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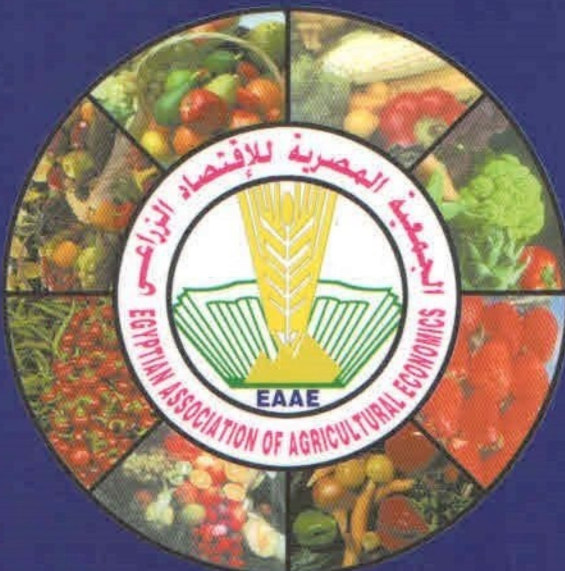

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Economic Assessment of some Technologies used in Irrigated Agriculture and their Impact on Farmers' Livelihoods: Case of the Egyptian Salt-affected Soils Farms

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Abstract: Salinity is a continuous challenge in Egypt because of the dry climate, and more salt being carried by the Nile River as a result of pollution, water shortage, seawater intrusion and human practices. Accumulation of excessive salt in irrigated soils of Egypt negatively affects crops' yields, reduce the effectiveness of irrigation, deteriorate soil structure and affect other soil quality. This study was carried as part of the activities of the "Water and Livelihood Initiative (WLI)". In this study, we hypothesized that farmers in the Salt-affected soils of Egypt grow crops at an economically efficient scheme, they efficiently use irrigation water and they can cope with soil salinity through using sustainable water-saving technologies and land conservation practices. This study aims to measure economic efficiency and water use efficiency for crops grown by the sample farmers, and identify sustainable water-saving technologies and land conservation practices they use to combat inappropriate soil conditions and poor irrigation management in the salt-affected land. The study used data of survey conducted in South El Husainia Plain (Egypt) in 2011/2012 to calculate some economic indicators. Empirical findings showed that growing wheat, clover, cotton and maize is promising in the study area. Therefore, farmers are encouraged to grow wheat and clover in winter whereas in summer, they are encouraged to grow cotton and maize since wheat and clover were the most economically efficient crops grown in winter whereas, cotton and maize gained the highest economic efficiency in the summer season. Clover and maize were the most profitable crops from water efficiency standpoints in winter and summer, respectively. Farmers in the study area use laser leveling, agricultural gypsum, sub-soiling, improved varieties and raised bed in their farms. Therefore, farmers are encouraged to adopt sustainable water-saving technologies and land conservation practices to overcome inappropriate soil conditions and irrigation management. Indeed, sufficient farmer's access to knowledge and improving communication channels between the farmer and the agricultural extension, and skilled extension personnel on management practices relevant to salt-affected areas are of high importance to transfer such promising techniques to farmers in the study area.

Key words: salt-affected soils, irrigation water management, economic efficiency, water use efficiency, technologies, Egypt.

1. Introduction

Water is the natural resource that exerts the greatest constraint on Egypt's agricultural production system(Attia, 2004). Egypt's total arable land reached 3.6 million hectares (ha) which are also irrigated land, representing less than 4% of Egypt's total area of about 100 million ha (MALR, 2012). However, Egypt's agriculture is under pressure to justify its use of water resource, which is scarce due to increased competition for water resources among other major water consuming sectors. For example, the agricultural sector consumes about 80% of Egypt's water resources, as compared to about 11%, 3% and 2% consumed by municipalities, industries and aquaculture farms, respectively (MWRI, 2010).

According to Ismail (2009), it is well established that optimum use of available resources becomes inevitable. The situation is not only being made worse by further land deterioration and salinity but also by population increase, climatic changes, etc. Salinity is one of the major environmental stresses that have significantly impaired agricultural production all over the world. Egypt is apart from this scene. Salinity is a persistent challenge in Egypt because of the dry climate, and more salt being carried by the Nile River as a result of pollution, water shortage, seawater intrusion and human practices (Ismail, 2009). Accumulation of excessive salt in irrigated soils of Egypt negatively affects crops' yields, reduce the effectiveness of irrigation, deteriorate soil structure, and affect other soil properties. More than 0.9 million ha of the arable land in Egypt are currently salt-affected, representing about 24% of the total arable land (Ismail, 2009). Moreover, salt balance in the salt-affected land of Egypt is significantly affected through inappropriate soil and water management and inappropriate irrigation schemes management and consequently has negative effects on crops' yields (Mohamedin et al., 2010). This situation resulted in socio-economic and environmental damage, especially when sudden increase in fertilizer prices occur (FAO, 2005).

It is within this framework that this study was carried as part of the activities of the "Water and Livelihood Initiative (WLI)" project jointly implemented by the socio-economic team of work from the Agricultural Research Centre of Egypt (ARC), Zagazig University (ZU) and the International Center for Agricultural Research in the Dry Areas (ICARDA).

The hypothesis of this study is that farmers in the Salt-affected soils of Egypt grow crops at an economically efficient scheme, they efficiently use irrigation water and they can cope with soil salinity through using sustainable water-saving technologies and land conservation practices. However, the objectives of this study are to measure economic efficiency and water use efficiency for crops grown by the sample farmers, and identify sustainable water-saving technologies and land conservation practices they use to combat inappropriate soil conditions and poor irrigation management in the salt-affected land.

The remainder of the study is organized as follows; the second section presents the methodological framework with special emphasis to the analytical method and data used. The third section discusses the empirical results and finally, the last section concludes with some remarks and recommendations on policy implications.

2. Methodological Framework

2.1. Data source and descriptive analysis

Region of study: The target Site for conducting the Study is located at South El

Husainia Plain, Sharkia Governorate, South of East Delta Region in Lower Egypt. According to Sayaf (2011) and East Delta Newlands Agricultural Services Project "EDNASP" (2009), South El Husainia Plain is one of six newly reclaimed areas in this Region that covers an area of about 24 thousand ha, out of which 16 thousand ha are cultivated areas which represents 66.5% of the total area. However, graduate settlement created in the studied area in 1993/94. This region is inhabited by recent settlers who received plots of land from the government. Soil structure and lack of fresh irrigation water, in addition to poor social and cultural services, made the region unattractive for many farmers.

Surveying procedure and data collection: Data was collected from a socio-economic farm and household survey conducted during the 2011/2012 season in El Husainia Plain. A sample of 152 households, representing about 7.7% of the total number of holders was randomly selected. The distribution of farm households across the defined five Villages (clusters) was determined based on the weight proportional importance of the total number of holders in each Village (proportional to the number of holders of each holding categories in the population). The sample was stratified based on holding categories (graduates, beneficiaries, small investors and new holders), to ensure the representativeness of each of the holders categories. Interviewed farmers were randomly selected using lists obtained from census offices. The distribution of sample farms is presented in Table 1. From this table, it appears that about 43%, 39%, 16% and 2% of the interviewed farmers were graduates, beneficiaries, small investors and new holders (new buyers)[1], respectively.

Table (1): Sample distribution according to target Villages and holding categories.

Target Villages	Frequency	%	Holding Categories	Frequency	%
Khalid Ben El Waleed	33	22	Graduates	65	43
Tarek Ben Ziad	20	13	Beneficiaries	60	39
El Rowad	31	20	Small Investors	24	16
El Salah	28	18	New Holders	3	2
El Ezdehar	40	27	Total	152	100
Total	152	100			

Source: The results of the socio-economic farm and household survey 2011/2012.

The questionnaire and data analysis: The questionnaire consists of eight sections: the first is related to agricultural activities and costs of production. The rest of sections are related to output and revenue of crop production, institutional framework, sustainable water-saving and soil-conserving practices, using recommended water management technologies, support and extension services, the most important problems facing farmers in addition to the main socio- economic characteristics related to the farmers.

2.2. Analytical method

To reach the objectives of this study, frequency tables representing absolute frequency and relative frequency (or percent) and quantitative methods of analysis were used. Moreover, water productivity (WP), defined as the quantity of main product per ha divided by the quantity of water consumed per ha was also used in order to indicate water use efficiency. With regard to water resources, the economic

[1] This group consists of individuals who purchased plots of land from other landholders.

return to water use was computed as gross margin per unit of water applied. This measure reports the profitability to scarce factors i.e. land ($/ha) and water ($/1000 CM), in which gross margins per unit of land and water were calculated based on the farm-gate prices. On the other hand, the economic productivity of water is defined as the 'value' derived per unit of water used. In this case this 'value' can refer to economic return or to profitability, nutrition, or more broadly to any other economic and social benefit e.g. jobs, welfare, environment, etc. (Sadras et al, 2007). Besides, the net return per unit of water (1000 CM) is used for evaluating the economic performance of water use in crop production. The net return per unit of water is defined as the net profit per unit of main product divided by the quantity of water consumed.

The main indicators of economic efficiency and water use efficiency for crops cultivated were calculated. The forms of these indicators are represented using the following formulas:

- *Total revenue per ton of main product (in $)=Total revenue ($/ha)÷Yield of main product (ton/ha)*
- *Variable costs per ton of main product (in $)=Variable costs ($/ha)÷Yield of main product (ton/ha)*
- *Total costs per ton of main product (in $)=Total costs ($/ha)÷Yield of main product (ton/ha)*
- *Gross margin per ha (in $)=Total revenue ($/ha)-Variable costs ($/ha)*
- *Gross margin per ton of main product (in $)=Gross margin per ha ($)÷yield of main product (ton/ha)*
- *Net profit per ha (in $) = Total revenue ($/ha)-Total costs ($/ha)*
- *Net profit per ton of main product (in $)=Net profit per ha ($)÷Yield of main product (ton/ha)*
- *Water productivity (in Kg/CM)=Yield of main product (ton/ha)÷Quantity of water consumed (CM)*
- *Gross margin per unit of water (in $/1000 CM)=Gross margin per ha ($)÷Quantity of water consumed (CM)*
- *Net return per unit of water (in $/1000 CM)=Net profit per ton of main product ($)/Quantity of water consumed (CM)*

3. Results and Discussion

3.1. Characteristics of selected sample

Level of soil salinity: Interviewed farmers were asked to estimate the level of soil salinity in their farms. Empirical findings showed that about 46% and 45% of the farms were of moderate and high level of soil salinity, respectively.

Source of irrigation: Empirical results indicate that fresh water, groundwater and drainage water were the main sources of irrigation water in the target Site representing the salt-affected land. About 69% of the area cultivated by winter and summer crops was irrigated by mixed water (Nile water mixed with Bahr El-Bakar drainage water). Regarding to the source of irrigated area, results indicates that about 24%, 7% and 1% of this area was irrigated by fresh water, drainage water (Bahr El-Bakar Drain) and sewage water, respectively.

Cropping pattern: The analytical results revealed that crops that can cope with high soil salinity were dominant in the studied area namely, sugar beet, wheat and clover in winter whereas, rice, cotton and maize were dominant in summer. For winter cropping pattern, sugar beet was the dominant crop (45%). in winter, about 9%, 33% and 13% of the cropped area was occupied by clover, wheat and barley, respectively. Rice was dominant in summer (85%). About 13% and 2% of the cropped area was occupied by cotton and maize, respectively.

This result was confirmed by Ismail (2009) indicating that the cropping pattern in Egypt is somewhat adjusted to soil condition. In the Nile Delta where soil salinity is somewhat high, wheat and clover are the main winter crops whereas, rice and cotton prevail in summer. All of these crops have proved to be salt-tolerant or semi-tolerant. However, the data collected from the survey revealed that crop selection is the main management practice that a farmer can use to combat soil salinity problems. According to MALR (2003), leaving the soil bare promotes evaporation and salt accumulation at the surface and fallowing or growing non-tolerant crops will probably aggravate the salinity problems in this area. Consequently, since the study area was recently reclaimed, farmers used to grow clover and barley in winter and rice in the summer season.

However, the results of East Delta Newlands Agricultural Services Project "EDNASP" (2009) reported that in soils of South El Husainia Plain, it is a challenge to cultivate crops due to difficulties facing farmers in the studied area e.g. poor soil fertility, low water supply and low level of experience. The cropping pattern in such areas should include crops with different water requirements, rooting depths, and salt and waterlogging tolerances.

3.2. Crop production and indicators of efficiency

Yield: Empirical findings also indicate that the average yields of crops grown in the target Site were lower than the average yields of the country since these crops suffered from poor soil fertility and low water supply (Table 2). From this table, it appears that some by-products of these crops were of high value e.g. the contribution of wheat straw and cotton wood to the total revenues per hectare on wheat and cotton represented about 13% and 20%, respectively.

Total revenue and costs of production: Among winter crops, sugar beet ranked first in terms of high total revenue, reaching about $ 1554 per ha whereas, wheat gained the lowest total revenue reaching about $ 1275 per ha. In summer, maize ranked first in terms of high total revenue of about $ 1468 per ha, followed by cotton and rice reaching about $ 1458 and 1354 per ha, respectively. The analysis of costs indicates that sugar beet ranked first in terms of high total costs per ha in winter. This is due to the intensive use of chemical fertilizers and hired labour which represents about 27% and 17% of the total costs, respectively. In summer, rice ranked first in terms of high total costs per ha and this is mainly explained by the intensive use of seedlings, chemical fertilizers and hired labour which represents about 8%, 24% and 21% of the total costs, respectively.

Indicators of efficiency: The indicators of economic efficiency and water use efficiency for the main crops are presented in Table 3. Results from this table indicate that the total revenues of one ton of wheat and cotton, considered the main products, were the highest among the winter and summer crops, reaching about $ 444 and $1166, respectively. However, clover and rice gained the lowest total revenues per ton in winter and summer, respectively.

Table (2): Average yields, total revenues and the costs of production for the main crops.

	Yield in the target Site (ton/ha)		Egypt's Av. Yield (ton/ha)	Farm-gate Price ($/ton)		Total Revenue ($/ha)	Variable Costs ($/ha)	Fixed Costs ($/ha)	Total Costs ($/ha)
	Main Product	By-product	Main Product	Main Product	By-product				
Sugar Beet	30.35	0.36	48.30	51	32	1554	681	496	1177
Wheat	2.87	2.20	5.70	388	73	1275	636	496	1132
Clover	44.74	0.00	69.50	30	0	1321	275	496	771
Rice	4.83	0.05	9.50	280	17	1354	737	496	1232
Cotton	1.25	0.60	2.40	1101	133	1458	704	496	1200
Maize	3.33	11.90	7.40	351	25	1468	484	496	980

Source: The results of the socio-economic farm and household survey 2011/2012.

The empirical results related to the cost analysis by each crop are also presented in Table 3. These findings revealed that wheat and cotton ranked first in terms of high variable and total costs per ton compared to other crops in winter and summer. However, clover and maize were the most profitable in terms of gross margin per ha in winter and summer, reaching about $ 1046 and 983 per ha, respectively.

Contrarily, wheat and rice were the least profitable in terms of gross margin per ha. In terms of gross margin per ton, wheat and cotton were the most profitable winter and summer crops. With respect to of the analysis of net profit, clover and maize were the most profitable crops reaching for about $ 550 and 488 per ha, respectively. The wheat and cotton crops were the most profitable in terms of net profits per ton and rice was the least profitable in terms of both indicators (Gross margin and net profits).

Table (3): Indicators of economic efficiency and water use efficiency for the main crops.

	Sugar Beet	Wheat	Clover	Rice	Cotton	Maize
Total revenue per ton of main product ($)	51	444	30	280	1166	441
Variable costs per ton of main product ($)	23	222	6	153	563	146
Total costs per ton of main product ($)	39	395	17	255	960	294
Gross margin per ha ($)	873	638	1046	617	754	983
Gross margin per ton of main product ($)	29	222	23	128	603	295
Net profit per ha ($)	377	143	550	121	258	488
Net profit per ton of main product ($)	13	50	12	25	206	146
Quantity of water consumed (CM)	5890	4586	6490	10786	10391	6119
Water productivity (kg/cm)	5.15	0.63	6.89	0.45	0.12	0.54
Gross margin per unit of water ($/1000 CM)	148.2	139.2	161.2	57.2	72.5	160.7
Net return per unit of water ($/1000 CM)	2.2	10.8	1.8	2.3	19.8	24.0

Source: The results of the socio-economic farm and household survey 2011/2012.

Empirical findings revealed also that amongst the cropping pattern prevailing in the studied area, winter crops (e.g. clover, sugar beet and wheat) were the most efficient in terms of water use reaching the highest water productivity. Clover reached the highest water productivity of 6.9 Kg/CM in winter whereas in the summer, water productivity of maize reached the highest value of 0.54 Kg/CM. These results are due to high yield of clover and little amount of water needs for maize. Moreover, water profitability for clover and maize was the highest in winter and summer, respectively since the gross margin per unit of water for these two crops reached $ 161.2 and 160.7 per 1000 CM of water, respectively. On the contrary, wheat and rice ranked the last in terms of water profitability, reaching only $ 139 and 57 per 1000 CM in winter and summer, respectively. This could be explained by the low gross margins per ha of these crops.

Furthermore and according to the results presented in the above table, in winter the net return per unit of water applied for wheat reached the highest value generated from water use in crop production estimated at about $ 10.8 per 1000 CM. in summer, maize reached the highest net return per unit of water estimated at about $ 24 per 1000 CM. Since clover and rice are high water-consuming crops, they ranked the last in terms of water profitability, reaching only about $ 1.8 and 2.3 per 1000 CM in winter and summer, respectively.

Based on these results, wheat and clover ranked first in terms of high values of most indicators of economic efficiency in winter whereas, cotton and maize gained the highest economic efficiency among studied crops in the summer season. However, clover and maize were the most profitable crops from water efficiency standpoints in winter and summer, respectively. According to this, farmers are encouraged to grow wheat and clover in winter whereas, they are encouraged to grow cotton and maize in summer.

3.3. The use of sustainable water-saving technologies and land conservation practices

According to Ismail (2009), there are several constraints to crop production at the salt-affected lands e.g. poor irrigation, poor drainage system, and insufficient supply of good quality seeds. Better agricultural and land management practices are necessary to reduce the impact of salinization. For the adoption of new technologies, farmers' constraints are the high cost of inputs, lack of knowledge about new technologies, unavailability of good-quality inputs (seeds, fertilizers, water, etc.), and lack of effective communication between farmers and agricultural extension officers. A study by FAO (2005) revealed that if appropriate irrigation management and drainage systems and good farming practices are not applied in time, it may be necessary to take the land out of production altogether.

In order to combat inappropriate soil conditions and poor irrigation management in the salt-affected land, interviewed farmers reported the use of sustainable water-saving technologies and land conservation practices such as laser leveling, adding agricultural gypsum, sub-soiling and growing improved varieties in their farms. The empirical findings revealed the following:

Laser leveling: As confirmed by MWRI (2010), laser leveling is strongly recommended to be used by farmers in order to increase the efficiency of irrigation and consequently to improve land leveling. On the basis of this statement, farmers were asked about the usage of laser leveling. Annex 1 revealed that 99% of the farmers heard about laser leveling whereas, only 88% of them used it. Neighbors was the main source of information about this technology for about 56% of the farmers whereas, about 12%, 30% and 2% of these farmers heard about laser leveling from agricultural extension, the media, and personal experience, respectively.

In Egypt, laser leveling is practiced by the Ministry of Agriculture and Land Reclamation, agricultural co-operatives, public and/or private sector. The results of our survey revealed that due to lack of laser leveling equipment in the agricultural co-operatives, about 66% and 32% of the farmers depend on private companies and mechanical service stations (Ministry of Agriculture and Land Reclamation) to conduct laser leveling for their lands, respectively.

Our findings are in compatible with the findings of El Zanaty et. al., (2002) indicating that about 13.7% of farmers in East Delta had their lands leveled by laser. This also highlights the results of a study by El Shazly (2009) on its argumentation that laser leveling in areas cultivated by wheat in Beheira Governorate increased its yield and gross margin by 22% and 45%, respectively and saved water consumption by decreasing the hours of irrigation by about 40% in addition to reduce the costs of seeds, chemical fertilizers, irrigation, tilling and labour by about 8%, 13%, 40%, 17% and 25%, respectively.

Adding agricultural gypsum: Our results showed that about 97% of the farmers heard about this practice (Annex 1) whereas, only 34% of them used it. However, about 67% of the farmers cited their neighbors as the source of their information about this practice whereas, about 21%, 9%, and 3% of these farmers heard about this practice from agricultural extension, media and personal experience, respectively. The results of a study by Aiad et al. (2012) showed that application of agricultural gypsum amendment generated considerable interest in the past few years to control alkalization, especially in the salt-affected soil in the North Delta of Egypt.

About 88%, 15% and 31% of the interviewed farmers believed that adding agricultural gypsum is useful, ineffective and neutral, respectively. Out of the farmers who believed in the usefulness of adding agricultural gypsum, about 94% believed that adding agricultural gypsum reduces soil alkalinity and salt content effectively. Thus, improving soil physical properties whereas, about 80% of them considered adding agricultural gypsum as an effective practice for improving crops' yields. Moreover, about 77% of farmers add agricultural gypsum because they believe in this practice as an easy and good practice to improve soil conditions. As well, about 68% and 54% of the farmers believed that adding agricultural gypsum reduces the costs of production effectively. This allows them to grow more crops. Based on these findings, about 69% of the farmers reported their intent to conduct this practice in the future, indicating the adding agricultural gypsum as a potential practice in the study area.

Our findings are confirmed by the results of another study by El Shazly (2009) that reported an increase in wheat yield and its gross margin by 9% and 19%, respectively due to adding agricultural gypsum in Beheira Governorate.

Sub-soiling: The empirical results presented in Annex 1 regarding the knowledge and perceptions of farmers to sub-soiling showed that about 21% of the interviewed farmers heard about and used this practice. Neighbors was the main source of information about this practice for about 85% of the farmers whereas, about 4%, and 12% of them farmers heard about this practice from agricultural extension and the media, respectively. Moreover, about 21% of the interviewed farmers conducted this practice.

Our results are supported by the results by El Shazly, (2009) that reported sub-soiling in Beheira Governorate increased wheat yield and its gross margin by 12% and 30%, respectively and saved water consumption by decreasing the hours of irrigation by about 20% in addition to reduce the costs of irrigation, tilling and total costs by about 20%, 33% and 1%, respectively.

Besides, the results of our survey are supported by the findings of Aiad et al. (2012) which revealed that yields of wheat, rice and sugar beet differed significantly in case of using certain technologies e.g. laser leveling, sub-soiling and a package of laser leveling with sub-soiling. The yields of wheat grain in the fields treated by laser leveling, sub-soiling and a package of laser leveling with sub-soiling exceeded the control treatment by about 24%, 34% and 41%, respectively. However, the corresponding yields of rice grain exceeded the control treatment by about 27%, 25% and 32%, respectively while, the root yields of sugar beet under laser leveling treatment was lower than that of the control by about 9%. Although, the root yields of sugar beet were higher with a package of laser leveling with sub-soiling.

Growing improved varieties: Based on the survey results, about 59% of the farmers grow improved varieties of sugar beet, wheat and rice. However, about 29% of them cited their neighbors as the source of this technology information. However, about 11%, 14%, and 1% of these farmers heard about this technology from agricultural extension, media (e.g. Sirr Al Ard "Land Secret" TV agricultural extension specific program) and sugar factory, respectively.

However, about 66% and 76% of the farmers believed that growing improved varieties is useful and growing improved varieties saves irrigation water effectively, respectively. About 63% of the farmers believed that growing these varieties saved agricultural inputs, time and efforts thus, reducing the costs of production and increasing farm income effectively whereas, about 80% of them considered growing improved varieties as an effective technique for improving crops' yields through disease-resistance. Based on this finding, about 61% of the interviewed farmers express their willingness to use this technology in the future as a potential technology in the study area.

In addition, farmers were also asked about the main reasons impeding the use of this technology. Results indicate that about 8% of them cited good traditional varieties they cultivate as the main reason hindering using this technology. About 83% of them cited that they don't know where to get such varieties from. Moreover, about 9% of the farmers reported that low yields of some improved varieties were the main reason impeding the use of this technology.

These findings are in concordance with previous results such as the study conducted by Ahmed et al. (2012) where its results revealed that growing improved varieties of cereals in Gharbia Governorate increased the yields of maize, wheat and rice. The results of our survey were emphasized by East Delta Newlands Agricultural Services Project "EDNASP" (2009) that reported land improvement technologies as the most technologies used in South El Husainia Plain (e.g. sub-soiling, adding agricultural gypsum and laser leveling), followed by growing improved varieties.

Besides, another study by MALR (2003) revealed that the Government of Egypt initiated an on-going ambitious land improvement program that includes gypsum application for improving land productivity; sub-soiling to improve soil physical properties, break up hard pans, soil compaction and all indurate layers within the root zone; land leveling and reshaping for better water management; and improvement of the drainage and canal system for salinity and waterlogging control. This program targets to improve 630 thousand ha annually all over the country. The results of this program indicated that application of sub-soiling with addition of agricultural gypsum and drainage increased yields of crops whereas, proper laser leveling increased crops' yields by about 10-25% and reduced irrigation time by about 25-50%.

Raised bed: The results of our survey showed that raised-bed is a potential water-saving technology suitable for the study area. Farmers heard from their neighbors about raised-bed and they started using it. Besides, farmers want to use this technology in the future.

This was confirmed by a study conducted by Karrou, M., Oweis, T., et al. (2011) which reported that raised bed technique (furrow technique) showed very satisfactory results in the different sites (old lands and marginal lands) investigated under cropping with the main winter crops (wheat and clover) and the summer ones (corn and cotton). This technique, besides saving around 25% of the water applied, increased crop production by 10% more than that produced following the farmer's customary irrigation practices. Furthermore, the implementation of such a simple technique resulted in average water saving of 20-25% over that corresponding to the basin irrigation practice of the farmers.

Generally, the empirical results showed that neighbors were the main source of information about sustainable water-saving technologies and land conservation practices in the studied area. This could be due to lack of information and communication between the farmer and the agricultural extension personnel.

The results of our survey were supported by the study conducted by Ismail (2009) which indicated that farmers and even extension personnel in salt-affected areas of Port Said, Dakhlia, Beharia, Dammietta, and Kafr El-Sheikh Governorates often mismanage their crops due to lack of access to knowledge and poorly trained extension personnel on management practices relevant to salt-affected areas. However, the results from East Delta Newlands Agricultural Services Project "EDNASP" (2009) revealed that soil and water inappropriate properties in South El Husainia Plain obstruct the use of other sustainable water-saving technologies such as drip and sprinkler irrigation systems.

4. Concluding remarks, recommendations and policy implications

The primary objectives of this study are to measure economic efficiency and water use efficiency for crops grown by the sample farmers, and identify sustainable water-saving technologies and land conservation practices they use to combat inappropriate soil conditions and poor irrigation management in the salt-affected land. However, the hypothesis of this study is that farmers in the Salt-affected soils of Egypt grow crops at an economically efficient scheme, they efficiently use irrigation water and they can cope with soil salinity through using sustainable water-saving technologies and land conservation practices. To reach this objective, the methodology used was based on the calculation of different economic indicators using a 152-farmers socio-economic farm and household survey conducted in South El Husainia Plain in 2011/2012.

Empirical findings showed that wheat and clover ranked first in terms of high values of most indicators of economic efficiency in winter whereas, cotton and maize gained the highest economic efficiency among studied crops in the summer season. However, clover and maize were the most profitable crops from water efficiency standpoints in winter and summer, respectively. Based on these results, farmers are encouraged to grow wheat and clover in winter whereas, they are encouraged to grow cotton and maize in summer.

Moreover, empirical results indicates that 88%, 34%, 21% and 59% of farmers in the study area use laser leveling, adding agricultural gypsum and sub-soiling and growing improved varieties and in their farms, respectively. Therefore, farmers are encouraged to adopt sustainable water-saving technologies and land conservation practices to overcome inappropriate soil conditions and irrigation management in the salt-affected land.

Furthermore, the results from this study confirm that raised bed is a potential suitable water-saving technology in the study area. Thus, sufficient farmer's access to knowledge and improving communication channels between farmers and agricultural extension and skilled extension personnel on management practices in the salt-affected areas are of high importance to transfer such promising techniques to farmers.

Finally, these recommendations are supported not only by our findings but also by the objectives of the National Agricultural Sustainable Development Strategy 2030 targeting the rationalizing of water and land use through the introduction of new high-yielding drought-tolerant varieties, introduction of agricultural management technology package and with the modernizing of on-farm irrigation in order to improve agricultural production systems (MALR, 2009). Moreover, these recommendations are in perfect concordance with the objectives of the Water Resources Strategy 2050 which targeted to improve on-farm water management practices such as laser land leveling, developing *mesqa* and water distribution structures, and forming water users associations (MWRI, 2010).

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Annexes:

Annex (1): Responds of the interviewed farmers about usage of sustainable water-saving technologies and land conservation practices.

	Frequency	%
Hearing about Laser Leveling	152	100
Yes	150	99
No	2	1
Source(s) of Information	101	100
Agricultural Extension	12	12
Neighbors	57	56
Media	30	30
Personal Experience	2	2
Using Laser Leveling	152	100
Yes	133	88
No	19	13
Executing Authority	146	100
Mechanical Service Stations (Ministry of Agriculture)	46	32
Agricultural Co-operatives	2	1
Private Companies	97	66
Unknown	1	1
Hearing about Using Agricultural Gypsum	152	100
Yes	147	97
No	5	3
Source(s) of Information	152	100
Agricultural Extension	32	21
Neighbors	102	67
Media	14	9
Personal Experience	4	3
Using Agricultural Gypsum	152	100
Yes	51	34
No	101	66
Desire for Future Use of Agricultural Gypsum	152	100
Yes	105	69
No	3	2
Not Sure	4	3
Unknown	40	26
Is this Agricultural Gypsum Useful	152	100
Yes	134	88
No	18	12
Hearing about Sub-soiling	152	100
Yes	32	21
No	120	79
Source(s) of Information	26	100
Agricultural Extension	1	4
Neighbors	22	85
Media	3	12
Using Sub-soiling	152	100
Yes	32	21
No	120	79
Hearing about Improved varieties	152	100
Yes	89	59
No	63	41
Source(s) of Information	152	100
Agricultural Extension	16	11
Neighbors	44	29
Media	22	14
Sugar Factory	2	1
Unknown	68	45
Growing Improved varieties	152	100
Yes	89	59
No	63	41
Reasons hindering Growing Improved varieties	144	100
The traditional varieties I use are good	12	8
The yields of some improved varieties are less	13	9
I don't know where I can get it from	119	83
Desire for Future Growing Improved varieties	152	100
Yes	92	61
No	15	10
Not Sure	24	16
Unknown	21	14
Growing Improved varieties was Useful	152	100
Yes	[illegible]	66
No	1	1
Not Sure	51	34

Source: The results of the socio-economic farm and household survey 2011/2012.

التقييم الاقتصادي لبعض التقنيات المستخدمة في الأراضي المروية وآثارها على سبل معيشة الزراع: دراسة حالة للأراضي المتأثرة بالأملاح في جمهورية مصر العربية

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بوبكر دهيبي	آدن أو–حسن
المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا)

الملخص

إن التراكم المفرط للأملاح في الأراضي المروية بجمهورية مصر العربية يقلل من فاعلية الري ويُضعف بناء التربة ، مما يؤثر سلباً على إنتاجية المحاصيل. وقد أجريت هذه الدراسة كجزء من أنشطة "مبادرة المياه وسبل العيش". واستهدفت الدراسة التعرف على المحاصيل الرئيسية بمنطقة الدراسة ، تحليل الكفاءة الاقتصادية لإنتاج المحاصيل الرئيسية ، التعرف على الممارسات والتقنيات التي يستخدمها الزراع لتوفير مياه الري والحفاظ على التربة الزراعية في ظل ظروف التربة السيئة وسوء إدارة مياه الري السائدين بمنطقة جنوب سهل الحسينية بمحافظة الشرقية والتي تُمثل الأراضي المتأثرة بالأملاح. واعتمدت الدراسة على نتائج استبيان للزراع بالموسم الزراعي ٢٠١٢/٢٠١١ ، حيث تم سحب عينة عشوائية طبقية عنقودية تضم ١٥٢ مفردة مُمَثِّلة لمجتمع الدراسة والذي يتكون من خمس قرى. وأوضحت نتائج الدراسة أن الزراع في منطقة الدراسة يزرعون المحاصيل التي تتحمل ارتفاع ملوحة التربة كبنجر السكر ، القمح والبرسيم في فصل الشتاء ، والأرز والقطن والذرة الشامية في فصل الصيف ، وأن المصادر الرئيسية لمياه الري هي المياه العذبة والمياه الجوفية ومياه الصرف ، كما أن نحو ثلث المساحة المزروعة تروى بمياه مخلوطة. وأظهرت النتائج أن محاصيل القمح والبرسيم والقطن والذرة هي الأكثر كفاءة من الناحية الاقتصادية ، كما أن البرسيم والذرة هي الأكثر ربحية من حيث كفاءة استخدام المياه ، لذا توصي الدراسة بتشجيع مزارعي المنطقة على زراعة محاصيل القمح والبرسيم والقطن والذرة الشامية. وأوضحت النتائج انخفاض إنتاجية المحاصيل بمنطقة الدراسة عن متوسط الجمهورية ويرجع ذلك لقلة خصوبة التربة وقلة وانخفاض نوعية مياه الري ، وبالتالي فإن الزراع بمنطقة الدراسة يستخدمون تقنيات التسوية بالليزر ، الجبس الزراعي ، الحرث العميق تحت التربية ، الأصناف المحسنة والمصاطب العريضة. لذا توصي الدراسة بتشجيع الزراع على تبني التقنيات والممارسات التي من شأنها ترشيد استخدام المياه والحفاظ على التربة الزراعية. وتوصي الدراسة كذلك بتحسين قنوات الاتصال بين الزراع والإرشاد الزراعي وإعطاء الزراع الفرصة الكافية للوصول للمعرفة والمهارات اللازمة حول التقنيات والممارسات التي من شأنها ترشيد استخدام المياه والحفاظ على التربة الزراعية في منطقة الدراسة.

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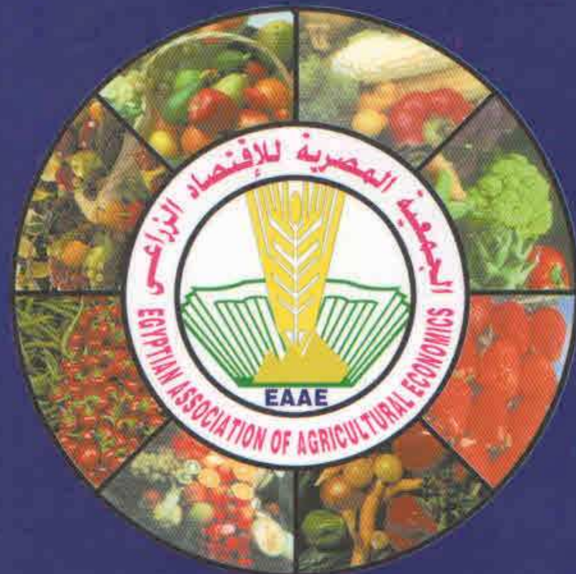

المجلد الثالث والعشرون العدد الثالث سبتمبر ٢٠١٣

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تصدرها
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