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The Economic Value of Varied Salinity Irrigation Water Use in the Egyptian Agriculture

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Abstract: The study aimed to identify the possibilities of agricultural drainage water reuse expansion in the Egyptian agricultural lands irrigation under the rareness water factor and the steady population increase conditions, these conditions led to food gap increase. Therefore, the paper concentrated on studying the effect of varied salinity water irrigation on farm returns of basic crops at the studied areas, also, the paper was interested in estimating the economic value of such varied qualities of the used irrigation water in such crops production. It was shown that, the financial evaluation criteria were decreased in the case of using low quality water (mixed and agricultural drainage water) compared to its similar which used fresh water, except black beans and rice crops at Bahera governorate. The results assured the impossibility of maize cultivation by using low quality water, either mixed or agricultural drainage water at both Sharkia and Bahera governorates; because of the maize sensitivity to salinity. The economic value of varied salinity water irrigation estimation results showed that the decrease of its value in all irrigated crops with mixed and agricultural drainage water, compared to its similar, which were irrigated with fresh water. It was also illustrated that, the increase of the economic value of water resource by almost 11% when its quantities were rationalized by 10% of its actual used quantities of all kinds and for all studied crops. It was clear from the study that, the rice and wheat agricultural cycle was the best agricultural cycle according to the financial evaluation criteria and economic value of irrigation water when it was cultivated with fresh water. Finally, the study recommends the expansion of using mixed and agricultural drainage water in salinity durable crops production, such as cotton, Black Beans and Rice, also avoiding maize cultivation by using low quality water, because of its sensitivity to salinity.

Key words: Economy, salinity, irrigation water, Egyptian agriculture

INTRODUCTION

The agricultural drainage water in Egypt is considered one of the most important untraditional water resources. The idea of reusing agricultural drainage water in irrigation started to take considerable place in the water policies since the seventies, then, stations for mixing drainage water at the main water ways were established, to meet the needed expansions in cultivated areas to overcome the food balance deficit which resulted from the steady increase in population counts. The used agricultural drainage water was estimated by 4.5 milliard M^3 annually in Delta area. Accordingly, the water policy is aiming now to increase the quantities of reused agricultural drainage water in order to reach 8.4 milliard M^3 annually in the year 2017.

The Study problem and justification: Egypt is facing the steady increase of its population and in the mean time, its facing the stability of both agricultural areas and available water supply, this fact caused the increase of the food gap between its production and consumption. Therefore, the state is considering carrying out horizontal expansion programs in order to add new areas to the current agricultural areas, taking in consideration, its protection against random urban extensions. Also, the state is giving its attention to water resources development, its securing, increasing its usage efficiency and maximizing its returns. Therefore, the state is following scientific methods to fulfill such aims in order to meet the increasing demand for water in different usages. Hence, reusing agricultural drainage water is considered one of the most important aimed method. But the expansion of its use need conducting environmental economic.

Studies to identify its use feasibility in the Egyptian agriculture because of the increase of pollution in such water quality resulting from both the increase of using agricultural chemicals and the increase of using agricultural chemicals and the increase of untreated industrial and sanitary wastes drainage.

The study aim: The study aimed to estimated the farm returns of field crop under irrigation condition with varied salinity water. Also, the economic value estimation of these different quality of used water in producing the most important field crops, in order to identify the possibilities of reused agricultural drainage water expansion in crops irrigation.

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Table 1: Available water needs and Resources till the year 2017.

Data	1997	2017
Needs	milliard M^3	milliard M^3
Agriculture	52.13*	67.13**
Loss by evaporation from the Nile and water ways	2.1	2.3
Sanitary and drinking user	4.54	6.6
Industrial used	7.42	10.56
River navigation	0.15	0.15
Water canal ganged to meet the required needs		
The river Nile share	55.5	55.5
Gongly canal project first stage	-	2.0
Under ground water at the Delta and valley	4.8	7.5
Reusing drainage water the Delta	4.9	8.4
Decreasing Nile drainage to the sea	0.15	-
Developing crop structure	-	3.0
Surplus resulted from irrigation development program desert	0.15	4.0
Underground reservoir	0.57	3.77
Treated drainage water	0.2	2.0
Northern shore rain and flowage water	1.0	1.5
Total	67.27	86.67

* The need of evaporation transpiration 37.4 milliard and efficiency 72%.
** The need of evaporation transpiration after expansion for 3.4 million feddan will teach 53.7 milliard and efficiency 80%.
Source: The ministry of water resources and irrigation; main textures of water policy towards the year 2017, January 2000.

The study methodology: The study depended on published and unpublished secondary data issued from the ministry of water resources and irrigation, in addition to, the data extracted from the field study, its individuals were chosen according to the statistical theory in order to be similar to the studied society. Three qualities of irrigation water were chosen: fresh water, mixed water and agricultural drainage water at Bahera and Sharkia governorate.

As for the methodology used in the estimation of the economic value of irrigation water, the study depended on" Return computed residuals" (Mahdy, 1983, Yang, 1996). This method depends on estimating the management return, which was assumed to be 5% of the total crop revenue including main and secondary product (Mahdy, 1996) and cost computing for substituted opportunity for the value of variable production cost – the variable capital return- at interest rate 10%. The economic value of used irrigation water in producing studied crops was computed as the residual of total marginal after deducting management return, variable capital return and land yield- according to actual used quantities in agriculture at the field study areas, compared to the quantities which represent equivalent to 90% of the currently used as a method to control the irrigation water.

Future plan for reusing agriculture drainage water: The reused agriculture drainage water volume in Egypt was estimated at the beginning of the twenty first century by 12.8 milliard m^3 annually of which, 4.9 milliard m^3/ were reused at lower Egypt (Bahri area) and 28 Milliard M^3 were reused directly from waterways by farmers, in upper Egypt water to the River Nile which was estimated by 4.1 milliard M^3 annually, as for the reused drainage water quantities, which was mixed with upper Egypt and Fayoum water ways, it was estimated by a milliard M^3 annually.

The data in table (1) showed the prediction of the aimed reused agricultural drainage water it illustrated the increase of such water at lower Egypt area from 4.9 milliard M^3 currently to 8.4 milliard M^3 by the year 2017. Taking in consideration, the need to improve waterways water quality by suitable treatment through small stations on sub-waterways or treating main

Table 2: The field study sample specification

	Sharkia		Bahera		Total	
Data	Number	%	Number	%	Number	%
Fresh water	26	32.5	25	35.7	51	34
Mixed water[(1)]	30	37.5	23	32.9	53	35.3
Agricultural drainage water	24	30	22	31.4	46	30.7
Total	80	100	70	100	150	100

[(1)]Mixed water at Sharkia governorate was mixed fresh water and agricultural drainage water by 1: 1, water saltiness was less than 1000 fraction of million. Mixed water at Bahera governorate was irrigation with 50% fresh water, 0% agricultural drainage water computed and gathered from the field study source.

waterways before mixing it. Also, by separating the industrial and sanitary drainage from agricultural drainage, controlling the use of fertilizers and pesticides and obliging water plluters with quality laws application. Besides, respecting the percentage of 50% to be drained in the sea, in order to keep the Delta water and salt balance, as well as, increasing the deep overlapping effect of sea water with underground reservoir at Northern Delta.

Uses of low quality water in the Egyptian Agriculture: There are three levels of reusing agriculture drainage water in irrigation at Delta area represented by; official use, unofficial use and intermediate use. The official use is meant by, main water sources mixed with waterways water by the ministry of water resources and irrigation with the percentage of 1:1, its saltiness reached 1085 fraction of a million. As for the unofficial use, it is done by farmers without any authorized permit, particularly, farmers living at the waterways ends and suffer from lack of irrigation water, its saltiness exceeds 3000 fraction of a million. The intermediate use of agricultural drainage water depends on mixing sub-waterways with nearby water courses before reaches the polluted main waterways.

The study sample and its specification: The study sample[(3)] was chosen to include two governorates; Sharkia governrate represented Eastern Delta area and Bahera governorate represented western Delta area. Both governorates were the most important users of varied salinity irrigation water in cultivating the most important crops. As shown in table (2) the sample size was 150 farmers distributed over both governorates; Sharkia governorate had 53.3% and Bahera governorate had 46.7%.

The sample followed the ranked random sampling methods where, it was divided into three ranks per governorate (fresh water, mixed water and agricultural drainage water). The sample's rank individuals were chosen separately and organized randomly. The data in table (2).

Total chosen sample at sherkia governorate of waterway mainly from Husinia center because it contained all three studied water qualities -80 farmers distributed as 32.5%, 37.5 and 30% for farms irrigated by fresh water, mixed water and agriculture drainage water respectively. As for the total sample of Bahera governorate – which was concentrated in Dlngat and Abou Homose centers 70 farmers were distributed as 35.7%, 32.9% and 31.4% for farms irrigated by fresh water, mixed water and agricultural drainage water, respectively.

Questionnaire for the agricultural season 2002/2003
Crop common structure of the studied sample: The crop structure of any agricultural season refelects land resources allocation per farmer, consequently, determining the production mixture of agriculture products and crops. This structure is controlled by other resource constraints represented by quantity and quality of available labor, Capital and irrigation water. The optimum crop structure is the one which achieves the most possible net income, this fact depends on input and output prices, also, the feddan productivity.

Crop common structure of the studied sample at Sharkia Governorate: Table (3) illustrated the crop common structure in the studied sample at Sharkia governorate, it was shown that, there was a decrease of the relative importance of wheat cultivated areas which was irrigated with agriculture drainage water – it was estimated by 28.5% compared to 35.3% and 36.6% in the cases of irrigated areas with fresh and mixed water, respectively. At the same time, the percentage of suger beet cultivated areas irrigated with fresh water showed increase (28.1%) than its similar areas which were irrigated with mixed water (23.4%) and areas which was irrigated with agricultural drainage water (17.9%).

As for summer crops, it was shown, increase of the relative importance of rice areas which were irrigated with agricultural drainage water (51.2%) and mixed water (55.7%) compared with its similar areas which were irrigated with fresh water (43.4%). Simultaneously, it

Table 3: The crop structure according to irrigation water quality in the studied sample at Sharkia Governorate.

	Fresh water		Mixed water		Agriculture drainage water	
Data Area	%	Area (feddan)	%	Area (feddan)	%	Area (feddan)
Winter season						
Wheat	26	35.3	81.5	36.6	36.24	28.5
Suger beed	20.7	28.1	52	23.4	22.7	17.9
Others	27	36.6	89	40	68	53.6
Total winter season	73.7	100	222.5	100	126.94	100
Summer season						
Rice	32	43.4	124	55.7	65	51.2
Maize	26	35.3	68	30.6	33	26
Others	15.7	21.3	30.5	13.7	16.24	22.8
Total summer season	73.7	100	222.5	100	126.94	100
Total crop areas	147.4	-	445	-	253.88	-

Source: added and computed from the 2002/2003 field study questionnaire for then season

Table 4: The crop structure according to irrigation water quality in the studied sample at Bahera Governorate.

	Fresh water		Mixed water		Agriculture drainage water	
Data	Area (feddan)	%	Area (feddan)	%	Area (feddan)	%
Winter season						
Wheat	35	47.7	45	66.9	39.26	48.9
Black beans	13	17.7	8.24	12.3	14	17.4
Others	25.3	34.5	14	20.8	27	33.7
Total winter season	73.3	100	67.24	100	80.26	100
Summer season						
Rice	29	39.6	39	58	35	43.6
Maize	20	27.3	15	22.3	11	13.7
Cotton	15	20.5	10	14.9	13	16.2
Others	9.3	12.6	3.24	4.8	21.23	26.5
Total summer season	73.3	100	67.24	100	80.26	100
Total crop areas	146.6	-	134.48	-	160.52	-

Source: added and computed from the seasons 2002/2003 study questionnaire for the agriculture.

showed a decrease of relative importance of cultivated maize areas which were irrigated with agriculture drainage water (28.9%) and mixed water (30.6), compared to its similar areas which were irrigated with fresh water (35.3%), because of the maize crop sensitivity to saltiness.

Crop common structure of the studied sample at Bahera Governorate: Table (4) showed the crop common structure in the studied sample at Bahera Governogate, it indicated that, the wheat and black beans were the most important winter crops in the studied area, where, it was cultivated with different irrigation water, in addition to permanent clover, potatoes, Lettuce, Cabbage and Onions.

It was clear that, the relative importance increased for the wheat cultivated areas which were irrigated with mixed water (66.9%) than its similar areas which were irrigated which agriculture drainage water (48.9%) or fresh water (47.7%). Also, it indicated that, there was increase of the relative importance of black beans areas

which were irrigated with fresh water (17.7%) compared to it similar areas which were irrigated with mixed water (12.3%) and agriculture drainage water (17.4%).

As for summer crops, it was stated that, there was an increase in the relative importance of rice cultivated areas which were irrigated with mixed water (58%) compared its similar area which were cultivated wit agricultural drainage water (43.6%) and fresh water (39.6%). Simultaneously, the relative importance of maize cultivated are which was irrigated wit agricultural drainage eater, showed decrease (13.7%) and mixed water (22.3%) compared to its similar cultivated areas, which were irrigated with fresh water (27.3%). As for cotton crop, it revealed a decrease in its areas which were irrigated with mixed water (14.9%) and agricultural drainage water (16.2%) compared to its similar areas which were irrigated with fresh water (20.5%).

The Effect of Irrigation with Varied Salinity Water the Farm Returns of the Studied Sample Crops: The study depended on the following criteria:

1. Total product value (Total Revenue): it was computed by multiplying marketable product disregarding the way of merchandising by average price at the farm doors.

2. Total margin: it is computed as the total product value subtracted from in the variable production cost, this criterion is considered the most important criteria in partial balance analysis.

3. Return/ Cost ratio: it is considered the return of cost spented pound, in addition to, it benefits the small producer, when it gives more significance to cost status then net return.

The study also depended on standard estimation of net return and return ration to cost in the financial evaluation also, comparing its estimation to its equivalent of production patterns under irrigation with varied salinity water conditions.

1. The effect of irrigation with varied salinity water on the farm returns of wheat Feddan: By studying the farm returns of wheat feddan at Sharkia gpvermprate under irrigation with varied salinity water conditions during the agriculture season 2002/2003, it was shown from table (5) that, the total revenue value in the wheat farms which were irrigated with fresh water was estimated by 2470 Egyptian pound per feddan with increase of around 17.6% and 38.1% than its similar areas which were cultivated with mixed w ater and agricultural drainage water, respectively. The total margin for fresh water farms was 1725 Egyptian pound per feddan with extra increase re ached around 39.3% and 101% compared to it similar farms using mixed water and agricultural drainage water, respectively. The net return and returns cost ratio per wheat feddan cost ratio per wheat feddan irrigation with agricultural drainage water were declined, it was estimated by 159 Egyptian pound and 1.1 whereas it was estimated 1025 Egyptian pound and it 1.71 in the case of fresh water irrigation.

As for wheat production at Bahera governorate under irrigation with varied salinity water conditions, the results of all used economic criteria showed improve, although the farms irrigated with fresh water showed superiority compared with its similar areas irrigated with mixed and agricultural drainage water. The percentage of increase between total revenue in fresh water f arms and reused agricultural drainage water farms was 6.8%. Whereas, the same percentage between the pervious two cases in total margin criterion around 41%. As for both net return and return/cost ratio, it was estimated by 904 Egyptian pound and 1.62. In the case of water fresh irrigation with increase percentage around 39.7% and 15.7% compared to its similar farms irrigation with mixed water 111.7 % and 30.6% compared to agricultural drainage water farms respectively. The improve of the economic criteria results in wheat farms irrigated with mixed and agricultural drainage water farms at Bahera governorate compared to its similar at Sharkia governorate – although it showed decrease compared to wheat farms irrigation with fresh water- Because of the feddan productivity closeness in the three farms at Bahera governorate.

2. The effect of irrigation with varied salinity water on farms Reutns of Black Beans Feddan: By studying the farms returns of black beans at Bahera governorate under irrigation with varied salinity water conditions during the agricultural season 2002/2003, it was illustrated in table (5), the superiority of f arms irrigated with mixed water compared with its similar farms which was irrigated with fresh and agricultural drainage water, since the increase percentage in total revenue criterion reached 34.4%, 22.9% in both fresh water and agricultural drainage water, respectively. Wherecsey the increase in the percentage of total margin criterion was 39.2% and 41.1% between irrigation with mixed water and irrigation with fresh and agricultural during water, respectively. As for the net return and cost/ return ratio, it was estimated by 787 L.E. and 1.49, respectively. It was shown also, irrigating with mixed water recorded outstanding results compared to its similar in the case of irrigating wit fresh and agricultural during water. The improve in economic criteria results at b lack beans farms irrigated with mixed water at Bhaera governorate, was dur to the increase of feddan production productivity.

Table 5: Field corps profitability criteria under varied salinity water irrigation at Bahera and Sharkia governorates for the agricultural season (2002/2003).

Governorate	Crop	Irrigation water quality	Total product value	Total margin	Farm activity profit	Return/ cost ratio
Sharkia	Wheat	Fresh	2470	1725	1025	1.71
		Mixed	2100	1238	537	1.34
		Drainage	1789	859	159	1.1
	Sugar beet	Fresh	2525	1705	1025	1.68
		Mixed	2463	1447	767	1.45
		Drainage	2450	1315	635	1.35
	Rice	Fresh	3713	2685	1985	2.15
		Mixed	3300	2068	1368	1.71
		Drainage	3383	2065	1364	1.68
	Maize	Fresh	2485	1394	874	1.67
		Mixed	1615	680	160	1.11
		Drainage	1330	319	-210	0.87
Bahera	Wheat	Fresh	2354	1634	904	1.62
		Mixed	2273	1376	647	1.4
		Drainage	2203	1158	427	1.24
	Black Beans	Fresh	1790	1025	385	1.27
		Mixed	2405	1427	787	1.49
		Drainage	2200	1011	371	1.2
	Cotton	Fresh	2413	1039	217	1.1
		Mixed	2628	973	151	1.06
		Drainage	2891	978	155	1.06
	Rice	Fresh	3255	2196	1456	1.81
		Mixed	3348	2095	1355	1.68
		Drainage	3720	2451	1711	1.85
	Maize	Fresh	2222	1286	736	1.5
		Mixed	1616	471	-79	0.95
		Drainage	1515	127	-423	0.78

Source: Added and computed from the field study

3. The effect of irrigation with varied salinity water on the farm returns of suger beet feddan: By studying the farm returns of suger beet feddan at Sharkia governorate under irrigation with varied salinity water conditions during the agriculture season 2002/2003, it was shown in table (5) that, the total revenue value of beet farms, which was irrigated wit fresh water, it was estimated with 2525 L.E. per feddan with extra increase 2.5% and 3.1% compared to its similar farms which was irrigated with mixed and agricultural drainage water, respectively. The total marginal was estimated for fresh water farms by 1705

L.E. per feedan with extra increase 17.8% and 29.7% compared to its similar farms which were irrigated with mixed and agricultural drainage water, respectively. Also, the net retune value for beet feddan, irrigated with fresh water, reached 1025 L.E. with extra increase 33.6% and 61.4% compared to its equivalent farms which were irrigated with mixed and agricultural drainage water, respectively. In addition, the return / cost ratio criteria indicated that, the suger beet production by using fresh water was better than its production by using mixed or agricultural drainage water.

4. The effect of irrigation with varied salinity water on the farm returns of cotton Feddan: Studying the farm returns of cotton feddan at Bahera governorate under irrigation with varied salinity water conditions during the agricultural season 2002/2003, it was clearly shown, in the (5) that, the total return value of cotton farms, which was irrigated with agricultural drainage water, it was estimated by 2891 L.E. per feddan, with extra increase 19.8% and 10% compared to its equivalent farms irrigated with fresh and mixed water, respectively. It was clear also that, the other c riteria, such as total margin, net returns and return/cost ratio, showed backward in its values, because of the increase in production costs in the case of agricultural drainage water to treat the extra salinity.

5. The Effect of irrigation with varied salinity water on the farm returns of rice feddan: By studying the farms returns of rice feddan at Sharkia governorate under irrigation with varied salinity water conditions during the agricultural season 2002/2003, it was illustrated in table (5) that, the total value of rice farms, which was irrigated wit fresh water, it was estimated by 3713 L.E. per feddan with extra increase 12.5% and 9.8% compared to its similar farms which was irrigated with mixed and agricultural drainage water, respectively, the total margin for fresh water farms was estimated by 2685 L.E. per feddan with extra increase 29.8% and 30% compared to its equivalent farms which were irrigated with mixed and a agricultural drainage water, respectively. The net return value of rice feddan; which was irrigated with fresh water was 1985 L.E. with extra increase 45.1% and 45.5% for mixed and agricultural drainage water farms, respectively. The return/cost ratio criteria indicated that, producing rice by using fresh water was the best compared to using mixed or agricultural drainage water.

As for rice production at Bahera governorate under the irrigateion with varied salinity water conditions, it w as clear that, the rice farms irrigated with agricultural drainage water showed superiority compared to it similar farms irrigated with fresh and mixed water in all used economic criteria, besides the superiority of farms which were irrigated with fresh water compared to its similar farms which were irrigated with mixed water. The total revenues total margin and net return in the farms irrigated with agricultural drainage water were 3720, 2451 and 1711 L.E., respectively. The extra increase were 14.3%, 11.6% and 17.5%, respectively, compared to its similar farms which were irrigated with fresh water. Also, it showed extra increase by 11.1%, 17% and 26.3% respectively for equivalent farms which were irrigated with mixed water. In addition to, the return/ cost ratio criteria indicated that the rice production by using agricultural drainage water was the best, compared to its production by using mixed or fresh water.

6. The Effect of Irrigation with varied salinity water on the farm returns of summer maize feddan: By studying farm returns of summer maize feedan at Sharkia governorate under irrigation with varied salinity water during the agricultural season 2002/2003, it was illustrated from table (5) that, the total revenue value in maize farms which was irrigated with fresh water, it was estimated by 2185 L.E. per feddan with extra increase 35.3% and 64.3% compared to its equivalent farms which were irrigated with mixed and agricultural drainage water, respectively. Also, the total margin of fresh water farms was doubled compared to its equivalent in farms irrigated with mixed water, it was estimated by 1394 L.E. with estimated extra increase more than four double its equivalent in farms which was irrigated with agricultural drainage water. Also it was illustrated that, the net revenue value was decreased for the maize feddan which was irrigated with mixed water besides recording loss in the case of irrigating with agricultural drainage water, it was estimated by 210 L.E. the return/ cost ratio assured that, producing maize by using fresh water was the best compared to its production with mixed water or agricultural drainage water.

As for maize production at Bahera governorate under irrigation by varied salinity water condition, it was shown that, all used economic criteria in farms irrigated with mixed and agricultural drainage water were worth, because of the decline of total margin value to reach 127, 471 L.E. in both previous cases, respectively. As for net return criterion, maize farms irrigated with mixed and agricultural drainage water recorded loss of 79,423 L.E., respectively. Also, the return/ cost criterion indicated the unfeasibility of producing maize under high salinity water conditions (mixed or agricultural drainage water), its production should be limited to fresh water irrigation only.

Table 6: Field corps profitability criteria under varied salinity water irrigation at Bahera and Sharkia governorates for the agricultural season (2002/2003).

Governorate	Crop	Irrigation water quality	Total product value	Total margin	Farm activity profit	Return/ cost ratio
Sharkia	Wheat +Rice	Fresh	6183	4410	3010	1.95
		Mixed	5400	3306	1905	1.55
		Agricultural drainage	5172	2924	1523	1.42
	Sugar beet + maize	Fresh	4710	3099	1899	1.68
		Mixed	4078	2127	927	1.29
		Agricultural drainage	3780	1634	425	1.13
Bahera	Wheat +Rice	Fresh	5609	3830	2360	1.73
		Mixed	5621	3471	2002	1.55
		Agricultural drainage	5923	3609	2138	1.57
	Wheat + maize	Fresh	4576	2920	1640	1.56
		Mixed	3889	1847	568	1.17
		Agricultural drainage	3718	1258	4	1.0
	Black beans + cotton	Fresh	4203	2064	602	1.17
		Mixed	5033	2400	938	1.23
		Agricultural drainage	5091	1989	526	1.12

Source: Added and computed from the field study

The effect of irrigation with varied salinity water on farm returns of agricultural cycles:

1- Rice and wheat cycle farm returns: By estimating farm returns of wheat and rice cycle at Sharkia governorate under varied salinity water irrigation conditions, it was shown in table (6) that, the total product value was estimated by 6183 L.E. per feddan, which was irrigated with fresh water, recording extra estimated increase by 14.5% and 19.5% compared to its similar which were irrigated with mixed and agricultural drainage water, respectively. Whereas, the total margin was estimated by 4410 L.E. with estimated percentage 33.4% and 50.8% compared to its similar farms which were irrigated with mixed and agricultural drainage water, respectively. The profit of farm activity (net return) of the agricultural cycle irrigated with fresh water was estimated by 3010 L.E., with extra increase 58% and 97.6% compared to its similar farms which were irrigated with mixed and agricultural drainage water, respectively. The return/ cost ratio criteria indicated that, producing wheat and rice by using fresh water was better than its production by using mixed or agricultural drainage water.

As for farm returns of wheat and rice cycle at Bahera governorate, the data in table (6) illustrated that, the total product value of the cycle irrigated with fresh water was estimated by 5609 L.E., with estimated decrease percentage of 0.21% of 5.3% compared of its similar farms which were irrigated with mixed and agricultural drainage water, respectively. Whereas, the total margin was estimated by 3830 L.E. with extra increase 10.30% and 6.1% compared to its similar farms which were irrigated with mixed and agricultural drainage water, respectively. The profit of farm activity (net return) of the irrigated cycle with fresh water was estimated with 2360 L.E. with extra increase 17.9% and 10.4% compared to its similar which were irrigated with mixed and agricultural drainage water, respectively. The return/ cost ratio criterion estimation assured the superiority of wheat and rice production cycle by using fresh water compared to its production by using mixed or agricultural drainage water.

2. Wheat and maize cycle farm returns: By estimating farm returns of what and maize cycle at Bahera governorate under varied salinity water irrigation conditions, it was shown in table (6) that, the total production value was estimated by 4576L.E. Per feddan, which was irrigated with fresh water, recording extra estimated increase by 17.7% and 23.1% compared to its similar which were irrigated with mixed and agricultural drainage water, respectively. The total margin was estimated by 2920 L.E. with extra estimated increase 58.1% and 132% compared to its similar which were irrigated with mixed and agricultural drainage water, respectively the farm activity profit (net return) of the irrigated cycle with fresh water was estimated by 1640L.E. with extra estimated increase 188.7% compared

Table 7: The Economic value of varied salinity irrigation water used in the most important field crops production at Sharkia Governorate According to Resedual Income methodology of the studied sample for the Agricultural season 2002/2003

	Wheat			Sugar Beat			Rice			Maizea		
Date	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage
Total product value (L.E./feddan)	2470	2100	1789	2525	2463	2450	3713	3300	3383	2185	1615	1330
Variable cost (L.E./feddan)	745	862	930	820	1016	1135	1028	1232	1318	791	935	1011
Total Margin (L.E./feddan)	1725	1238	859	1705	1447	1315	2685	2068	2065	1394	680	319
Variable capital return (L.E./feddan)	37	43	47	41	51	57	51	62	66	40	47	51
Land Return (L.E./ feddan)	700	700	700	680	680	680	700	700	700	520	520	520
Management return (L.E/feddan)	124	105	89	126	123	123	186	165	169	109	81	67
Water quantity per feddan/M^3												
- At the actual level	2218	2427	2675	3173	3329	3567	7487	7541	7754	3210	3304	3194
- At 90% of the actual level	1996	2184	2408	2856	2996	3210	6738	6787	6979	2889	2974	2875
The economic value of water irrigation in the long run (L.E./M^3)												
- At the actual level	0.39	0.161	0.0086	0.27	0.178	0.128	0.233	0.151	0.145	0.226	0.0097	-0.0999
- At 90% of the actual level	0.433	0.179	0.0096	0.30	0.198	0.142	0.259	0.168	0.162	0.251	0.011	-0.111

Note: A feddan=4200 M^2
Source: Added and computed from the field study

to its similar which was irrigated with mixed water, whereas, that cycle did not achieve more than four L.E. in the case of agricultural drainage water irrigation. The return/cost ratio criterion indicated that, producing wheat an maize by using fresh water was better than using mixed water. Also, it was shown, the unfeasibility of this cycle production by using agricultural drainage water.

3. Black beans and cotton cycle farm returns: By estimating farm returns of black beans and cotton cycle at Bahera governorate under varied salinity water irrigation conditions, it was explained in table (6) that, the total production values were estimated by 4203 L.E per feddan, which was irrigated with fresh water, recorded estimated decrease of 16.5% and 17.4% compared to its similar, which were irrigated with mixed and agricultural drainage water, respectively. Whereas the total margin was estimated by 2064 L.E. with estimated decrease 14% compared to its similar which was irrigated with mixed water and estimated increase 3.8% compared to it similar which was irrigated with agricultural drainage water. The farm activity profit (net return) of the irrigated cycle with fresh water was estimated by 602 L.E. with extra estimated decrease 35.8% compared to its similar which was irrigated with mixed water and extra estimated increase 14.4% compared to its similar which was irrigated with agricultural drainage water, respectively. The total margin was estimated by 3099 with estimated extra increase 45.7% and 89.7% compared to its similar, which was irrigated with mixed and agricultural drainage water, respectively. The farm activity profit (net return) of the irrigated cycle with fresh water was estimated by 1899 L.E. with extra increase 105% and 347% compared to its similar which was irrigated with mixed and agricultural drainage water, respectively. The return/ cost ratio criterion indicated that, producing sugar beet and maize by using fresh water was better than its production by using mixed or agricultural drainage water.

4. Sugar Beet and Maize Cycle Farm Returns: By estimating farm returns of sugar beet and maize cycle at Sharkia governorate under varied salinity water irrigation conditions, it was clear from table (6) that the total production value was estimated by 4710 L.E. per feddan, which was irrigated with fresh water, recorded estimated increase 15.5% and 24.6% compared to its similar, which were irrigated with mixed and agricultural drainage water, respectively.

The total margin was estimated by 3099L.E. with estimated extra increase 45.7% and 89.7% compared to its similar whichwas irrigated with mixed and agricultural drainage water, respectively. The farm activity profit (net return) of the irrigated cycle with fresh water was estimated by 1899 L.E. with extra increase 105% and 347% compared to its similar which was irrigated with mixed and agricultural drainage water, respectively. The return/cost ratio criterion indicated that, producing sugar beet and maize by using fresh water was better than its production by using mixed or agricultural drainage water.

Table 8: The Economic value of varied salinity irrigation water used in the most important field crops production at Bahera Governorate According to Resedual Income methodology of the studied sample for the Agricultural season 2002/2003

	Wheat			Black beans			Cotton			Rice			Maize		
Date	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage
Total product value (faddan)	2354	2273	2203	1790	2405	2200	2413	2628	2891	3255	3348	3720	2222	1616	1515
Variable cost (L.E./feddan)	720	897	1045	765	978	1189	1374	1655	1913	1059	1253	1269	936	1145	1388
Total Margin (L.E./feddan)	1634	1376	1158	1025	1427	1011	1039	973	978	2196	2095	2451	1286	471	127
Variable capital return (L.E./feddan)	36	45	52	32	41	50	117	96	112	53	63	63	47	57	69
Land Return (L.E./ feddan)	730	730	730	640	640	640	822	822	822	740	740	740	550	550	550
Management return (L.E/ feddan)	118	114	110	90	120	110	121	131	145	163	167	186	111	81	76
Water quantity per feddan/M^3															
- At the actual level	2326	2496	2576	1201	1426	1608	4300	4722	5037	8223	8642	9002	3315	3395	3336
- At 90% of the actual level	2126	2246	2318	1081	1283	1447	3870	4250	4533	7401	7778	8102	2984	3056	3002
The economic value of water irrigation in the long run (L.E./M^3)															
- At the actual level	0.318	0.195	0.103	0.219	0.439	0.131	-0.005	-0.0161	-0.0201	0.151	0.130	0.162	0.174	-0.064	-0.17
- At 90% of the actual level	0.353	0.217	0.115	0.243	0.488	0.146	-0.0054	-0.0179	-0.0223	0.168	0.145	0.180	0.194	-0.071	-0.189

Source: Added and computed from the field study

Hence, it was illustrated from the previous analysis that, there was decline in the financial evaluation criteria represented by net return and return/ cost ratio in all studied crops production by using low quality water mixed and agricultural drainage water compared to the case of using fresh water, except black beans and rice crops at Bahera governorate. Black beans producers at Bahera governorate achieved-by using mixed water irrigation- superiority in both net return and return/cost ratio criteria compared to using fresh and agricultural drainage water. In addition, rice producers at Behera governorate achieved- by using agricultural drainage water – superiority in both net return and return/ cost ratio criteria compared to using fresh and mixed water. The results illustrated the impossibility of maize cultivation by using low quality water, either mixed or agricultural drainage water in both Sharkia and Bahera governorates.

The Economic value of varied salinity irrigation water used in the most important field crops production:

1. The economic value of varied salinity irrigation water used in wheat production: By estimating the economic value of varied salinity irrigation water used in wheat crop production at Sharkia governorate of the actual (current) level of irrigation water use, as it was illustrated at table (7), its highest econimc value was achieve din the case of fresh water irrigation, it was estimated by 0.39 L.E/M^3 with extra increase 142.2% and 208.7% compared to its similar using mixed irrigation water and agricultural drainage irrigation water and agricultural drainage irrigation water, keeping in consideration that the last source of water irrigation was at the least value where, its value did not exceed 0.01 L.E. per M^3 of water. It was seen also that, following usage rationalization by 10% of the actual use, caused increase of all kinds of irrigation water value with the increase of fresh water value.

By estimating the economic value of varied salinity irrigation water used in wheat crop production at Behera governorate of the actual (current) level of irrigation water use, as it was shown in Table (8), its highest economic value was achieved in the case of fresh water irrigation, it was estimated by 0.318 L.E./M^3 with extra increase 63.1% and 208.7%, compared to its similar using mixed and agricultural drainage irrigation water, respectively. In the mean time, it was seen that, following usage rationalization by 10% of the actual use, caused increase of all kinds of irrigation water with the increase of fresh water value.

2-The economic value of varied salinity irrigation water used in black beans production: By estimating the economic value of varied salinity irrigation water used in black beans crop production at Bahera governorate of the actual (current) level of irrigation water use, as it was seen in Table (8), its highest economic value was achieved in the case of mixed water irrigation, it was estimated by 0.439 L.E./M^3 with extra increase 100% and 235%, compared to its similar using fresh and agricultural drainage water, respectively. Accordingly, it was shown that, following usage rationalization by 10% of the actual use, caused increase of all kinds of irrigation water with the increase the mixed water value.

3-The economic value of varied salinity irrigation water used in sugar beet production: By estimating the economic value of varied salinity irrigation water used in sugar beet crop production at Sharkia governorate of the actual (current) level of irrigation water use, it was shown in Table (7), its highest economic value was achieved in the case of mixed water irrigation, it was estimated by 0.27 L.E./M^3 with extra increase 51.7% and 110.9%, compared to its

Table 9: The economic value of varied salinity irrigation water used in field crops according to the residual income methodology of the studied sample for the agricultural season (2002/2003)

	Wheat + Rice (Bahera)			Wheat + Maize (Bahera)			Black Beans + cotton (Bahera)			Wheat + Rice (Sharkia)			Sugar Beet + Maize (Sharkia)		
Date	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage	Fresh	Mixed	Drainage
* Total production value	5609	5621	5923	4576	3889	3718	4203	5033	5091	6183	5400	5172	4710	4078	3780
* Variable cost	1779	2150	2314	1656	2042	2433	2139	2633	3102	1773	2094	2248	1611	1951	2146
* Total margin	3830	3471	3609	2920	1874	1258	2064	2400	1989	4410	3306	2924	3099	2127	1634
* Variable capital return	178	215	231	166	2040	243	214	263	310	177	209	245	161	195	215
* Land return	1470	1470	1470	1280	1280	1280	1462	1462	1462	1400	1400	1400	1200	1200	1200
* Management return	280	281	296	229	194	186	210	252	255	309	270	259	336	204	189
* Irrigation water quantity per Feddan															
- At the Actual level	10585	11138	11578	5677	5891	5912	5501	6148	6645	9705	9968	10429	6383	6633	6442
- At 90% of the actual level	9527	10024	10420	5110	5302	5321	4951	5533	5980	8734	8971	9386	5745	5970	5797
*The Economic irrigation water in the long run															
- At the actual level	0.179	0.135	0.139	0.219	0.029	-0.076	0.032	0.069	-0.0057	0.260	0.143	0.098	0.220	0.080	0.0047
- At 90% of the actual level	0.199	0.150	0.155	0.244	0.032	-0.085	0.036	0.076	-0.0064	0.289	0.159	0.109	0.244	0.088	0.0052

Source: Added and computed from the field study

similar using fresh and agricultural drainage water, respectively.

4. The economic value of varied salinity irrigation water use din rice crop production: By estimating the economic value of varied salinity irrigation water used in Rice crop production at Sharkia governorate of the actual (current) level of irrigation water use, it was shown in Table (7), its highest economic value was achieved in the case of fresh water irrigation, it was estimated by 0.233 L.E./M^3 with extra increase 54.3% and 59.6%, compared to its similar using mixed and agricultural drainage water, respectively. It was shown that, following usage rationalization by 10% of the actual use, caused increase of all kinds of irrigation water with the increase of fresh water value.

By estimating the economic value of varied salinity irrigation water used in Rice crop production at Bahera governorate of the actual (current) level of irrigation water use, it was shown in table (8), that the highest economic value was achieved in the case of fresh water irrigation, it was estimated by 0.151 L.E/M^3 with extra increase of 16.2%, compared to its similar using mixed water, whereas, it recorded 6.8% decrease, compared to its similar using agricultural drainage water.

5. The economic value of varied salinity irrigation water used in cotton crop production: By estimating the economic value of varied salinity irrigation water used in cotton crop production at Behera governorate of the actual (current) level of irrigation water use, it was shown in Table (8) that, the economic value of using water irrigation in cotton production achieved net loss of 0.05, 0.161 and 0.201 L.E./M^3 in all used cases of fresh, mixed and agricultural drainage water, respectively.

6. The economic value of varied salinity irrigation water used in Maize crop production: By estimating the economic value of varied salinity irrigation water used in maize crop production at Sharkia governorate of the actual (current) level of irrigation water use, it was shown in Table (7) that, the highest economic value was achieved in the case of using fresh water, it was estimated by 0.226 L.E./M^3 instead of 0.0097 L.E./M^3 in the case of mixed water and net loss of 0.0999 L.E./M^3 in the case of agricultural drainage water.

By estimating the economic value of varied salinity irrigation water used in maize crop production at Bahera governorate of the actual (current) level of irrigation water use, it was shown in table (8) that, the highest economic value was achieved in the case of using fresh water, it was estimated by 0.147 L.E./M^3. Whereas, net loss of 0.17and 0.064 and L.E./M^3 in both mixed and agricultural drainage water cases, respectively.

The economic value of varied salinity, irrigation water used in the most important agricultural cycles production in the studied sample: By estimating the economic value of varied salinity irrigation water used in the most important agricultural cycles production in the studied sample at the actual (current level) of irrigation water use, it was seen in Table (9) that, the highest economic value was achieved in wheat and rice cycle at Sharkia governorate in the case of fresh water use it was estimated by 0.26 L.E./M^3, then, the sugar beet and maize cycle at the same governorate. Whereas, the economic value of using mixed and agricultural drainage water were decreased in all agricultural cycles.

Finally the black beans and cotton cycle at Bahera governorate recorded loss in the case of agricultural drainage irrigation. The recorded decrease in the economic value of irrigation water used in agricultural cycles production by mixed and agricultural drainage water may be resulted from the variable cost production increase to overcome salinity problem of the mentioned lands and its productivity decrease.

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