Journal of Sustainable Agricultural and Environmental Sciences ISSN-Print: 2735-4377
https://jsaes.journals.ekb.eg/ ISSN-Online: 2785-9878
JSAES, 2022,1(1): 210 - 222

Effectiveness of Surface Irrigation Modernization on Irrigation Efficiency and Productivity

M. H. Elattar[1], A. A. Derbala[2], A. M. Elmetwalli[2], S. S. Hassan[3] and A. M. Elglaly[1]

[1]Fac. of Agric. Eng., Al-Azhar Univ., (Assiut Branch), Egypt.
[2]Agric, Eng. Dept., Fac. of Agric., Tanta University, Egypt.
[3]Field Irrigation Eng. Dept., Agric. Eng. Res. Inst. (AEnRI), ARC., Egypt

Corresponding author:

J.Sust.Agri.Env.Sci (JSAES)

Keywords:
Surface irrigation; Modernized methods; Maize productivity; Irrigation efficiencies; Types of surface irrigation; Modernization; Mesqa.

ABSTRACT

Field experiments for this research were conducted in the northern Nile Delta in the Kafr El-Sheikh governorate. by studying the impact of Modernization surface irrigation and evaluating its performance in the old lands through the modernized of Marwa and Mesqa traditional by replacing them with one of the modernized methods (lined mesqa - buried pipes), in order to increase the efficiency of using water this was done by estimating the efficiency of water application and the rate of increase in crop productivity per unit of water for the most important summer crops (Maize) compared to the traditional irrigation system. The research also includes a hydraulic study of the systems modernized, the results can be summarized as follows: The results revealed that the average water application efficiencies were as 82, 79 and 49 % for buried pipes, lining mesqa and earthen mesqa respectively. Also showed that the average values of the water distribution Efficiency through buried pipe and lining mesqa comparing with conventional irrigation methods were 78, 75 and 72 % respectively during season. It was found that the value of (FWUE) was 1.52,1.36 and 0.99 kg ⁄m^3 for buried pipes, lining mesqa and earthen mesqa respectively.

1. INTRODUCTION

Under the present economic and increase also because the prospective environmental challenges, Egypt is

rapidly facing serious water scarcity issue. Water availability per capita rate is already one among rock bottom within the world. In 2000, water withdrawal per capita was around 1000 m^3. this is often alleged to halve and, hence, fall below the scarcity rate by 2025. Also, per capita renewable water share has been declining from 853.5 m^3(2002) to 785.4 m^3(2007) and reached 722.2 m^3(2012). this is often predicted to succeed in 534 m^3 by 2030.Food and Agricultural Organization of The United Nations **(FAO, 2014)** Surface irrigation is the oldest and most common method of applying water to croplands. Also, referred to as flood irrigation, the essential feature of this irrigation system is that water is applied at a specific location and allowed to flow freely over the field surface, and thereby apply and distribute the necessary water to refill the crop root zone. **(USDA, 2012)** Surface irrigation has evolved into an in-depth array of configurations which may broadly be classified as: basin irrigation, border irrigation, furrow irrigation and wild flooding. the excellence between the varied classifications is usually subjective. for instance, a basin or border system could also be furrowed. **(Ismail *et al.*, 2014)** Average per capita fresh water availability in Egypt is on a gentle decline from about 1,893 cubic meters per year in 1959 to about 900 cubic meters in 2000, to 700 cubic meters in 2012. consistent with government, population in Egypt will likely reach 98.7 million in 2025. consistent with the Ministry of Water Resources and Irrigation, Egypt will need 20 percent more water by 2020, Egypt already uses 127% of its water resources; meaning that Egypt imports 27% of its water used through imported food and other products; and by 2020 Egypt might be using 147%. United Nations now says Egypt might be water scarce by 2025. Assuming that Egyptians' population carries on growing, the land reclamation projects in deserts and therefore the incontrovertible fact that Egypt is already importing quite 50% of the cereals it consumes, Egypt cannot meet its food demand by counting on Nile water for irrigation. Industrial facilities are source of commercial waste water, which is taken into account one among the main causes of pollution in Egypt and thus, these facilities must be inspected and subjected to Egyptian laws; which preserve a particular balance between economic gain and preservation of water resources from pollution. **(Gad, 2017)** Urgent got to review water management, particularly in areas with demographic changes and vulnerability to climate, so as to make sure sustainable and safe water supply. Implications by climate fluctuations should be carefully evaluated, covering a wide range of human activity and environment. Water management should address the emerging conflicts between water users by providing primary options and alternatives in distribution and use of water resources while protecting the sustainability of water resources. **(Tzanakakis *et al.*, 2020)** Water is a unique and non-substitutable resource. As the foundation of life, societies and economies, it carries multiple values and benefits. But unlike most other natural resources, it has proven extremely difficult to determine its 'true' value. As such, the overall importance of this vital resource has not been appropriately reflected in political attention and financial investment in many parts of the world. This not only leads to inequalities in access to water resources and water-related services, but also to inefficient and unsustainable use and degradation of water supplies themselves, affecting the fulfilment of nearly all the Sustainable Development Goals (SDGs), as well as basic human rights. **(UNWW, 2021)** Water application efficiency provides a general indication of how well an irrigation system performs its primary task of delivering water from the conveyance system to the crop. water application efficiency may be a measure of the fraction the entire volume of water delivered to the farm or field thereto which is stored within the root zone to satisfy the crop evapotranspiration needs. losses from the sector occur as deep percolation (depths greater than required depth) and as field tail water or runoff and reduce the application efficiency**. (Odhiambo and Kranz, 2011)** Found that the worth of (WUE) in improved irrigation systems for Mesqa and Marwa were 1.52 and 1.38 kg/m^3 respectively for wheat and it had been 1.16 kg/m^3 under traditional surface irrigation. the worth of (WUE) in improved irrigation systems by Mesqa and Marwa were 1.71 and 1.54 kg/m^3 respectively for maize and it had been 1.27 kg/m^3 under traditional surface irrigation. **(Awwad *et al.*, 2016)** Application of wide beds under a coffee infiltration soil can produce negative effects on crops within the bed middle thanks to poor lateral infiltration; therefore, convenient management of bed furrow sizes consistent with soil and field conditions has the potential to save lots of irrigation water and increase crop yield and water productivity. **(Akbar *et al.*, 2017)** Noted that increasing flow in clay soil improved surface irrigation indices. Increasing flow from 0.37 to 0.74 L/s increased application efficiency from 64.5% to 67% and application uniformity from 76.87% to 78.5% for continuous flow irrigation. **(Amer and Attafy, 2017)** Used improved management practices package (land leveling, cultivation on raised beds and irrigation scheduling) are often useful in reducing applied water and soil loss. **(Zohry *et al.*, 2020)** Shortest advance time of 64 min was obtained at treatment of (W80+Q3). rock bottom total applied water of 1407 m3/fed. was obtained by the treatment (W120+Q3) which saved irrigation water by about 58.7% comparing with the very best treatment (F+Q1=3403 m3/fed). **(Elkholy *et al.*, 2021)** Effect of stream size (2.0, 3.0 and 4.0 L/s) in clay soil on advance time, seasonal applied water and irrigation efficiency for wheat crop under strip surface irrigation system and different tillage depths (10-20 cm and 20-30 cm). She resulted that increasing stream size decreased advance time and seasonal applied water; rock bottom value was (4174 m^3/ha) which obtained at 4.0 L/s discharge and was but the primary and second stream size by about 22.5 and 12.6%, respectively. Increasing flow from 2.0 to 4.0 L/s increased application efficiency from 43.5 % to 74.4% and from 42.3 you must 72% during the first and 2nd seasons, respectively. Increasing flow rate from 2.0 to 4.0 L/s increased water distribution efficiency from 63.34 % to 90.25% and from 67.95 % to 93.86% during the first and 2nd seasons, respectively. **(Eid, 2021)** Stated that field water uses Efficiency (FWUE) has been the most widely used parameter to describe the efficiency of irrigation in terms of crop yield. Field Water use efficiency (FWUE) is the ratio between economic yield and water applied in season. **(Howell, 2003)** Canal lining is a which includes concrete, stone, ferro cement, bricks and shotcrete (pneumatically applied mortar), exposed and buried membranes such as butyl rubber, polyvinyl chloride (PVC) and polyethylene, soil linings and soil sealants, like silts, clays and some chemicals, can also be used for lining. **(Ahmed *et al,* 2009)**

The main objective of this study was conducted to gauge the system of the On-farm Irrigation Development in Nile Delta Egypt, so as to develop the surface irrigation and to extend the sector water use efficiency, to maximizing the productivity, raise the efficiency of surface irrigation system. The consequent effects both of them water application efficiency, water distribution efficiency, yield crops and field water use efficiency for crop maize was considered.

2. MATERIALS AND METHODS

A field experiment was carried out during the summer planting season 2021. in the northern Nile Delta in the Kafr El-Sheikh governorate in the Dakalt region. Fig (1 to 3). Shows the general layout of modernized surface irrigation and traditional surface irrigation. The study was conducted to by studying the impact of Modernization surface irrigation and evaluating its performance in the old lands through the development of Marwa and Mesqa traditional by replacing them with one of the development methods (lined mesqa - buried pipes), in order to increase the efficiency of using This was done by estimating the efficiency of water application, the efficiency of water use for irrigation, and the rate of increase in crop productivity per unit of water. To studying the impact of Modernization surface irrigation and evaluating its

method of augmenting water quantity. Lining of irrigation channels can be done in various ways viz: hard surface lining,

performance in the old lands, three fields were irrigated by three different systems with equal areas 27 × 100. The First field which irrigated by buried pipe 280 mm diameter, The Second field was irrigated by lining mesqa, 0.4 m width and 0.6 m height, The Third field irrigated by earthen mesqa. Three fields were selected for crop maize (Pioneer 30K8) in summer season where, maize is considering principle crops in the study area.

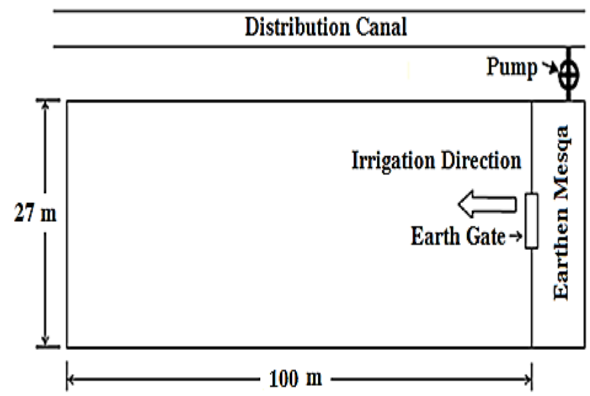
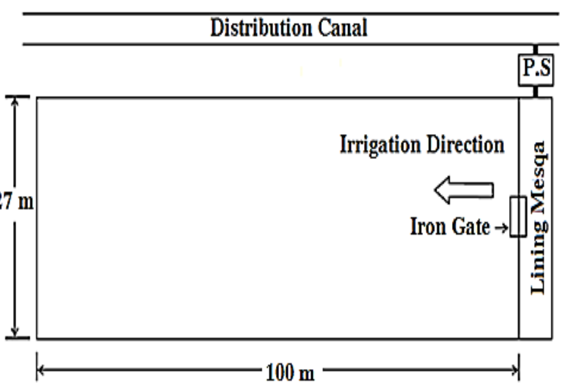


Fig. 1 General layout of traditional surface irrigation for field (No.1).



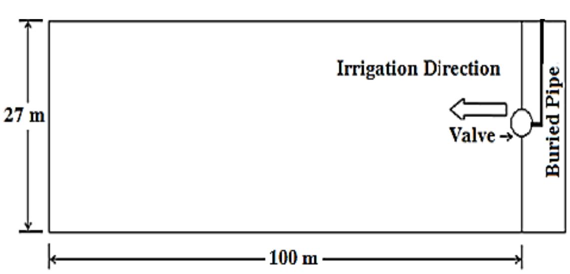


Fig. 2 General layout of modernized surface irrigation (pipe line) for field (No.2).

Fig. 3 General layout of modernized surface irrigation (lining mesqa) for field (No.3)

Soil properties

The soil texture of the experimental site according to Black, G. R. and K. Hartage 1986 is classified as clay soil as shown in table (1 to 3).

Table 1 The physical and mechanical analysis of soil, at first experimental field (Buried Pipes) field (No.1)

Depth, cm	Mechanical analysis			Soil texture	Field capacity, %	Wilting point, %	Bulk density, g/cm^3
	Clay	Silt	Sand				
0 - 15	49.99	27.56	22.45	Clay	36.20	17.40	1.12
15 - 30	50.30	27.75	21.95	Clay	38.10	18.10	1.13
30 - 45	52.57	26.86	20.57	Clay	36.50	20.20	1.15
45 - 60	52.95	26.51	20.54	Clay	35.80	19.00	1.17
Mean	**51.45**	**27.17**	**21.38**	**Clay**	**36.65**	**18.68**	**1.14**

Table 2 The physical and mechanical analysis of soil, at second experimental (Lining mesqa) field (No.2)

Depth, cm	Mechanical analysis			Soil texture	Field capacity, %	Wilting point, %	Bulk density, g/cm^3
	Clay	Silt	Sand				
0 - 15	52.11	26.21	21.68	Clay	37.10	17.9	1.14
15 - 30	52.23	26.32	21.45	Clay	36.50	18.50	1.15
30 - 45	53.66	25.96	20.38	Clay	36.90	19.8	1.18
45 - 60	53.35	26.44	20.21	Clay	35.20	20.00	1.19
Mean	**52.84**	**26.23**	**20.93**	**Clay**	**36.43**	**19.05**	**1.17**

Table 3 The physical and mechanical analysis of soil, at second experimental (traditional surface irrigation) field (No.3)

Depth, cm	Mechanical analysis			Soil texture	Field capacity, %	Wilting point, %	Bulk density, g/cm^3
	Clay	Silt	Sand				
0 - 15	51.81	26.65	21.54	Clay	35.30	18.10	1.18
15 - 30	51.55	26.9	21.55	Clay	37.20	19.20	1.19
30 - 45	53.72	25.75	20.53	Clay	35.60	21.10	1.20
45 - 60	53.13	26.47	20.4	Clay	34.90	22.00	1.22
Mean	**52.55**	**26.44**	**21.005**	**Clay**	**35.75**	**20.10**	**1.20**

Modernized surface irrigation.

In modernized surface irrigation the field received irrigation water from the branch canal through electric pumping unit to the main and branch buried UPVC pipes instead of traditional Mesqa and Marwa. The main line (Mesqa) diameter ranged from 225mm to 280mm and branch line (Marwa) diameter was 180 mm. The UPVC pipes were connected together using faucet rubber ring jointing system. On branch line there is risers ended by 160 mm hydrant valve. Fig (4). Shows vertical section for buried pipelines.

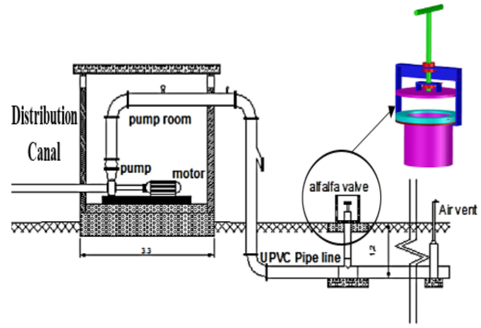


Fig. 4 Shows vertical section for buried pipelines.

In the present work, one U-section Mesqas were used. It is about lifted Mesqas up to the ground. Mesqas aspects and its base of bricks U-section height 40 cm and width 60 cm. The water is lifted to the Mesqas using pumps. The irrigation water come through holes located at the head of each Marwa. Fig (5). Shows vertical section for lining Mesqa.

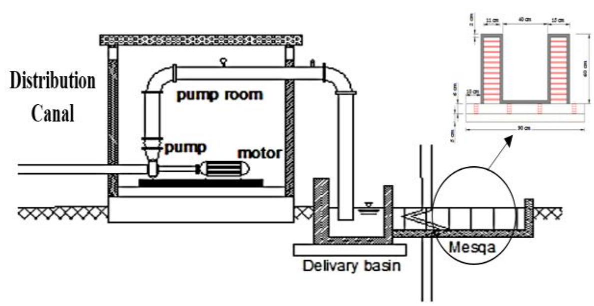


Fig. 5 Shows vertical section for lining Mesqa.

Earthen Mesqas receive irrigation water by individual farmer's pumping units. The pump lift irrigation water from the branch canal to convey irrigation water to earthen Marwa by gravity then to the field. The area served by a Mesqa is usually 20 to 100 feddan.

Water application efficiency (WAE).

Water application efficiency was calculated from the following formula (1) according to **(FAO, 1989)**

$$WAE = \left[\frac{WDZ}{WT}\right] \times 100 \ (1)$$

Where:

WDZ = Depth of water stored in the root zone, cm.

WT = Gross depth of applied water, cm.

Soil moisture distribution "SMD" was determined according to Liven and Van Rooyen (1979). For each treatment, six locations were taken along the field. The soil moisture content was determined using the gravimetric method. SMD was identified at six points along field and three depths at root zone (0-15, 15-30, 30-45 and 45-60) before and after irrigation. Soil samples were collected by soil auger. Moisture content for each treatment was measured directly before irrigation and 48 hours after irrigation. Soil moisture content percentage (S.M.C.) % was determined as a dry weight according to the following formula (2):

$$S.M.W = \left[\frac{(W_1 - W_2)}{W_2}\right] \times 100 \ (2)$$

Where:

W1 = mass of the wet soil sample, g.

W2 = mass of the oven dried soil sample, g. at 105 oC for 24 hours.

Formula (3) was used to find the depth of water that entered to root zone (WDZ) during irrigation.

$$W.D.Z = [\,(S.M.W\,2 - S.M.W\,1) \times \rho \times D \,/\, 100 \ (3)$$

Where:

P = specific weight of soil

$S.M.W_2$ = soil moisture content in the Field 48 hours after irrigation, %.

$S.M.W_1$ = is moisture content in the field before irrigation, %.

D = root depth, cm.

Water distribution efficiency, (WDE)

To determine the water distribution efficiency of irrigation water in the field, soil moisture samples were augured from the selected farmer`s field starting from the head to the end of the field. At each selected points of the field, soil samples were collected at depths of 0-15, 15-30, 30-45 and 45-60 cm and the moisture contents of the soil were computed to determine the depth of water penetration. For calculating the distribution uniformity, the root depths of the crops were taken as the zone of distribution and were calculated using formula (4) according to **(Merriam and Keller, 1978)**

$$\mathbf{WDE} = \frac{Zlq}{Zav} \ (4)$$

Where:

WDE = distribution uniformity %

Zlq = the minimum infiltration depth in a quarter of the total length of the field (cm)

Zav = the average of the infiltrated depth (cm).

Field Water use efficiency (FWUE).

After determining the amount of water applied to crop in the season. Water use efficiency was calculated according to the following formula (5) according to **(Howell, 2003).**

$$FWUE\ (kg/m^3) = \frac{Yield,(\frac{kg}{fed})}{water\ applied,(\frac{m^3}{fed})} \times 100 \ (5)$$

The buried pipes system calibration and test procedure.

The water uniformity distribution through valves outlets along pipes along its hole length was experimentally tested under field condition through the variation of flow (q_{var}) using equation (6). On the other hands the pressure head variation (H_{var}) could be determined by equations, (7) under the same condition. Was calculated according to the following formula (6 and 7) according to **(Jensen, 1980).**

$$q_{var} = \frac{q_{max} - q_{min}}{q_{max}} \ (6)$$

Where:
q_{var} = The outlet flow variation %,
q_{max} = The maximum outlet flow along the lateral line.
q_{min} = The minimum outlet flow along the lateral line.
Where:
H_{var} = pressure variation along the pipe, as a percentage,
H_{max} = maximum pressure in sub-main, m, and
H_{min} = minimum pressure in sub-main, m

Hydraulic evaluation of irrigation systems

The value of both velocity and discharge were determined as the most important engineering design parameters for the Mesqa and the Marwa.

The velocity through open mesqas

The velocity was calculated from the following formula (8) according to **(Khurmi, 1982)**

$$\mathbf{V} = \boldsymbol{c}\sqrt{\boldsymbol{m}.\boldsymbol{i}} \quad \textbf{(8)}$$

$$\boldsymbol{C} = \frac{\mathbf{157.6}}{\mathbf{1.81} + \frac{\boldsymbol{K}}{\sqrt{\boldsymbol{m}}}} \quad \textbf{(9)}$$

$$\mathbf{m} = \frac{\mathbf{A}}{\mathbf{P}} \quad \textbf{(10)}$$

The earthen and lining mesqas were trapezoidal and rectangular cross section respectively, the breadth and depth were calculated from the following formula (11) through (14).

$$\boldsymbol{A} = (\boldsymbol{b} + \boldsymbol{n}\,\boldsymbol{y})\,\boldsymbol{y} \quad \textbf{(11)}$$

$$\boldsymbol{P} = \boldsymbol{b} + \mathbf{2}\,\boldsymbol{y}\sqrt{(\mathbf{1} + \boldsymbol{n}^{\mathbf{2}})} \quad \textbf{(12)}$$

$$\boldsymbol{A} = \boldsymbol{b} \times \boldsymbol{y} \quad \textbf{(13)}$$

$$\boldsymbol{P} = \boldsymbol{b} + \mathbf{2}\,\boldsymbol{y} \quad \textbf{(14)}$$

The discharge through open mesqas

The discharge was calculated from the following formula (15) according to **(Khurmi, 1982)**

$$\mathbf{Q} = \mathbf{A}\,.\,\boldsymbol{c}\sqrt{\boldsymbol{m}.\boldsymbol{i}} \quad \textbf{(15)}$$

Where:
Q = The discharge, m^3/s.
A = Area of flow, m^2.

3. RESULTS AND DISCUSSION

Water application efficiency (WAE)

Mostly, water application efficiency is one of the most important criteria used to describe field irrigation efficiency which defined as the

The pressure head variation through buried pipes system:

The pressure head variation can be determined by:

$$\boldsymbol{H_{var}} = \frac{\boldsymbol{H_{max}} - \boldsymbol{H_{min}}}{\boldsymbol{H_{max}}} \quad \textbf{(7)}$$

ratio of the average depths of the irrigation water stored in the root zone to the average depths of the total irrigation water amount .The average depths of the irrigation water stored in the root zone under buried pipe and lining mesqa irrigation compared with earthen mesqa depending on soil moisture content before and after each irrigation were 36.74, 39.20 and 35.07 cm for different mesqa respectively in season.

Fig. (6) showed that the average values of water application efficiency (WAE) through Buried pipes and Lining mesqa comparing with traditional mesqa were 82, 79 and 49 % respectively during the season. Concerning the effect of mesqas type on water application efficiency (WAE), the results showed that the best water application efficiency (WAE) obtained in case of using buried pipe.

On the other hand, the results showed that increased the average values of the water application efficiency (WAE) in case of using buried pipe and lining mesqa by 33 and 30 % than irrigation traditional mesqa respectively for season.

The maximum value of water application efficiency (WAE) was achieved in case of buried pipe and its determination was 82 %, due to decrease the water irrigation losses by deep percolation.

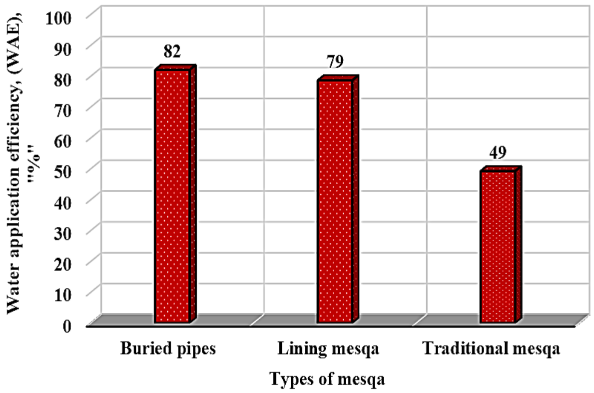


Fig. 6 Water application efficiency affected by type mesqa for season.

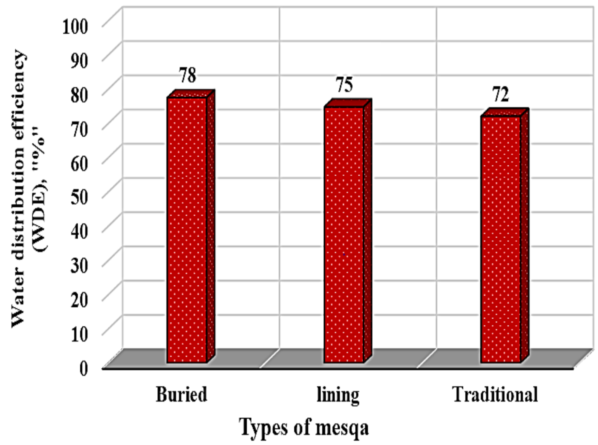


Fig. 7 Water distribution efficiency affected by type mesqa for season

.

Concerning the effect of irrigation systems on water distribution efficiency, the results showed that the best water distribution efficiency obtained in case of using buried pipe. on the other side, the conventional irrigation methods give a minimum average value of the water distribution efficiency than buried pipe or lining mesqa due to the good uniformity of water application resulting decreased the water losses by both deep percolation and run off and also reduce the time needed to irrigation.

Mostly, as such as results show that water distribution efficiency (WDE) under Buried pipes was higher by 6.99 % during season and 3.62 % during season as compared to traditional surface irrigation. The differences in (WDE) between improvement and traditional surface irrigation are not great because the root depths of the crops were taken as the zone of distribution in improvement and traditional surface irrigation.

Water distribution efficiency (WDE. %)

Water distribution efficiency indicates the extent to which water is uniformly distribution along the run.

Fig. (7) showed that the average values of the water distribution Efficiency through buried pipe and lining mesqa comparing with conventional irrigation methods were 78, 75 and 72 % respectively during season.

Effect of modernized surface irrigation on field water use efficiency.

Concerning water use efficiency (WUE) which considered as the evaluation parameter of the capability of converting irrigation water to crop productivity. The (WUE) was considered a tool for maximizing crop production per each unit of water amount.

Field water use efficiency (FWUE) considered as an indicator of the capability of irrigation system to converting irrigation water to crop. The (FWUE) was considered a tool for maximizing crop production per each unit of water applied. So, values of (FWUE) for maize were calculated under developed and traditional surface irrigation.

Table (4) and fig (8) illustrates the effects of modernized and traditional surface irrigation on maize field water use efficiency. It was found that the value of (FWUE) was 0.99 kg ⁄m3 under traditional surface irrigation. The value of (FWUE) for crop under buried pipes was 1.52 kg ⁄ m^3. Also, it found that the value of (FWUE) in lining mesqa was 1.36 kg ⁄ m^3. From previous results the (FWUE) under developed surface irrigation is higher than that under traditional surface irrigation because of the volume of water applied per feddan in developed surface irrigation less than the traditional surface irrigation and productivity per feddan in developed surface irrigation higher than the traditional surface irrigation so, the (FWUE) under the developed surface irrigation is higher than the traditional surface irrigation.

Table 4 Effect of developed surface irrigation on (FWUE) for maize crop.

Types of mesqas		Productivity (kg/fed)	Productivity, (ardab/fed)	Percentage of increase, %
Modernized	Buried pipes	3550	25	22
	Lining mesqa	3250	23	15
Traditional	Earthen mesqa	2775	20	——

The results revealed that the maximum value of water use efficiency for the irrigation with buried pipes and lining mesqas was achieved due to decreased the water irrigation amount. The minimum value of water use efficiency for irrigation with buried pipes and lining mesqas was achieved due to increase the water irrigation amount and also increased the water irrigation losses by deep- percolation and run off as increased the irrigation run. Concerning the effect of using buried pipes and lining mesqas or earthen mesqa on the water use efficiency.

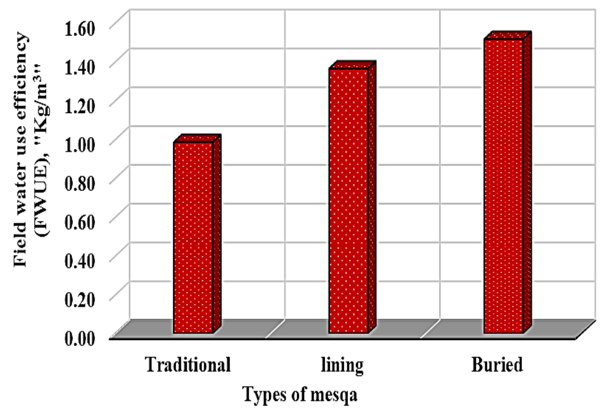


Fig. 8 Field water use efficiency affected by type mesqa for season.

Crop productivity

The values of the crop productivity of season, for earthen mesqa, lining mesqa and buried pipe were determined actually on the field during season. The productivity of crop was affected by using modernized surface irrigation as it is high compared with traditional surface irrigation.

The productivity of crop was 3550, 3250 kg/ fed under buried pipes and lining mesqa, it was 2775 kg / fed under earthen mesqa. The results of table (5) were graphically expressed in fig (9) to facilitate the discussion.

Table 5 Effect of earthen mesqa, lining mesqa and buried pipe on crop yield, Kg/ feddan

Types of mesqa		**Productivity (kg/fed)**	**Water applied, (m^3/fed)**	**FWUE, (kg/m^3)**
Modernized	**Buried pipes**	**2380**	**1571**	**1.52**
	Lining mesqa	**2170**	**1592**	**1.36**
Traditional	**Earthen mesqa**	**1960**	**1988**	**0.99**

The lowest value of crop was under traditional surface irrigation condition. The percentage of increase in productivity of crop under buried pipes was 22 % compared with traditional surface irrigation. Also, the percentage of increase in productivity of crop under lining mesqa was 15 % compared with traditional surface irrigation.

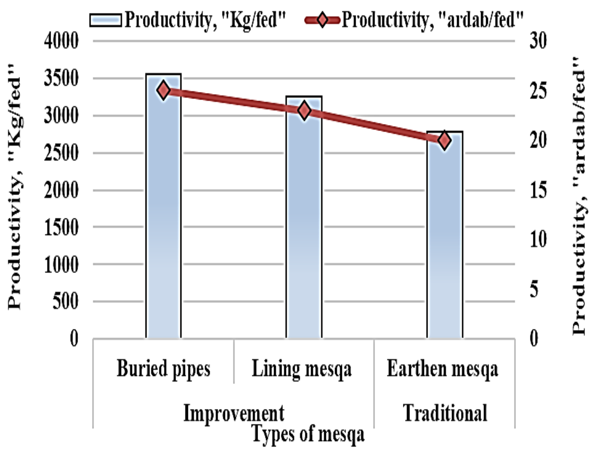


Fig. 9 Effect of mesqa modernized on productivity of crop.

Hydraulic estimation of irrigation systems

The value of both velocity and discharge they are control the engineering design of the channels in terms of the speed and volume of water passing through the channels. The results of the measurements of the average values of both velocity and discharge rates through different types of mesqas are shown graphically expressed in fig (10) and fig (11) to facilitate the discussion. Fig (10) showed that the average values of the velocity through different type of mesqas were 0.20, 0.11, 0.36 and 0.22 m/s for Ordinary, Roughness, Lining mesqas and Buried mesqa respectively. Also, showed that the average values of the discharge through different type of mesqas were 0.18, 0.05, 0.09 and 0.01 m3/s for Ordinary, Roughness, Lining mesqas and Buried mesqa respectively. Fig (11) showed that the average values of the wetted parameters through different type of mesqas were 2.62, 2.02, 1.60 and 0.6 m for Ordinary, Roughness, Lining mesqas and Buried mesqa respectively. Also, showed that the average values of the hydraulic radius through different type of mesqas were 0.35, 0.22, 0.15 and 0.05 m for Ordinary, Roughness, Lining mesqas and Buried mesqa respectively

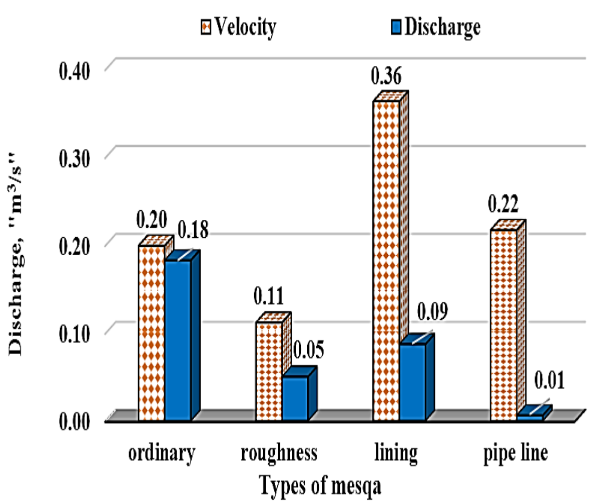


Fig. 10 Effect of modernized surface irrigation system on velocity and discharge.

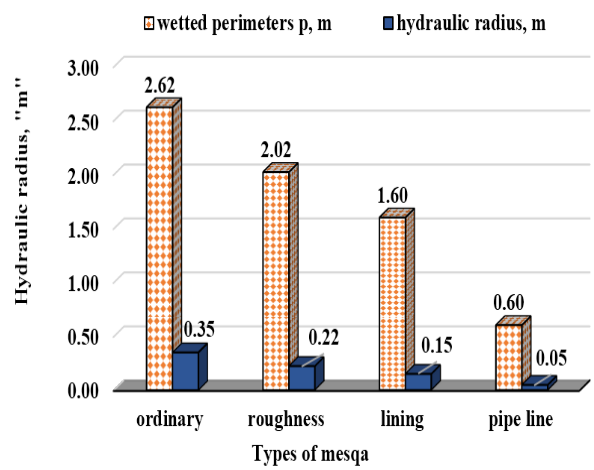


Fig. 11 Effect of modernized surface irrigation system on hydraulic radius and wetted perimeters.

4. DISCUSSION

- Using modernized systems for irrigating crop led to increase water application efficiency, without observed reduction in productivity. In addition to the above, from a health point of view, eliminating pathogens, including mosquitoes and snails
- It is preferable to use the modernized irrigation system instead of the traditional irrigation. As the use of traditional irrigation is exposed to environmental pollution as a result of direct contacts between farms and water, and then the use of this developed system provides water that can be directed and used to cultivate alternative spaces. In addition to the above, productivity increases compared to conventional irrigation systems.
- Modernization Surface Irrigation have many advantages such as: Saving irrigation Water, hence minimize the drainage problems and improve the usage efficiencies equity of water distribution. Therefore, it is recommended to utilize the modernized canals in the northern Nile Delta, especially the buried pipes.

5. REFERENCES

Ahmed, T. M.; T. El Gamri and M. A. Isam (2009). Use of precast concrete slabs and bricks for lining irrigation canals., J. Sci. Tech.; Sudan, 10 (2): 201-215.

Akbar, G.; M. M. Ahmad; M. Khan and M. Asif (2017). Furrow lateral wetting potential for optimizing bed width in silty clay. Irrig. and Drain., 66: 218–226.

Amer, M. H. and T. M. Attafy (2017). Effect of surge flow on some irrigation indices of furrow irrigation system. J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (12): 703 – 708.

Awwad, A. H.; A. S. Mohammed and M. A. Shabana (2016). Evaluation of Water Management and Requirements Under Developed Surface Irrigation System. J.Soil Sci. and Agric. Eng., Mansoura Univ., 7(11): 847 – 855.

Black, G. R. and K. Hartage (1986). Bulk density Methods of Soil Analysis.Part1 Agron. 2nd ed. 363376. ASA and SSSA, Madison.

Eid, A. S. M. E (2021). Development of surface irrigation in delta soil for wheat crop. M. Sc. Thesis, Agric. Eng. Dept., Fac. of Agric., Kafr Elsheikh Univ., Egypt.

El-kholy, E. M.; T. M. Attafy; A. H. Elmetwalli and A. Derbala (2021). Optimizing Bed Width and Orifice Flow Rate for Wheat Crop Irrigation in The Nile Delta. J. of Soil Sciences and Agricultural Engineering, Mansoura Univ.,12 (4):289-294.

FAO (2014). AQUASTAT Database. Retrieved September 29, 2014, from Food and Agriculture Organization of the United Nations:
http://www.fao.org/nr/water/aquastat/main/index.stm

FAO (Food and agricultural Organization) (1989). Guidelines for Designing and Evaluating Surface Irrigation System: Irrigation and Drainage Paper. No. 45. FAO, Rome.

Gad, W. A. (2017) water scarcity in Egypt: causes and consequences. IIOAB. J. 8 (4): 40 – 47.

Howell, A. T. (2003). Irrigation efficiency. United States Dept. of Agric. (USDA), Bushland, Taxas, U.S.A. Marcel Dekker, Inc. New York.

Ismail, S. M.; T. K. Zin El-Abedin; A. Zein El-Din and A. Hedia (2014). Validation and utilization of the soil conservation services for furrow Irrigation design method. Asian Journal of Science and Technology, 5 (12): 745-754.

Jensen, M. E. (1980). Design and operation of farm irrigation system. ASAE, Monogr. 3, ASAE., St.Joseph, MI, 829 pp.

Khurmi, R. S. (1982). A text book of fluid mechanics. Published by S. Chand & Company Ltd, Ram Nagar, New Delhi, 11Th. Ed: 630 pp.

Liven, P. C.; F. Van and C. Rooyen (1979). The effect of discharge rate and intermittent water application by point-source irrigation on the soil moisture distribution pattern.Soil Sci.Amer. J. 43: 8-5.

Merriam, J. L. and J. Keller (1978). Farm irrigation system evaluation: A guide formanagement. Department of Agricultural and Irrigation Engineering, Utah State University. Logan, Utah.

Morcos, M. A., A. F. El Sahrigi, M. Hanafy and S. S. Hassan (1994). A mathematical approach to predict the pressure head inside the perforated tubes. Misr J. Agr. Eng. 11(4): 1041-1065.

Tzanakakis, V. A; N. V. Paranychianakis and A. N. Angelakis (2020). Water Supply and Water Scarcity.12, 2347; doi:10.3390/w12092347 www.mdpi.com/journal/water

UNWW (United Nations World Water) (2021). The United Nations World Water Development Report 2021 Valuing Water

USDA, NRCS (2012). National Engineering Handbook Part 623 Irrigation chapter 4 Surface Irrigation (623–VI–NEH, September (2012). USDA online at www.ascr.usda.gov.

Zohry, A.; S. Ouda and T. Abd El-Wahab (2020). Sustainable intensive cropping to reduce irrigation-induced erosion: Intercropping systems under surface irrigation practice. Moroccan Journal of Agricultural Sciences, 1(2): 63-71.

فعالية تطوير الري السطحي علي كفاءة الري والإنتاجية

محمد حسن العطار، أسعد عبد القادر دربالة ، عادل محمد المتولي، سامي سعد حسن ،أحمد محمد الجلالي

مجلة العلوم الزراعية والبيئية المستدامة

الملخص

أجريت التجارب الحقلية لهذا البحث في شمال دلتا النيل بمحافظة كفر الشيخ بمنطقة دقلت، خلال موسم الزراعة الصيفي ٢٠٢١، وذلك بدراسة تأثير تطوير الري السطحي وتقييم أدائه في الأراضي القديمة من خلال تطوير المراوي والمساقي التقليدية واستبدالها باحدي طرق التطوير (المساقي المبطنة – الانابيب المدفونة)، وذلك من أجل زيادة كفاءة استخدام المياة وتعظيم الإنتاجية وترشيد استخدام مياه الري وتحقيق التنمية المستدامة للزراعة وتم ذلك بتقديركفاءة إضافة المياة، وكفاءة استخدام المياة للري، ومعدل الزيادة في إنتاجية المحصول لكل وحدة من المياه لاهم المحاصيل الصيفية (الذرة) مقارنة بالنظام التقليدي للري، كما يشتمل البحث علي إجراء دراسة هيدروليكية للنظم المطورة، ويمكن سرد النتائج وتلخيصها علي النحو الاتي: أوضحت النتائج أن متوسط كفاءة إضافة المياه كانت ٨٢ و ٧٩ و ٤٩٪ للأنابيب المدفونة والمساقي المبطنة والمساقي الترابية على التوالي. كما بينت ان متوسط قيم كفاءة توزيع المياه من خلال الانابيب المدفونة والمساقي المبطنة مقارنة بطرق الري التقليدية كانت ٧٨ و ٧٥ و ٧٢٪ على التوالي خلال الموسم ووجد ان قيمة كفاءة إستخدام المياة الحقلية كانت ١,٥٢و١,٣٦ و ٠,٩٩ كجم.م^3 للمواسير المدفونة والمساقي المبطنة والمساقي الترابية على التوالي. كما بلغت إنتاجية المحصول ٣٥٥٠ ، ٣٢٥٠ كجم/فدان تحت الأنابيب المدفونة والمساقي المبطنة ، وبلغت ٢٧٧٥ كجم/فدان تحت المساقي الترابية. أظهرت نتيجة التقييم الهيدروليكي لأنظمة الري أن متوسط قيم قياس المحيط المبتل من خلال أنواع مختلفة من المساقي كانت ٢,٦٢ ، ٢,٠٢ ، ١,٦٠ و ٠,٦ متر للمساقي العادية ، الخشنة ، المبطنة ، والانابيب المدفونة على التوالي. كما بينت أن متوسط قيم نصف القطر الهيدروليكي من خلال أنواع مختلفة من المساقي كان ٠,٣٥ و ٠,٢٢ و ٠,١٥ و ٠,٠٥ م للمساقي العادية والخشنة والمبطنة والانابيب المدفونة على التوالي.