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A Net-back, Revenues and Applied Energy Analysis of Irrigated Wheat Using Pressurized Irrigation Systems under Environmental Desert Multi-Criteria

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Abstract: The two field trials were carried out under four pressurized irrigation systems in season (2012/2013) at the site of NRC Farm, Nubaria, Behaira Governorate, This study aims to investigate the energy feasibility (a net-back, applied and revenues energy Analysis) of cultivating wheat (Triticum aestivum L. cv. Gemmaiza 9), under various pressurized irrigation systems [surface drip (SD), subsurface drip (buried hoses) (BD), fixed sprinkler (FS), semi-portable sprinkler (PS). Applied irrigation water amounts are (50, 75 and 100% of calculated applied water and called W1, W2 and W3, respectively). The statistical experiment design was a complete split plots, the main results are: The highest energy efficiency of crop irrigation (EECI) were (PS, W3), (PS, W2), (FS, W3) and (FS, W2) respectively, while the other treatment is semi close. The highest pumping power is (FS, PS, SD and BD) irrigation systems, respectively. Otherwise, the highest energy requirements were (SD, W3), (SD, W2), (SD, W1), (FS, W3), (PS, W3) and the other treatment is semi close. The highest applied installing energy is (BD, FS, SD and PS) irrigation systems respectively, as we have seen the last energy parameters lead to the operating and annual total energy As we will see later, it's crystal clear that the highest applied operating energy is (PS, W3), (BD, W3), (BD, W2), (PS, W2) and (SD, W3) respectively. The highest annual total irrigation energy inputs (ATEI) is (BD, W3), (BD, W2), (BD, W1), (FS, W3), (FS, W2), (FS, W1) likewise SD then PS irrigation systems. The highest energy-applied efficiency (EAE) is (BD, W1), (BD, W2), (BD, W3), (SD, W1), (SD, W2), (PS, W2), while the others treatments are semi close and are not faraway about the last value. The highest value of both of AIEI and REC is (BD, W1), (SD, W1), (FS, W1), (PS, W1), (BD, W2), and (SD, W2). By the same token, FS then PS irrigation systems. Conversely, the behavior of both of EECI and EP increases beginning of BD, SD, and FS reaching to PS irrigation systems.

Keywords: Water, Energy, Pumping, Irrigation Pressurized, Sprinkler, Drip, Economy, Wheat, Desert.

1. Introduction

There's no doubt that, energy is a fundamental factor in the process of economic agricultural development, as it provides all important services that maintain economic activity and the quality of human spirit. Modern farming has become very energy-intensive. Energy in agriculture is significant in conditions of crop production and agro-processing for value adding. The aims of this study were to determine energy consumption and energy indexes in peach production, to investigate the efficiency of energy consumption and to make an economic analysis of peach orchards, according to [1]. Irrigation cost of production unit under the surface micro drip and subsurface micro drip irrigation system for the different water treatments was lower than under the surface drip and subsurface drip irrigation systems for the experimental water treatments, it was doubled under subsurface drip and surface drip irrigation systems comparing with subsurface micro dry and surface micro drip [2]. Mainly regarding basic resources as water and energy, is compulsory. For such purpose a wider overview of how water and energy are used in a PWS is necessary to identify where are located the pouches of energy savings. Any serious ex- ante analysis will require proceed in that way. This general picture of the energy requirements, summarized by adequate performance indicators will give a precise idea about the use of the energy in a PWS, about how much room for improvements exists and last the actions to be

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taken to improve the situation. A new protocol, well resumed by the sentence think globally, act locally, and is the proposed strategy [3]. A new pottery dripper was being invented from biomaterial using local, environmental and cheap materials and working under low-head pressure results low operating pressure and applied energy [4]. 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 [5].

Closed circuits of drip irrigation system require about half of the water needed by a sprinkler or surface irrigation. Lower operating pressures and flow rates result in reduced energy costs [6]. To meet the growing demand for food, more than half of world cereal production is anticipated to be produced using irrigation by 2050 [7]. Demand for food crops has been increasing in response to a number of factors including a growing global population, expanding economies in developing countries, and rising biofuels production among other factors [8]. When water is inexpensive or free, farmers make irrigation decisions based on water needs and the energy cost of pumping water, not the price of water [9 and 10]. The high energy costs causes the breakeven price of corn to increase, according to [9, 10, 11, 12 and 13]. Several studies analyzed the feasibility of investing in irrigation systems at the farm level [11, 14, 15, 16, 17, 18 and 13]. These studies, however, focus on arid regions where water is scarce and irrigation is vital for crop production. The aforementioned analysis are insightful for arid regions because they demonstrate methods to reduce irrigation costs. However, water is relatively cheap and abundant in the southeastern United States another humid areas, and producers have little incentive to conserve water or increase water use efficiency [16 and 19]. There are many studies that seek to quantify the energy consumption associated with crop production in various countries [20, 21, 22, 23, 24, 25, 26, 27 28, 29, 30 and 31]. Therefore, these studies provide little insight into the profitability of irrigating crops in humid regions such as the southeastern United States, simulated yields for irrigating corn in Iowa, and calculated the breakeven corn price for irrigation on a 52 ha field. They found a breakeven corn price for irrigation of $182.18 Mg_1. Irrigation was not profitable since the average price of corn used to calculate net returns was $79 Mg_1 ($2 bu_1). Although [32]. During the using the energy cost of pumping water as a proxy for the price of water. They found that energy cost slightly influenced water demand, but crop prices have the greatest influence on irrigation water demand. Other economic research on irrigation in humid regions has primarily focused on production risk management [9]. The determining of optimal irrigation scheduling that maximized net returns [33].

List of acronyms and nomenclature

BD	= Buried drip irrigation systems.
SD	= Surface drip irrigation systems.
FS	= Fixed sprinkler irrigation systems.
PS	= Portable sprinkler irrigation systems.
W1	= 50 % of wheat irrigation requirements.
W2	= 75 % of wheat irrigation requirements.
W3	= 100% of wheat irrigation requirements.
IS	= Irrigation systems.
WA	= Water amounts (m3).
ATE I	= Annual total irrigation energy inputs, (MJ. ha-1-yr)
AWU	= Annual water used, (m3. ha-1-yr),
AIEI	= Annual total irrigation energy inputs for applying water (MJ.M-3yr.).
RCE	= Relative consumed energy, (MJ. kg-1),
ATEO	= Annual total irrigation energy outputs, (MJ. ha-1-yr)
EECI	= Energy efficiency of crop irrigation, (%),
EP	= Energy productivity, (kg. MJ-1), and
NEG	= Net Energy Gain (MJ. ha-1).
EAE	= Energy-applied efficiency

The main aims of research are a Net-back, revenues and applied energy analysis of irrigated wheat using pressurized irrigation systems under environmental desert multi-criteria energy, and efficiencies to determine the economic impact which related to pressurizes irrigation operating head, labors, installing, maintenance and repairs.

2. Materials and methods

The two field experiments were carried out under four pressurized irrigation systems in season (2012/2013) at the site of 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 study aims to investigate the energy feasibility (a net-back, applied and revenues energy Analysis) of cultivating wheat *(Triticum aestivum L. cv. Gemmaiza 9),* under various pressurized irrigation systems [surface drip (SD), subsurface drip (buried hoses) (BD), fixed sprinkler (FS), semi-portable sprinkler (PS). Applied irrigation 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 a split plot in two factors where the main factor is irrigation systems and the sub-main factor is the applied water amounts.

The 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 [34].

Soil preparation and fertilization program:

The amounts of wheat 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 24 m^3. ha^{-1} was thoroughly mixed with 0 - 30 cm of the surface soil layer before planting in addition to 240 kg superphosphate per hectare (15.5 % P2O5) and 120 kg potassium sulphate (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. Gemmaiza 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:

a) 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 plant 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 (BD) at a depth 20cm.

Table 2: 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_v)			5547.8 m^3 ha^{-1}. season		

Where:

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

b) 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 fixed sprinkler systems used is similar to the portable one except that the location of water source and pumping plant is fixed.

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 [36].

Water requirements for wheat crop were calculated according to the following equation as recommended by [37]. 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}
- **Et_o** = Potential evapo-transpiration, mm day^{-1}
- **KC** = Crop factor of wheat,
- **A** = Area irrigated, (m^2)
- **Ea** = Application efficiency, %, where 90%.
- **LR** = Leaching requirements.

The crop factor of wheat was used to calculate Etcrop values, according to [35].

Measurements and calculations:

Energy analysis:

Total energy inputs into irrigation:

The total energy inputs into irrigation were determined by an annual basis and by both area and volume of applied water.

Basis, The total seasonal energy is the sum of the seasonal fixed installation energy and the seasonal operation energy [38].

- The seasonal fixed installation energy is the energy required to install the irrigation system for a useful life of at least the length of any evaluation period divided by the number years of the period. In this study, the evaluation period was twenty years.

- Energy associated with transporting of different components to the site was not considered in this study, because of unreliable data records.

The total irrigation energy calculations procedure:

The total seasonal irrigation energy is the sum of the seasonal installation; operations (pumping plus maintenance) and human labor energies were evaluated as follows:

Installation energy (IE):

The installation energy includes:

The annual fixed energy to manufacture a limited number of products used in irrigation system was calculated by the method of [39].

$$AFE = \frac{(ERM + ERC)(NTR)}{(ESL)}$$

Where:

- **AFE** = Annual fixed energy, (MJ. $kg^{-1}yr^{-1}$.),
- **ERM** = The energy input to manufacture products from raw materials, (MJ. kg^{-1}.),
- **ERC** = The energy input to manufacture products from recycled materials (MJ. kg^{-1}.),
- **NTR** = Number of times a product is replaced over the expected life of the system, and
- **ESL** = Expected system life, (years).

-The manufacturing energy for certain products used in irrigation systems by [39].

(b) The energy required manufacturing equipment or machinery.

(ME) which used in excavation and land forming was computed by the following relationship, [40].

$$ME = \left[kW \times 14.88\ \frac{MJ}{kW} + Equip.Wt. \times 71.2\ \frac{MJ}{ton}\right] \times \frac{hours\,on\,job}{expected\,life,\,h}$$

Where:

ME = Manufacture energy,
kW = Engine power, kW, and
Equip.Wt. = Operating weight of machine (ton)

Expected life (hours) = Expected life (years) × Activity (hours.year^{-1}) × Load Factor.
According to [41].

(c) The energy associated with fuel consumption was computed directly on the basis on 41.06 MJ. Liter$^{-1,}$ [39].
(d) Energy associated with the repairs and maintenance of the machinery was estimated as 5 percent of machinery energy inputs, [42].
(e) Human labor energy associated was estimated as follows [43]. .

$$EHL = \frac{CHL}{Fc} \times NL$$

Where:

EHL = Human labor energy. MJ. ha^{-1},
CHL = Energy input coefficient represents the human labor energy, 2.3, MJ. man^{-1}h^{-1},
NL = The number of laborers required for any operation, and
Fc = Field capacity, ha. h^{-1}.

Operation energy (O.E):
Energy inputs in the operation tor irrigation system, including maintenance and pumping energies:
(a) Annual maintenance energy for irrigation system was roughly estimated as 3 percent of annual installation energy [39].
(b) The pumping energy was calculated directly by the following relationship, [39 and 44].

$$PE = K.\frac{A.D.H}{Ep.Ei}$$

Where:

PE = Pumping energy, (MJ. ha^{-1}),
K = Conversion factor depending on the units used,
A = Area irrigated, (hectare),
D = Net depth of irrigation water requirement, (m),
H = Pumping head, (m),
E_p = Pumping system efficiency, and
E_i = Irrigation efficiency.

Human labor energy:
The energy associated with labor for system operation and management was determined as follows, [39].

$$EHL = \frac{t.n.c}{A}.NL$$

Where:

EHL = Human labor energy, (MJ.ha^{-1}yr^{-1}),
t = Time of one irrigation, (h),
n = Number of irrigation's in the year,
C = Energy input coef. Represents human labor energy, 1.26 MJ. Man-1. h^{-1},
NL = The number of laborers required for one irrigation, and
A = Area irrigated, ha

-Human labor energy inputs associated with the operation and control of the water in this study were those of manual labor with water control structures installed represents the anegligibleenergy input of less than 0.42 MJ. ha^{-1} -yr. [38].

Energy yield:
The annual yields of crops were calculated according to [45 and 22].

Relative consumed energy, RCE.
RCE, (MJ.kg^{-1}) = total enregy input (MJ.ha^{-1}) ÷ wheat yield (kg.ha^{-1}).
Energy efficiency of crop irrigation (energy ratio), (%), EECI.
Energy Ratio = total energy outputs (MJ.ha^{-1}) ÷ total energy inputs (MJ.ha^{-1}).
Annual total irrigation energy outputs, (MJ. ha^{-1}-yr),
ATEO = wheat grain yied (kg.ha^{-1}) × the digestible energy of wheat, kg.
The digestible energy of wheat is 16.4 MJ/kg accrding to [46].
Energy productivity = wheat yield (kg.ha^{-1}) ÷ total input energy (MJ.ha^{-1}).

Net Energy Gain (MJ. ha^{-1}) = Total Energy Output (MJ. ha^{-1}) - Total Energy Input (MJ. ha^{-1})

Energy requirements and energy-applied efficiency **(EAE)** were determined for various drip irrigation systems according to [39]. by following a formula:
- Power consumption use for pumping water **(B_p)** was calculate, ,as follows:

$$BP = \frac{Q * TDH * Yw}{E\,i * Ep * 1000}$$

Where:

Q = Total system flow rate (m^3),
TDH = Total dynamic head (m),
E_i = Total system efficiency,
E_p = Pump efficiency, and
Y_w = Water specific weight (taken as 9810 N. m^{-3}).

Pumping energy requirements **(E_r) (kW.h)** were calculated as follows:

$$E_r = B_p \times H$$

Where:
H = Irrigation time per season (h).

-Pumping energyappliedefficiency (EAE) was calculated as follows:

$$EAE,\ (kg.kW^{-1}.h^{-1}) = \frac{Total\,fresh\ yield\,(kg)}{Energy\ requirements\,(kW.h)}$$

(SD, W_3), (SD, W_2), (SD, W_1), (FS, W_3), (PS, W_3) and the other treatments are semi close. The highest applied installing energy is (BD, FS, SD and PS) irrigation systems respectively, as we have seen the last energy parameters lead

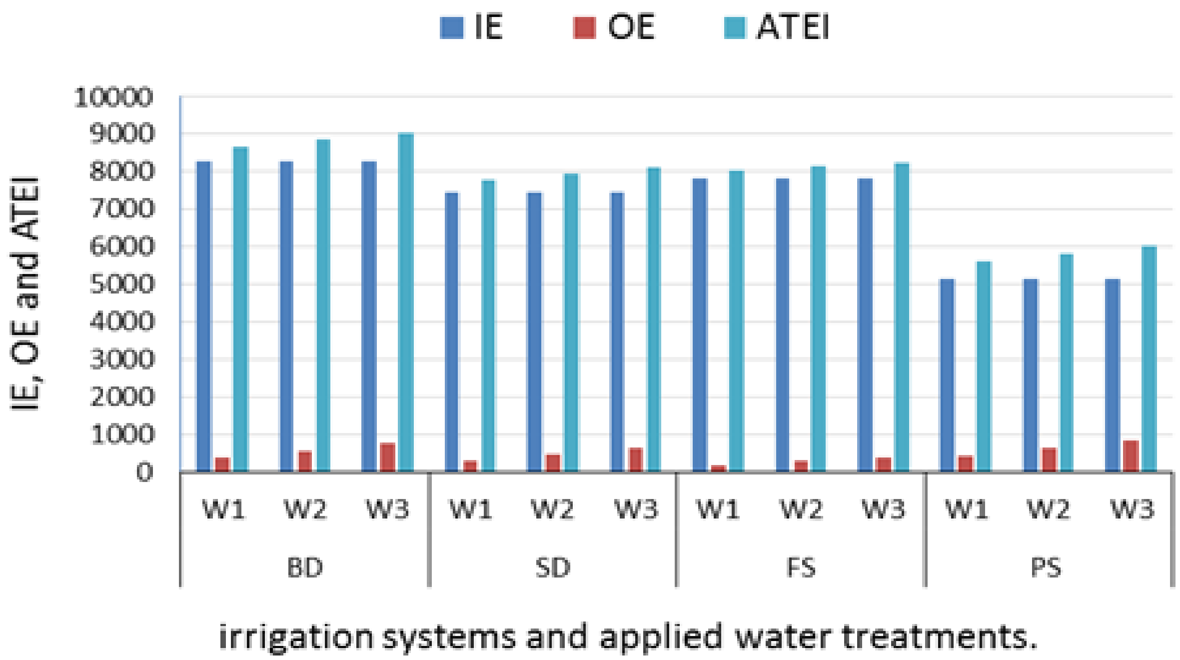

Figure 1: The installing energy inputs (IE), operating energy (OE), annual total energy inputs (ATEI), vs irrigation systems and applied water treatments.

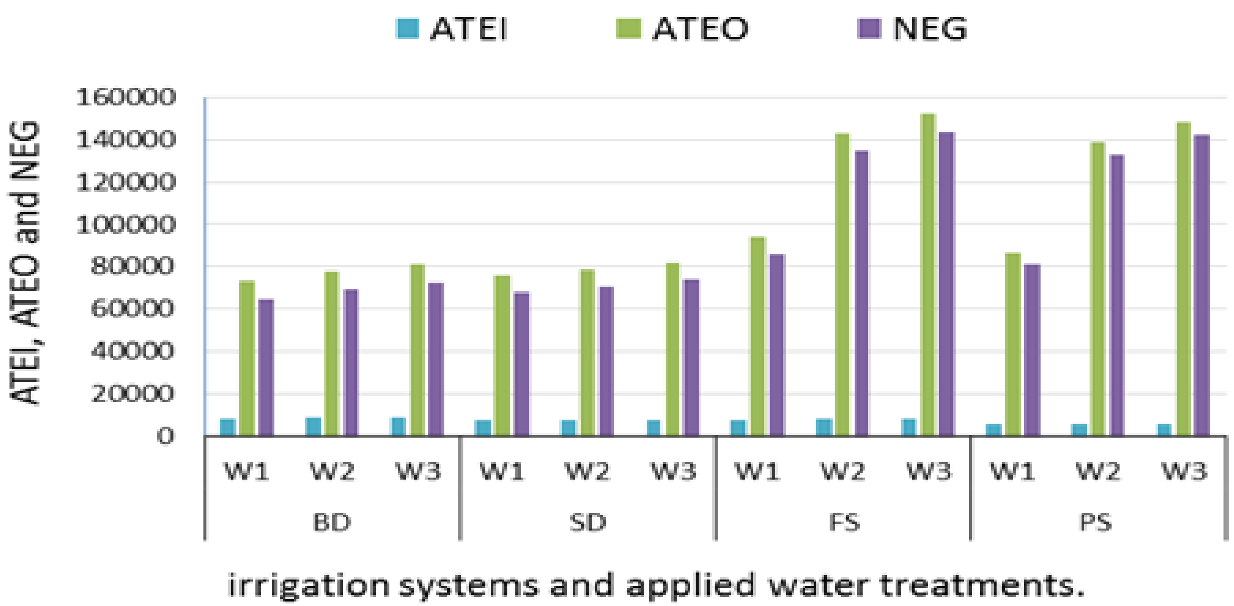

Figure 2: The annual total energy inputs (ATEI), annual total energy outputs (ATEO), and net Energy gain (NEG).vs irrigation systems and applied water treatments.

3. Results

To start with the irrigation pumping power consumption, which the main factor of operating energy, the highest pumping power is (FS, PS, SD and BD) irrigation systems, respectively. Otherwise, the highest energy requirement is to the operating and annual total energy As we will see later, it's crystal clear that the highest applied operating energy is (PS, W_3), (BD, W_3), (BD, W_2), (PS, W_2) and (SD, W_3) respectively. The highest ATEI is (BD, W_3), (BD, W_2), (BD, W1), (FS, W3), (FS, W2), (FS, W1) likewise SD then PS irrigation systems. The type of irrigation system used

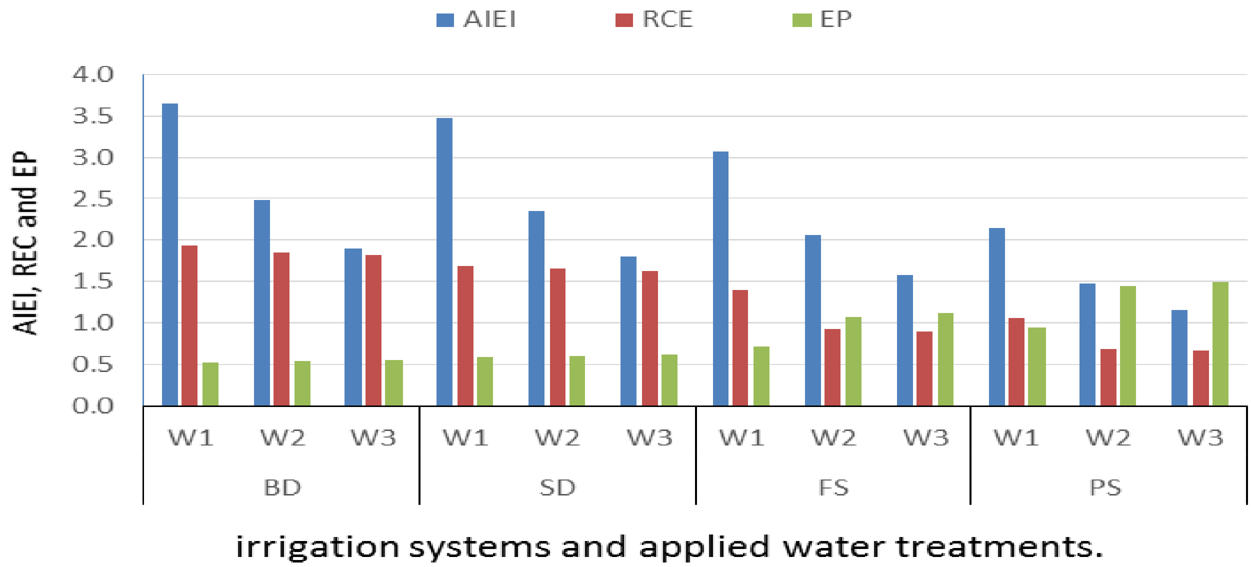

Figure 3: The annual total irrigation energy inputs for applying water (AIEI), applying water relative, consumed energy (RCE) and energy productivity (EP) vs irrigation systems and applied water treatments.

obviously has an impact on the amount of energy consumed, even within pressurized systems, as the energy required for pumping depends on the total dynamic head, flow rate and system efficiency [47].

Indirect irrigation energy inputs are associated with the energy embodied in irrigation infrastructure and its operation. [47 and 48]. the approximately 23% of direct energy use in crop production was used for on-farm pumping.

Subsequently, the highest ATEO and NEG is (FS, W_3), (PS, W_3), (FS, W_2), (PS, W_2), and the other treatments are semi close, But we should also consider, the big difference between the ATEO and ATEI wherever, the highest ATEI is (BD, W_3), (BD, W_2), (BD, W_1), (FS, W_3), (FS, W_2), (SD, W_1), and (FS, W_1) reaching to the lowest ATEI which is (PS, W_1).

The highest EAE is (BD, W_1), (BD, W_2), (BD, W_3), (SD, W_1), (SD, W_2), (PS, W_2), while the other treatments are semi close and are not far away about the last value. The highest value of both of AIEI and REC is (BD, W_1), (SD, W_1), (FS, W_1), (PS, W_1), (BD, W_2), and (SD, W_2). By the same token, FS then PS irrigation systems. Conversely, the behavior of both of EECI and EP increases beginning of BD, SD, FS is reaching to PS irrigation systems.

According to the statically analysis, it's Evidently, there's a significant impact of both of applied water amounts and irrigation systems means on the energy parameters, besides, there's a crystal clear significant influence of the applied water amounts, the pressurized irrigation systems and the interaction of them on all of the energy parameters. Pursuing this further the interaction impact is clear, especially in IE, ATEI, AIEI, REC at LSD = 0.05. Table.2. Fig.1, 2, 3 and 4.

4. Discussion and conclusion

The significant difference in pumping power of sprinkler irrigation system and drip irrigation system is due to the higher operating head, which is necessary to sprinkler water jet, and the pumping power of FS is higher than the PS irrigation system as a result to the number of operating sprinklers at the same time, as we have seen, the number of operating sprinklers in one hectare is 70 sprinklers at the same time at FS irrigation systems. In comparison, the number of operating sprinklers in one hectare is 24 sprinklers at the same time in the PS irrigation systems and this what make the difference of applied pumping power, [47 and 49]. In addition to, the total operating head of FS is higher than the PS irrigation systems. Having considered the last PS systems, it is also reasonable to look at the more needing of human labor energy for portable sprinkler irrigation systems. The last interpretation is supported by [50 and 51]. Table.3.

For installing energy, it can be noted that the higher installing energy is BD, FS, SD and PS irrigation systems. As a consequence of annual fixed energy which related to the weight of material of irrigation system which installing in one hectare. As we will see, the weights of both of PVC and PE of BD, SD, FS and PS is 195, 195, 1278 and 876 kg of PVC per one hectare, and 250, 250, 5.5 and 1.92 kg of PE per one hectare. By the same token, the highest manufacture energy of FS, PS, BD and SD, and irrigation systems is 10.6, 7.2, 4.6 and 3.92 MJ. ha^{-1}, respectively, and as known it's related to the excavation and backfill cubes of soil to install the irrigation systems beside the ratio of work capacity. [47 and 48]. Moreover, how many hours on one job per hectare. It can be seen from the above As a consequence, to the more of operating hours of the irrigation process in addition to the number of labor, which do the irrigation process which increasing the human labor energy per hectare. The heights human labor energy per hectare is (PS, W_3), (BD, W_3), (SD, W_3), and (FS, W_3) respectively, and for applied water amounts the highest the human labor energy per hectare is W_3, W_2 and W_1 respectively [51].

It is quite predictable that, the lowest value of both of AIEI and RCE is PS, FS, SD and BD respectively, also W_3, W_2 and W_1 according to the applied amounts of water which need more applied energy to pumping. Correspondingly, the highest value of both of the EP, ATEO and NEG is FS, PS,

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

IS		***BD***			***SD***			***FS***			***PS***	
WA	W_1	W_2	W_3	W_1	W_2	W_3	W_1	W_2	W_3	W_1	W_2	W_3
Bp	2.4	2.4	2.4	4.3	4.3	4.3	17.7	17.7	17.7	12.5	12.5	12.5
IE		8306			7466			7848			5172	
OE	376	564	751	329	494	658	197	295	393	428	642	856
ATEI	8682	8870	9057	7795	7960	8124	8045	8143	8241	5600	5814	6028
AWU	2383	3574	4766	2247	3371	4494	2622	3933	5244	2621	3931	5244
AIEI	3.6	2.5	1.9	3.5	2.4	1.8	3.1	2.1	1.6	2.1	1.5	1.1
Er	229	343	458	1714	2572	3429	465	697	929	393	589	786
EAE	20	14	11	13	9	7	7	8	6	8	9	7
Yield	4488	4769	4968	4622	4786	5006	5729	8717	9259	5297	8450	9041
RCE	1.93	1.86	1.82	1.69	1.66	1.62	1.40	0.93	0.89	1.06	0.69	0.67
ATEO	73603	78208	81475	75807	78484	82105	93952	142956	151851	86868	138587	148269
EECI	8.48	8.82	9.00	9.72	9.86	10.11	11.68	17.56	18.43	15.51	23.84	24.60
EP	0.52	0.54	0.55	0.59	0.60	0.62	0.71	1.07	1.12	0.95	1.45	1.50
NEG	64921	69339	72418	68012	70524	73981	85908	134812	143609	81268	132773	142241

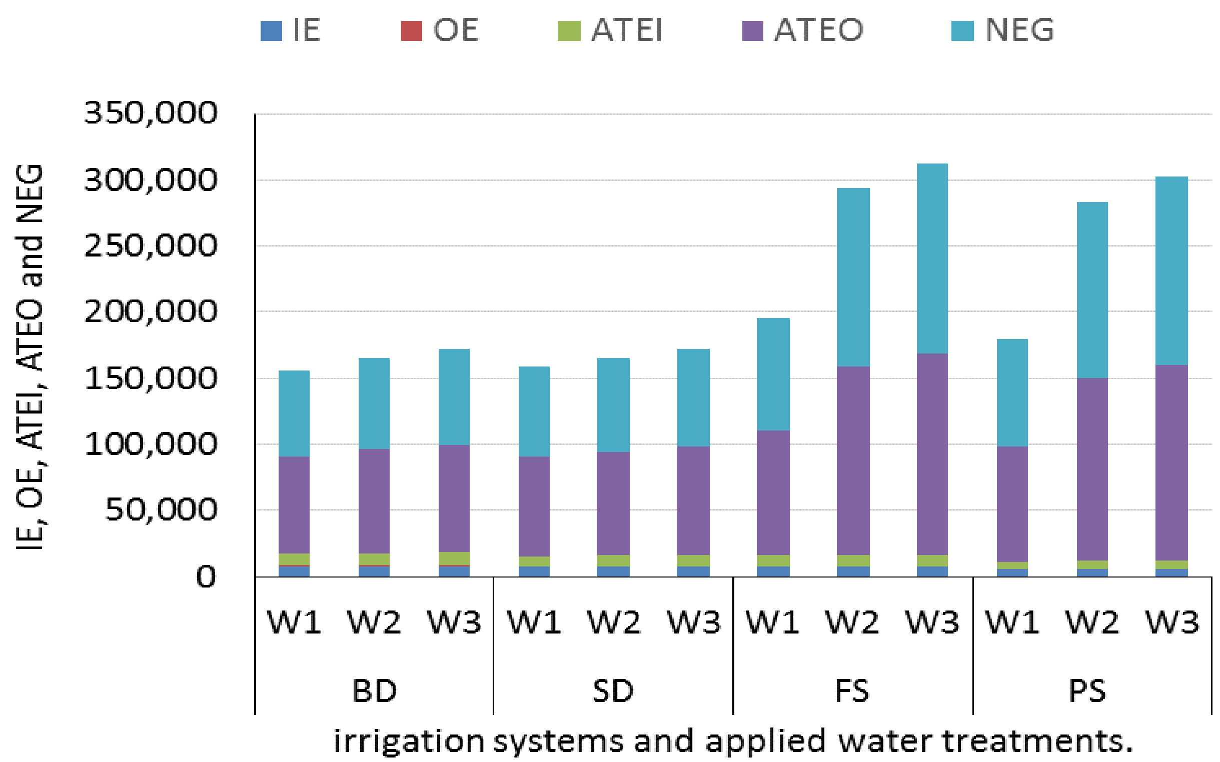

Figure 4: The installing energy inputs (IE), operating energy (OE), annual total energy inputs (ATEI), annual total energy outputs (ATEO), and net energy gain (NEG).vs irrigation systems and applied water treatments.

SD and BD due to the highest grain yield of wheat of sprinkler systems.

With respect to the drip irrigation systems. Undoubtedly, these results are reflected in the sprinkler irrigation system flexibility of wheat or intensive agriculture in comparison to the drip irrigation systems. According to [52].

Table 3: The influence of pressurized irrigation systems and water amounts of the various energy parameters.

IS	*WA*	*IE*	*OE*	*ATEI*	*AWU*	*AIEI*	*Er*	*EAE*	*RCE*	*ATEO*	*EECI*	*EP*	*NEG*
	W_1		376a	8682a	2383a	3.6a	229a	20a	1.93a	73603a	8.48a	0.52a	64921a
BD	W_2	8306	564b	8870b	3574b	2.5b	343b	14b	1.86ba	78208b	8.82ba	0.54ba	69339b
	W_3		751c	9057c	4766c	1.9c	458c	11c	1.82cab	81475c	9.00cab	0.55cab	72418c
Mean			**564b**	**8870a**	**3574d**	**2.7a**	**343d**	**15a**	**1.87a**	**77762d**	**8.77d**	**0.54dc**	**68893d**
	W_1		329a	7795a	2247a	3.5a	1714a	13a	1.69a	75807a	9.72a	0.59a	68012a
SD	W_2	7466	494b	7960b	3371b	2.4b	2572b	9b	1.66ba	78484b	9.86ba	0.60ba	70524b
	W_3		658c	8124c	4494c	1.8c	3429c	7c	1.62cab	82105c	10.11cab	0.62cba	73981c
Mean			**494cb**	**7960c**	**3371c**	**2.6ba**	**2572a**	**10b**	**1.66b**	**78799c**	**9.90c**	**0.60c**	**70839c**
	W_1		197a	8045a	2622a	3.1a	465a	7ba	1.40a	93952a	11.68a	0.71a	85908a
FS	W_2	7848	295b	8143b	3933b	2.1b	697b	8a	0.93b	142956b	17.56b	1.07b	134812b
	W_3		393c	8241c	5244c	1.6c	929c	6cb	0.89cb	151851c	18.43c	1.12cb	143609c
Mean			**295d**	**8143b**	**3933a**	**2.3c**	**697b**	**7dc**	**1.07c**	**129586a**	**15.89b**	**0.97b**	**121443a**
	W_1		428a	5600a	2621a	2.1a	393a	8ba	1.06a	86868a	15.51a	0.95a	81268a
PS	W_2	5172	642b	5814b	3931b	1.5b	589b	9a	0.69b	138587b	23.84b	1.45b	132773b
	W_3		856c	6028c	5244c	1.1c	786c	7cb	0.67ba	148269c	24.60cb	1.50cb	142241c
Mean			**642a**	**5814d**	**3932ba**	**1.6d**	**589c**	**8c**	**0.81d**	**124575b**	**21.32a**	**1.30a**	**118761b**
LSD 0.05			**68**	**165**	**408**	**0.3**	**88**	**1.5**	**0.16**	**1578**	**3.7**	**0.22**	**1726**
	W_1		**332.5a**	**7530.5a**	**2468a**	**3.1a**	**700.3a**	**12a**	**1.52a**	**82558a**	**11.35a**	**0.69a**	**75027a**
Mean	W_2		**498.8b**	**7696.8b**	**3702b**	**2.1b**	**1050.3b**	**10b**	**1.29b**	**109559b**	**15.02b**	**0.92b**	**91558b**
	W_3		**664.5c**	**7862.5c**	**4937c**	**1.6c**	**1400.5c**	**8c**	**1.25cb**	**115925c**	**15.54cb**	**0.95cb**	**108062c**
LSD 0.05			**102**	**117**	**756**	**0.8**	**347**	**1.1**	**0.12**	**2976**	**2.4**	**0.12**	**1236**
$LSD_{0.5}$ (I x II)			**23**	**42**	**146**	**0.4**	**104**	**0.2**	**0.02**	**519**	**1.2**	**0.06**	**452**

Finally, it can be noted that the means NEG of (FS, W_3), (PS, W_3), (FS, W_2) and (PS, W_2) are higher than the means of the other treatments by 47 % approximately, the highest EECI is (PS, W_3), (PS, W_2), (FS, W_3) and (FS, W_2) respectively, while the other treatment are semi close according to the highest overlap irrigated area of sprinkler systems in comparison to drip irrigation, which need more and more of land surface drip tubes to cover the intensive cultivated area by wheat, In conclusion, the sprinkler irrigation systems have a higher net-back energy with respect to drip irrigation system for wheat cultivating, whatever the sprinkle irrigation systems need more total operating head. But we should also consider the many operating hours of irrigation process, the plant intensive and the covering efficiency of applied water under drip irrigation in comparison to any type sprinkler irrigation systems. According to [47 and 54].

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References

[1] Zarini R. Land Akram A., (2014). Energy consumption and economic analysis for peach production in Mazandaran province of Iran. The Experiment, ISSN-2319-2119 Vol. 20(5), 1427-1435.

[2] El-Hagarey M. E. El-Nesr1M. N., H. M. Mehanna. And H. A. Mansour. (2014). Energy, economic analysis and efficiencies of micro drip irrigation I- Energy Analysis. (IOSR-JAVS) 7 (8) Ver. II (Aug. 2014), PP 19-26.

[3] Cabrera, E., Cabrera, E., Cobacho, R., and Soriano, J. (2014). "Towards an Energy Labelling of Pressurized Water Networks." Procedia Engineering, 10.1016/j.proeng.2014.02.024, 209-217.

[4] El-Hagarey. M. E. 2014. Design and Manufacture of Pottery Dripper for the Use of Saline Water in Irrigation Systems. Journal of Agriculture and Veterinary Science (IOSR-JAVS). 7 (5) Ver. IV (May. 2014), PP 7080

[5] Omima M. E. and M. E. El-Hagarey. (2014): Evaluation of Ultra-low Drip Irrigation and Relationship between Moisture and Salts in Soil and Peach (pruns perssica) Yield. Journal of American Science 2014; 10 (8). PP 13-28.

[6] Mansour H. A., H.M. Mehanna, M. E. El-Hagarey, A. S. Hassan. (2013). Using Automation Controller System and Simulation Program for Testing Closed Circuits of Mini-Sprinkler Irrigation System. OJMSi. Vol.1 No.2.pp 14-23.

[7] Rosegrant, M.W., Ringler, C., Zhu, T., 2009. Water for agriculture: maintaining food security under growing scarcity. Annu. Rev. Environ. Resour. 34, 205–222.

[8] Trostle, R. 2008. Global agricultural supply and demand factors contributing to the recent increase in commodity prices. WRS-0801. Washington DC: U.S. Department of Agriculture, Economic Research Service.

[9] Gonzalez-Alvarez, Y., Keeler, A.G., Mullen, J.D., 2006. Farm-level irrigation and the marginal cost of water use: Evidence from Georgia. J. Environ. Manage. 80, 311– 317.

[10] Mullen, J.D., Yu, Y., Hoogenboom, G., 2009. Estimating the demand for irrigation water in a humid climate: a case study from the Southeastern United States. Agric. Water Manage. 96, 1421–1428.

[11] Peterson, J.M., Ding, Y., 2005. Economic adjustments to groundwater depletion in the high plains: do water-saving irrigation systems save water. Am. J. Agric. Econ. 87, 147–159.

[12] Scheierling, S.M., Loomis, J.B., Young, R.A., 2006. Irrigation water demand: a meta-analysis of price elasticities. Water Resour. Res. 42. http://dx.doi.org/10.1029/ 2005WR004009.

[13] Seo, S., Segarra, E., Mitchell, P.D., Leatham, D.J., 2008. Irrigation rechnology adoption and its implications for water conservation in the Texas high plains: a real option approach. Agric. Econ. 38, 47–55.

[14] Caswell, M., Zilberman, D., 1986. The effects of well depth and land quality on the choice of irrigation technology. Am. J. Agric. Econ. 68, 798–811.

[15] Guerrero, B.L., Amosson, S.H., Marek, T.H., Johnson, J.W., 2010. Economic evaluation of wind energy as an alternative to natural gas powered irrigation. J. Agric. Appl. Econ. 42, 277–287.

[16] Letey, J., Dinar, A., Woodring, C., Oster, J.D., 1990. An economic analysis of irrigation systems. Irrig. Sci. 11, 37–43.

[17] O'Brien, D.M., Lamm, F.R., Stone, L.R., Rogers, D.H., 2001. Corn-yield and profitability for low-capacity irrigation systems. Appl. Eng. Agric. 17, 315–321.

[18] Sheriff, G., 2005. Efficient waste? Why farmers over-apply nutrients and the implications for policy design. Rev. Agric. Econ. 24, 542–557.

[19] Vories, E.D., Tacker, P.L., Lancaster, S.W., Glover, R.E., 2009. Subsurface drip irrigation of corn in the United States Mid-South. Agric. Water Manage. 96, 912–916.

[20] Pimental, D., Doughty, R., Carothers, C., Lamberson, S., Bora, N., Lee, K., et al. (2002). Energy Inputs in Crop Production in Developing and Developed Countries. In R Lal (Ed.), Food Security and Environmental Quality in the Developing World (pp. 129-151). USA: CRC Press.

[21] Barber, A. (2004). Seven Case Study Farms: Total Energy and Carbon Indicators for New Zealand Arable and Outdoor Vegetable Production: AgriLINK New Zealand.

[22] Canakci, M., Topakci, M., Akinci, I., & Ozmerzi, A. (2005). Energy Use Pattern of Some Field Crops and Vegetable Production: Case Study for Antalya Region, Turkey. Energy Conversion and Management, 46(4), 655-666.

[23] Tzilivakis, J., Warner, D. J., May, M., Lewis, K A., & Jaggard, K (2005).An assessment of the energy inputs and greenhouse gas emissions in sugar beet (Beta vulgaris) production in the UK. Agricultural Systems, 85, 101-119.

[24] Chamsing, A., Salokhe, V., & Singh, G. (2006). Energy Consumption Analysis for Selected Crops in Different Regions of Thailand. Agricultural Engineering International.' the CIGREjoumal, 8.
[25] Chaudhary, V., Gangwar, B., & Pandey, D. (2006). Auditing of Energy Use and Output of Different Cropping Systems in India. Agricultural Engineering International.' the CIGREjoumal, 8.
[26] Hatirli, S. A., Ozkan, B., & Fert, C. (2006). Energy inputs and crop yield relationship in greenhouse tomato production. Renewable Energy, 31, 427-438.
[27] Erdal, G., Esungun, K, Erdal, H., & DGunduz, O. (2007). Energy use and economic analysis of sugar beet production in Tokat province of Turkey. Energy, 32, 35-41.
[28] Esungun, K., Erdal, G., Gunduz, O., & Erdal, H. (2007). An economic analysis and energy use in stake-tomato production in Tokat province of Turkey. Renewable Energy, 32, 1873-1881.
[29] Ozkan, B., Fert, C., & Karadeniz, C. F. (2007). Energy and cost analysis for greenhouse and open-field grape production. Energy, 32, 15001504
[30] Singh, H., Singh, A. K., Kushwaha, H. L., & Singh, A. (2007). Energy consumption pattern of wheat production in India. Energy, 32, 1848-1854.
[31] Khan, S., Khan, M. A., Hanjra, M. A., & Mu, J. (2008a). Pathways to reduce the environmental footprints of water and energy inputs in food production. Food Policy, In Press.
[32] DeJonge, K.C., Kaleita, A.L., Thorp, K.R., 2007. Simulating the effects of spatially variable irrigation on corn yields, costs, and revenue in Iowa. Agric. Waer. Manage. 92, 99–109.
[33] Boggess, W.G., Lynne, G.D., Jones, J.W., Swaney, D.P., 1983. Risk-return assessment of irrigation decisions in humid regions. Southern J. Agric. Econ. 15, 135–143.
[34] Klute, A. (1986). Water retention: Laboratory methods. In A. Klute (ed.), Methods of Soil Analysi, Part1, Physical and mineralogical methods.635-662, 9 ASA and SSSA, Madison, WI
[35] Allen R. G., Pereira, L. S.,Raes, D. and Smith, M. (1998). Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56. FAO - Food and Agriculture Organization of the United Nations Rome, 1998
[36] Doorenobs, J. and W.O. Pruitt (1977). Guidelines for predicting crop water requirements. FAO Irrigation. And Drainage. Paper 24. Rome, Italy: p 156.
[37] Keller, J. and D. Karmeli (1975). Trickle irrigation design rain bird sprinkler manufacturing crop. Glendor. Calfi, 91740 USA: 24-26.
[38] Down, M. J., A. K. Turner and T. A. McMahon, (1986). On farm energy used in irrigation. Final Report No. 78/86 of a project supported by the NER. Development and demonstration Council. Melbourne Univ., Civil and Agric. Eng. Dept. 78pp, Australia.
[39] Batty, J. C. and J. keller, (1980), Energy requirement for irrigation. D. Pimentel (ed): Hbook of Energy Utilization. In Agriculture. Florida, CRC press: 35-44, USA.
[40] Batty, J. C.; S. N. Hamad and J. Keller (1975). Energy inputs to irrigation. J. of Irri. Drain. Div., ASCE, 101 (IR4): 293-307.
[41] EPA (Assessment and Standards Division). 2002. Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling. Report No. NR-005b.pp1-47. http://www.epa.gov/otaq/models/nonrdmdl/p02014.pdf
[42] Larson, D. L. and D. D. Fang Meier (1978), Energy in irrigated crop production. J. of the ASAE, 21:1075-1080, USA.
[43] Kassem, A.S, (1986). A mathematical model for determining total energy consumption for agriculture systems. Misr. J. Agric. Eng., 3 (1): 39-57, Egypt
[44] lsraelsen, O. W. and V. E. Hansen, "Eds",(1962a). Flow of water into and through soils. Hbook of Irrigation Principal and Practices. 3rd Edition, John Wiley and Sons, Inc., New York, U.S.A.
[45] Rao, A.R., Malik, R.K., 1982. Methodological considerations of irrigation energetics. Energy 7 (10), 855–859.
[46] McAllister et al. 1990. A Study of the Sequential Digestion of Barley, Corn, Sorghum and Wheat by Rumen Microorganisms. Can. J. Anim. Sci. 70:571-579.
[47] Lal, R. (2004). Carbon emission from farm operations. Environment International, 30, 981-990.
[48] Hodges, A. W., Lynne, G. D., Rahmani, M., & Casey, C. F. (1994). Adoption of Energy and Water-Conserving Irrigation Technologies in Florida: University of Florida.
[49] Singh, H., Mishra, D., & Nahar, N. M. (2002). Energy use pattern in production agriculture of a typical village in arid zone, India - part I. Energy Conversion and Management, 43, 2275-2286.
[50] Phocaides, A. (2001). Handbook on pressurized irrigation techniques. Rome: Food and Agriculture Organization of the United Nations.
[51] Martin, J. F., Diemont, S. A. W., Powell, E., Stanton, M., & Levy-Tacher, S. (2006). Energy Evaluation of the Performance and Sustainability of Three Agricultural Systems with Different Scales and Management. Agriculture Ecosystems & Environment, 115(I-4), 128-140.
[52] Rodríguez-Díaz D. J. A., L. Pérez-Urrestaraz, E. Camacho-Poyato and P. Montesinos.(2011). The paradox of irrigation scheme modernization: more efficient water use linked to higher energy. Spanish Journal of Agricultural Research 2011 9(4), 1000-1008 ISSN: 1695-971-X eISSN: 2171-9292
[53] Srivastava, R C., Verma, H. C., Mohanty, S., & Pattnaik, S. K (2003). Investment decision model for drip irrigation. Irrigation Science, 22, 79-85.

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