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Economic efficiency and productivity of lifting and distribution methods of groundwater for wheat and tomato in New Valley governorate

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Abstract

Background: This research was aimed to study the structure of actual investment costs and operating and maintenance costs for raising and distributing ground water through the use of different irrigation methods and for estimating the most important economic and technical indicators for raising and distributing groundwater for the most important agricultural crops in Wadi El-Gadid (New Valley province).

Methods: This work was based on secondary data issued by the Ministry of Agriculture and Land Reclamation and field data obtained through personal interviews of wheat and tomato farmers by irrigation method (spray, flooding, and the method of lifting and distribution of water in the case of the use of diesel and conveyor belts), and the use of electricity and deep pumps, through the questionnaire design. A sample of 40 farmers was used.

Results: The results showed that the productivity and economic efficiency indicators for the lifting and distribution of groundwater by a power source during the agricultural season 2017/2018 increased the average productivity of total yield, net revenue/fed., net return/pound, and irrigation water in both crops.

Conclusion: The results showed that the method of lifting and distribution of water is more efficient than irrigation by flooding.

Keywords: Ground pipes, Groundwater, Spray irrigation, Flooding irrigation

Introduction

The issue of water and achieving economic efficiency for the use of irrigation water is one of the most important contemporary and future issues of Egyptian agriculture, and the issue of food security increasing and to increase the conviction that policies for the management and use of these resources needs to be revised and reworked as one of the main trends in increasing production and productivity (Osama 2005).

Sustainable agricultural development programs require the implementation of agricultural expansion projects both vertical and horizontal under more efficient water rates and more effective practices in the exploitation of limited water and area. Therefore, the achievement of these objectives depends on the availability of water for irrigation at the desired location and the appropriate timing with appropriate quantities and types, in an appropriate economic and environmental framework where the problem is the limited water resources and not using it better. So, we must make maximum benefit of the available water (Heba 2008).

The State has given great importance to the horizontal expansion of new and desert lands in the light of the limited land resources used in agriculture. Therefore, it has been concerned with the policy of land reclamation to increase agricultural land. Therefore, the aim of agricultural planning at the national or partial level is to distribute available economic resources in order to arrive to an appropriate economic use of these resources in the circumstances and possibilities available in society and to reach a pattern of economic use for these resources

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under the conditions and possibilities available in society (Mohamed et al. 2018).

The New Valley province was chosen as the place to conduct the study as it is one of the most promising desert border provinces. It is located in southwestern Egypt and shares its borders with the Giza province and Marsa Matrouh province in the north. Also, the other provinces in the east of the New Valley province are Minya, Assiut, and Qena, with an area of about 440 thousand km^2 equivalent to about 44% of Egypt's area (Hani and Salah 2013).

Groundwater is the main source of irrigation for agricultural crops and is dependent on horizontal agricultural expansion. Many studies indicate that the groundwater reserves in this governorate are estimated at 78 thousand billion m^3 and an annual feed rate of 584 million m^3/year; the estimated amount of water available from 150 m of Nubian sandstone was estimated at 234 billion m^3, and this quantity, along with the annual feeding, can be used to irrigate 5000.000 fed. for an estimated period of 700 years (Jalal 2003).

Several studies have shown that there are around 55 thousand billion m^3 of underground water. However, due to economic considerations, this quantity cannot be exploited. Therefore, the economically exploited quantities are only about 15 thousand billion m^3 (Abdul Majid 2018).

Research problem

The pattern of groundwater use is affected by irrigation method (traditional and unconventional) and the method of raising and distributing water in New Valley governorate on the amount of water used, then the cost of using them, and therefore the amount of production and income from agricultural crops, which requires the study of the efficiency indicators of these different types.

Aim of the research

The aim of the research was to identify the patterns of lifting and distribution of groundwater in New Valley governorate by studying the structure of actual investment costs and operating and maintenance costs to raise and distribute these water through the use of different irrigation methods and to estimate the actual costs of raising water and irrigation using the most important economic and technical indicators for wheat and tomato crops.

Materials and methods

The research depended on two types of data first. The first type was the secondary data issued by the Ministry of Agriculture and Land Reclamation. The second type was from the field data obtained through personal interviews of wheat and tomato farmers by irrigation method using the questionnaire which included all the variables. A sample of 40 farmers distributed evenly between the two methods of raising and distributing water for both crops according to irrigation method was chosen.

Results

Methods of lifting and distribution of groundwater

The different methods used in raising and using under groundwater in New Valley are different. This difference is mainly due to the different material resources and different equipment of the farmers. There are several types of plantations in the governorate, including the type of farms that use vertical lifting pumps. It is usually used to transport traffic from its source to the pump, as it is directly connected to the transmission shaft. Therefore, it does not need to be built on the ground directly. It is characterized by the absence of a missing capacity during the transmission and the reduction of fuel losses.

The second type is the construction of a park and getting off the water lifting pump at depths ranging from 15 to 25 m below the surface of the earth until reaching the groundwater. The movement is transferred from the motor to the pump using the belts and the planes. It is characteristic that it does not require technical labor. The third type is the use of electricity as an energy source to raise the water and the use of deep pumps.

The relative importance of the structure of investment costs

The results indicated in Table 1 show the relative importance of the investment costs required to raise the groundwater by power source in New Valley governorate during the 2017/2018 agricultural season. It has been shown that the investment costs include the cost of motor and lifting equipment and pipes. Its cost in the case of diesel and conveyor belts is about 11.93, 6.33, and 6.12 thousand pounds, representing about 48.94%, 25.96%, and 25.10%, respectively, of the total investment costs of about LE 24.29 thousand.

In the case of the use of electricity and deep water pumps, it amounted to about 36.7, 3.26, and 3.31 thousand pounds, representing 84.1%, 7.54%, and 7.65%, respectively, of the total investment costs of about 43.28 thousand pounds. From the above statement, it is clear that the costs of motor and lifting equipment represent the most important items of investment costs necessary for the pumping of groundwater in New Valley, which requires shedding light on those items in some detail as follows.

Motor and lifting equipment

The cost of purchasing and transporting the pump, motor, pump chassis, motor chassis, diesel, transmission, electricity, and deep pumps is added to the previous costs in the case of diesel and conveyor belts. In the case

Table 1 The relative importance of investment costs required to raise groundwater by source of capacity in New Valley governorate during season 2017/2018

Power source	Statement	Use of electricity and deep pumps			Use of diesel and conveyor belts		
		LE	Main items (%)	Sub-items (%)	LE	Main items (%)	Sub-items (%)
Motor and lifting equipment	Price of buying and transporting pump	3240.00	13.29	27.15	4266.00	9.85	11.62
	Price of buying and moving motor	7128.00	29.23	59.73	4071.60	9.42	11.09
	Cost of pump chassis	432.00	1.77	3.62	518.40	1.20	1.42
	Cost of motor chassis	378.00	1.55	3.17	432.00	0.99	1.18
	Cost of tires	410.00	1.68	3.43	0.00	0.00	0.00
	Cost of belts	345.6.	1.42	2.90	0.00	0.00	0.00
	Price of converter and components	0.00	0.00	0.00	27413.96	63.35	74.69
	Total value of motor and lifting equipment	11934.00	48.94	100.00	36701.96	84.81	100.00
Harpoons and pipes	Price of ground pipes	3066.12	12.57	48.41	2700.00	6.24	82.78
	Price of pumping tubes	561.60	2.30	8.87	561.6	1.30	17.22
	Cost of installing pipes	1782.00	7.31	28.14	8.00	0.00	0.00
	Cost chiming	237.60	0.97	3.75	0.00	0.00	0.00
	Cost of packaging	410.40	1.68	6.48	0.00	0.00	0.00
	Cost of salinity tests	275.40	1.13	4.35	0.00	0.00	0.00
	Total value of pipes	6333.12	25.96	100.00	3261.6	7.54	100.00
Buildings	Cost of ground	2160.00	8.68	35.29	1188.00	2.74	35.87
	Cost of building Bayyara	2718.36	11.15	44.42	0.00	0.00	0.00
	Cost of motor room	918.00	3.76	15.00	1800.40	4.16	54.35
	Cost of distribution basin	324.00	1.33	5.29	324.00	0.75	9.78
	Total value of building Bayyara	6120.36	25.10	100.00	3312.04	7.65	100.00
Total of investment costs		24387.48	100.00	0.00	43275.56	100.00	–

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, unpublished data

Table 2 The relative importance of annual operation and maintenance costs of well of raising the groundwater by the source of capacity in New Valley governorate during season 2017/2018

Power source	Statement	Use of electricity and deep pumps			Use of diesel and conveyor belts		
		LE	Main items (%)	Sub-items (%)	LE	Main items (%)	Sub-items (%)
Fuel and maintenance	Fuel	4898.88	34.10	68.80	6026.40	40.00	70.30
	Motor maintenance	731.380	5.10	10.30	1298.27	8.60	15.10
	Repair	1060.60	7.40	14.90	1252.8	8.30	14.60
	Maintenance of belts and tires	432.00	3.00	6.00	0.00	0.00	0.00
	Total fuel and maintenance	7122.86	49.60	100.00	8577.47	57.00	100.00
Employment	Sustainable	3628.80	25.30	93.30	3888.00	25.80	73.20
	Artistic	259.20	1.80	6.70	1422.79	9.40	26.80
	Total employment	3888.00	27.10	100.00	5310.79	35.30	100.00
Oils and lubricants	Value of oils	1728.00	12.00	51.60	0.00	0.00	0.00
	Diesel and oil filters	972.00	6.80	29.10	864.00	5.70	73.90
	Greases	648.00	4.50	19.30	305.10	2.00	26.10
	Total oils and lubricants	3348.00	23.30	100.00	1169.10	7.80	100.00
Total operating and maintenance costs		14358.80	100.00	0.00	15057.00	100.00	0.00

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, unpublished data

of the use of electricity and deep water pumps, the price of the transformer and its components were added. The cost of diesel and conveyor belts was 3.24, 7.13, 0.43, 0.38, 0.41, and 0.35 thousand pounds, representing about 13.29%, 29.23%, 1.77%, 1.55%, and 1.42%, respectively, out of the total investment costs amounting to LE 24.39 thousand.

Representing about 27.15%, 59.73%, 3.62%, 3.17%, 3.43%, and 2.9% of the total cost of buying motor and lifting equipment, it is amounting to about 11.93 thousand pounds. The total value of the total investment costs of about 43.88% was 0.22%, 0.92%, 0.34%, and 0.35%, respectively, fairly. Representing 11.62%, 11.09%, 1.42%, 1.18%, and 4.69% of the total cost of the purchase of motor and lifting equipment, it is amounting to about 36.70 thousand pounds. In the case of the use of electricity and deep water pumps, the price and components of the transformers are included in the top of these items. The total cost of the motor and lifting equipment in the case of the use of electricity and deep water pumps are three times the cost in the case of the use of diesel and conveyor belts, mainly due to the higher cost of purchasing the transformer and its components.

Pipes and war

It includes the cost of ground pipes and discharge pipes in the case of the use of diesel, transmission belts, and electricity and deep pumps, in addition to the previous costs in the case of the use of diesel and transmission belts and the cost of each of the pipes, warp, warp wire, and salinity tests. The relative importance of the previous items indicates that their cost in the case of diesel and conveyor belts reached 3.10%, 0.56, 1.78, 0.24, 0.41, and 0.28 thousand, representing about 12.60%, 2.30%, 7.30%, 0.97%, and 1.68%, respectively, out of the total investment costs amounting to LE 24.39 thousand. About 48.40%, 8.87%, 28.10%, 3.75%, 6.48%, and 4.35% of the total cost of buying pipes and war is amounting to about 6.33 thousand pounds.

It was about LE 2.56 thousand in the case of the use of electricity and deep pumps, representing about 6.24% and 1.30% respectively of the total of the total investment costs of about 43.28 thousand pounds, representing about 82.78% and 17.22% of the total cost of buying pipes and war, and amounting to about 3.26 thousand pounds. It is also clear that while the top of these items is the cost of ground pipes in the case of the use of diesel and conveyor belts, the case of the use of electricity and deep pumps are also in the forefront and the total cost of pipes and war in the case of the use of electricity and pumps of the depths equivalent to about half of the cost in the case of the use of diesel and conveyor belts, mainly because the latter system requires more technical operations and at a greater cost such as pipe knock and warp and warp wire and salinity tests.

Buildings the well

The relative importance of the items, the cost of the ground, the building of the well, the motor room, and the distribution basin, indicates that the cost of diesel and conveyor belts reached 2.16, 2.72, 0.92, and 0.32 thousand pounds, representing 8.86%, 11.15%, 3.76%, and 1.33% respectively of the total investment costs amounting to about 24.39 thousand pounds. Representing about 35.29%, 44.42%, 15%, and 5.29% of the total cost of construction, it is amounting to about 6.12 thousand pounds. In the case of the use of electricity and deep water pumps, the cost includes the cost of the lighting floor, the motor room, and the distribution basin, and the relative importance of the previous items shows that the cost was about 11.88, 1.80, and 0.32 thousand pounds, representing about 2.74%, 4.16%, and 0.75% of the total investment costs of about 43.28 thousand pounds.

Representing 35.87%, 54.35%, and 9.78% of the total cost of buildings and buildings, it amounted to about 3.31 thousand pounds in the case of the use of electricity and deep water pumps. The cost of the motor room is at the top. The total cost of the all well buildings in the case of the use of electricity and deep water pumps is compared to 54.12% of the same in the case of the use of diesel and conveyor belts, mainly because the latter system does not require the cost of construction of the building, and finally, in general, the total investment costs in the case of the use of electricity and deep pumps are equivalent to about 1.77 times compared to diesel machine use and transfer conveyor movement, due to the significant rise in the price of electrical transformer and all accessories.

Relative importance of operating and maintenance cost structure

The results in Table 1 show the relative importance of the operational and maintenance cost structure required for groundwater recharge according to the source of capacity in New Valley governorate during the 2017/2018 agricultural season. It was found that the operation and maintenance costs include the cost of fuel and maintenance, human labor, oils, and lubricants, and the cost of diesel and conveyor belts reached 7.12, 3.89, and 3.35 thousand pounds, accounting for 49.60%, 27.10%, and 23.30%, respectively, of total operating and maintenance costs, amounting to LE 14.40 thousand. In the case of the use of electricity and deep pumps, it is about 57%, 35.3%, and 7.8% respectively of the total operating and maintenance costs of about LE 15.06 thousand.

From the above statement, it is clear that a fuel and maintenance cost represents the most important items of the annual operating.

Fuel and maintenance

It includes the cost of fuel, motor maintenance, repair in the case of diesel use and conveyor belts and transmission belts, and electricity and pumps depths, in addition to the previous costs in the case of the use of diesel and conveyor maintenance of the belt and the cost. In the case of diesel and conveyor belts, as follows, 0.73, 1.06, and 0.43 thousand pounds, it is representing about 34.10%, 5.10%, 7.40%, and 3.00% respectively of the total operating and maintenance costs of about LE 14.36 thousand and about 68.8%, 10.30%, 14.90%, and 6.10% of the total cost of fuel and maintenance, amounting to about 7.12 thousand pounds (about LE 6.03, 1.30 and 1.26 thousand).

In the case of electricity and deep water pumps, it is about 40.00%, 8.60%, and 8.30% respectively of the total operating and maintenance costs of about LE 15.10 thousand, and it is about 70.30%, 15.10%, and 14.60% of the total cost of fuel and maintenance of about 8.60 thousand pounds. The cost of fuel in the case of the use of diesel and conveyor belts is also at the top of the cost items in the case of the use of electricity and deep water pumps. The total cost of fuel and maintenance in the case of the use of electricity and deep water pumps is 1.20 times such as the use of diesel and conveyor belts, mainly due to the higher cost of all items in the case of the use of electricity and deep pumps compared to the case of diesel and transmission belts.

Human work

These include the cost of permanent labor and technical labor. The cost of using diesel and conveyor belts is about 3.63 and 0.56 thousand pounds, and these include the cost of permanent labor and technical labor. So, the cost if we are using diesel and conveyor belts is about 3.63 and 0.56 thousand pounds, representing about 25.30% and 1.80% of the total operating and maintenance costs of about LE 14.36 thousand accounting for 93.30% and 6.70% of the total labor cost of about 3.89 thousand pounds.

It was about 3.89 thousand pounds and 1.42 thousand pounds in the case of the use of electricity and deep pumps, representing about 25.80% and 9.40% respectively of the total operating and maintenance costs of about 15.10 thousand pounds. It is representing about 73.20% and 26.80% of the total labor cost, which amounted to about 5.31 thousand pounds. From the above statement, it is clear that these items are the costs of permanent employment in the case of the use of diesel and conveyor belts come first; otherwise, the case of the use of electricity and deep pumps also comes in the forefront as that the total cost of human labor in the case of the use of electricity and the depth pumps is equivalent to about 1.37 times the same as in the case of the use of diesel and transmission; mainly, this is primarily due to the fact that the first system needs more technical labor at greater cost in operations.

Oils and lubricants

These include the cost of lubricants, diesel, and oil filters in the case of diesel, transmission, electricity transmission lines, electricity, and deep water pumps, in addition to the previous costs in the case of the use of diesel and conveyor belts; the cost of oil and the relative importance of the previous items indicate that the cost in the case of the use of diesel and conveyor belts amounted to about 1.73, 0.97, and 0.65 thousand pounds, representing about 12.00%, 6.80%, and 4.50%. The order of the total of the general total of operating and maintenance costs is amounting to about LE 14.36 thousand, representing about 51.60%, 29.10%, and 19.30% of the total cost of oils and lubricants, amounting to about 3.35 thousand pounds. It was about 0.86 and 0.31 thousand pounds in the case of the use of electricity and deep pumps, representing about 5.7% and 2% respectively of the total of the total operating and maintenance costs of about 15.10 thousand pounds and accounted for 73.90% and 26.10% of the total cost of oils and lubricants, amounting to about 1.17 thousand pounds.

It is also clear that while the top of these items is the cost of oil in the case of the use of diesel and conveyor belts, the case of the use of electricity and deep pumps comes in the forefront of the cost of diesel filters and oil and the total cost of oils and lubricants in the case of the use of electricity and pumps. The depth is equivalent to 0.35 of the same in the case of the use of diesel and conveyor belts, mainly due to the lack of electricity to use the oil in abundance, and, in general, the overall operation and maintenance costs in the case of the use of electricity and deep pumps is equivalent to about 1.05 times the same as the case of the use of diesel and conveyor belts.

Actual costs of groundwater recharge

The data and results presented in Table 3 refer to the structure of the cost of raising the thousand cubic meters of groundwater in New Valley governorate during the agricultural season 2017/2018. It is clear that this cost includes the cost of capital depreciation, return on capital, from the source of capacity to the other, where the value is about 1.91, 0.62, and 14.40 thousand pounds, representing about 11.30%, 3.70%, and 85.00% respectively of the total actual costs in the case of the use of diesel and conveyor belts amounting to about

Table 3 The cost of raising thousand cubic meters of groundwater in New Valley governorate during season 2017/2018

Power source	Statement	Use of electricity and deep pumps			Use of diesel and conveyor belts		
		LE	Life expectancy	Depreciation premium	LE	Life expectancy	Depreciation premium
Investment costs	Motor and lifting equipment	11934.00	10.00	1193.40	367.20	10.00	3670.002
	Towing and lifting pipes	6057.72	15.00	403.805	3261.60	15.00	217.44
	Bayyara pipes	5796.36	20.00	289.802	2988.40	20.00	149.42
	Distribution basin	324.00	15.00	21.60	324.00	15.00	21.60
	Total capital depreciation			1908.70			1095.60
	Return on capital			617.40			6026.40
Operating and maintenance costs	Fuel			4898.88			6026.40
	Maintenance of motors, pumps, belts, and tires			2223.98			2551.07
	Sustainable and technical labor wages			3888.00			5310.79
	Oils, filters and lubricants			3348.00			1169.10
	Total operating and maintenance costs			14358.80			15057.40
Total actual costs				16884.90			20211.70
Disposal of water a thousand m^3/year				128.79			128.79
Cost of raising a thousand cubic meters of water in pounds				131.10			156.94

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, unpublished data
Osama Mahmoud Aweida, economic efficiency of the methods of lifting and distribution of groundwater in the new land in Egypt, reference above
Return on capital = (total investment costs price, interest rate on the loan 22) to estimate the interest rate for the first and last term, and the interest rate announced by the Central Bank of Egypt in 2017 was 19.75
Water disposal A m^3/year = 540 h operating × 238.5 m^3/h = 128.79 m^3/year
Water disposal A m^3/year/cost of raising a thousand cubic meters of water = total. Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, unpublished data. Actual costs and maintenance costs required for the pumping of groundwater in New Valley governorate which requires shedding light on those items in some detail as follows

Table 4 Relative Importance of costs of raising and distribution of groundwater for field sample field crops by source of capacity in New Valley governorate during season 2017/2018

Statement	Unit	Tomatoes		Wheat	
		Flooding irrigation	Spray irrigation	Flooding irrigation	Spray irrigation
Quantity of irrigation water	Thousand m^3/fed	5.49	4.25	3.52	2.08
Cost of raising water by diesel	Pounds/m^3	131.10	131.10	131.10	131.10
Cost of raising water by electricity	Pounds/m^3	156.90	156.90	156.90	156.90
Cost of raising water by diesel	Pounds/acres	719.70	557.20	461.50	272.70
Relative importance	%	8.99	5.53	55.71	36.93
Cost of raising water by electricity	Pounds/acres	861.40	666.80	552.30	326.40
Relative importance	%	10.76	6.62	66.67	44.19
Variable cost by diesel	Pounds/acres	8726.00	10637.00	1290.00	1011.00
Variable cost by diesel	Pounds/acres	8867.00	10747.00	1381.00	1065.00
Fixed costs	Thousand m^3/fed	2386.00	2386.00	1996.00	2195.00
Total diesel costs	Pounds/m3	11111.00	13023.00	3286.00	3206.00
Total costs	Pounds/acres	11253.00	13133.00	3376.00	3260.00

Source: collected and calculated from the questionnaire data for the agricultural season 2017/2018

16.90 thousand pounds. It amounted to 4.10, 1.10, and 15.10 thousand pounds, representing about 20.10%, 5.40%, and 74.50% respectively of the total actual costs in the case of the use of electricity and deep pumps, amounting to about 20.20 thousand pounds.

It is also clear that while the top of these items is the cost of operation and maintenance in the case of the use of diesel and conveyor belts, in the case of the use of electricity and deep pumps are also in the forefront, and the total actual cost in the case of the use of electricity and deep pumps is equivalent to 1.20 times in the case of the use of diesel and conveyor belts. As a result, the annual disposal of irrigation water for the two plants has become stable. The cost of raising the millimeter of irrigation water is about 131.10 and 156.90 pounds for the two types of power supply in the case of diesel and electricity respectively.

The relative importance of irrigation costs

The results shown in Table 4 are the relative importance of irrigation costs of groundwater by power source in New Valley governorate during the agricultural season 2017/2018. From the table, it is clear that the water parameters for irrigating the acre vary according to the difference irrigation water requirements per feddan and vary according to different types of crop, irrigation method, and power source, but in general, the water needs of the tomato crop and the required water of the tomato crop are higher than of the wheat crop in the flood irrigation and higher in spray irrigation; as for the cost of raising water for the crop, the cost in the case of the use of electricity and deep water pumps is higher than in the case of diesel and conveyor belts. This is due to the high cost of raising the cubic meter in each of them by a difference of about 25.80 pounds/thousand m^3 water.

The cost of rising in the case of irrigation sprinkler is less than that in the case of irrigation by flooding due to the difference in the amount of water quantity of irrigation water required for the crop. According to the method of irrigation, the total costs vary from one crop to another, increasing in the way the source of electricity in the case of the use of diesel and conveyor belts; based on the above statement, it is clear that the relative importance of the costs of raising and distributing water compared to the total variable costs per feddan is different. For wheat, it represents about 36.93% and 55.71% of the total variable costs of about 1011.00 and 1290.00 LE/fed respectively, according to the two methods of spray irrigation and flooding irrigation in the case of diesel and conveyor belts, while it reached about 44.19% and 66.67% of the total variable costs of 1.07 and 1.38 thousand pounds/fed, respectively, in the flooding irrigation in the case of electricity use.

The total cost of the tomato crop was about 5.53% and about 8.99% of the total variable costs, which amounted to about 10.64 and 8.73 thousand pounds/fed respectively, according to the two methods of spray irrigation and flooding irrigation in the case under the use of diesel and conveyor belts and about 6.62% and 10.76% of the total variable costs and 8.87 thousand pounds/fed., respectively, according to the two methods of spray irrigation and irrigation by flooding in the case of the use of electricity.

Productive efficiency indicators and economic to raise and distribute groundwater

The results are shown in Table 5, representing the indicators of productivity and economic efficiency of the

Table 5 Economic efficiency indicators for raising and distribution of groundwater for field sample crops for tomatoes and wheat during season 2017/2018

Statement	Unit	Tomatoes		Wheat	
		Flooding irrigation	Spray irrigation	Flooding irrigation	Spray irrigation
Average productivity		14.49	19.80	13.20	16.78
Average farm price	Pounds	1319.00	1391.00	419.40	419.60
Total return	Pounds	19106.00	27546.00	5535.00	7040.00
Net yield in pound sterling*	Diesel	7995.00	14523.00	2250.00	3834.00
	Electricity	7853.00	14414.00	2159.00	3780.00
Net return on the pound**	Diesel	0.72	1.12	0.69	1.20
	Electricity	0.70	1.10	0.64	1.16
Net return on 1000 m^3 irrigation water in pounds***	Diesel	1456.00	3417.00	639.20	1843.00
	Electricity	1430.00	3391.00	613.40	1817.00

Source: collected and calculated from the questionnaire data for the agricultural season 2017/2018
*Net yield in pounds = total return − total costs
**Net return on the pound = net return total costs × 100
***Water net = net yield water quantity per thousand m^3

lifting and distribution of groundwater from power source in New Valley governorate during the agricultural season 2017/2018 which is the average yield, the total yield, the net yield per feddan, the net yield on the pound, and the net return on 1000 m^3 irrigation water, and the table shows the increase in productivity in both crops, wheat and tomatoes, according to the method of irrigation spray, reaching about 16.78 ardab/fed and 19.80 ton/fed, compared to about 13.20 ardab/fed and 14.49 ton/fed according to the method of irrigation by flooding; this shows that irrigation spray is more efficient in the case of irrigation by flooding. The table also shows the increase in the total yield in crops, wheat and tomato, according to the method of sprinkler irrigation, reaching about 7.04 pounds/fed and 27.55 thousand pounds/fed, compared to about 5.54 pounds/fed and 19.11 thousand pounds/fed according to the irrigation method. It also shows the total return from spraying irrigation is higher than in the case of irrigation by flooding due to increased productivity; on the other hand, the net yield of both crops was also increased in the case of spraying irrigation from irrigation by flooding. However, in the absence of an impact on the overall yield potential and this effect on the total cost of production, the net return takes the opposite direction of total costs, which means a higher net return in the case of the use of diesel and conveyor belts compared to the same in the case of the use of electricity and deep pumps.

As for the net return on the pound spent in the production of wheat crop, it was shown from the same table above to increase it to a maximum in the case of spraying irrigation with the use of diesel and conveyor belts, which amounted to about 1.19 pounds and decreased to reach below in the case of irrigation flooding in the case of the use of electricity and deep pumps, which amounted to about 0.64 pounds.

In the case of the tomato crop, the net yield on the pound spent in the production of the crop was shown to increase to a maximum in the case of spray irrigation with the use of diesel and conveyor belts, which amounted to about 1.12 pounds and decreased to reach below in the case of flooding irrigation in the case of the use of electricity and deep pumps, about 0.70 pounds. The net return on one thousand m^3 irrigation water in the production of wheat crop has been shown from the same table above to increase it to a maximum in the case of spray irrigation with the use of diesel and conveyor belts, which amounted to about 1.84 thousand pounds and decreased below in the case of flooding irrigation in the case of electricity use and the depth pumps reached about 0.613 thousand pounds. In the case of the tomato crop, the net yield per 1000 m^3 irrigation water in the production of the crop has been shown to increase to a maximum in the case of spray irrigation with the use of diesel and conveyor belts amounted to about 3.42 thousand pounds and decreased to reach below in the case of flooding irrigation in the case of the use of electricity and pumps depth of about 1.43 thousand pounds.

Discussion

The results showed that the productivity and economic efficiency indicators for the raising and distribution of groundwater by power source in New Valley governorate during the agricultural season 2017/2018, namely the average productivity, total yield, net revenue per feddan, net return on the pound, and net return on 1000 m^3 irrigation water. The increase in productivity in both crops showed wheat and tomatoes according to the method of spraying irrigation, reaching about 16.78 ardab/fed and 19.80 tons/fed, compared to 13.20 ardab/fed and 14.49 ton/fed according to the method of irrigation by flooding. This indicates that spraying irrigation is more efficient than a similar case of irrigation of flooding. The table also shows that the total yield of both crops increased, with wheat and tomatoes reaching LE 7.04/feddan, about LE 27.55 thousand/fed, compared to LE 5.54/fed and 19.11 thousand LE/fed according to the irrigation method. It also shows that the total return from spraying irrigation is higher than in the case of irrigation by flooding due to increased productivity.

The net yield of both crops was also increased in the case of spray irrigation for irrigation by flooding. However, in the absence of an impact on the overall yield potential and this effect on total production costs, the net return takes the opposite direction of total costs, which means a higher net return in the case of the use of diesel and conveyor belts compared to the same in the case of the use of electricity and deep pumps.

As for the net yield on the pound spent in the production of wheat crop, it was shown from the same table above to increase it to a maximum in the case of spray irrigation with the use of diesel and conveyor belts, which amounted to about 1.19 pounds and decreased to reach below in the case of irrigation flooding in the case of the use of electricity and deep pumps about 0.64 pounds. In the case of the tomato crop, the net yield on the pound spent in the production of the crop has been shown to increase up to a maximum in the case of spray irrigation with the use of diesel and conveyor belts, which amounted to about 1.12 pounds and decreased to reach below in the case of irrigation flooding in the case of the use of electricity and deep pumps, about 0.70 pounds

As for the net return on one thousand m^3 irrigation water in the production of wheat crop, it has been shown from the same table above to increase it to a maximum in the case of spray irrigation with the use of

diesel and conveyor belts, which amounted to about 1.84 thousand pounds and decreased to the below in the case of flooding irrigation in the case of electricity use and deep pumps reached about 0.61 thousand pounds. In the case of the tomato crop, the net yield per 1000 m^3 irrigation water in the production of the crop has been shown to increase to a maximum in the case of spray irrigation with the use of diesel and conveyor belts amounted to about 3.42 thousand pounds and decreased to reach below in the case of irrigation flooding in the case of the use of electricity and pump depth of about 1.43 thousand pounds.

Conclusion

It could be concluded that the net return on one thousand m^3 irrigation water in the production of wheat crop was increased and the net yield in both crops was increased in the case of spray irrigation instead of irrigation by flooding.

Abbreviations

fed: Feddan; DRC: Desert Research Center; LE: Egyptian pound

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Authors' contributions

HE contributed to the review of the paper, aggregation and analysis of data, and the references. EA contributed to the writing of the paper and the references. RE contributed to the review and writing of the paper and aggregation and analysis of data. MM contributed to the analysis of data and writing and reviewing of the paper. All authors read and approved the final manuscript.

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Ok

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