than half of the respondents are dissatisfied with the management of water supply in terms of quantity.

Section 3. Impact of different quality additional water on agriculture

Despite the fact that water is very limited and the entire area is facing the problem of high demand , the IWRM management and creation of comprehensive paradigm might be the solution , the following are the main resources can be utilized

Treated Waste Water.

Treated waste water from existing ElBireh waste water treatment plant and the future planned Jericho waste water treatment plant.

Under the current circumstance the amount of water can be used for agriculture or artificial recharge range from (1-3 Mm^3) Million m^3 , But this amount can be increased by further investment to reduce the losses and evaporation , however the long distant flow helps the water for further self treatment.

In the coming years the Jericho waste water treatment will be available, the added value of JG project will accelerate the process of construction by signing agreement with Jericho Municipality .to purchase the water since the donor (JAICA) has concerns about the future reuse of the treated waste water

Brackish water

Different local and international studies have mentioned that the importance of the potentiality of brackish water to be desalinated for both drinking and agriculture, the cost and the increasing Stalinization process are the main constrains of using it , the estimated potential brackish water in the area between 4-6 million cubic meter , this amount can be obtained by drilling a cluster of shallow well between 60-120 m^3, the location of proposed wells should be along the wadi Al-Qilt with range distance 1-2 km .

Storm water

The intent of storm water harvesting schemes is to augment existing water resources. It was assumed that any Proposed -scheme would have to be implemented on a local scale in order to be "effective," both for recharge and direct use. Because of time constraints in which the evaluation of alternatives was performed on a qualitative level. Criteria which were considered are:

- Technical difficulty;
- Cost (order of magnitude);
- Benefit to potential users;
- Water quality;
- Impacts on land use;
- Impact on aquifer recharge;
- O&M considerations;
- Institutional considerations; and
- Environmental impacts.
- The selected location is approximately 2 km southeast of the center of Jericho, on the south side of Wadi Al-Qilt. the site was
  selected because:
- The scheme optimizes the volume of captured water - and the scheme could be

- combined with spring water routing during winter months when excess water from Ein Sultan is discharged unused.
- The land is available and easily accessible - in fact, the land currently stands idle. The recharge basins would cover a total area of about 1 km2.
- The scheme would not flood any of the surrounding farmland.
- The site is less than 3 km from the main agricultural area in Jericho.
- Topography is such that water from Wadi Al-Qilt would flow by gravity to the recharge basins. Thus, pumping of storm water from the wadi is not needed.
- Hydrogeological conditions are favorable with relatively permeable soils and a

  As shown in the following table around 4 million cubic meter can be harvested additional to that the pond can be used as storage place for Ein sultan water during the winter.

Small Wadis in The area

Within the borders of JG land several small seasonal wadis flow from west to east . All attributes are forming three major main streams , taking into consideration the area of the catchments , the average rain and high filtration rate , the three main streams have the capacity for storage around 0.7 million Cubic Meter , this amounts highly depends on the purpose of water tapping (recharge or storage) and the location of retention walls or earth dams . **(full engineerin study will help for defining locations)**

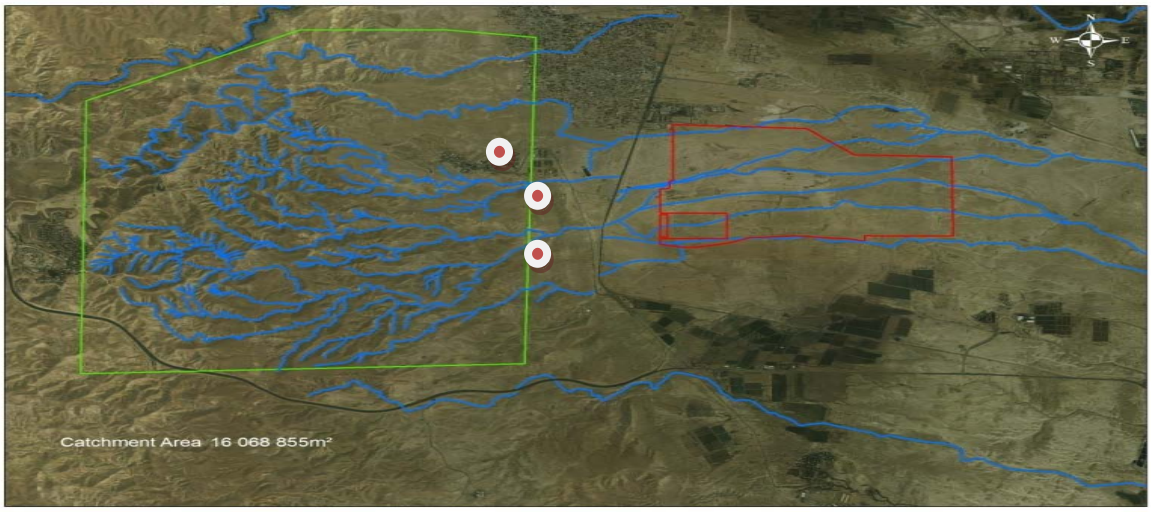

Figure 5.Small wadis can be used for water harvesting

Waste water economical impact

Since no reuse for waste water in the Jordan valley , similar conditions reuse site have been selected in Beitlahia There, a less saline TWW (around 2 dS/m) coming from the Bait Lahia WWTP was available in unlimited quantities and a new experimental irrigated areas could be developed in large empty sandy dunes areas available around the village. An initial attempt of vegetables production had been done in a greenhouse inside the WWTP but it was later abandoned due to the resistance of the consumers. Due to the good quality of water, the production of flowers (carnation) was initially considered but the Ministry of Agriculture decided not to use waste water for this production because of hypothetic risks on export, especially for the Israeli market. The existence of an important Bedouin village with many animals and big areas of unoccupied sandy dunes has oriented the project to a demonstration of fodder production.

Finally, two separated pilot projects have been conducted in those two areas and the first results are presented below.

Table 1.Economic balance for the year 2011

BEIT LAHIA PILOT PROJECT 1 : ECONOMCAL BALANCE FOR 2011							
	Unit	Quantity	Price	Total Price	time	Price/Year	Pr./year/du.
INCOME							
Alfalfa	Kg	52 635,00	0,13	7 000,46	1,00	7 000,46	519,32
Total income						**7 000,46**	**519,32**
COSTS							
Variable Costs							
Pesticides	Application	2,00	180,00	360,00	1,00	360,00	26,71
Crop Husbandry (1 Worker)	Month	12,00	1 125,00	13 500,00	1,00	13 500,00	1 001,48
Crop Irrigation (1 Worker)	Month	12,00	1 125,00	13 500,00	1,00	13 500,00	1 001,48
Crop Harvesting	Operation	6,00	291,69	1 750,11	1,00	1 750,11	129,83
Maintenance		1,00	1 000,00	1 000,00	1,00	1 000,00	74,18
Pump Electricity Consumption	kW	5 742,85	0,42	2 412,00	1,00	2 412,00	178,93
Total variable cost						**32 522,11**	**2 412,62**
Fixed Costs							
Land Preparation	Operation	1,00	1 400,00	1 400,00	7,00	200,00	14,84

Sowing	Operation	1,00	1 640,00	1 640,00	7,00	234,29	17,38
Seeds Kg/Dunum	kg	25,00	50,00	1 250,00	7,00	178,57	13,25
Irrigation system+Fence		1,00	62 789,00	62 789,00	10,00	6 278,90	465,79
Room+Electrical Connection		1,00	11 590,00	11 590,00	20,00	579,50	42,99
Claying	Operation	1,00	39 000,00	39 000,00	100,00	390,00	28,93
Total fixed cost						**7 861,26**	**583,18**
Total cost						**40 383,37**	**2 995,80**
Balance						**-33 382,91**	**-2 476,48**

The incomes and the costs have been recorded, based on the real data.For the price of the alfalfa, we considered the real price the alfalfa has been sold to the Bedouin people, that is to say 2 shekel for 1 bandle (15 kg), or 0.13 shekel/kg. The cost of the pesticide includes the transportation from the ministry of agriculture to the site, and the gas for the applicator. The 2 workers salary has been divided between the husbandry (1 worker, 250 US$) and the irrigation (1 worker, 250 US$).The costs for the land preparation (plowing), the sowing and the seeds have been by 7 years, as the alfalfa is supposed to last for 7 years.The costs for the irrigations system and the fence have been divided by 10 years, as it is supposed to be installed for 10 years. The costs for the room and the electrical conection have been divided by 20 years, as it is supposed to be installed for 20 years.The cost for the claying has been divided by 100 years, as it is supposed to be installed for at least 100 years.The price/year/dunum is the price/year divided by 13.48, as the effective productive land is 13,48 dunums.

Potential economical balance:

If we consider that the yield should be 800 kg/du, as we should harvest 8 cuts per year, considering 13,48 effective dunums the potential quantity of alfalfa produced during 1 year is 86 272 kg. The price should be the market price, that is around 0,5 shekel per kilo.Normally, one worker is enough to cover the work of husbandry and irrigation for this land (actually, only one is covering this work and all the required measurements for the year 2011).

Table 12,Potantial economic Balance

BEIT LAHIA PILOT PROJECT 1 : POTENTIAL ECONOMICAL BALANCE							
	Unit	**Quantity**	**Price**	**Total Price**	**time**	**Price/Year**	**Pr./year/du.**
INCOME							
Alfalfa	Kg	86,272.00	0.50	43,136.00	1.00	43,136.00	3,200.00
total income						**43,136.00**	**3,200.00**
COSTS							
Variable Costs							
Pesticides	Application	2.00	180.00	360.00	1.00	360.00	26.71
Crop Husbandry (1 Worker)	Month	6.00	1,125.00	6,750.00	1.00	6,750.00	500.74
Crop Irrigation (1 Worker)	Month	6.00	1,125.00	6,750.00	1.00	6,750.00	500.74
Crop Harvesting	Operation	6.00	718.93	4,313.60	1.00	4,313.60	320.00
Maintenance		1.00	1,000.00	1,000.00	1.00	1,000.00	74.18
Pump Electricity Consumption	kW	5,742.85	0.42	2,412.00	1.00	2,412.00	178.93
Total variable cost						**21,585.60**	**1,601.31**
Fixed Costs							
Land Preparation	Operation	1.00	1,400.00	1,400.00	7.00	200.00	14.84
Sowing	Operation	1.00	1,640.00	1,640.00	7.00	234.29	17.38
Seeds Kg/Dunum	Kg	25.00	50.00	1,250.00	7.00	178.57	13.25
Irrigation system+Fence		1.00	62,789.00	62,789.00	10.00	6,278.90	465.79
Room+Electrical Connection		1.00	11,590.00	11,590.00	20.00	579.50	42.99
Claying	Operation	1.00	39,000.00	39,000.00	100.00	390.00	28.93
Total fixed cost						**7,861.26**	**583.18**
Total cost						**29,446.85**	**2,184.48**
Balance						**13,689.15**	**1,015.52**

In the table 12, we can see that in this case the balance is positive. The production allow a benefit of 1015 shekel/dunum, that is around 225 US$/dunum. This result is really interesting, as it shows the potential sustainability of the waste water reuse in agriculture for producing alfalfa.

Table 13.Area of land for expanding different crops

i: Area of land available for expanding grains/cereal cultivation

Community Name	Area of land available for expanding grains/cereal cultivation			
	Mean (dunum)	Minimum (dunum)	Maximum (dunum)	Standard deviation (dunum)
'Ein el Beida	1	0	10	2
Ad Duyuk	0	0	0	0
Al 'Auja	8	0	30	13
Al Badhan	0	0	0	0
Al Jiftlik	0	0	0	0
An Nassariya	0	0	0	0
An Nuwei'ma	0	0	0	0
Az Zubeidat	4	0	50	14
Bardala	0	0	0	0
Fasayil	0	0	0	0
Jericho City	0	0	0	0
Kardala	0	0	0	0
Marj al Ghazal	0	0	0	0
Marj Na'ja	0	0	0	0
Overall:	**0.7**	**0**	**50**	**4.8**

ii.Area of land available for expanding fruits (directly consumed) cultivation

Community Name	Area of land available for expanding fruits (directly consumed) cultivation			
	Mean (dunum)	**Minimum (dunum)**	**Maximum (dunum)**	**Standard deviation (dunum)**
'Ein el Beida	6	0	50	12
Ad Duyuk	8	0	20	8
Al 'Auja	35	0	150	40
Al Badhan	1	0	5	2
Al Jiftlik	0	0	0	0
An Nassariya	0	0	0	0
An Nuwei'ma	4	0	20	6
Az Zubeidat	4	0	50	14
Bardala	2	0	10	4
Fasayil	40	0	60	28
Jericho City	0	0	0	0
Kardala	0	0	0	0
Marj al Ghazal	0	0	0	0
Marj Na'ja	1	0	10	3
Overall:	**4.8**	**0**	**150**	**15**

iii. Area of land available for expanding fruits (for processing) cultivation

Community Name	Area of land available for expanding fruits (for processing) cultivation			
	Mean (dunum)	Minimum (dunum)	Maximum (dunum)	Standard deviation (dunum)
'Ein el Beida	19	0	100	23
Ad Duyuk	3	0	20	6
Al 'Auja	12	0	50	16
Al Badhan	0	0	0	0
Al Jiftlik	4	0	50	14
An Nassariya	0	0	5	1
An Nuwei'ma	0	0	0	0
Az Zubeidat	4	0	50	14
Bardala	9	0	30	9
Fasayil	62	0	160	68
Jericho City	31	0	300	85
Kardala	1	0	10	4
Marj al Ghazal	0	0	0	0
Marj Na'ja	0	0	0	0
Overall:	**7.8**	**0**	**300**	**28**

iv. Area of land available for expanding vegetables cultivation

Community Name	Area of land available for expanding vegetables cultivation			
	Mean (dunum)	Minimum (dunum)	Maximum (dunum)	Standard deviation (dunum)
'Ein el Beida	19	0	150	34
Ad Duyuk	23	0	60	21
Al 'Auja	47	0	130	39
Al Badhan	1	0	7	2
Al Jiftlik	4	0	50	14
An Nassariya	8	0	50	16
An Nuwei'ma	6	0	30	10
Az Zubeidat	12	0	100	30
Bardala	18	0	100	27
Fasayil	43	10	70	20
Jericho City	33	0	200	61
Kardala	4	0	40	11
Marj al Ghazal	0	0	0	0
Marj Na'ja	0	0	0	0
Overall:	**13**	**0**	**200**	**28**

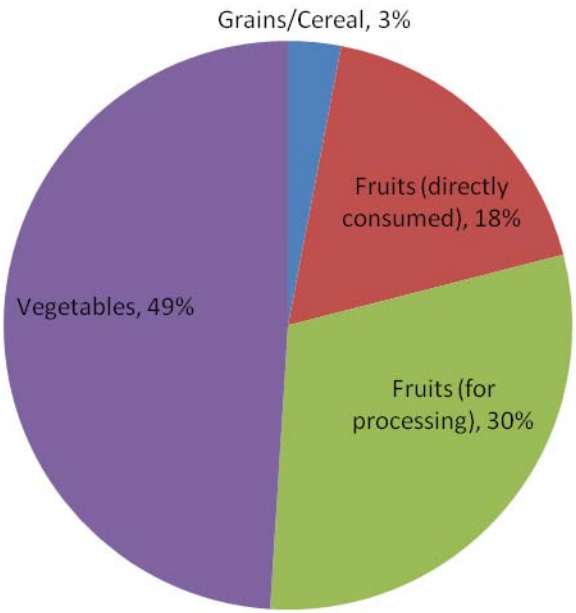

Figure 6.land availability for agricultural expansion

The majority of the land available for potential agricultural expansion will be used for cultivating grains if both labor and water are provided.

Chapter Three :Conclusions and Recommendations

Cost /revenue highly depends on differences in the quality of water, volume of water , technology , the following are the average cost for different options.

The cost of each management option highly depend on the following

- Volume of water
- Location of the option
- Environmental conditions (water quality , temperature…etc)
- Energy cost
- Purpose of use

However based on regional and international experience the following table shows the estimated cost per each management option

Table 14.Cost per water source $/m3

Management option	$/m^3	Revenue per selected crop $/m$^{3(1)}$			
		Vegetable (2)	Banana(2)	palm(2)	Green houses(2)
Ground water wells drilling	**0.30**	**1.07**	**0.88**	**4.2**	**0.94**
Rehabilitation of ground water wells	**0.20-0.30**	**1.48**	**1.25**	**5.24**	**1.33**
Brackish water desalination	**0.46 (without investment**	**0.35**	**0.22**	**2.3**	**0.27**
Water harvesting	**0.15 without investment**	**3.14**	**2.75**	**9.4**	**2.89**
Water transfer	**0.5**	**0.24**	**0.13**	**2.12**	**0.17**
Artificial recharge	**0.3**	**1.07**	**0.88**	**4.2**	**0.94**
Waste water reuse	**0.5 without investment**	**0.24**	**0.13**	**2.2**	**0.17**

(1) Based on the price index published by Palestinian center for statistics 2012
(2) Water requirements based on FAO (2008a)

The above table 14 shows the following results:
The best water management option for vegetables .Banana and palm and green houses is the water harvesting and the most expensive water option and less revenue is water transfer for vegetables and banana . this is the clarification why the palestinian farmers recent years intensivly started to cultvate palm trees (nowadays more than 15thousan trees are cultivated)

From the all mentioned above the following results can be concluded;

- Water harvesting the cheapest option and highest economical revenue
- Waste water is important potential resource for agriculture area expansion
- Desalinated water is expensive and the using solar energy will have a good economic impact

- Analysis of the results shows that the majority of the respondents rely on crop sales (including by-products) for their income while no one relies on governmental aid, religious group/institutions or handiwork for their income.
- The majority of the respondents earn a total ranging from 1000 to 3000 NIS. Many spend more than they earn from life savings or loans and credits due to the difficult economical and employment situation.
- The results clearly show that the greatest portion of the income comes from agriculture. and using of additional water resources will improve the income by expension the cultivated land .
- Analysis results showed that none of the participants' monthly income and living standards have improved during the last 5 years. It is important to note that the high percentage of people owning mobiles does not reflect the living standards of the respondents but it is considered to be a necessity in the area. Also, it was interesting to note that a considerable portion due not own appliances essential for every household such as an iron or a radio.
- When asked about the water sources, it was obvious that residents rely on more than one source for their supply. From the results it is also obvious that the respondents in general do not use rainwater harvesting for their water supply due to the scarcity of rainfall in the area and that they mainly rely on water networks and the water company.
- Results show that the majority are at least fairly satisfied with the water supply for domestic use in terms of both the quantity and quality.
- The mean monthly household expenditure on water supply for domestic purposes in the targeted areas was estimated to be 95 NIS.
- The results show that almost half of the respondents rely on springs for agricultural water supply. It was also clear that rainwater is not used for water supply mainly due to the limited amounts in the area. Most of the respondents use more than one source but mainly rely on springs and groundwater wells.
- The majority of the land available for potential agricultural expansion will be used for cultivating grains if both labor and water are provided.

Recommendations

The following recommendation can be summarized

- The additional water needs to be large scale in order to reduce the cost of cubic meter and to be used by large number of farmers
- Solar energy should be used for desalination to reduce the cost of cubic meter
- Blending brackish water with fresh harvested rain water is the best option to use the brackish water available in the are
- Palm farming is the most economical agriculture (using treated waste water and brackish water is the best option)
- Palm trees cultivation highly recommended since it has low water consumption, poor water quality can be used and high revenues.

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Sample of farmers using multiple quality sources

Current Situation			
Owners	Name	Telephone	Ownership
	Rajih Hafez Al-Shak′a	0599-872011	50%
	Farid Hafez Al-Shak′a	0599-718697	50%
Use	90% for agricultural purposes and 10%for domestic use		
Area of irrigated land	260 dunum (owned by the well owner, the tenants and other farmers)		
Water prices			
Water cost (per unit)	100 NIS/hr (estimated by the well owner)		
Margin of profit	No profit, the costs only include the operational expenses of the well such as the fuel		
Collection of fees	The well owner (which is currently the operator) is responsible for collecting the fees. The fees are collected from each of the farmers immediately after each supply time.		
Water quality	Monitored by PWA and the Ministry of Agriculture (When the water level decreases the salinity of the water increases)		
Water quantity	The quantity of water supplied to each farmer is not limited but is based the need		
Well maintenance			
Maintenance responsibility	Well owner		
Last maintenance	Had not been maintained since a long time (about seven years ago) due to the lack of financial resources and the availability of another water resource (El Far′a Channel)		
Well maintenance history			
Item	Year of maintenance	Cost (NIS)	Source of fund
Pump	1987	60000	Well owner
Riser Pipes	2001	2500	Well owner
Well Head	1987	1500	Well owner
Motor	1995	150000	Well owner
Electrical Switch Board	-	-	-
Fittings (Valves, Gauges,…etc)	2006	10000	Well owner
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