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Evaluation of Water Management and Requirements Under Developed Surface Irrigation System

Awwad, A. H.[1]; A. S. H. Mohammed[1] and M. M. A. Shabana[2]
[1]On Farm Irrigation Research Dept., AEnRI, ARC Egypt.
[2]Soils, Water and Environment Res. Inst., ARC, Egypt.

ABSTRACT

To evaluate the effect of modified surface irrigation in old land through improving Mesqas (buried pipeline) and Marwas of irrigation systems developer which were chosen to evaluate it in area of about 73 feddan on the field level to achieve sustainable agricultural development and to know the effect of surface irrigation system developer on the properties of the soil and its effect on plants to improve crop yields (productivity) and rationalizing of irrigation water leading to improved agricultural environment. Also the economic evaluation in the field as important indicator in this study which includes the productivity per unit of irrigation water for the most important winter crop (wheat) and summer crop (maize) and the study also includes the technical evaluation in the field in terms of water losses in delivery and distribution for developed Mesqa and Marwa, as well as water and land saving as a result of the use of modified surface irrigation system compared to traditional irrigation surface system. The agricultural land which was saved through using buried pipes instead of traditional Mesqa ranged from about 2.1 % to 3.7 % with developed surface irrigation systems for Mesqa and Marwa respectively. Average conveyance efficiency were obtained as ranged from about 91% and more 98% with developed surface irrigation systems for Mesqa and Marwa respectively and Average conveyance efficiency was about 83% with traditional surface irrigation while the average application efficiencies for irrigation systems developer by Mesqa and Marwa were ranged from about 61.5 % to 77 % and ranged from about 65 % to 84.4 % respectively and it was ranged from about 53 % to 66.4 % under traditional surface irrigation according to type of crop. The percentage of increase in the productivity under developed irrigation systems for Marwa was 2.32% and 3.6% for wheat and 0.2% and 1.38% for maize compared with irrigation systems developer by Mesqa and traditional surface irrigation respectively. The value of (WUE) in improved irrigation systems for Mesqa and Marwa were 1.52 and 1.38 kg/m^3 respectively for wheat and it was 1.16 kg/m^3 under traditional surface irrigation. The value of (WUE) in improved irrigation systems by Mesqa and Marwa were 1.71 and 1.54 kg/m^3 respectively for maize and it was 1.27 kg/m^3 under traditional surface irrigation.

Keywords: Water management, Surface developer irrigation system, Mesqa, Marwa, water relation,

INTRODUCTION

Egypt is living a new era of challenges faced at all levels politically, economically and socially the most important of these challenges is the availability of water which plays an important role in food security as the water is exposed in Egypt (since not too long ago) to great challenges can be represented in threat of water from the Nile basin (55.5 billion m^3 annually). On the other side, the Nile River water pollution is the most important challenges facing the agriculture sector, also the water which wasted by using traditional irrigation methods especially in the old areas in Delta where is one of the disadvantages of surface irrigation is poor efficiency which may be reach 50% due to deep percolation, run off and low distribution uniformity for water and the final result is low production.

The saved agricultural land through using buried pipes instead of traditional mesqa ranged from about 2.74 % to 2.067 % and in the lining canal it ranged from1.33 % to 1.04 % which were occupied by the channels and ridges. Average conveyance efficiency values were obtained as 82.4%, 92.7%, and 98.38% respectively for earth mesqa, lining mesqa and buried pipes. The average application efficiency values were 81.5 % under improved surface irrigation and it was 59% under traditional surface irrigation. The irrigation time decreased by using improved surface irrigation 31.39% compared with traditional surface irrigation. The percentage of increase in the productivity of wheat and sorghum under improved surface irrigation was 10.81% and 10.44 % respectively compared with traditional surface irrigation. The value of (WUE) in improved surface irrigation 1.49 kg/m^3 for wheat and it was 0.87 kg/m^3 under traditional surface irrigation. The value of (WUE) in improved surface irrigation 1.08 kg/m^3 for sorghum and it was 0.631 kg/m^3 under traditional surface irrigation (Said el din et al. 2016).

Improving the surface irrigation and increase the water use efficiency in the Egyptian old lands is Improving the Mesqa delivery system, this is accomplished by changing from a below ground delivery with multiple-point lifting to low pressure buried PVC pipelines delivery system with single lifting (pumping) at the head of the Mesqa. Improving conveyance system in the field by changing from a below ground Marwa to low pressure buried PVC pipelines and irrigate the farm by using valve and hydrant systems. Establishment of Water User Association (WUA) for each individual Mesqa, which The WUAs have the responsibility of operating and maintaining the Mesqas. Farmer field improvements such as laser land-leveling, deep ploughing and gypsum treatment. The main goal of this project is to improve on-farm irrigation systems in 2.1 million ha in the Nile Delta and Valley during the action plan period (2011-2021) to save water for reclaiming the targeted areas in the 2030 strategic plan. Also, on-farm irrigation in the newly reclaimed land (0.88 million ha) will improve and be managed during the first action plan 2010-2017 (El-Gendy 2011). Egyptian agriculture accounts for approximately 85% of the total limited water resources (MWRI, 2005).

The conveyance losses in earth marwas located on selected mesqas in Kafr El Shiekh governorate were ranged from 14.47 to 21.36% while in El Bahera governorate these losses were ranged from 13.43 to 21.88%. Concerning the adopting of the marwa lining, the project lined 205.39km length of earth marwas with farmers' participation in eleven governorate since 1998 to 2005. The cost per one meter paid by project was reduced from 100 LE in 1998/1999 to 9.4L.E. in 2004/2005 as a result to great participation by the farmers which reached to 75.26 % in 2005 Also , data declared that the area saved by the lined marwas was about 0.6%of total area..(Abo soliman *et al.,* 2005)

Elshorbagy (2000), FAO, 2005; ElKassar, 2007; WMRI, 2008). Egypt has adopted a water policy that involves cost sharing by establishing water boards and promoting management at the tertiary canal level. Water users themselves perform operational and maintenance works, and this trend toward user-driven management is a major step forward in institutional reform. About 85–90% of the construction cost was spent at the farm (tertiary canal) level for the improvement of infrastructure, including equipment (pump sets and gates), whereas 10–15% was spent on the main canals (MERI and WMRI, 2005). The entire construction cost expected to recover from the beneficiaries.

During the last 50 years, the actual level of per capita water supply decreased significantly in Egypt due to population increase, drought, and inefficient water use. Irrigation water consumes about 80 % of the water budget for cultivating (El-Quosy 2011).

Abou Kheira (2009) studied the impacts of the irrigation improvement project on crop water requirements, crop yields and crop water productivity under changing irrigation and cultural practices in the northern Nile Delta. Two branch canals (improved and unimproved) were selected in the Met Yazed Main Canal command area, Kafr El-Sheikh, Egypt. Sample tertiary units were selected, six in each branch canal, which were selected purposively to reflect different conditions at head, middle and tail locations. Six fields on each Mesqa were selected and distributed between head, middle and tail locations on the Mesqa. Two main summer crops (rice and cotton) and two main winter crops (berseem and wheat) were studied on each Mesqa.

The term application efficiency is still used to characterize the management relative to a given event; meanwhile, already proposed its replacement by the term water application ratio. However, these terms is very meaningful. (Bos *et al.* 2005).

Engels (2006) analyzed water use for Kemry Branch Canal which is part of the Eastern Nile Delta by comparing both improved and unimproved "mesqas" (tertiary units) situated along the branch canal. The field application efficiency ratio was set at 0.7 (medium/light soils). And from this he concluded field canal efficiency used for the study as 0.95 and 0.85 for improved and unimproved mesqas, respectively. The irrigation efficiency at farm level was taken as 0.67 for improved mesqas and as 0.6 for unimproved ones.

So, the goal of this study to know the effect of surface irrigation system developer by Mesqa and Marwa on yields (productivity), rationalizing of irrigation (water saving) and land saving. Also the economic evaluation in the field, as well as a result of the use of modified surface irrigation system compared to traditional irrigation surface system.

MATERIALS AND METHODS

A field experiment was conducted during the winter season of 2015/2016 and summer season of 2015 in Kafr-ELdawar District, EL-Bhera Governorate, Egypt (4 m altitude, 31° 07' 11.2" latitude and 030° 04' 07.7" longitude) to study the effect of improved irrigation system compared with the traditional surface irrigation system as well as reducing water logging problems, reducing soil compaction, salt removal from heavy clay salt affected soils, and increasing crop production

The experimental design used was randomized complete block design, with three replicates for tested variables the traditional surface irrigation system (s_1), improved irrigation systems for Mesqa (s_2) and improved irrigation systems for Marwa (s_3).

Two different types of design for irrigation systems developer were, chosen to evaluate it in area of about 73 feddan (Fig.1) where, irrigation systems developer by Mesqa. The first design (Fig.3) contains one feddan in the first of chosen area and the second design (Fig.4) contains 3 feddan in the center of chosen area where irrigation systems developer by Marwa were compared those designs with the traditional irrigation system (Fig.2) in order to reach the optimal design which will give the highest efficiency and productivity. Where the irrigation systems developer is a complex irrigation system and has one point lift for the 73 feddan, which includes many designs of irrigation systems developer for an area 73fedden (Fig.1).

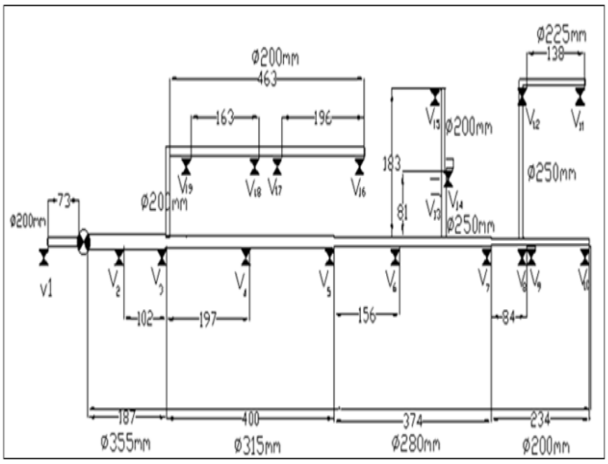

Fig. 1. Layout of the field experiment (73feddan).

Nitrogenous fertilizers (recommended dose) in the form of urea and ammonium nitrate were divided into three equal doses, the first dose was applied before the second irrigation, the second dose was applied before (the third irrigation) and the third dose was applied before the fourth irrigation. Potassium fertilizer (recommended dose) was applied as potassium sulphate (48 % K_2O), and Phoshorus (recommended dose) in the form of Ca-superphosphate (15.5% P_2O_5) were added with soil preparation.

Improved irrigation system and traditional irrigation system had been investigated in this study. Soil properties, yields (productivity), rationalizing of water, the productivity per unit of irrigation water, losses in delivery and distribution of water.

Design the network and irrigation scheduling

Data in table (1) and figure (1) were showed diameters and lengths of masque pipes which were calculated by using the equations 1 and 2. The discharge of valve was 20 l/s and its diameter was 160mm.

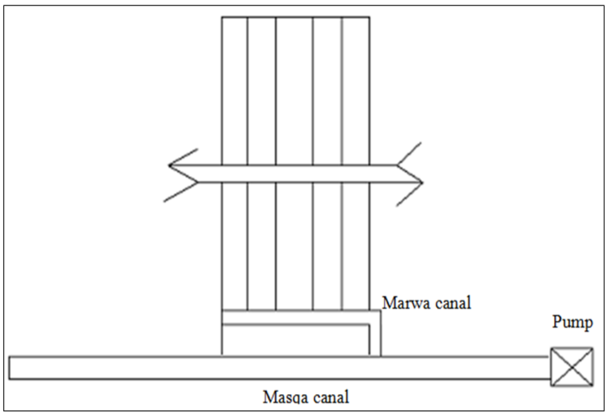

Fig. 2. Layout of the traditional irrigation system (s_1).

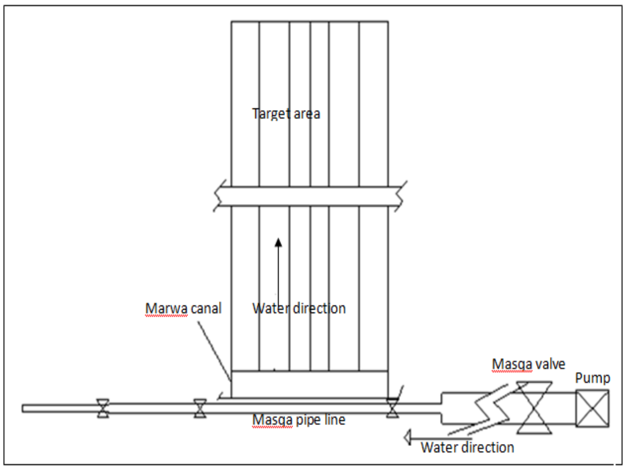

Fig. 3. Layout of the irrigation system developer by Mesqa (s2).

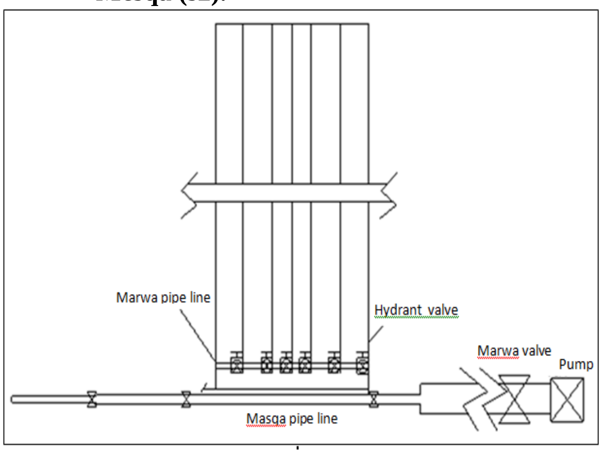

Fig. 4. Layout of the irrigation system developer by Marwa (s_3).

The pipes with 200 mm diameter were fixed on ending valve with 20 l/s discharge. Through opening two valves discharge of 20 l/s (the total discharge was 40 l/s), the suitable diameter in this case was 250 mm and when opening more valve 20 l/s, (the total discharge was 60 l/s), the suitable diameter was 280 mm and when opening more valve 20 l/s, (the total discharge was 80 l/s), the suitable diameter was 315 mm and when opening more valve 20 l/s this valve disposal of 90 l/s, the private station suitable diameter was 355 mm. As for the Marwa line was opened one valve along the line mesqas discharge of 20 l/s, until the finishing of the irrigation area then closed the hydrant and open the next valve according to the water scheduling with the rest of the space within the control of the station and was calculated losses of pressure at the ends of the valves mesqas so, the head of pump was (13m) and the discharge of pump was (30L/s) were chosen according to the fraction losses which calculated in equations (2 and 3).

Table 1. Design the lengths and diameter of pipes for Mesqa (s_2) and Marwa (s_2)

Mesqa		Marwa	
Length (m)	**Diameter (mm)**	**Length (m)**	**Diameter (mm)**
850	200	1990	180
140	225	410	200
280	250	-	-
440	280	-	-
400	315	-	-
190	355	-	-
Total=2300m	-	Total=2400m	-

The total numbers of main valves (butterfly valve) were 19 valves under study area. The irrigation systems developer contains a control unit with three pumps (discharge 90 l/s, engine capacity 10 hp, number of laps in 1440 Rev/min, and head 13 meters) and to make sure of the validity of water Marwa pipes and Marwa diameters of 180 mm and 200 mm depending on the length of the Marwa. On the other hand, the traditional irrigation system (Fig.2) is the prevailing system in Delta which has many of lifting points, one diesel pump per 5 feddan, (discharge 70 m^3/h, engine capacity 5 hp, number of laps in 1000 Rev/min, and head 5 meters). The water source is a main canal of Mahmudiyah canal and branch canal is Apis Algadida, Kafr Aldoar- El-Beheira.

Generally, in improved irrigation system received irrigation water flowing from the branch canal through electric pumping unit to the buried PVC pipes main and sub-main line instead of traditional mesqa and marwa. The PVC main or sub-main line having diameter ranging from 200 mm to 355 mm for improved irrigation system for Mesqa and from 180 mm to 200 mm for improved irrigation system for Marwa. The PVC pipes were connected together using faucet rubber ring jointing system. On sub-main line there is a riser setting up on it valve 160mm (hydrants) and on main line there is a riser setting up on it valve 160mm (butterfly) in order to deliver irrigation water to field. Figure (5) show components of improved surface irrigation network.

Water discharge

Water discharge was measured by using a rectangular sharp crested weir. The discharge was calculated using the following equation as described by (Masoud, 1969).

$$Q = RL(H)^{1.5} \quad \text{……………………..(1)}$$

Where:

Q: Discharge (m^3/s), L: Length of the crest (m), H: Head above the weir (m),

R: Empirical coefficient determined from discharge measurement.

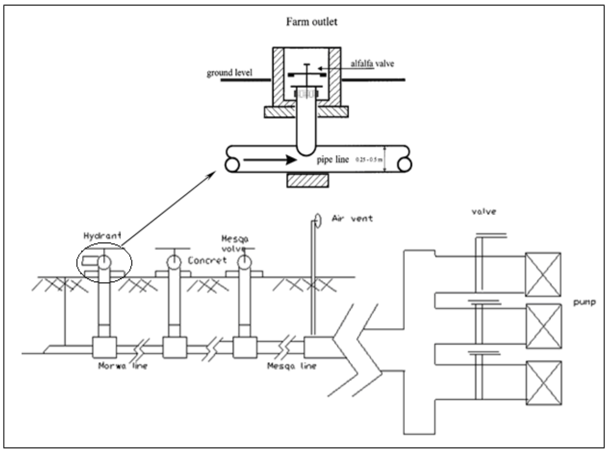

Fig. 5. Components of irrigation system developer network.

The average diameter of main and sub-main line

Determination of the average diameter of main and sub-main line at the network from equation (3) could be determined as:

$$q_i = c_d \times \frac{\pi}{4} d^2 \times v \quad \text{------------------(2)}$$

Where:

q: Average discharge of water flowing in the main line (m^3/sec).

c_d: Average coefficient of discharge (c_d = 0.65).

d: Average diameter of the main and sub-main line (m^2).

v: Average velocity in the line (1.5 m/sec).

Calculation of head losses due to friction

Equation 4 was used to calculate the friction head losses according to Hazen-Williams equation (1920) as follows:

$$h_f = \frac{1.22 \times 10^{10} L}{D^{4.87}} \left[\frac{Q}{C}\right]^{1.852} \quad \text{----------------------(3)}$$

Where:

h_f: Friction head losses (m)

L: Length of pipe (m)

D: Inner diameter of pipe (mm)

Q: Average discharge of water flowing in the main line (L/sec)

C: Hazen-Williams coefficient (according to type of pipe, 150 for PVC).

Water consumptive use (CU): was calculated using the equation of Israelson and Hansen (1962).

$$CU = (\Theta_2 - \Theta_1)\ )\ * Bd * RD \quad \text{………..(4)}$$

Where:

CU: water consumptive use (m^3/fed)

Θ_2: soil moisture percentage by weight 48 hours after irrigation

Θ_1: soil moisture percentage by weight 48 hours before following irrigation

Bd: bulk density in (g/cm^3)

RD: effective root depth (m)

Water productivity for irrigation water (WIP)

It was calculated in kg m^{-3} for different irrigation systems to clarify how much kg yield is produced from one cubic meter applied (Michael, 1978).

WP =Yield (kg fed^{-1}) / Applied water (AW) (m3 fed^{-1}).. ..(5)

Water productivity (WP).

It was calculated by the following equation according to Abd El -Rasool et al. (1971).

WP =Yield (kg fed^{-1}) / Water consumptive use (m^3 fed^{-1}).. (6)

Applied water (AW) was calculated as described by Giriappa (1983) as follows:

AW=IW+ER ……..…………… (7)

Where, IW: irrigation water applied,
ER: effective rainfall.

Soil analysis

Soil samples were collected from different layers and subjected to the following hydrophysico- chemical analysis according to Jackson (1967) and (Ali and Mohammed 2015). Field capacity (F.C.) and permanent wilting point (P.W.P) were determined by pressure membrane method according to Klute (1986). Infiltration rate was measured using double ring cylinder infiltrometer as described by Garcia (1978) before plant cultivation and after plant harvesting.

Soil bulk density and total porosity of the different layers of soil profile (at four depths: 0-20, 20-40, 40-60 and 60-80 cm) were measured before plant cultivation and after harvesting for all treatments using the core sampling technique as described by Campbell (1994). Some chemical and physical properties of the experimental soil are shown in Tables (2).

Table 2. Soil chemical and physical properties of the field experimental

Soil depth (cm)	Particle size distribution Sand%	Silt%	Clay%	Soil texture	Bulk density (g/cm^3)	Field capacity %	Wilting point %	IR*** (cm/h)	EC** (dS/m)	pH*
0-20	12.46	32.46	55.08	Clayey	1.18	42.15	20.37		3.18	7.76
20-40	12.22	33.41	54.37	Clayey	1.26	41.61	20.02		3.78	7.86
40-60	13.16	32.99	53.85	Clayey	1.36	39.95	19.89	0.65	4.33	7.87
60-80	13.74	31.41	54.85	Clayey	1.44	39.81	19.85		4.61	7.83
Mean	12.90	32.57	54.54	Clayey	1.31	40.88	20.03		3.98	7.83

*** pH was determined in soil water suspension (ratio 1.0 : 2.5).**
**** EC was determined in saturated soil paste extract.**
***** IR was Basic infiltration rate**

Conveyance efficiency

The conveyance efficiency was measured in earth canal by measuring discharges from pump by using known size tank in known time and discharge from the entrance of the field measuring by using pipe and known size tank in known time The conveyance efficiency was measured by the equation (8) according to Howell (2003). This test was replicated five times in summer and five times in winter.

$$E_c = \frac{W_f}{W_d} \times 100 \qquad \text{………... (8)}$$

Where:

E_C: Water-conveyance efficiency, percent.

W_f: Water delivered to the irrigation plot.

W_d: Water diverted from the source.

Water application efficiency (Ea).

Water application efficiency was calculated from the following formula (9) according to (FAO, 1989):-

Ea = [W_{DZ} /D_T]*100 …………….(9)

Where:

W_{DZ}: Depth of water stored in the root zone, cm.

D_T: Depth of Applied water to irrigated area, cm.

Water saving.

Water saving was expressed in terms of volume ratio. The ratio of water volume applied to improved surface irrigation system as related to the volume of water applied in the traditional irrigation system was calculated using the following equation:

Water saving (%) = (v_c - v_s) / v_c x 100 …(10)

Where:

v_s**:** water volume in improved surface irrigation system per season.

vc: water volume in traditional irrigation system.

Economical efficiency

Economical efficiency was calculated from the following formula**:-**

Economical efficiency= net income /total cost …..(11)

Statistical analysis

Data were statistically analyzed using analysis of variance (ANOVA). Treatments means and significance of differences were calculated and presented using (LSD). All statistical analyses were performed using analysis of variance technique by mean of CoHort Computer software.

RESULTS AND DISCUSSION

Amount of irrigation water applied.

Data in Figs. (6 and 7) Showed that, with wheat crop, using s_3 resulted in less amount of water applied (1856 m^3/fed) compared with s_2 and s_1 treatments which were 1996 m^3/fed and 2335 m^3/fed respectively. The lowest amounts of water applied were achieved by s_3, followed by s_2, where the highest one was obtained from s_1. It is worthy to mention that, s_3 and s_2 saved irrigation water by 20.51 % and 14.52 % compared with s_1, respectively and the same trend was found with maize crop where using s_3 and s_2 saved irrigation water by 24.49 % and 16.31 % compared with s_1, respectively.

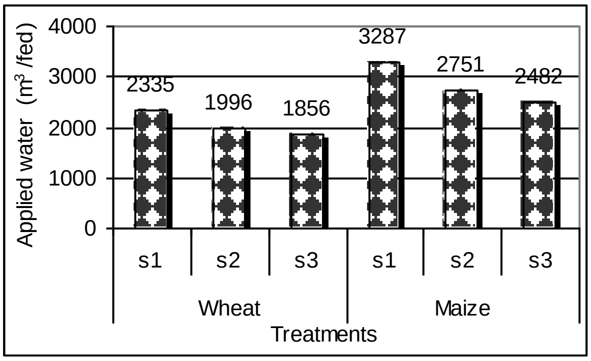

Fig. 6. Applied water (AW) (m^3/fed) with all treatments

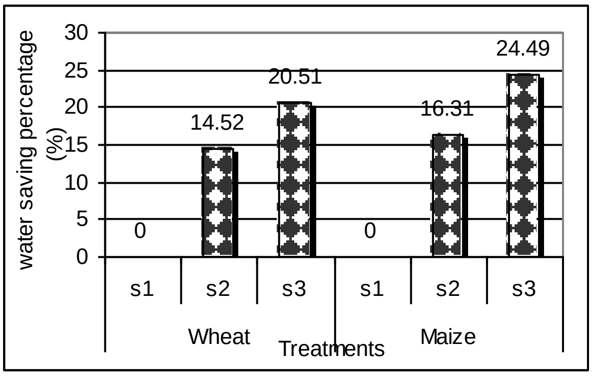

Fig. 7. Water saving (%) with all treatments.

Actual water consumptive use

Data in Fig. (8) indicate that the seasonal water consumptive use values were affected by improving irrigation surface method. With wheat crop, the highest value (1234 m^3 fed^{-1}) was obtained from traditional surface irrigation (s_1), while, the lowest one (1105 m^3 fed^{-1}) was obtained under (s_3) followed by 1130 m^3 fed^{-1} (s_2). While under cultivation maize crop, the highest value (2167 m^3 fed^{-1}) was obtained from traditional surface irrigation (s_1), and the lowest one (1970 m^3 fed^{-1}) was obtained under s_3 followed by s_2 treatment which was 2024 m^3 fed^{-1}.

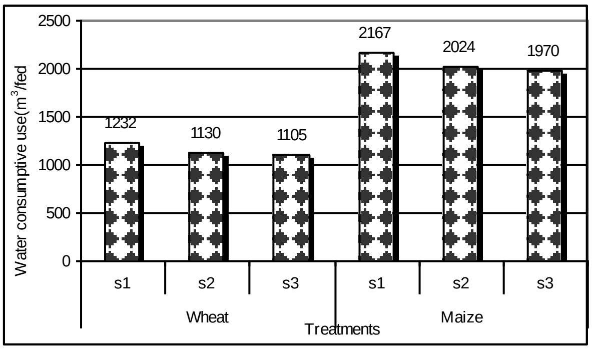

Fig. 8. Water consumptive use (m^3/fed) with all treatments

Water stored

Water stored in the effective root zone, which showed in Fig. (9), is one of the most important criteria which related to the field irrigation efficiency with different irrigation techniques. Meanwhile, the highest amount of water stored under maize crop was 2181 m^3 fed^{-1} under traditional surface irrigation, while the lowest amount of water stored was obtained under (s_3) technique (2096 m^3 fed^{-1}). On the other hand, the highest amount of water stored under wheat crop was 1237 m^3 fed^{-1} under traditional surface irrigation, while the lowest of amount water stored was obtained under (s_3) technique (1206 m^3 fed^{-1}).

Water application efficiency

Data in Fig. (10) reveal that, with maize crop, the highest value of water application efficiency (84.43%) was achieved under (s_3), while the lowest one (66.34%) was detected under (s_1) treatment. It was expected that application efficiency was improved by 18.09 % and 19.57 % due to irrigation with (s_3) and (s_2), respectively compared with traditional irrigation (s_1). While with wheat crop, the application efficiency was improved by 11.94 % and 8.56 % due to irrigation with (s_3) and (s_2), respectively compared to traditional irrigation (s_1). This may be due to the uniform water distribution from the outlet of pipe compared to traditional surface irrigation which tend to reduce the percolation losses.

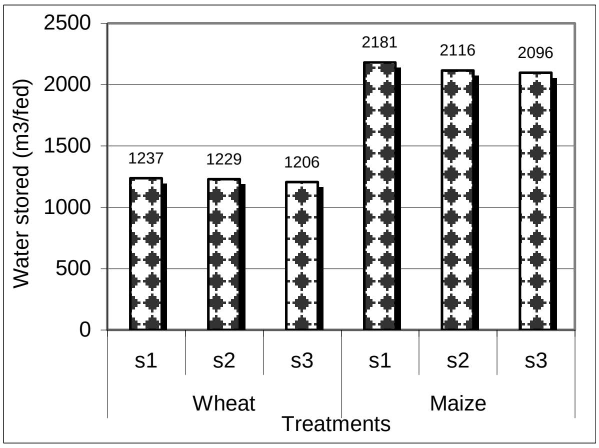

Fig. 9. Water stored (m^3/fed) with all treatments

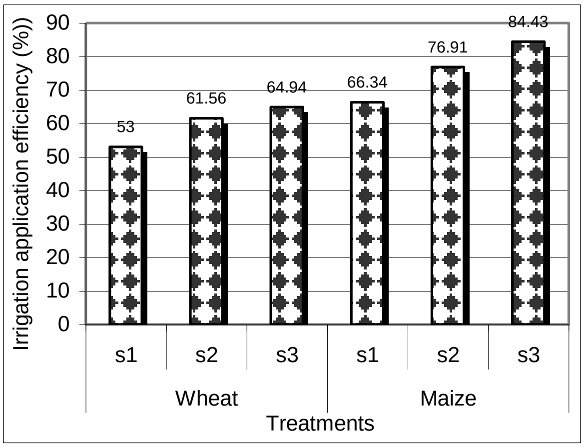

Fig. 10. Irrigation application efficiency (%) with all treatments

Conveyance efficiency

Data in Fig. (11) showed that, the conveyance efficiency were 90.7%, 98.3% and 83% under improved irrigation system by Mesqa, Marwa and traditional surface irrigation system respectively. It means that the conveyance efficiency was improved by 15.3 % and 7.7% with improved irrigation system by Marwa, Mesqa compared to traditional surface irrigation system respectively. This may be due to the losses of water by the percolation losses and evapotranspiration.

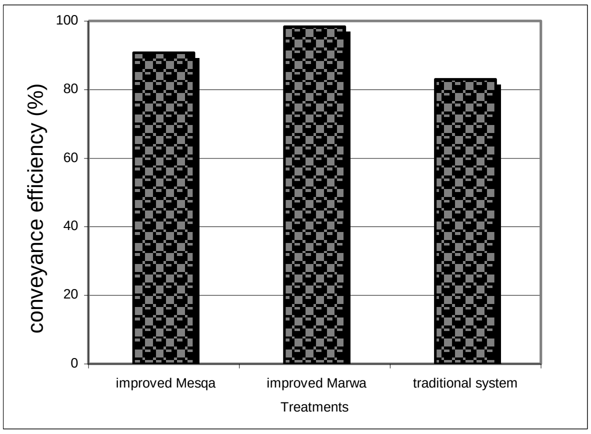

Fig. 11. Conveyance efficiency (%) with all treatments

Land saving

The waste of agricultural land through using the traditional mesqa with traditional irrigation system before developing was 155 m^2/fed (Fig.1) and after developing by using irrigation systems developer by Mesqa and Marwa were 86.5m^2/fed. and 155m^2/fed. respectively. It means that, use of irrigation systems developer saved land with irrigation systems developer by Mesqa and Marwa compared with traditional irrigation by a ratio 2.1% and 3.7% due to replacement of traditional marwa (open channel) with buried pipe (main and sub-main line).

Crop yield

Data in table (3) showed that, the higher production yields of maize grain was obtained in the Treatment s_3 (4248.8 kg/fed.) and surpassed the treatments s_2 and s_1, increasing the yield by a ratio 0.2% and 1.38% respectively. While the higher straw yield of maize was obtained in the Treatment s_3 (14593 kg/fed.) which was superior that of the treatments s_2 and s_1, by a ratio 0.2% and 1.19% respectively.

On the other hand, data showed that the higher grain yield of wheat was obtained in the Treatment s_3 (2819.3 kg/fed.) compared to the treatments s_2 and s_1, by a ratio 2.32% and 3.6% respectively and the lower dry yield of wheat was obtained in the Treatment s_3 (2534 kg/fed.) compared to the treatments s_2 and s_1, and the increase percentage were 0.05% and 0.09% respectively. The higher yield for treatment s_3 could be attributed to the uniform distribution of sufficient available water and the increasing in the irrigation efficiency.

Table 3. Effect of irrigation system on grain and straw yield (kg fed^{-1}) of maize and wheat crop

Yield	Site	Grain yield (kg fed^{-1})	Straw yield (kg fed^{-1})
	s_1	4189.8b	14419.5b
Maize	s_2	4240a	14562.5 a
	s_3	4248.5a	14593a
F Test		*	**
LSD at 0.05		46.75	89.58
	s_1	2717.8b	2536.3a
Wheat	s_2	2754b	2535.3ab
	s_3	2819.3 a	2534b
F Test		**	*
LSD at 0.05		52.75	1.49

Water productivity (WP) and water productivity for irrigation water (WIP)

Data in Figs. (12 and 13) Showed that, the average values of WP obtained for maize grain increased in the treatment (s_3) by 0.07% and 0.23% than that of the (s_2 and s_1) respectively, and the average values of WIP obtained for maize grain increased in the treatment (s_3) by 0.17% and 0.44% than that of the (s_2 and s_1) respectively. On the other hand, the average values of WP obtained for straw of maize increased in the treatment (s_3) by 0.22% and 0.76% than that of the (s_2 and s_1) respectively, and the average values of WIP obtained for maize straw increased in the treatment (s_3) by 0.59% and 1.49% than that of the (s_2 and s_1) respectively.

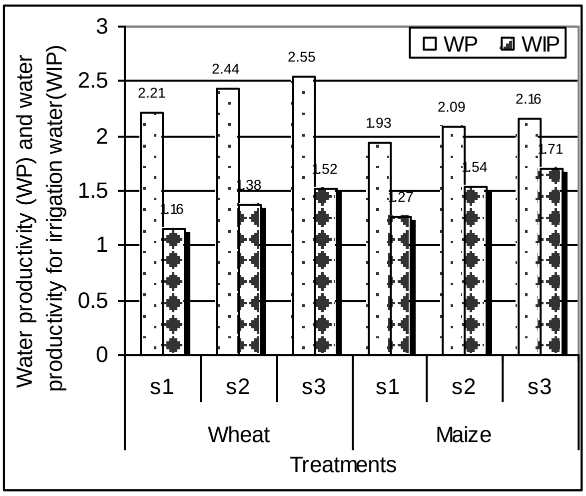

Fig.12.Water productivity and water productivity for irrigation water (kg m^{-3}) of grain yield

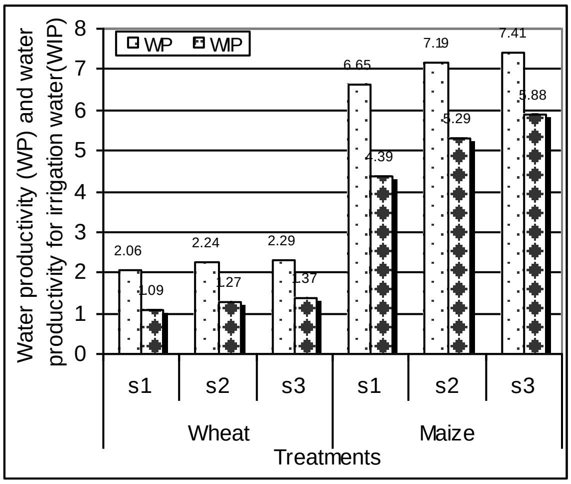

Fig.13.Water productivity and water productivity for irrigation water (kg m^{-3})of straw and stem yield.

While data showed that, the average values of WP obtained for wheat grain increased in the treatment (s_3) by 0.11% and 0.34% than that of the (s_2 and s_1) respectively, and the average values of WIP obtained for wheat grain increased in the treatment (s_3) by 0.14% and 0.36% than that of the (s_2 and s_1) respectively. On the other hand, the average values of WP obtained for straw of wheat increased in the treatment (s_3) by 0.05% and 0.23% than that of the (s_2 and s_1) respectively, and the average values of WIP obtained for wheat straw increased in the treatment (s_3) by 0.1% and 0.28% than that of the (s_2 and s_1) respectively.

Economical evaluation

The economic impact of the development of surface irrigation on major crops

This part estimate productivity and economic efficiency of land which used developed surface irrigation compared to traditional surface irrigation system. Therefore has been selected the most important crops (wheat of winter crop and maize of summer crop). The data in table (4) indicate the results of analysis the standards of income and costs of measurement in the study area. There was the presence of certain statistically significant differences between the lands which used developed irrigation system compared to their counter parts lands that used traditional surface irrigation.

1- impact of the developed surface irrigation on wheat crop

Data in table (4) and Fig. (14) showed that the revenue (grain and straw) increased by 95 L.E/fed and 268 L.E/fed by a ratio 1.03% and 2.85 % compared with the lands that used surface irrigation traditional, as demonstrated by the total costs decreased by 157 L.E/fed and 182 L.E/fed by a ratio 6.18 % and 7.16 % compared with the lands that used surface irrigation traditional. As it turns out that the net income (L.E/fed) increase of about 253 L.E/fed and 450 L.E/fed representing about 3.7% and 6.4% compared to the lands that used surface irrigation traditional.

While the net income from water unit (L.E/m^3) increased by a ratio 17.67 % and 25.57 % compared with traditional irrigation system. it turns out that the economical efficiency (Standard profitability) amounted to about 259.37, while the corresponding figure in the land used for irrigation surface developer s_2 and s_3 were 2.87% and 2.99% respectively.

2- Impact of the development of surface irrigation to maize crop

Data in table (4) and Figs. (14) showed that the revenue (grain and stem) the revenue increased by 139 L.E/fed and 96 L.E/fed by a ratio 1.7 % and 1.18 % compared with the lands that used surface irrigation traditional, as demonstrated by the total costs which decreased by 104 L.E/fed and 129 L.E/fed by a ratio 3.67 % and 4.56 % compared with the lands that used surface irrigation traditional. As it turns out that the net income (L.E/fed) increase of about 198 L.E/fed and 240 L.E/fed representing about 3.66% and 4.4% compared to the lands that used surface irrigation traditional.

While the net income from water unit (L.E/m^3) on land use surface irrigation traditional (s_1) was 1.587 L.E/m^3 while it reached 1.696 L.E/m^3 and 2.198 L.E/m^3 on land used for irrigation surface developer s_2 and s_3 respectively, the net income from water unit increased by a ratio 19.4% and 27.8% compared with traditional irrigation system. it turns out that the economical efficiency (Standard profitability) on land used for irrigation surface traditional amounted to about 1.84%, while the corresponding figure in the land used for irrigation surface developer s_2 and s_3 were 1.99% and 2.02% respectively.

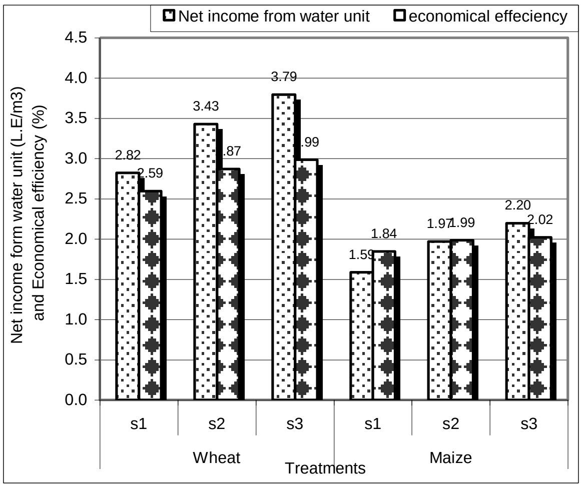

Fig. 14.Net income form water unit (L.E/m³) and Economical efficiency (%) with all treatments.

Table 4. Net income, of all crops as affected by irrigation and treatments.

Yield	Site	Income (L.E/fed) Grain	Stem-Straw	Total income (L.E/fed)	Total variable cost L.E/fed	Net income L.E/fed
Maize	S_1	7542	505	8046	2830	5217
	S_2	7632	510	8142	2726	5415
	S_3	7647	511	8158	2701	5457
Wheat	S_1	7229	1902	9132	2541	6591
	S_2	7326	1901	9227	2384	6844
	S_3	7499	1901	9400	2359	7041

CONCLUSION

1- The old lands of Delta could be use the developer of irrigation system instead of the traditional irrigation because of many advantages, including that the highest efficiency up to 70% with irrigation system by Mesqa and up to 77% with irrigation system by Marwa, as can provide a large area of land (3.7%) were wasted in the canals in and around each piece of land to be used for irrigation traditional. as the use of traditional irrigation of those lands is vulnerable to the presence of environmental pollution as a result of direct touches between farms and water, and then to use this developer system provides at least from 10%-24% of the water that can directed and used for the cultivation of alternative spaces of up to hundreds of Fadden or directed to other crops. In addition to the above, productivity increase by about 0.2-1.4 % for maize grain and about 2.3-3.6% for grain wheat compared to traditional irrigation systems.

2- Use the Irrigation system developer improved the economic and social conditions of Egyptian farmers through the development and use of improved system, water management, and associated practices that promote water use efficiency and decrease drainage problems and then increase agricultural production.

3- Using Marwa develop for irrigating crops led to improve water application efficiency, saving more water, net income, and net income from water unit and economical efficiency without observed reduction in yields.

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تقييم إدارة المياه والإحتياجات المائية تحت نظام الرى السطحى المطور

أمين حسين عواد[1]،أحمد صلاح حسن[1] و محمود عبد الحي شبانة[2]

[1] معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – وزارة الزراعة .

[2] معهد بحوث الاراضي والمياه – مركز البحوث الزراعية – وزارة الزراعة.

تم إجراء هذا البحث خلال موسمي الزراعة 2015-2016 بمنطقة كفر الدوار بمحافظة البحيرة لتقييم تأثير الري السطحي المطور في الأراضي القديمة من خلال تطوير المساقي (خطوط الأنابيب المدفونة) والمراوي على خصائص التربة وتأثيرها على الانتاجية وترشيد مياه الري مما يؤدي إلى تحسين البيئة الزراعية لتحقيق التنمية الزراعية المستدامة حيث تم اختيار مساحة 73 فدان على المستوى الحقلي كما يتضمن البحث التقييم الاقتصادي كمؤشر مهم في هذه الدراسة التي تشتمل علي الإنتاجية لكل وحدة من مياه الري لأهم المحاصيل الشتوية (القمح) والمحاصيل الصيفية (الذرة) وأيضا تقييم فني من حيث حساب الفاقد من المياه في نقل وتوزيع المساقي والمراوي للمياه (كفاءة النقل والتوزيع) وكذلك حساب توفير المياه والأراضي نتيجة لاستخدام نظام الري السطحي المطور مقارنة نظام الري السطحي التقليدي. ويمكن تلخيص أهم النتائج التي تم التوصل إليها على النحو التالي: وتراوحت المساحة الأرضية التي تم توفيرها من خلال استخدام أنابيب مدفونة بدلا من المساقي الترابية (التقليدية) بنحو 2.1٪ إلى 3.7٪ مع أنظمة الري السطحي المطورللمساقي والمراوي على التوالي. وقد أظهرت النتائج أن متوسط كفاءة النقل تراوحت من 91٪ لأكثر من 98٪ مع أنظمة الري السطحي المطور للمساقي والمراوي على التوالي ومتوسط كفاءة النقل بنحو 83٪ مع الري السطحي التقليدي في حين أن متوسط كفاءة اضافة المياه مع أنظمة الري السطحي المطور للمساقي قد تراوحت ما بين 61.5٪ إلى 77٪ وتراوحت تحت أنظمة الري السطحي المطور للمراوي من حوالي 65٪ إلى 84.4٪ على التوالي. و كانت حوالي من 53٪ إلى 66.4٪ تحت الري السطحي التقليدي وفقا لنوع المحصول. وكانت نسبة الزيادة في الإنتاجية مع أنظمة الري السطحي المطور للمراوي من 2.32٪ الي 3.6٪ للقمح ومن 0.2٪ الي 1.38٪ للذرة مقارنة مع أنظمة الري المطور للمساقي والري السطحي التقليدي على التوالي. وكانت قيمة كفاءة الاستخدام المائي في أنظمة الري المطور للمساقي والمراوي 1.52 و 1.38 كجم/م^3 على التوالي للقمح وكانت 1.16 كجم/م^3 تحت الري السطحي التقليدي. وكانت قيمة كفاءة الاستخدام المائي في أنظمة الري المطورة للمساقي والمراوي 1.71 و1.54 كجم/م^3 على التوالي للذرة وكانت 1.27 كجم/م^3 تحت الري السطحي التقليدي.