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RESEARCH ARTICLE

Economic Feasibility Analysis of Pressurized Irrigation Systems for Wheat under Desert Environmental Conditions

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Abstract

The trials were conducted under four pressurized irrigation systems in season (2012/2013) at the site of NRC Farm, Nubaria, Behaira Governorate, the altitude of trial position are 30° 31'44" & 30°36'44"N and longitudes 30°20'19" & 30°26' 50"E. This research aims to investigate the economic feasibility of cultivating wheat (Triticum aestivum L. CV. Gemmaiza 9), under various pressurized irrigation systems [surface drip (SD), subsurface drip (SSD), solid-set sprinkler (SS), semi-portable sprinkler (SPS). Irrigation applied water amounts are (50, 75 and 100% of calculated applied water and called W_1, W_2 and W_3, respectively). The statistical experiment design was randomized complete blocks. The main results of research are the highest annual fixed cost is SSD, SD, SPS and SS irrigation systems respectively, wherever the highest annual operating cost is SS, SPS, SSD and SD irrigation systems respectively, while the highest annual operating cost for water amount is W_3, W_2 and W_1 respectively. The highest irrigation cost of water unite is SPS then SS is very close to the last system under W_1. According to annual total costs, the highest annual total cost is SSD, SD, SS and SPS irrigation systems respectively. By the same token, the irrigation cost of unite production. The highest crop water use efficiency is SS and SPS under W_1 and W_2 and the others treatment are close. Finally, the economic efficiency of irrigation systems are the heights for SS and SPS under both of W_2 and W_3 of applied water amount. As we have seen, the sprinkler irrigation systems are more economical for wheat irrigation than drip irrigation systems, whenever the type of sprinkler irrigation systems.

INTRODUCTION

No one can deny that the water is the basic factor of life, plant cannot grow under drought conditions, beside the climate changes go to the more of aired changeable of many semi aired regions, and increasing of population specially in developmental countries like Egypt. So the development and improvement of irrigation systems are critical need to save water and nutrients to have the available highest income, yield. Therefore, the economic feasibility is critical study of pressurized irrigation systems. There's no doubt that, security and stability of food in the world greatly depends on the management and various usage approaches of natural resources. According to, the depletion of water resources and a population increasing, **(Hargreaves and Mekley, 1998).** The design of pressurized irrigation systems has been the subject of a number of research works, due to the relevance of its economic feasibility, environmental and social aspects **(Alperovits and Shamir, 1977; Goulter and Morgan, 1985; Savic and Walters, 1997; Lansey et al., 1989).** There is a strong relationship between irrigation nozzles flows, it's very important to understand the nature of sandy soil physical and hydraulics characters and the suitable emitter flow rate of drip irrigation system. And its influence on the spatiotemporal distribution of soil moisture contents, salts and temperature. Which don't cause water or salt stress and don't cause water loss by deep-percolation then nutrients leaching to drainage and taking into account the root zone depths of cultivated crops, **(El-Hagarey and Gyuricza, 2015).** Regarding to the effect of investigating irrigation systems on WUE of wheat grain and straw, their values were increased by about 12 and 11 % compared with the SD irrigation system, respectively **(Mansour and bed El-Hady, 2014).** Pottery drippers are invented then designed and manufactured from local and environmental material, as one of the models in the Agricultural Waste Recycling Industry, that lead to reduce the initial cost of this type of drippers beside solve the minimum limit of saline water agriculture usage in irrigation process. **(El-Hagarey. 2014).** There was a high gradation for CWUE under various water amounts; water saved more water that saved 40% than T2 by 20% especially at subsurface ultra-low flow drip and surface ultra-low flow drip where the difference was clear when compared to surface drip and subsurface drip irrigation systems. And this result reflects the net revenues**. (Omima and El-Hagarey. 2014).** Subsurface micro drip and surface micro drip irrigation systems were more economical comparing with surface drip and subsurface drip irrigation systems. **(El-Hagarey et al. 2014).** The peaches production unit of irrigation costs more under subsurface drip and surface drip irrigation systems was doubled compared with subsurface micro drip and surface micro drip. **(El-Hagarey et al 2014).**

The potential yield increase from adopting the irrigation technologies used in this research must be weighed up against the cost involved in buying, installing and maintaining the irrigation systems. **(Karlberg et al. 2007).** The advantages of pressurized irrigation systems can increase yield and revenue, reduce water and fertilizer unit costs, especially micro irrigation systems and decrease cultural costs compared to other irrigation methods **(Hanson and May, 2006).** Among, the different types of irrigation systems, the on-demand system offers the greatest potential **(Lamaddalena and Sagardoy, 2000).** Several researchers have argued that farmers' irrigation systems application criteria and preferences are not included in the probabilistic approach **(D'Urso et al., 1995; Pulido-Calvo et al., 2003).** Water and nutrient management, potential for improved yields, crop quality and WE are the most obtained advantages of micro-irrigation systems **(Phene et al., 1987; Smith et al., 1991; Hutmacheret al., 1996; Ayars et al., 1998, 1999).** Subsurface drip irrigation is gradually gaining wider acceptance. Excellent reviews of subsurface drip irrigation research are provided by **Lamm et al. (2007) and Camp (1998).** The wheat height and yield increased with the irrigation amount under drained conditions, but they were decreased under poor drained conditions **(Katerji et al., 2000). Khosla and Gupta (1997)**.

The major advantages of surface drip irrigation in the soil–water environment include: more WUE since surface deep percolation losses, evaporation, and surface runoff can be reduced or nearly eliminated. SDI facilitates the use of degraded quality water **(Palacios-Díaz et al., 2009).** The weather, yield, soil type, area and the economic conditions necessary for profitability are the basic factors which answer to the next questionnaires "What is the minimum irrigation capacity for irrigated corn? And what is the suitable irrigation system for irrigating corn?" **(Abdrabbo A. Abou Kheira, 2009).**

Sprinkler irrigation system, as one of the useful technologies to increase crop production and water use efficiency, the soil evaporation component of ETc can be high when a sprinkler irrigation system is used with a high frequency of irrigation events **(López-Urrea et al. (2009).**

Most farmers still use primitive methods of irrigation systems, the application of some irrigation methods and fertilizers is usually by hand with low efficiency, resulting in higher costs and environmental problems. **(Abdrabbo A. Abou Kheira, 2005).** The combination of decreasing non beneficial water balance components and better usage of precipitation may save 20-25% of water irrigation. **(Lamm, 2005).** In the Great Plains, surface drip irrigation systems for irrigating corn can reduce water use by 35–55% compared with traditional irrigation systems used in the region. In the last decades. **(Lamm and Trooien, 2003).** Sprinkler irrigation system is an advanced irrigation technique for saving of water and fertigation beside in accurately controlling irrigation scheduling **(Li and Rao, 2003)**. Low-cost drip systems using gravity as the force to push water through the pipes. In low-head drip irrigation systems, normally a head of only 0.5–1 m is used for bucket kits **(Sijali, 2001).**

Sprinkler irrigation systems can produce a favorable microclimate for crop growth beside results higher crop yield and water use efficiency. **Tolk et al. (1995)**. In the past several decades, many researches have been carried out all over the world for investigating water evaporation and the microclimate change pattern of the sprinkler irrigation systems. Water evaporation were from droplets, canopy interception and wet soil surface. **(Frost and Schwalen, 1955; Dylla and Shull, 1983; Norman and Campbell, 1983; Steiner et al., 1983; Kohl et al., 1987; Walter,**

1988; Ayars et al., 1991; Thompson et al., 1997; Li and Rao, 2000; Tarjuelo et al., 2000). Flow rate might be a factor to take into consideration when choosing between different low-cost drip-systems. **(Dasberg and Or, 1999).**

The objectives of the current research work are: the economic feasibility investigation of cultivating wheat (Triticum aestivum L. CV. Gemmaiza 9), under various pressurized irrigation systems [surface drip (SD), subsurface drip (SSD), solid-set sprinkler (SS), semi-portable sprinkler (SPS). Irrigation applied water amounts are (50, 75 and 100% of calculated applied water and called W_1, W_2 and W_3, respectively).

During, determination of the more economic pressurized irrigation system to cultivate wheat under the desert environmental conditions, the best benefits, Net-back and revenues of water unite pumping costs, crop water use efficiency, field water use efficiency, economic efficiency of irrigation systems and the irrigation cost of yield unites production.

Materials And Methods

The trials were conducted under four pressurized irrigation systems in season (2012/2013) at the site on NRC Farm, Nubaria, Behaira Governorate, the attitude of trial position are 30° 31'44" & 30°36'44"N and longitudes 30°20'19" & 30°26' 50"E. This research aims to investigate the economic feasibility of cultivating wheat (Triticum aestivum L. CV. Gemmaiza 9), under various pressurized irrigation systems [surface drip (SD), subsurface drip (SSD), solid-set sprinkler (SS), semi-portable sprinkler (SPS). Irrigation applied water amounts are (50, 75 and 100% of calculated applied water and called W_1, W_2 and W_3, respectively). The statistical experiment design was randomized complete blocks, beside the statistical analysis will be done using Co State.

Soil texture is sandy loam, poor in organic matter (1.3 %) and CaCO3 (3.8%). In addition to the soil reaction (pH 8.2), the soil is non-saline (2.6 dSm-1 of the extracted soil paste). Soil water content at field capacity and wilting point were 12.6 and 4.7 % on a weight basis, which carried out after **(Klute, 1986)**.

Soil preparation and fertilization program:

For wheat, amounts of fertilizers are applied according to the recommendations of the Field Crop Institute, ARC, Egypt, Ministry of Agricultural and Land Reclamation for wheat crop (Triticum aestivum L. CV. Gemmaiza 9).

Farmyard manure (FYM) had been added at the rate of 10 m^3 ha^{-1} was thoroughly mixed with 0 - 30 cm of the surface soil layer before planting in addition to 100 kg superphosphate ha^{-1} (15.5 % P2O5) and 50 kg potassium sulfate (48% K2O). As well as addition recommended dose of nitrogen (100 kg N ha^{-1}) in two equal doses, 4 and 10 weeks after completion germination. Wheat (Triticum aestivum L. CV. Games 9) was sown on 10 November.

Irrigation systems:

The pressurized irrigation systems (drip and subsurface drip irrigation system, solid-set sprinkler, and portable sprinkler irrigation systems) consisted of the following components:

1. **Drip irrigation systems:**

Control head consisted of centrifugal pump (35 m lift and 27 $m^3.h^{-1}$ discharge), driven by a diesel engine, pressure gauges, control valves, inflow gauges, and water source in the form of an aquifer, main line then lateral lines and dripper lines. For traditional drip irrigation, Gr dripper (4 $l.h^{-1}$ discharge, three emitters at one meter) was used. The space between plants rows 25cm. length of Gr hoses is 0.3 meters. The first position of drip hose is surface irrigation (SD) and the second is subsurface drip at depth 20cm.

2. sprinkler irrigation systems:

Control head consisted of centrifugal pump (65 m lift and 60 m^3. h^{-1} discharge), driven by a diesel engine, pressure gauges, control valves, inflow gauges, water source in the form of an aquifer, main line

The components of semi-portable sprinkler system used usually consists of the following components Tubing-main/sub-mains and aluminum lateral pipes (inside diameters are 150, 110 and 90 mm), respectively, couplers, sprinkler head (l. h^{-1}) the space of sprinkler is 12 x 12 m, the sprinkler flow is one $m^{3.}$ h^{-1}, other accessories such as valves, bends, plugs and risers. The solid-set sprinkler systems used is similar to the portable one except that the location of water source and pumping plant is fixed. Fig.1.

Irrigation requirements:

Irrigation water requirements for wheat were calculated according to the local weather station data at Al-Beharia Governorate, belonged to the Central Laboratory for Agricultural Climate **(C.L.A.C.),** Ministry of Agriculture and Land Reclamation.

Irrigation process was done by calculating crop consumptive use (mm. Day^{-1}) according to **Doorenbos and Pruitt (1977).**

Water requirements for wheat crop were calculated according to the following equation as recommended by **Keller and Karmeli (1975).** Table (1).

$$IR = \left[\frac{K_c \times Et_o \times A \times C_F}{10^7 \times Ea} \right] + LR$$

Where:

IR	=	Irrigation water requirements, m^3. $ha^{-1}day^{-1}$.
E t_o	=	Potential evapo-transpiration, mm. Day^{-1}
KC	=	Crop factor of wheat,
A	=	Area irrigated, (m^2)
Ea	=	Application efficiency, %, where 90% drip irrigation.
LR	=	Leaching requirements.

The Crop factor of wheat was used to calculate Et_{crop} values, according to **(Allen et al, 1998).**

Fig.1. Irrigation systems in experimental sit under economic feasibility investigation.

Table .1. Irrigation requirements of wheat at Nubaria sites, Egypt.

Growth stage	month	ET_o Mm. Day^{-1}	KC	Et_c Mm. Day^{-1}	I_d (m^3. ha^{-1} Day^{-1})
Planting	December	2.8	0.4	1.1	11.2
Rapid	January	6.3	0.4	2.5	25.2
Vegetative	February	5.9	0.8	4.7	47.2
Flowering seed fill	March	4.2	1.3	5.5	54.6
Maturity and	April	7.4	0.5	3.7	37
harvesting	May	2.0	0.4	0.8	8
Total (I_y)		5547.8 m^3 ha^{-1}. season			

Where:

- I_d = Irrigation requirements for hectare of wheat per day, (m^3 ha^{-1}. Day),
- I_y = Irrigation requirements for hectare per season for wheat, ($m^{3.}$ ha^{-1}. $season^{-1}$).

Measurements and calculations:

Economic and Cost Feasibility analysis:

Cost analysis to evaluate surface and subsurface drip irrigation systems comparing with semiprtable and solid-set sprinkler irrigation systems, cost analysis were computed according to **Worth and Xin (1983),** Fixed and operation costs are calculated according to market price level of 2012 for equipment and operating irrigation process, cost analysis is based on one hectar.

1– Initial cost (IC):

Initial cost (IC) (LE. ha^{-1}.) = Irrigation systems price **(**LE**)** × Item quantity per ha.

2– Annual fixed cost (F):

Fixed annual cost (LE. $year^{-1}$) invested in the irrigation system was calculated according to the following equation:

$$F = D + I + T$$

Where:

- **F** = Fixed annual cost (LE. $year^{-1}$),
- **D** = Depreciation rate (LE. $year^{-1}$),
- **I** = The interested (LE. $year^{-1}$), and
- **T** = Taxes and overhead ratios (LE. $year^{-1}$) taken 1.5% of the initial cost. According to (**UC DANR 1976)**

Depreciation rate cost was calculated using the following equation:

$$D = (I.C - D.C) \times (E.L)^{-1}$$

$$I = (I.C + D.C) \times 0.5IR$$

Interest on initial was calculated as follows:

Where:

- **I.C** = Initial cost (LE. ha^{-1}),
- **D.C** = Price after depreciation (LE),
- **E.L** = Expected life (year), and
- **IR** = Interest rate per year (taken 14%).

Taxes and overhead ratios were taken as 1.5 % of the initial cost.

3– Operating cost (O):

Annual operating cost (LE. $year^{-1}$) of the capital investment in the irrigation system was calculated as follows:

$$O = L + E + (R \& M)$$

Where:

O	=	Operating cost,
L	=	Labor cost (LE. $year^{-1}$),
E	=	Energy cost (LE. $year^{-1}$),
R & M	=	Repair and maintenance costs (LE. $year^{-1}$), R & M cost taken as 3 % of the initial cost, and

Labor cost was calculated based on one man for irrigation systems. Beside Maintenance and repair costs were calculated based on a percentage of the initial cost of system components, and the useful lives assumed for the major system components according to (**Jensen <u>1983</u>**), **(The UC Committee of Consultants <u>1988</u>)** and **(the San Joaquin Valley Drainage Program <u>1989</u>).**

Energy cost was calculated as follows:

$$Bp = \frac{Q \ . \ TDH}{k \,.\, E}$$

Where:

Bp	=	Brake horsepower (HP),
Q	=	Discharge rate (L. h^{-1}),
TDH	=	Total dynamic head (m),
K	=	Coefficient to convert to energy unit, 1.2, and
E	=	The overall efficiency, 55% for pump driven by an internal combustion engine.

The power cost of diesel type source was calculated using the following formula:

$$E.C = 1.2\ Bp\ H * S * F.C$$

Where:

E.C	=	The energy cost of diesel (LE.Hp^{-1}),
H	=	Annual operating hours (h),
S	=	Specific fuel consumption (LHp^{-1}. h^{-1}),
F.C	=	Fuel price (LE), and
1.2	=	Factor accounting for lubrication.

4–Total annual cost (LE. $year^{-1}$) = F + O

5- Unit production irrigation cost (LE.kg^{-1}) = [Annual irrigation cost (LE.m^{-3})] ÷ [FWUE (kg.m^{-3})]

Water use efficiency (WUE, kg. m^{-3}).

This crop water use efficiency was defined as the percentage of yield and its ratio or irrigation water requirements. In practice irrigation water use efficiency would be more conveniently expressed as mass of marketable crop per unit volume of water (kg. m^{-3}) as it has been done by many others over the past two decades, on the other hand the field water use efficiency was defined as the percentage of yield and applied water that's mean water consumption plus water losses or by other mean, it's the water consumption multiply irrigation system efficiency. But this very important, the water use efficiency is may become deceptive value, by believing in its good wherever it becomes high, but that's not true because it's may be high value according to the saving and reducing water applied with having a yield value which is being less that the economic yield of hectare in this case, the water use efficiency becomes so deceptive value so, it's very necessary to use it under the economic yield of a hectare. **Michael, 1978.**

Water uptake efficiency under irrigation systems, (WPE, %).

The water uptake regarding the irrigation systems was defined as the percentage of crop water use efficiency and field Crop water use efficiency, beside consider a good indicator of irrigation system efficiencies

Crop water use efficiency (kg. m^{-3})	=	[Grain yield ÷ actual crop water consumption,]
Field Crop water use efficiency (kg. m^{-3})	=	[Grain yield ÷ irrigation water requirements.]

Water uptake efficiency under irrigation systems, (%). = [Crop water use efficiency ÷ Field Crop water use efficiency]

- **Economic efficiency of irrigation systems (EEIS, %).**

The economic efficiency of irrigation systems was defined as the percentage of actual yield and typical yield per hectare.

EEIS = (Actual yield ÷ typical yield) per ha

Results and Discussions

Economic Feasibility and Cost analysis:

For initial costs, The initial cost of both of SD and SSD is the high capital cost it's greater than SS by 6.5% and than SPS by 14.11 %, but it's so important to mention that, the expected life of mine, lateral pipes and nozzles initial cost is 10 for SS, 7 for SPS, 4 for SD and 2 years for the SSD irrigation system. While for Annual fixed cost, the highest annual fixed cost is SSD, SD, SPS and SS irrigation systems respectively.

Wherever the highest annual operating costs of the wheat irrigation process is SS, SPS, SSD and SD irrigation systems respectively, the heights labor cost is SPS then SSD, SD and SS respectively. Beside the heights annual operating and energy cost is (SSD, W_3), while the lowest annual operating and energy cost is (SD, W_1). And these results are compatible with **(Dasberg and Or, 1999) and** (**Louise et al. 2007).** The heights annual total costs is (SSD, W_3) while the lowest annual total costs is (SS, W_1). The heights irrigation cost of water unites is (SS, W_1) and (SPS, W_1) while the lowest annual total costs is (SD, W_2) and (SD, W_3) beside (SSD, W_3). The heights irrigation cost of unite production of the wheat crop is (SD, W_3) while the lowest irrigation cost of unite production is (SS, W_3), table .2., Figs.2 and 3. According to **(Jean Schwab. 2015), (Larry S et al. 1999) and Stephen S. And K. G., Linden. (2010).**

Table. 2. Economical and cost feasibility analysis of pressurized irrigation systems and water amounts:

Irrigation systems		**SD**			**SSD**			**SS**			**SPS**		
Water amounts		W_1	W_2	W_3	W_1	W_2	W_3	W_1	W_2	W_3	W_1	W_2	W_3
1 – Capital cost, LE. ha^{-1}.													
Control head, LE. ha^{-1}. (A)				10440						10440			
Pipes cost, LE ha^{-1}. (B)				8836.1					7089.6			5455.2	
Nozzles cost, LE. ha^{-1}. (B)				2083.3						2450			
Expected life (years)	**(A)**						30 years						
	(B)		4			2			10			7	
Subtotal				**21359.4**					**19979.6**			**18345.2**	
2 – Annual fixed cost, LE. year^{-1}													
Deprecation	**(A)**						261						
	(B)		1877.7			4197.1			715.47			1118.571	
Interest	**(A)**						913.5						
	(B)		711.3			649.5			89.4			69.2	
Taxes and Insurance				320					299.7			275.2	
Subtotal			4083			**6341**			**2279.1**			**2637.5**	
3 –Annual operating costs, LE. ha^{-1}.													

Labor		86.4			168			40.5			360	
Energy	148	222	296	232	348	464	501	752	1002	425	637	850
Repairs and maintenance			640.1					599.4			550.4	
Subtotal	875	222	296	400	348	464	1141	752	1002	1335	637	850
Annual Total Costs, LE. ha-1. season	4958	4305	4379	6741	6689	6805	3420	3031	3282	3972	3274	3487
Irrigation Cost of water unite (LE.m-3)	2.08	1.20	0.92	3.00	1.98	1.51	1.30	0.77	0.63	1.52	0.83	0.66
Irrigation Cost of unite production (LE.kg-1)	1.10	0.90	0.88	1.46	1.40	1.36	0.60	0.35	0.35	0.75	0.39	1.10

(A) = Control head initial cost.

(B) = Main, lateral pipes and nozzles initial cost.

According to statistical analysis, it's crystal clear that there's a significant influence of applied water amounts on annual total irrigation systems costs under all of used pressurized systems, on irrigation cost of water unite under SSD, SS and SPS irrigation systems, irrigation cost of unite production of wheat under SS and SPS irrigation systems, beside there are clear significant impacts of pressurized irrigation systems and applied water amounts on all of means of annual total Costs, irrigation cost of water unite and irrigation cost of unite production of wheat crop. Table.3.

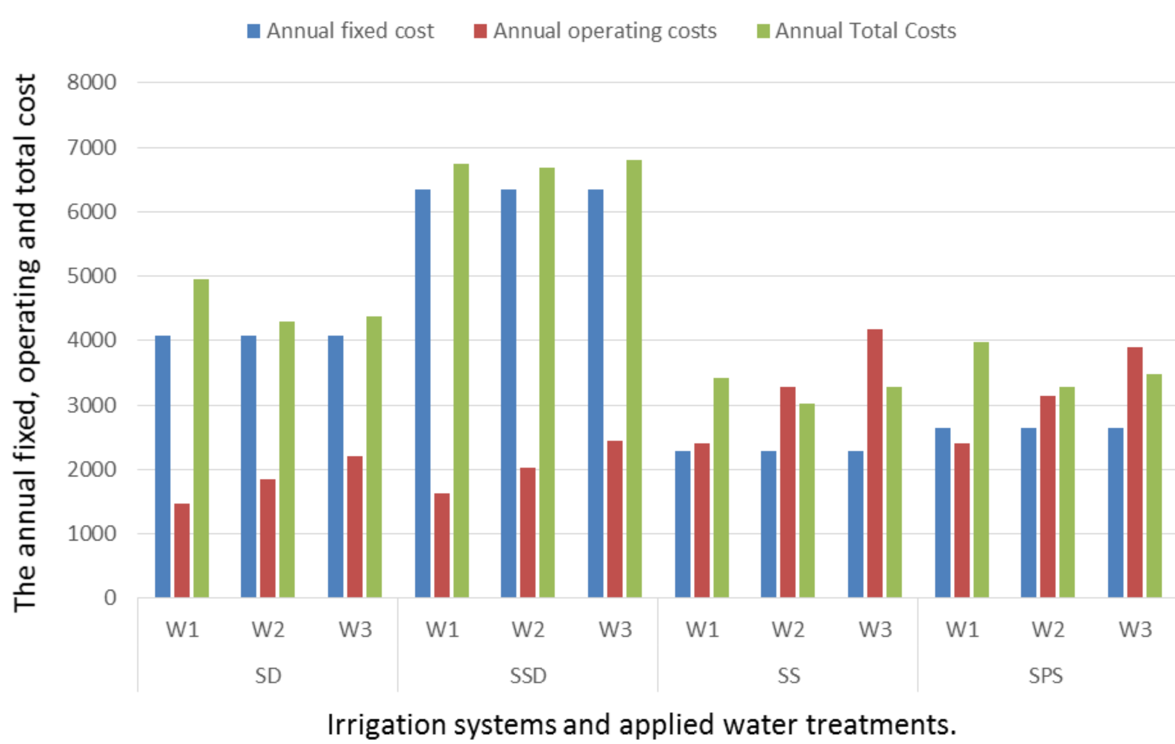

Fig. 2. The annual fixed, operating and total cost vs irrigation systems and applied water treatments.

The highest sginifcat differences of CWUE are obtained by both of the SS and SPS under W_2 and W_3 applied water With respect to the other treatments Which are almost close. On the other side, the highest sginifcat differences of FWUE are obtained by both of SS and SPS under W_2 and W_3 applied water, in addition to (SD, W_1) and (SSD, W_1) -the lowest applied water- which will be interpreted by the discussion in the next paragraph. Finally the other treatments are almost close. Table.4., Fig.4.

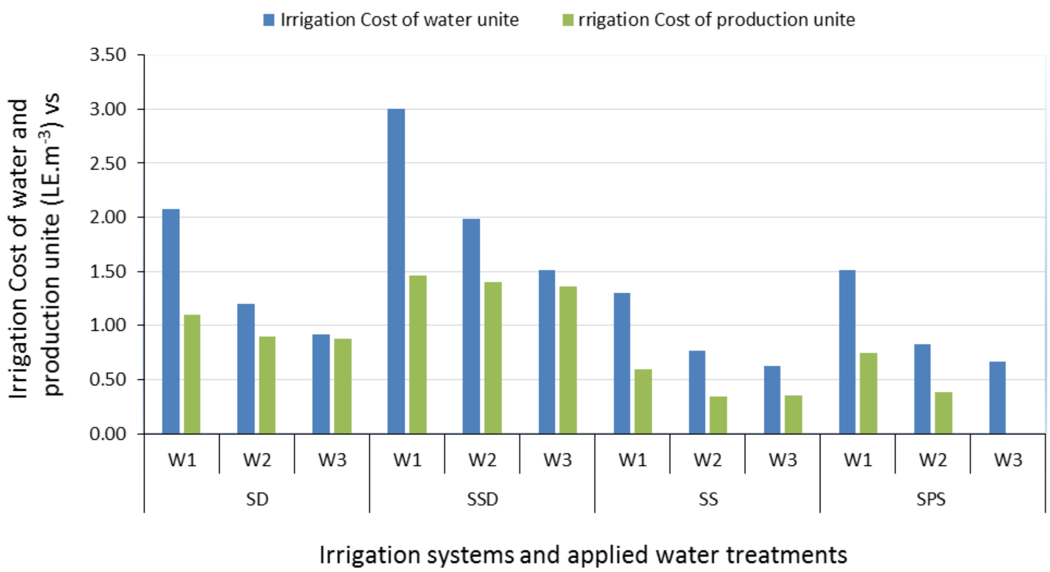

Fig. 3. The irrigation costs of water and production unite vs irrigation systems and applied water treatments.

Irrigation system efficiencies:

Water uptake efficiency under irrigation systems is the percentage which expresses about the ratio of CWUE and FWUE, it's clear and present a new approach to determination the irrigation systems or the water uptake by wheat crop, according to the actual environmental conditions, the highest WPE value is (SPS, W_3), (SS, W_3), (SD, W_3) and (SSD, W_3) respectively, and by the same token, the height WPE of water treatments is (W_3, W_2 and W_1) respectively.

Table.3. The influence of different irrigation systems and water amounts on cost analysis.

Irrigation system (I)	Water treatments (II)	Annual Total Costs, LE. ha^{-1}. season	Irrigation Cost of water unite ($LE.m^{-3}$)	Irrigation Cost of unite production ($LE.kg^{-1}$)
	W_1	4958a	2.08a	1.10a
SD	**W_2**	4305b	1.20b	0.90ba
	W_3	4379c	0.92c	0.88cba
Mean		**4547b**	**1.40b**	**0.96b**
	W_1	6741a	3.00a	1.46a
SSD	**W_2**	6689b	1.98b	1.40ba
	W_3	6805c	1.51c	1.36cba
Mean		**6745a**	**2.16a**	**1.41a**
SS	**W_1**	3420a	1.30a	0.60a

	W_2	3031b	0.77b	0.35b
	W_3	3282c	0.63c	0.35cb
Mean		**3244d**	**0.90d**	**0.43d**
	W_1	3972a	1.52a	0.75a
SPS	**W_2**	3274b	0.83b	0.39b
	W_3	3487c	0.66c	1.10c
Mean		**3578c**	**1.00c**	**0.75c**
$LSD_{0.5}$		**65.4**	**0.04**	**0.24**
	W_1	**4773a**	**1.98a**	**0.98a**
Mean	**W_2**	**4325b**	**1.20b**	**0.76b**
	W_3	**4488c**	**0.93c**	**0.92c**
$LSD_{0.5}$		**126**	**0.21**	**0.11**
$LSD_{0.5}$ (I x II)		**56**	**0.15**	**0.08**

The economic efficiency of irrigation systems, it's effective value clear the economic feasibility of every treatment alone and easy to indicate and recommendation. The highest sginifcat differences of EEIS are obtained by (SS, W_2), (SS, W_3), and (SPS, W_3) With respect to the other treatments Which are almost close. Table.4 and 5, Fig.5.

Table.4. Pressurized irrigation system efficiencies.

Irrigation systems	**SD**			**SSD**			**SS**			**SPS**		
Water amounts	**W_1**	**W_2**	**W_3**	**W_1**	**W_2**	**W_3**	**W_1**	**W_2**	**W_3**	**W_1**	**W_2**	**W_3**
(CWUE, kg. m^{-3}).	0.81	0.86	0.9	0.83	0.86	0.9	1.03	1.57	1.67	0.95	1.52	1.52
(FWUE, kg. m^{-3}).	1.88	1.33	1.04	2.06	1.42	1.11	2.18	2.22	1.77	2.02	2.15	1.72
(WPE, %).	43	64	86	41	61	81	47	71	95	47	71	95
(EEIS, %).	83	88	92	86	89	93	106	161	171	98	156	167

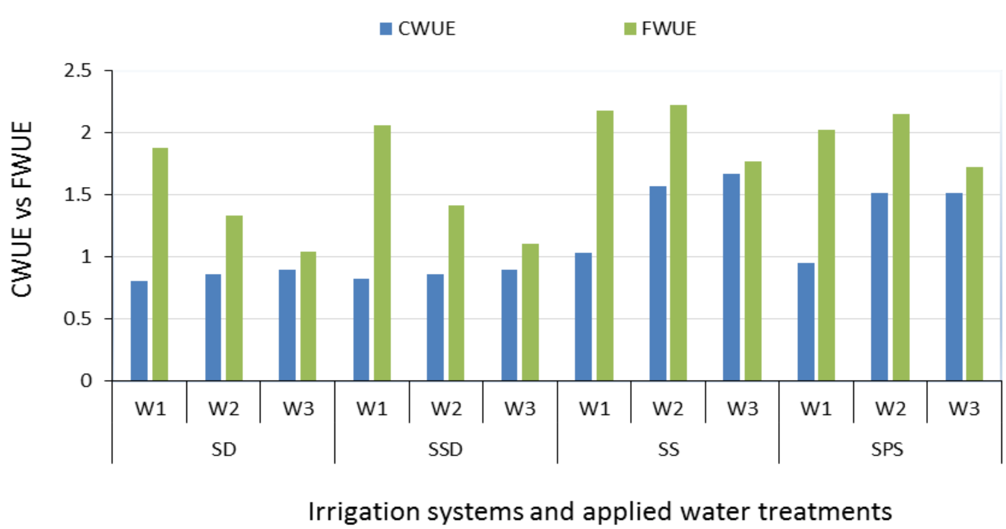

Fig.4. The crop and field water use efficiency s irrigation systems and applied water treatments.

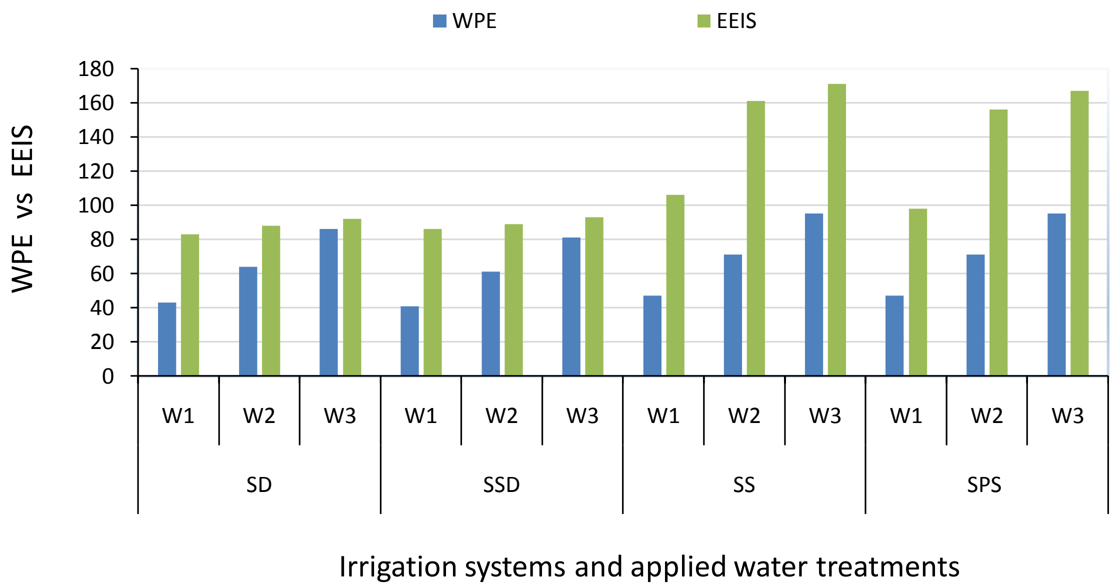

Fig. 5. The Water uptake efficiency and economic efficiency vs irrigation systems and applied water treatments.

Discussion and Conclusion

As we have seen, the significant difference of initial costs, The initial cost of (SD, SSD) and (SS, SPS), As a result, to the drip tubes beside the density of wheat crop on land which needs more covering of drip tubes, as a consequence, the initial costs of SD and SSD are higher more than with respect to. SS and SPS which cover a wild area of crop covreing zone. Another significant factor, the expected life of main, lateral pipes and nozzles initial cost is 10 for SS according it's depending on fixed main and leateral lines and sprinklers, then 7 years for SPS due to the portable of aluminum pipes cause the shorter expected life, Correspondingly, 4 for SD and 2 years for SSD irrigation system as a result to the shrot expect life of drip tubes net which more exposes to crop services, sunshine, agricultural machine compact and clooging.Accordingly, for Annual fixed cost, the highest annual fixed cost is SD, SSD, SPS and SS irrigation systems respectively. Fig.6.

Table.5. The impact of irrigation systems and water amounts on CWUE, FWUE, WPE%, and EEIS%.

Irrigation systems (I)	**Water treatments (II)**	**(CWUE, kg. m^{-3}).**	**(FWUE, kg. m^{-3}).**	**(WPE, %).**	**(EEIS, %).**
SD	**W_1**	0.98a	1.88a	43a	83a
	W_2	0.94ba	1.33b	64b	88b
	W_3	0.93ca	1.04c	86c	92c
Mean		**0.95c**	**1.42c**	**64c**	**88c**
SSD	**W_1**	0.83a	2.06a	41a	86a
	W_2	0.86ba	1.42b	61b	89ba

	W_3	0.90ca	1.11c	81c	93ca
Mean		**0.86d**	**1.53d**	**61dc**	**89dc**
	W_1	1.03a	2.18a	47a	106a
SS	**W_2**	1.57b	2.22ba	87b	161b
	W_3	1.67c	1.77ca	95c	171c
Mean		**1.42a**	**2.06a**	**76a**	**146a**
	W_1	0.95a	2.02a	47a	98a
SPS	**W_2**	1.52ba	2.15b	71b	156b
	W_3	1.52ca	1.72c	95c	167c
Mean		**1.33b**	**1.96b**	**71b**	**140b**
$LSD_{0.5}$		**0.08**	**0.06**	**5**	**4**
	W_1	0.91a	2.03a	44.5a	39a
Mean	**W_2**	1.20b	1.78b	66.8b	124b
	W_3	1.25c	1.41c	89.3c	131c
$LSD_{0.5}$		**0.03**	**0.22**	**14**	**5**
$LSD_{0.5}$ (I x II)		**0.4**	**0.11**	**8**	**3**

Conversely, the highest annual operating costs of wheat irrigation process is SS and SPS as a result to the high operation head of sprinklers, then SSD and SD irrigation systems respectively, the highest annual operating and energy costs of applied water amounts is (W3, W2 and W1) respectively as a result of the applied water amount which needs more of hours of irrigation process and more energy. As a consequence, the behavior of annual operating costs of applied water amounts of irrigated wheat. The highest sginifcat differences of CWUE are obtained by both of SS and SPS under W_2 and W_3 applied water according to the high efficency of overlap and covring of irrigation water under SS and SPS beside the soil moisture pattrens of SS and SPS is supports the intensive agriculture. The highest irrigation cost of unite production of wheat crop is SSD, SD, SPS and SS respectivly accordign to the burial process of SSD and the dripper hoses costs.

Conversely, the SD and SSD irrigation system, in addtion to the W_2 and W_3 give the higest CWUE due to the wheat water requirment under the desert enviornmental condititons. On the other side, the highest sginifcat differences of FWUE are obtained by both of SS and SPS under W_2 and W_3 applied water, in adition to (SD, W_1) and (SSD, W_1) -the lowest applied water- which will be interpreted by the discussion in the next paragraph. Finally the others treatments are almost close.

Crop water use efficiency is a perecentage expresses about the ratio of wheat crop yield and wheat crop water requirments, while the field water use efficiency is a percentage which expresses about the the ratio of wheat crop yield and wheat crop water requirments plus the water losses or the water irrigation requirments or by other mean, the crop water requirment multiple the irrigation system efficiency. But we should also consider, the both of CWUE and FWUE is may be fallacious indicator values, this counter argument is supported by evidence from, the both of CWUE and FWUE percentage is high otherwise, the crop yield is under economic level. For this reason, it's so important to just relie the CWUE and FWUE values under the economic crop yield.

The hiegst WPE value is (SPS,W_3), (SS, W_3), (SD, W_3) and (SSD, W_3) respectivly, and by the same token, the hieght WPE of water treatments is (W_3, W_2 and W_1) respectivly. Due to the soil moisture pattrens under SPS and SS which more suitable for wheat crop more SD and SSd irrigation systems, By the same token the infulenc of watre losses is more clear in water treatments is (W_3, W_2 and W_1) respectivly as aresult to constant amount of water losess at the expense of wheat water consumption. The highest sginifcat differences of EEIS are obtained by (SS, W_2), (SS, W_3), and (SPS, W_3) according to the natural of SS and SPS irrigation system to the wheat crop and intensive agriculture. In conclusion, the sprinkler irrigation systems is more economic for wheat irrigation than drip irrigation systems, whenever the type of sprinkler irrigation systems, the high energy costs.

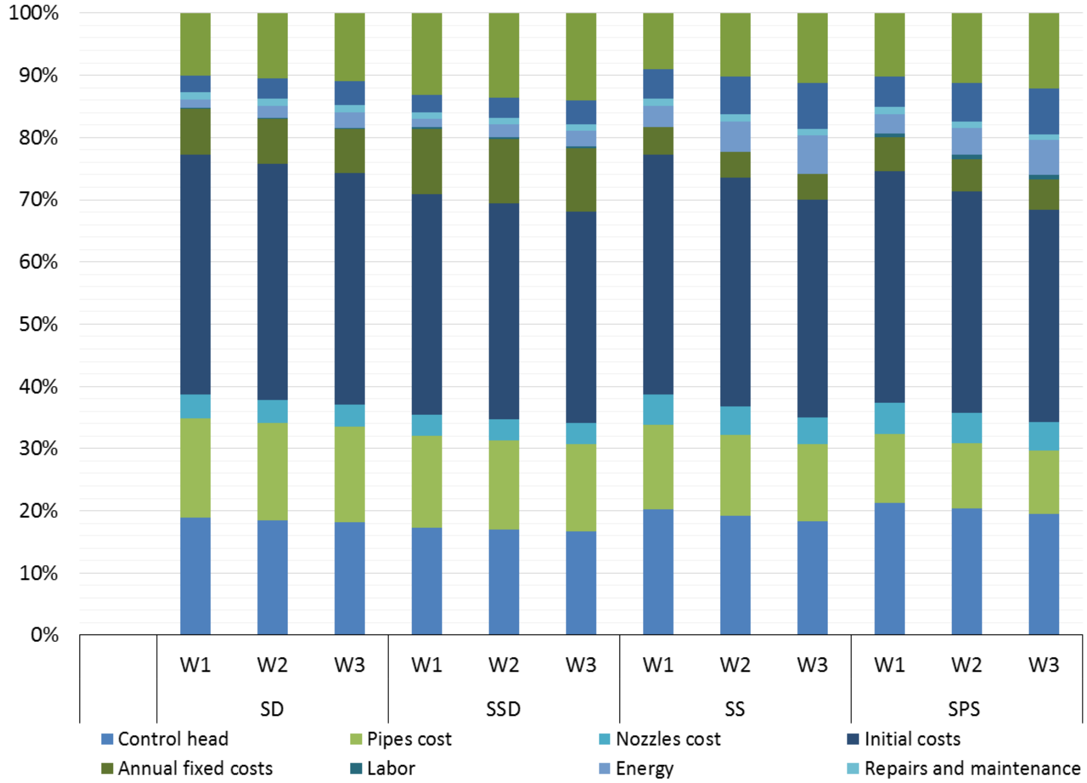

Fig.6. The economic feasibility of irrigation systems under applied water amounts for the wheat crop.

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