Chapter 3: Enhancing soil fertility and irrigation management in the new lands

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R. Abo El-Enein, M. Sherif, M. Karrou, T. Oweis, B. Benli, M. Qadir and H. Farahani

3.1 Characteristics of the new lands

3.1.1 El-Bustan site

The selected site, El-Husain village, is located in Behaira Governorate in North Delta as shown in Figure 3.1. It is situated about 45 km east of the Alexandria desert road and south of Nubaria canal on branches No. 5 and 12. It was selected purposely to represent the particular community and serves an area of about 100 feddan. The mesqa is still under improvement.

The new lands are represented by the El-Bustan area. The soils of the site are mostly sandy with low fertility and relatively low water holding capacity and crops are grown exclusively under irrigation using modern irrigation systems.

The site has the general characteristics of the new lands:

Figure 3.1. The new lands site location at El-Bustan.

- No fixed cropping pattern
- Shortage of irrigation water, especially in summer
- Availability of improved irrigation systems (drip irrigation and sprinkler irrigation)
- After agricultural liberalization, the cropping pattern has changed gradually towards the production of vegetables at the expense of field crops.

El-Bustan 2 secondary canal, which supports improved irrigation systems, was selected as the community for study (irrigation branch 5). This canal passes across five villages, Abd El Monem Riad, El Ghazaly, El Husain, Mohamed Refaat, and Ahmed Ramy. It serves about 25,000 feddan. There are 16 mesqas (branches) along this canal, serving the five villages.

3.1.2 Soil characteristics

The physical and chemical characteristics of the soil and the N, P, and K content are presented in Table 3.1 for the El-Monofia, El-Serw, and El-Bustan sites.

The analysis of the soils of the new lands El-Bustan site shows that they are sandy with the sand fraction corresponding to nearly 90% of the soils' mechanical separates. However, compared to the other soils investigated in the other sites, they have the lowest EC value – not exceeding 0.3 dS/m. Furthermore, the soils corresponding to this site are the poorest in their nutrient contents, especially potassium, when compared with those of both the Monofia and El-Serw sites.

Agricultural practices in the newly reclaimed lands (known as new lands)

Table 3.1. Fertility and physical and chemical analyses of the soils of the new lands (El Bustan).

Farm no.	N (ppm)	P (ppm)	K (ppm)	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	$CaCO_3$ (%)	EC (dS/m)	pH (1:2.5)
With water users associations										
1	45	11.7	50	66.8	25.5	1.55	6.15	4.8	0.29	7.87
2	15	14.82	35	69.4	22.5	1.74	6.36	5.1	0.28	7.7
Without water users associations										
3	35	40.56	50	58.5	35.6	1.25	4.65	4.6	0.27	7.95
4	60	11.7	70	76.2	16.6	1.45	5.75	5.0	0.3	8.04

differ from those of the old lands. In the new lands, most farmers grow fruit trees on half their areas. The farmers select their cropping patterns according to labor availability and the profitability of the cultivated crops.

In these lands, farmers are not aware of water productivity or its return. Therefore, this study focused on the importance of these criteria besides clarifying the role of the water users associations (WUAs) in solving water problems as well.

3.1.3 Farmer selection procedures

Twenty-nine farmers were interviewed (8% of the total farmer population live in the village) and they are spatially distributed as follows:

- 17 farmers are members in the WUA area
- 12 farmers live in an area without a water users association (No WUA).

Superimposed on this spatial stratification, 41% of the sample is made up of university graduates who live in the No WUA area while the rest (59%) are members of the WUA area. We also worked on two separate irrigation groups, surveying farmers from the heads to the ends of the irrigation canals, to have a third criterion of differentiation based on water supply.

The farmers were partitioned into two different groups located across the Nubaria canal. Two basins were selected (referred to as groups). The first group was labeled WUA, and included farms irrigated according to the WUA basis. The second group, labeled No WUA, involved farms which have no WUA and work illegally.

A sample of 10 farmers was selected to monitor the biophysical and socioeconomic parameters. The selected farmers were interviewed twice a year. Table 3.2 shows a breakdown of the sample according to the type of group and the gender divisions within each group.

Table 3.2. Group membership and gender of the selected farmers.

Group	Men	Women	Total
WUA	4	1	5
No WUA	5	0	5
Total	9	1	10

Source: Collected and calculated from the multidisciplinary survey

3.1.4 Characteristics of the community

All the farmers in El-Husain village settled there at almost the same time in 1988-1989. The earliest arrivals were in 1988 and the latest in 1989. Moreover, all the farmers are university graduates.

3.1.5 Farm size

There is no variation in farm size among the farmers in the two groups because each graduate has settled 5 feddan according to the law of land settlements. Thus, all graduates in both groups approximately own the same area (2.1 ha), but some of them rent out their lands to beneficiaries or graduates and prefer to return to their original place; although they are still legally tied to their land.

3.1.6 Family size and workforce

All the families are nearly the same size; but the family workforces differ between the two groups. Thus, the total family labor is estimated at 16 HLU in the WUA group and 12 HLU in the No WUA group. This difference arises from the high variability of the cropping patterns in the two categories. Most WUA farmers grow tree fruits, which need less labor than vegetable and field crops.

3.1.7 Structural ratios

The average amount of land available per family member (cultivated area by human consumption unit, or CA/HCU) is also almost the same for the graduates – 0.3 ha in the WUA group versus 0.35 ha in No WUA group. The average family labor available per hectare (HLU/CA) is less 0.45 for the WUA graduates as compared to 0.48 in the No WUA group. Therefore, there is a greater need for hired labor in the No WUA group.

3.1.8 Livestock holding

Of the farmers, 28% have animals while the remaining 72% do not have or are not interested in animal production. Graduates who have animals usually lend them to beneficiaries or other graduates under a sharing system – the animal and half of the off-spring belongs to the owner. The other farmer is totally responsible for feeding and tending the animals, and receives animal products in exchange, plus keeps half the off-spring. All graduates have slightly larger livestock holdings, but variability is high. Therefore, this difference is not considered as really significant.

3.1.9 Farmers' incomes

The participating farmers were asked about their present and future plans for purchasing, constructing, or expanding their new lands holdings, buying trucks, buildings, or any other investments during the last year which affected the farmers' capability to save and invest. Table 3.3 shows that not all the farmers invested part of their agricultural income, but most farmers were willing to invest for the future.

Table 3.4 shows that farmers in El-Bustan area consider wheat as their main source of agricultural income in winter. This is supplemented by the income from their fruit trees. There is high variation in the total

Table 3.3. Current and future investments of the farmers.

Farmer code	Current investment	Future investment
1	-	Expanding building a house
2	-	Expanding building a house
3	Building a house	Building a store
4	-	Buying a tractor
5	-	Establishing a greenhouse
6	Complete building a house	Buying a car to manage the farm
7	Complete building a house	
8	Complete building a house	
9	Complete building a house	Buying a truck
10	Complete building a house	Buying a truck for marketing crops

Source: Monitoring and Evaluation (M&E) Survey Report, 2006.

income earned from crop sales, ranging between EGP 1250 and EGP 7900.

In the summer the income from the fruit trees supplements that from peanuts, the main source of income in this period. Table 3.5 shows the variation in total income earned from crop sales. This ranged between EGP 3380 and EGP 10,500. It can be seen that the WUA group farmers earned higher incomes from horticultural crops (24%) than their No WUA counterparts, while the No WUA farmers earned higher incomes from field crops (87.5%) than those of the WUA group.

Table 3.6 gives an overview of the main descriptors used in characterizing the samples.

Table 3.4. Income earned in the winter from different activities for the two groups (EGP).

Farmers code no.	Wheat	Faba bean	Peas	Berseem	Potatoes	Total
WUA						
1	4,900	3,000				7,900
2	5,200					5,200
3	7,500					7,500
4	1,400		900	1,400		3,700
5	2,100				4,800	6,900
No WUA						
1	7,500					7,500
2	3,900					3,900
3					3,600	3,600
4*						
5		1,250				1,250

Note: * Farmer no. 4 did not plant any field crops and substituted these with fruit trees.
Source: M&E Survey of winter 2006.

Table 3.5. Income earned in the summer from different activities for the two groups (EGP).

Farmer code no.	Peanut	Maize	Watermelon seeds	Guava	Green beans	Total
WUA						
1	5,000	1,000	800			6,800
2	6,300					6,300
3	7,500					7,500
4	1,400	1,980				3,380
5	2,520				1,120	3,640
No WUA						
1	6,825					6,825
2	5,250					5,250
3	1,680	4,050		2,500		8,230
4*						
5	10,500					10,500

Note: * Farmer no. 4 did not plant any field crops and substituted these with fruit trees.
Source: M&E Survey of summer 2006.

Table 3.6. Average values of the structural descriptors for the two groups.

Criterion	WUA	NWUA	Whole sample
Median age (years)	40	42	41
Years of settlement	17	17	17
Family size (HCU)	7	6	7
Family workforce (HLU)	16	12	14
Total farm area (feddan)	85	60	145
Farmland use (feddan)	85	60	145
Share of different treatments (feddan)			
Fallow		12	
Trees	12.5	20	
Crops	72.5	28	
Animal holders (%)	30	26	28
Average livestock holding (LU)	3	3	3
Structural ratios			
CA/HCU	0.3	0.35	
HLU/CA	0.45	0.48	

Note: HCU – human consumption unit; HLU – human labor unit; LU– livestock unit; CA – cultivated area.
1 feddan = 0.42 ha.
Source: Collected and calculated from the multidisciplinary survey.

3.1.10 Cropping patterns

Table 3.7 shows that most farmers in El-Bustan plant half of their holding area to fruit trees because of the shortage of labor. Maize and peanut are the main crops in summer and wheat and berseem are the main crops in winter for the two groups. Table 3.8 illustrates the main crop rotations for the two groups.

3.1.11 Area under production

Table 3.9 displays some economic indicators of the winter crops and Table 3.10 shows some economic indicators of the summer crops for the two groups.

Table 3.7. Cropping patterns for the two groups.

Group	Summer 2006	Winter 2006-2007
WUA	Maize, potatoes, peanut,	Wheat, berseem, faba bean, beans
No WUA	Peanut, maize,	Wheat, berseem,

Source: Collected and calculated from the multidisciplinary survey.

3.1.12 Farm budget

Tables 3.11, 3.12, and 3.13 illustrate some economic indicators for peanut, maize, and green beans crops, respectively, for the two groups.

Table 3.14 shows such economic indicators as total cost, total revenue, net return or benefit, and the benefit-cost ratio. These

Table 3.8. The crop rotations for the two groups and the number of farmers for each rotation.

Rotation	WUA	N0 WUA
Potato + peanut	5	4
Potato + potato	2	1
Potato + maize	4	3
Wheat+ maize	2	1
Wheat+ melon	2	0
Wheat + peanut	1	4
Faba bean + maize	1	3
Berseem + maize	2	1

Source: Collected and calculated from the multidisciplinary survey.

Table 3.9. Area (ha) under production for the two groups in winter.

Potato 2006	Potato 2005	Peas 2006	Berseem 2006	Berseem 2005	Faba bean 2006	Wheat 2006	Wheat 2005	Farm code no.
WUA:								
	1				0.6	1		1
						1.2	1	2
	1.2						2	3
	1.6	0.2	0.2	0.2	0.4	0.4		4
0.4	1					0.4		5
No WUA:								
	1					1.2		1
				1		0.6	1	2
1.6	1.6							3
								4*
	2				2			5

Note: * Farmer no. 4 did not plant any field crops and substituted these with fruit trees.
Source: M&E Survey of winter 2006.

Table 3.10. Area (ha) under production for the two groups in summer.

Peanut			Maize			Group
2006	2005	2004	2006	2005	2004	
WUA						
0.8	1	1	0.5	1		1
1						2
1.2	1.2	1			0.8	3
0.4	0.4	1.4	0.6	0.6	0.2	4
0.4	0.8	0.5			0.5	5
No WUA						
1				1	1	1
0.8	0.8	1				2
0.4	1.6		1.2			3
						4*
2	2					5

Note: * Farmer no. 4 did not plant any field crops and substituted these with fruit trees.
Source: M&E Survey of summer 2006.

indicators differ for the WUA and No WUA groups and among their crops, except for the berseem crop, where the benefit-cost ratio is higher for the WUA group than the No WUA group. The difference is higher in the case of wheat because of the lower benefit to the No WUA group. Berseem has the highest benefit-cost ratio (0.33) for the WUA group compared to 0.55 for the No WUA group. This is a consequence of its price and its importance as animal fodder.

3.1.13 Crop varieties

The different varieties planted by the two groups were, for wheat, Sakha 93 and Sakha 68, for maize, Hybrid 1 and Single Hybrid 310, and Sponta for potato.

3.1.14 Soil and nutrient improvement practices

The two groups use manure and chemical fertilizers. The WUA group has no manure and buys it from the market. However, the

Table 3.11. Some economic indicators of peanut for the two groups

Group	WUA					No WUA			
Code	1	2	3	4	5	1	2	3	5
TV cost (EGP)	1,534	1,028	1,210	1,190	1,750	1,798	1,142	1,245	1,145
G. margin (EGP)	2,500	2,520	3,000	1,680	2,520	2,730	2,625	1,680	2,100
Net return (EGP)	966	1,492	1,790	490	770	932	1,483	435	955
B/C ratio	0.63	1.45	1.48	0.41	0.44	0.52	1.30	0.35	0.83
BE price (EGP)	1,918	1,028	1,345	1,983	1,944	1,854	1,446	2,371	1,527
BE yield	0.58	0.37	0.36	0.51	0.63	0.64	0.34	0.39	0.41

Note: TV. cost – total variable cost; G. margin – gross margin; B/C ratio – benefit to cost ratio; BE price – break even price; BE yield – break even yield.
Source: M&E Survey of summer 2006.

Table 3.12. Some economic indicators of maize for the two groups.

Group	WUA		No WUA
Farmer code no.	1	4	3
TV cost	1,303	813	1,195
Gross margin	1,760	1,320	1,350
Net return	4,57	507	155
B/C ratio	0.35	0.62	0.13
BE price (EGP)	1,086	397	569
BE yield	1.95	1.26	1.86

Source: M&E Survey of summer 2006.

Table 3.13. Some economic indicators of green beans for the two groups.

Group	WUA
Farmer code no.	5
TV cost	729
Gross margin	1120
Net return	391.00
B/C ratio	0.54
BE price (EGP)	521
BE yield	0.23

Source: M&E Survey of summer 2006.

Table 3.14. Some economic indicators of wheat for the two groups.

Crop	Wheat		Berseem		Potato		Faba bean	
Item	WUA	No WUA	WUA	No WUA	WUA	No WUA	WUA	No WUA
Total cost	5,683	5,761	2,921	2,700	21,946	17,589	1,819	1,415
Total revenue	7,057	6,042	3,875	3,588	23,973	18,656	2,000	1,249
Benefit	1,374	281	955	1,588	2,026	1,067	181	121
B/C ratio	0.24	0.05	0.33	0.55	0.09	0.06	0.10	0.09

Source: M&E Survey.

No WUA group has manure and uses a greater quantity compared to the WUA group. Thus, the cost of manure is higher for the WUA group. The two groups apply the same quantities of ammonium fertilizer, but the second group applies more ammonium sulfate and mono superphosphate (15.5%). However, the No WUA group applies more potassium sulfate as shown in Table 3.15.

Table 3.15. Quantity of fertilizer applied (per ha) for the two groups.

Item	WUA	No WUA
Manure:		
Available	No	Yes
Application	Yes	Yes
Quantity (m^3)	25	37.5
Price (EGP/m^3)	150	62.5
Leaf fertilizer:		
Application	Yes	Yes
Chemical fertilizer (50 kg bag):		
Urea 46.5%		
Ammonium nitrate 33.5%	25	25
Ammonium sulfate 20%		4
Mono superphosphate 15.5%	7.5	10
Potassium 48%	5	1.25

Source: Checklist of Participatory Rural Appraisal.

There are many treatments to maintain good quality soil. No farmer in either of the groups has salinity problems on their lands. In general, there is no drainage system in El-Bustan area, whether open or subsurface. However, this is not considered a problem in sandy soils. Thus, the absence of drainage and its commonly related consequences (high water table, water-logging, and salinity) is a major issue for some farmers having their fields in depressions; it is even more of a problem if they are located close to major canals. To maintain soil fertility, all farmers add manure and chemical fertilizers.

3.1.15 Water management and supply

Farms situated far from the line heads of three irrigation lines were surveyed to investigate water supply variations among the farmers in El-Bustan village depending on the distances between their fields and the main canal. The irrigation water is fresh and of good quality. Fresh water is mixed with drainage water in June and July, but the quality remains good, in general

The farmers were grouped into three classes based on the distances of their fields from the line head – beginning class (0 to 300 m), middle class (300 to 900 m), and tail class (900 to 2000 m). The maximum distance from the line head was assumed to be 2 km and the minimum distance was 5 m. Each class contained 10 farmers.

The survey showed that there was no significant difference in water supply between those farmers located close to the head of the irrigation line and those located at the end, especially in the WUA group. Problems of low pressure are common at the end of the line, especially if there is a slope between the head and the tail. However, the water supply is not really a criterion for differentiation between farmers, especially regarding the cropping pattern and rotations they practice.

The majority of farmers use moving sprinklers. However, some farmers changed to a fixed irrigation system using drippers. The average number of irrigations and the hours/mohaya irrigation for each crop are listed in Table 3.16. As can be seen from the Table there is considerable variation between the two groups (WUA and NWUA) for the potato and berseem crops, especially regarding the number of irrigations. This is one positive outcome of the WUA on water availability (quantity and quality).

Table 3.16. Length of time (hour/ha) and number of irrigations for the two groups.

Item	WUA		NWUA	
	Mohaya (hr/ha)	No of irrigations	*Mohaya* (hr/ha)	No of irrigations
Potato	3	40	3	30
Wheat	2	30	2.5	30
Faba bean	1.5	25	2	25
Berseem	3	50	3	25

Note: Mohaya – first, post-planting irrigation.

Source: Collected and calculated from the multidisciplinary survey.

Farmers in the two groups do not experience water table problems during most months of the year except June and July. The farmers in the WUA group solve these problems by allocating the irrigation time among themselves. Of the farmers in the NWUA group, those at the end of the canal experience some problems, but they are not unduly negatively affected because they try to solve these problems in a manner similar to the farmers in the WUA.

3.1.16 Irrigation costs

Table 3.17 shows that the total irrigation costs of the WUA group are less than those of the NWUA one. These reduced costs arise from the use of regular irrigation water and the shorter irrigation times, and they demonstrate the positive influence of the WUA on irrigation costs.

Water shortages may occur in April, August, and September, affecting the productivity of some crops, such as wheat, peanut, maize, and fruit trees.

3.1.17 Pest and weed control

Weeds are found in the lands of both groups. Manure and water are the main sources for these infestations. Farmers apply both manual and chemical controls. Nematodes and berseem and bean dodders are the main plant pests for the two groups. They also resort to manual and chemical pest control to deal with these.

Table 3.17. Irrigation costs of the main crops for the two groups.

Crop	NWUA				WUA			
	No of irri.	hr/ha.	EGP/hr	Total cost (EGP/ha)	No of irri.	hr/ha.	EGP/hr	Total cost (EGP/ha)
Winter crops								
Wheat	30	5	2.5	375	17	7	2.5	159
Potatoes	20	5	2.5	250	12	7.5	2.5	225
Faba bean	25	5	2.5	312.5	15	4	2.5	141
Summer crops								
Peanut	30	5	2.5	375	16	7.5	2.5	300
Maize	35	5	2.5	437.5	20	7.5	2.5	375
Potatoes	25	5	2.5	312.5	20	7.5	2.5	375

Source: Collected and calculated from the multidisciplinary survey.

3.1.18 Land productivity

Total production was recorded to compare the positive or negative impacts of the project. Total production is equal to the yield per unit area multiplied by the associated area planted. So, while it is not valid to compare the total production between the two groups, it is useful to use this production divided by the water requirement to reflect water productivity. Tables 3.18 and 3.19 show the total production in the winter and summer seasons for the two groups.

Table 3.20 shows the productivity of the two groups compared to other sites located at Nubaria. It can be seen that the productivity of wheat and maize are smaller than at the Nubaria sites. Moreover, the productivity of the NWUA group is higher than that of the WUA group except for watermelon seeds and maize. The productivity of summer potato is the same for the two groups.

3.2 Objectives and methodologies

3.2.1 New lands

a) Winter crops (wheat and faba bean)

- Farmers' irrigation practices
- Full irrigation (ET + 0.2ET for leaching requirements)
- 80% of full irrigation.

b) Summer crops (groundnut)

- Full irrigation (1.2 ET)
- Deficit irrigation (85% of full irrigation)
- Farmers' irrigation practices

Table 3.18. Total production (t/ha) in winter for the two groups.

Potato 2006	Potato 2005	Peas 2006	Berseem 2006	Berseem 2005	Faba bean 2006	Wheat 2006	Wheat 2005	Group
WUA								
	75				5.6	12.5		1
						12.75	10.3	2
	75					18.75		3
	135	2.5	15	15	5.7	3.5		4
15	75					5.25		5
NWUA								
	112.5					18.8		1
				37.5		6.5	10.3	2
100	80				-			3
					-			4*
	125				19.5			5

Note: * Farmer no. 4 did not plant any field crops and substituted them with fruit trees.

Source: Collected and calculated from the multidisciplinary survey.

Table 3.19. Total production (t/ha) in summer for the two groups.

Peanut 2006	Peanut 2005	Peanut 2004	Maize 2006	Maize 2005	Maize 2004	Group
WUA						
4.7	5.6	4.7	5.5	10.5		1
5.6						2
6.8	5.3	5.0			3.8	3
1.5	2.6	10.0	7.7	7.0	2.5	4
2.3	4.7	7.5			5	5
NWUA						
6.1				15	12.5	1
3.9	4.7	6.8				2
1.3	7.0	-	15.8			3
	4.4	7.0		8.8	9.4	4*
9.4	13.1					5

Note: * Farmer no. 4 did not plant any field crops and substituted them with fruit trees.
Source: Collected and Calculated from the Multidisciplinary survey.

Table 3.20. Productivity (t/ha) of the main crops in El-Husain village.

Crop	WUA	NWUA	Nubaria
Winter season crops			
Wheat	4.5	4.9	6.0
Winter potatoes	30.0	32.5	
Faba bean	3.5	3.9	3.9
Summer season crops			
Peanut	2.25	2.8125	3.3
Water melon seeds	0.75	0.5	1.7
Maize	5.95	3.5	9.4
Summer potatoes	42.5	42.5	26.6
Green beans	3.125		6.6

Source: Productivity of the two groups is collected and calculated from the multidisciplinary survey Productivity at the Nubaria sites was collected from the Agricultural Economics magazine, Ministry of Agriculture.

3.3 Results

3.3.1 Wheat

The data for yield and water productivity are shown in Tables 3.21 and 3.22. Compared to the farmers' irrigation practices, deficit irrigation saved on irrigation water by about 113 mm (26%), 75 mm (18%), 98mm (23%), and 85 mm, (23%) in the 2005-2006 season for Farms 1, 2, 3, and 4, respectively. In the 2006-2007 seasons, the amounts of water saved by the same four farms were 97 mm (27%), 132 mm (31%), 133 mm (30%), and 116 mm (28%).

In 2005-2006 there were not significant reductions in the wheat yields of 36 kg/ha (1%) for Farm 2 and 215 kg/ha (5%) for Farm 4 while Farm 3 showed an increase of 324 kg/ha (5%).. In 2006-2007 the reductions in were 127 kg/ha (3%) for Farm 1, 109 kg/ha (2%) for Farm 2, 46 kg/ha (1%) for Farm 3, and 126 kg/ha (6%) for Farm 4.

Table 3.21. Quantity of water used, yield, and WP for the winter wheat crop (new lands, 2005-2006 and 2006-2007) at El-Bustan site.

	2005-2006 season						2006-2007 season					
	Yield (t/ha)	Amt of water (mm)	WP (kg/m³)	Yield (t/ha.)	Amt of water (mm)	WP (kg/m³)	Yield (t/ha)	Amt of water (mm)	WP (kg/m³)	Yield (t/ha.)	Amt of water (mm)	WP (kg/m³)
	Farm 1			Farm 3			Farm 1			Farm 3		
Farmer practice				5.786	425	1.36	4.663	400	1.165	5.545	435	1.273
Req				6.75	428	1.58	4.46	366	1.219	5.418	362	1.497
80% full irri.				6.11	351	1.74	4.536	296	1.532	5.499	303	1.815
	Farm 2			Farm 4			Farm 2			Farm 4		
Farmer practice	3.893	424	0.92	3.929	414	0.95	5.544	427	1.297	2.142	422	0.507
Full irri.	4.214	387	1.09	3.75	388	0.97	5.544	358	1.549	2.016	365	0.552
80% full irri.	3.857	311	1.24	3.714	316	1.21	5.435	295	1.842	2.016	306	0.659
	NS			NS			NS			Ns		

Note: NS – not significant.

Table 3.22. Average values for the yield, relative yield, amount of irrigation water used, and WP for wheat (new lands, 2005-2006 and 2006-2007) the El-Bustan site.

Irrigation treatment	Yield (t/ha)	Relative yield	Amount of water used (mm)	Relative amount of water used	WP (kg/m³)	Relative WP
2005-2006						
Farmer practice	4.54	1	421	1	1.08	1
Full irri.	4.90	1.08	401	0.95	1.21	1.12
80% full irri.	4.56	1.01	326	0.77	1.38	1.28
2006-2007						
Farmer practice	4.47	1	421	1	1.06	1
Full irri.	4.36	0.98	363	0.86	1.20	1.14
80% full irri.	4.37	0.98	300	0.71	1.46	1.38

It is clear that deficit irrigation resulted in higher water productivity than that obtained from the farmers' irrigation practices (see Tables 3.21 and 3.22). Deficit irrigation yields were 0.32 kg/m^3 (35%), 0.38 kg/m^3 (28%), and 0.22 kg/m^3 (23%) higher than those obtained using the farmers' traditional practices for Farms 2, 3 and 4 respectively in the 2005-2006 season. In the 2006-2007 season, water productivities on Farms 1, 2, 3, and 4 were, respectively, 0.367 kg/m^3 (32%), 0.545 kg/m^3 (42%), 0.542 kg/m^3 (43%), and 0.152 kg/m^3 (30%) higher than those obtained following the farmers' usual practices.

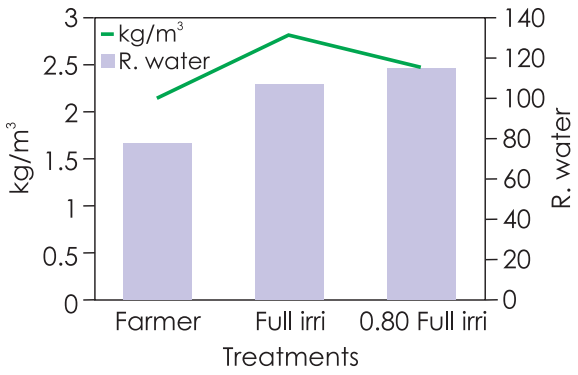

Figure 3.2. Water productivity and relative water productivity for various irrigation treatments of faba bean grown on new land in the 2005-2006 season.

3.3.2 Faba bean

Table 3.23 and Figs 3.2 and 3.3 show the effect of the interventions used on the amount of water saved and the yield produced. There was no significant difference in faba bean yield that could be attributed to irrigation treatments in the 2005-2006 and 2006-2007 seasons. From the first season results it is apparent that the farmers' traditional irrigation practices used 80 mm which is 23% more than used in the deficit irrigation practice. This reduced the faba bean yield by 838 kg/ha (13%). Deficit irrigation saved 97 mm on the amount of water applied by farmer and increased yield by 648 kg/m^3 (11%). Also, the deficit irrigation resulted in higher water productivities. These were 0.800 kg/m^3 (48%)

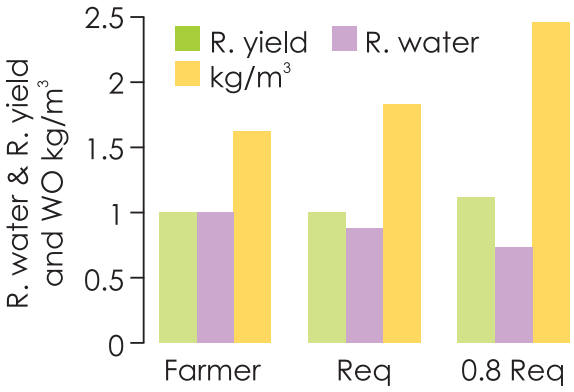

Figure 3.3. Average relative amount of water used, relative yield and WP of faba bean under different irrigation treatments, at El-Bustan in the 2006-2007 season.

Table 3.23. Amount of water used, yield, and WP for the winter faba bean crop (new lands, 2005-2006 and 2006-2007) El-Bustan site.

	2005-06			2006-07		
Irrigation treatment	**Yield (t/ha)**	**Amount of water used (mm)**	**Water productivity (kg/m^3)**	**Yield (t/ha)**	**Amount of water used (mm)**	**Water productivity (kg/m^3)**
Farmer	5.714	347	1.65	5.880	362.8	1.621
Full irri.	7.467	326	2.29	5.880	321	1.830
80% full irri.	6.552	267	2.45	6.528	266	2.450
				NS		

Note: NS – not significant

and 0.829 kg/m^3 (51%) more than that obtained from farmers' irrigation practices for the 2005-2006 and 2006-2007 seasons.

3.3.3 Groundnut

Table 3.24 presents the effects of water interventions on yield and water productivity of groundnut in the new lands for the 2006and 2007 cropping seasons. It was found that irrigating with 85% of the full irrigation requirement produced a higher yield than with the farmers' traditional irrigation practices. The yields for 2006 were 3.4 t/ha under 85% of full irrigation and 3.14 t/ha under the farmers' traditional practices, while in the 2007 the yields were 2.84 t/ha (85% of full irrigation) and 2.97 t/ha (farmers' irrigation practices). The amounts of water saved as compared to the farmers' irrigation practices were 101 mm (18%) in the 2006 season and 72 mm (13%) in the 2007 season. In 2006, the increase in yield attributed to 85% of full irrigation treatment ranged from 0.01 t/ha (8%) to 0.47 t/ha (14%), while the amount of water saved varied between 92

Table 3.24. Effects of different irrigation regimes on the yield and WP of groundnut on new lands in the 2006 and 2007seasons.

	2006						2007					
Farm no.	**FP**	**Req**	**85% of req**	**FP**	**Req**	**85% of req**	**FP**	**Req**	**85% of req**	**FP**	**Req**	**85% of req**
	Yield (t/ha)			**Relative yield**			**Yield (t/ha)**			**Relative yield**		
1	3.14	3.44	3.44	1	1.1	1.1	2.68	3.23	2.85	1	1.21	1.06
2	2.65	2.47	2.66	1	0.93	1	2.72	2.65	2.8	1	0.97	1.03
3	3.42	3.96	3.89	1	1.16	1.14	4.18	4.15	3.64	1	0.99	0.87
4	3.35	3.78	3.62	1	1.05	1.08	2.31	2.37	2.07	1	1.03	0.9
Aver	3.14	3.16	3.40	1	1	1.08	2.973	3.1	2.84	1	1.04	0.96
	Amount of water used (mm)			**Relative amount of water used**			**Amount of water used (mm)**			**Relative amount of water used**		
1	586	545	479	1	0.93	0.82	521	541	462	1	1.04	0.89
2	560	540	468	1	0.96	0.84	588	547	465	1	0.93	0.79
3	620	592	515	1	0.95	0.83	520	570	497	1	1.1	0.96
4	574	551	476	1	0.96	0.83	537	548	455	1	1.02	0.85
Aver	585	557	484.5	1	0.95	0.83	541.5	551.5	469.75	1	1.02	0.87
	Water productivity (kg/m^3)			**Relative water productivity**			**Water productivity (kg/m^3)**			**Relative water productivity**		
1	0.536	0.631	0.718	1	1.18	1.34	0.522	0.49	0.606	1	0.94	1.16
2	0.473	0.457	0.568	1	0.97	1.2	0.463	0.484	0.602	1	1.05	1.3
3	0.552	0.669	0.755	1	1.21	1.37	0.804	0.728	0.732	1	0.91	0.91
4	0.584	0.505	0.761	1	0.86	1.3	0.43	0.432	0.455	1	1.01	1.06
Aver	0.536	0.566	0.701	1	1.06	1.3	0.555	0.534	0.599	1	0.96	1.08

Note: FP – farmer practice; Req – required amount of water.

mm (16%) and 105 mm (18%). In the second season, for Farm 1, the deficit irrigation increased the yield by 80 kg/ha (6%) while saving 59 mm (15%) of irrigation water while for Farm 2 the comparable figures were to 170 kg/ha (3%) and 123 mm (21%).

The average water productivity of the irrigation treatments, for all farms, indicated that full irrigation and 85% of full irrigation improved water productivity. The WP for full irrigation was increased by 6% (0.03 kg/m^3) and that for 85% of full irrigation was increased by 30% (0.165 kg/m^3).

3.4 Conclusions

- The results of the on-farm trials showed that recommended irrigation techniques are simple techniques that can be easily implemented by the farmers. They can lead to a significant increase in the yield, crop water productivity, and in the amounts of water saved as compared with those obtained following the farmers' traditional practices.
- Deficit irrigation is a technique that has shown a beneficial effect in maximizing crop water productivity. The results of the trials carried showed that the implementation of such a technique, where a relatively high proportion of the irrigation water is saved, did not result in any significant losses in yield for the major crops.
- The trials on wheat in the new lands (sandy soils), showed that using 70% of the required amount of water did not affect wheat production at all. The yield losses were only about 2%; but the crop water productivity was significantly increased – it was nearly 38% higher than that obtained under the farmers' usual practices.