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(Original Article)

Economic and Productivity Efficiency of Using Modern Irrigation Systems in Egypt (Case Study of Fayoum Governorate)

Mahmoud A. Ahmed *

Department of Agricultural Economics, Fayoum University, Egypt .

Corresponding author: maa16@fayoum.edu.eg
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Abstract

The purpose of the study is to estimate economic efficiency and Compare results of applying modern irrigation systems in new lands with traditional irrigation systems used in Fayoum Governorate. This study was based on descriptive statistics were used in analyze data collected; two hundred producers were randomly selected from Fayoum Governorate.

Results showed Using of drip irrigation increasing in net return value about 9155.7, 1498.1, 3856.5 EGP per feddan for crops (onion, Sugar Beet, wheat) respectively. and it also leads to increase in feddan productivity about 3.2, 3, 2 tons represented 20.9%, 18.7%, 13.3% for crops (onion, Sugar Beet, wheat) respectively Comparison to flood irrigation. and irrigation water quantity decreases by about 600, 738, 364 m^3 per feddan represented 25%, 27.2%, 16.7% for crops (onion, Sugar Beet, wheat) respectively.

By generalizing the results to the cultivated area of onion, in Fayoum it is possible to saving about 5.32 million m^3, this amount of water can increasing in cultivated area of onion by about 2.9 thousand feddan. As for the national level it is possible to saving about 29.3 million m^3, this amount of water can increasing in cultivated area of onions by about 16.3 thousand feddan. By generalizing the results to the cultivated area of wheat, in Fayoum it is possible to saving about 2.73 million m^3, this amount of water can increasing in cultivated area of wheat by about 1.5 thousand feddan. As for the national level it is possible to saving about 261.68 million m^3, this amount of water can increasing in cultivated area of wheat by about 145 thousand feddan.

Keywords: *Water Scarcity, Irrigation Efficiency, Irrigation Systems, Water Resources .*

Introduction

The agricultural policy aims to increase agricultural production through both horizontal and vertical agricultural development programs, Water is a significant resource for agricultural development, One of the main challenges of this century is the preservation of this important resource, Since water resources are the main determinant of agricultural production (Osama *et al*., 2005), it is therefore important to work to achieve efficiency in the use of this resource in light of their limitations (Alcon *et al*., 2019; Berbel *et al*., 2019).

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Egypt suffers from a severe shortage of available water resources, as its share of the Nile River water is approximately 55.5 billion m^3 (Molle *et al*., 2018). Water resources in Egypt are insufficient for all activities, including agriculture, industry, household uses. The agricultural sector is a major water consumer; for instance, it consumes approximately 81.6% of Egypt's annual water resources (Osman *et al*., 2016). In addition to the problem of water scarcity and the exacerbation of the deficit in the water balance, in light of the steady population increase that led to an increase in the demand for food, and then on agricultural production as a main source of food, as well as in light of the decrease efficiency of the use of water resources, which in turn was reflected on Increasing demand for water in both agricultural and non-agricultural purposes, and it is expected that the per capita share will reach less than 500 m^3 annually in 2030, which is less than the water safety limit of 1000 m^3 annually(CAPMAS., 2018).

Economic efficiency is described as "the highest production level that farmers can reach using a specific quantity of inputs, or the same amount of output with the least number of inputs, (Banker *et al*., 1984; Coelli *et al*., 2002; See, 2015).

Fayoum Governorate is located in the Western Desert of Egypt, and some areas suffer from a severe shortage of irrigation water, especially at the ends of the canals, the irrigation system used in most of the old lands in the governorate is the flood irrigation system, which represents a huge consumption of irrigation water in addition to the increase in losses, of it in the form of waste water. This causes problems such as loss of irrigation water and an increase in the load on the drainage areas represented in Lake Qarun and the lakes of Wadi El Rayan. In addition to the decrease in the quantities of irrigation water available for use in Fayoum Governorate, as a result of the waste and extravagance in the use of these water resources, especially in agriculture, as well as a result of the traditional surface irrigation system (flood) in irrigating various agricultural crops.

From all of the above it is clear that there is a need to rationalize the use of irrigation water in agriculture, as it is the largest consumer of water, through use of modern irrigation systems such as (drip, sprinkler) which lead to saving large amount of water that contribute to the horizontal expansion of the cultivated area and to achieve the desired efficiency, which leads to the achievement of many positive results whose effects are reflected on the agricultural economic.

The purpose of the study is to estimate economic efficiency and Compare results of applying modern irrigation systems in new lands with traditional irrigation systems used in Fayoum Governorate.

Material and Methods

Data Collection Method

This study used approach "multi-stage random sample", in first stage where Fayoum Governorate selected as the study area, which is in middle Egypt and 116 km south of Cairo.

The cultivated area of new lands in Fayoum governorate is about 25,000 feddans, and farmers use different irrigation systems such as flood irrigation, drip irrigation and sprinkler irrigation. This governorate has reclaimed land. In second stage, selected two districts (Youssef Al Seddik, fayoum) from among the governorate's seven districts, based on the largest area in the new lands in the governorate, Youssef Al-Siddiq district represents 55.7%, and Fayoum district represents 25.8% of the total new lands in the governorate. Crops (Onion, sugar beet and wheat) were selected because it is the largest crops in terms of cultivated area in the new lands. Where the cultivated area of wheat crop represents 43.7%, onion crop area represents 20.6%, area of sugar beet crop represents 6.4% of the total cultivated area in the two districts. Finally 200 producers were selected randomly from these two districts.

Data Analysis

This study was based on descriptive statistics were used in analyze data collected; also estimate some of the indicators of Economic and Productive Efficiency as well as using the quantitative analysis method like the use of some indicators of economic efficiency and productivity such as:

Water productivity (kg) = "Number of units produced/ Total water quantity used".

Cost of irrigation per unit produced= "Total cost of irrigation/Number of units produced".

Variable cost per unit produced = "Total variable cost / Total units produced".

Total cost per unit produced = "Total cost/ Total unit produced".

Net revenue per unit produced = "Total net revenue / Number of units produced".

Net revenue per unit of water used = "Total net yield / Water quantity used

Results and Discussion

Total Production Cost and Revenue under Different Irrigation System

Cost and revenue per feddan of onion crop

Table No. (1) Shows that by comparing use of the drip irrigation method with the flood irrigation method, it becomes clear that the drip irrigation method leads to an increase in both the Operating cost and the total cost over the flood irrigation method by about 2241, 817.3 EGP per feddan, which is equivalent to about 212.2%, 7.1% respectively. While variable production cost decreasing about 1423.7 EGP, which is equivalent to about 15.7%. As for the net return, the drip irrigation method, compared to flood irrigation, achieved an increase estimated at about 9155.7 EGP /feddan, represented about 61.1%.

Table 1. Cost and revenue in irrigation systems for onion crop (EGP/feddan)

Irrigation systems Item	Drip Irrigation	Flood Irrigation	the amount of change *	for the amount of change % **
Operating irrigation cost	3297	1056	2241	212.2
variable production cost	7620	9043.7	(1423.7)	(15.7)
Fixed production cost	1300	1300	-	-
Total cost	12217	11399.7	817.3	7.1
Total revenue	36360	26387	9973	37.8
Net return	24143	14987.3	9155.7	61.1

* Change = Modern Irrigation - Flood Irrigation
** % of Change = Amount of change/value when using flood irrigation *100
- Numbers in brackets ( ) go to negative values.
Source. Computed from field survey data, 2022.

Cost and revenue per feddan of Sugar Beet crop

Table No. (2) Shows that by comparing use of the drip irrigation method with the flood irrigation method, it becomes clear that the drip irrigation method leads to an increase in both the Operating cost and the total cost over the flood irrigation method by about 1832, 246.9 EGP per feddan, which is equivalent to about 95.8%, 2.7% respectively. While variable production cost decreasing about 1585.1 EGP, which is equivalent to about 27.4%. as for the net return, the drip irrigation method, compared to flood irrigation, achieved an increase estimated at about 1498.1 EGP /feddan, represented about 85%.

Table 2. Cost and revenue in irrigation systems for Sugar Beet crop (EGP/feddan)

Irrigation systems Item	Drip Irrigation	Flood Irrigation	the amount of change *	for the amount of change % **
Operating irrigation cost	3744.8	1912.8	1832	95.8
Variable production cost	4198	5783.1	(1585.1)	(27.4)
Fixed production cost	1300	1300	-	-
Total cost	9242.8	8995.9	246.9	2.7
Total revenue	12503	10758	1745	16.2
Net return	3260.2	1762.1	1498.1	85

*** Change = Modern Irrigation - Flood Irrigation**
**** % of Change = Amount of change/value when using flood irrigation *100**
- Numbers in brackets ( ) go to negative values.
Source. Computed from field survey data, 2022.

Cost and revenue per feddan of wheat crop

Table No. (3) Shows that by comparing use of the drip irrigation method with the flood irrigation method, it becomes clear that the drip irrigation method leads to an increase in both the Operating cost and the total cost over the flood irrigation method by about to 2559, 320.5 EGP per feddan represented 313.6%, 3.5% respectively. While variable production cost decreasing about 2238.5 EGP represented 32%, total revenue and net return increase about 4177, 3856.5 EGP per feddan, which represented 34%, 121.7% respectively. Increase in revenue value will cover increase in total cost. Using of Sprinkler irrigation increasing in both operating irrigation cost and Total cost amounted to 3720.2, 1483.8 EGP per

feddan represented 455.9%, 16.3%. While variable production cost decreasing about 1679 EGP represented 24 %, total revenue and net return increase by 1590, 1483.8 EGP per feddan, which represented 12.9%, 46.8 %. Increase in revenue value will cover increase in total cost. (Table 3)

Table 3. Cost and revenue in irrigation systems for wheat (EGP/feddan)

Irrigation systems Item	Flood Irrigation	Sprinkler Irrigation	Drip Irrigation	impact of modern irrigation systems on cost and revenue			
				Sprinkler irrigation (change)	%	Drip irrigation (change)	%
Operating irrigation cost	816	4536.2	3375	3720.2	455.9	2559	313.6
Variable production cost	6984.5	5305.5	4746	(1679)	(24)	(2238.5)	(32)
Fixed production cost	1300	1300	1300	-	-	-	-
Total cost	9100.5	11141.7	9421	1483.8	16.3	320.5	3.5
Total revenue	12269	15794	16446	1590	12.9	4177	34
Net return	3168.5	4652.3	7025	1483.8	46.8	3856.5	121.7

* Change = Modern Irrigation - Flood Irrigation

** % of Change = Amount of change/value when using flood irrigation *100

- Numbers in brackets ( ) go to negative values.

Source. Computed from field survey data, 2022.

Impact of Modern Irrigation Systems

change in feddan productivity, quantity of irrigation water and cultivated area of the study crops.

Onion crop

Table No. (4) shows using drip irrigation leads to increase in feddan productivity of onion by 3.2 ton represented 20.9% Comparison to flood irrigation, irrigation water quantity decreases by about 600 m^3 per feddan represented 25%, cultivated area increases by about 3 karat per feddan in drip irrigation, represented 14.28%.

Table 4. Productivity, quantity of irrigation water and cultivated area of Onion cropindifferentirrigation systems

Irrigation systems Item	Flood Irrigation	Drip Irrigation	Drip Irrigation	
			saving amount	%
Productivity (ton/feddan)	15.3	18.5	3.2	20.9
Water Quantity used (m^3/feddan)	2400	1800	600	25
Cultivated area (karat)	21	24	3	14.28

Source: Computed from field survey data, 2022.

Sugar Beet crop

Table No. (5) shows using drip irrigation leads to increase in feddan productivity of Sugar Beet by 3 tons represented 18.7% Comparison to flood irrigation, irrigation water quantity decreases by about 738 m^3 per feddan

represented 27.2%, cultivated area increases by about 3 karat per feddan in drip irrigation, represented 14.28%.

Table 5. Productivity, quantity of irrigation water and cultivated area of sugar Beet crop in different irrigation systems

Irrigation systems Item	Flood Irrigation	Drip Irrigation	Drip Irrigation	
			saving amount	%
Productivity (ton/feddan)	16	19	3	18.7
Water Quantity used (m^3/feddan)	2712	1974	738	27.21
Cultivated area (karat)	21	24	3	14.28

Source: Computed from field survey data, 2022.

Wheat crop

Table No. (6) shows using drip and sprinkler irrigation leads to increase in feddan productivity of wheat by 2, 1 Ardab represented 13.3%, 6.6% respectively, Comparison to flood irrigation, irrigation water quantity decreases by about 364 m^3, 181 m^3 per feddan represented 16.7%, 8.3% in drip and sprinkler irrigation respectively, cultivated area increases by about 3 karat per feddan in drip and sprinkler irrigation, represented 14.28%.

Table 6. Productivity, quantity of irrigation water and cultivated area of wheat crop in different irrigation systems

Irrigation systems Item	Flood irrigation	sprinkler irrigation	drip irrigation	drip irrigation		sprinkler irrigation	
				saving amount	%	saving amount	%
Productivity (Ardab /feddan)	15	16	17	2	13.3	1	6.6
Water Quantity used (m^3/feddan)	2162	1981	1798	364	16.7	181	8.3
Cultivated area (karat)	21	24	24	3	14.28	3	14.28

Source: Computed from field survey data, 2022.

Indicators of the productivity and Economic Efficiency for the unit of water used

In this part of the study, present the indicators of the productivity and economic efficiency for the unit of water used to irrigate the various crops of the study, according to the irrigation systems used, which include the productivity of water unit, cost of irrigation per unit produced, variable cost per unit produced, total cost per unit produced. Net revenue per unit produced, net revenue per unit of water used.

Onion crop

Using drip irrigation leads to increase in productivity of a cubic meter of water by 3.8 kg/m^3 represented 59.4% Comparison to flood irrigation system. Irrigation cost of ton onion in drip irrigation about 178.2 EGP, an increase of 109.19 EGP/ton represented 158.2% Comparison to flood irrigation system. Variable cost in drip irrigation amounted to 590.1 EGP/ton, decreasing of 70

EGP/ton represented 10.6% compared to flood irrigation system. Total cost in drip irrigation amounted to 660.3 EGP/ton, decrease of 84.8 EGP/ton by 11.4% compared to flood irrigation system. net revenue per producing unit about 1319.3 EGP/ton, an increase of 399.7 EGP/ton, represented 34.7% compared to flood irrigation system. net return of a cubic meter of water in drip irrigation amounted to about 13.4 EGP/ m^3, an increase of 7.2 EGP/m^3 represented 116.1% compared to flood irrigation system. Table no (7)

Table 7.Indicators of productivity and economic efficiency of water unit for Onion cropin different irrigation systems

Irrigation systems Item	Flood irrigation	Drip irrigation	the amount of change *	for the amount of change % **
water productivity (kg/m^3)	6.4	10.2	3.8	59.4
irrigation cost of producing unit (EGP)	69.01	178.2	109.19	158.2
variable cost per unit produced (EGP)	660.1	590.1	(70)	(10.6)
total cost per unit produced (EGP)	745.1	660.3	(84.8)	(11.4)
net revenue per producing unit (EGP)	979.6	1319.3	339.7	34.7
net revenue per unit of water used (EGP)	6.2	13.4	7.2	116.1

* Amount of change = Modern Irrigation - Flood Irrigation
** % of Change = Amount of change/value when using flood irrigation *100
Numbers in brackets ( ) go to negative values.
Source Computed from tables number (1), (4)

Sugar Beet crop

Table 8. Indicators of productivity and economic efficiency of water unit for sugar Beet crop in different irrigation systems

Irrigation systems Item	Flood irrigation	Drip irrigation	the amount of change *	for the amount of change % **
water productivity (kg/m^3)	5.8	9.6	3.8	65.5
irrigation cost of producing unit (EGP)	119.6	197.1	77.5	64.8
variable cost per unit produced(EGP)	480.9	418	(62.9)	(13.1)
total cost per unit produced (EGP)	562.2	486.5	(75.7)	(13.5)
net revenue per producing unit (EGP)	110.1	171.6	61.5	55.9
net revenue per unit of water used (EGP)	0.6	1.7	1.1	183.3

* Amount of change = Modern Irrigation - Flood Irrigation
** % of Change = Amount of change/value when using flood irrigation *100
Numbers in brackets ( ) go to negative values.
Source Computed from table number (2), (5)

Using drip irrigation leads to increase in productivity of a cubic meter of water by 3.8 kg/m^3 represented 65.5% Comparison to flood irrigation system. Irrigation cost of ton Sugar Beet in drip irrigation about 197.1 EGP, an increase of 77.5 EGP/ton represented 64.8% Comparison to flood irrigation system.

Variable cost in drip irrigation amounted to 418 EGP/ton; decreasing of 62.9 EGP/ton represented 13.1% Comparison to flood irrigation system. Total cost in drip irrigation amounted to 486.5 EGP /ton, decrease of 75.7 EGP/ton by 13.5% compared to flood irrigation system. Net revenue per producing unit about 171.6 EGP/ton, an increase of 61.5 EGP/ton, represented 55.9% Comparison to flood irrigation system. Net return of a cubic meter of water in drip irrigation amounted to about 1.7 EGP/ m^3, an increase of 1.1 EGP/m^3 represented 183.3% Comparison to flood irrigation system Table no. (8)

Wheat crop

Using drip irrigation and sprinkler irrigation leads to increase in productivity of a cubic meter of water by 9.5 kg/m^3, 8.1 kg/m^3 represented 39.1%,18.8% respectively Comparison to flood irrigation system. Irrigation cost of Ardab wheat in drip irrigation and sprinkler irrigation about 198.5, 283.2 EGP an increase of 144.1, 228. EGP/Ardab represented 264.7%, 420.6% respectively Comparison to flood irrigation system. Variable cost in drip irrigation amounted to 477.7 EGP/Ardab, decreasing of 42.3 EGP /Ardab represented 8.1% compared to flood irrigation system. While variable cost in sprinkler irrigation amounted to 615.1 EGP/Ardab, an increase of 95.1 EGP/Ardab represented 18.3% Comparison to flood irrigation system.

Table 9. Indicators of productivity and economic efficiency of water unit for wheat crop in different irrigation systems

Irrigation systems / Item	Flood irrigation	sprinkler irrigation	drip irrigation	drip irrigation		sprinkler irrigation	
				the amount of change *	for the amount of change % **	the amount of change *	for the amount of change % **
water productivity (kg/m^3)	6.9	8.1	9.5	2.6	39.1	1.2	18.8
irrigation cost of producing unit (EGP)	54.4	283.2	198.5	144.1	264.7	228.8	420.6
variable cost per unit produced(EGP)	520	615.1	477.7	(42.3)	(8.1)	95.1	18.3
total cost per unit produced (EGP)	606.7	696.3	554.2	(52.2)	(8.6)	89.6	14.7
net revenue per producing unit (EGP)	211.2	290.8	413.2	202	95.6	79.6	37.7
net revenue per unit of water used (EGP)	1.5	2.3	3.9	2.4	160	0.8	53.3

Source: Computed from table number (3), (6)

Numbers in brackets ( ) go to negative values

Total cost/Ardab in drip irrigation amounted to 554.2 EGP/Ardab, decrease of 52.2 EGP/Ardab by 8.6% compared to flood irrigation system, While total cost/Ardab in sprinkler irrigation amounted to 696.3 EGP/Ardab, an increase of 89.6 EGP/Ardab by 14.7% compared to flood irrigation system. net revenue per

producing unit in drip irrigation and sprinkler irrigation about 413.2, 290.8 EGP/Ardab, an increase of 202, 79.6 EGP/Ardab, represented 95.6%, 37.7% respectively compared to flood irrigation system. net return of a cubic meter of water in drip irrigation and sprinkler irrigation amounted to about 3.9, 2.3 EGP/m^3, an increase of 2.4, 0.8 EGP/m^3 represented 160%,53.3 respectively compared to flood irrigation system. Table no (9)

Economic Return of using ModernIrrigation SystemsinFayoum Governorate and at the National Level

On the basis of integrated agriculture water management optimization model, (this paper defines the agriculture water saving potential as the water saving quantity based on maximum economic benefit under a certain planting scale) (Dongmei Zhang *et al*., 2016)

In this part of the study, the obtained results, which include production cost, productivity and efficiency indicators for the study crops, are used and circulated at the level of Fayoum governorate and at the national level to estimate the economic return of using modern irrigation systems in terms of saving in production cost, saving the amount of water used for agriculture, increasing productivity as well as increasing net return as an attempt to develop a clear vision for the decision maker about the use of modern irrigation systems.

Impact of using modern irrigation systems on the total production

Table (10) show the results of estimating the impact of modern irrigation systems on the total production of onion, sugar beet and wheat crops in Fayoum Governorate and for the whole republic.

Table 10. Impact of using modern irrigation systems on total production in Fayoum Governorate and at the national level

item / crop	Increase in productivity	Total increase in production		
		unit	Fayoum	the national level
Onion (ton /feddan)	3.2	**thousand tons**	28.5	156.5
Sugar beet (ton /feddan)	3	**thousand tons**	21.6	1341
Wheat drip (Ardab /feddan)	2	**thousand Ardab**	15	1437.8
wheat sprinkle (Ardab /feddan)	1	**thousand Ardab**	7.5	718.9

Source Computed from tables number (4), (5), (6)

Onion crop

Use drip irrigation system increases the productivity of feddan by about 3.2 tons than flood irrigation, and by generalizing the results to the cultivated area of onions, As the governorate level it is possible to increase the total production by about 28.5 thousand tons. As for the national level it is possible to increase the total Production by 156.5 thousand tons.

Sugar Beet crop

Use of the drip irrigation system increases the productivity of Sugar Beet per feddan by about 3 tons compared to flood irrigation, and by generalizing the results to the cultivated area of Sugar beet in Fayoum, it is possible to increase the total production by about 21.6 thousand tons. As for the the national level it is possible to increase the total Production by 1.3 million tons.

Wheat crop

Use of the drip irrigation system leads to an increase in the feddan productivity of wheat by about 2 Ardab compared to flood irrigation, and by generalizing the results to the cultivated area of wheat in Fayoum, it is possible to increase the total production by about 15 thousand Ardab, As for the whole republic it is possible to increase total Production by about 1.44 million Ardab. and use of the sprinkler irrigation system increases the feddan productivity of wheat by about one Ardab than the flood irrigation, it is possible to increase the total production by about 7.5 thousand Ardab, As for the national level it is possible to increase total Production by about 0.718 million Ardab.

Where

The area of onions cultivate in the new land in Fayoum Governorate is 8.9 thousand feddan, at the national level is 48.9 thousand feddan.

The area of wheat cultivate in the new land in Fayoum is 7.5 thousand feddan, and at the national level is 718.9 thousand feddan.

The area of sugar beet cultivate in the new land in Fayoum is 3.6 thousand feddan, and at the national level is 447 thousand feddan.

Impact of using different irrigation systems on rationalizing irrigation water and increasing in cultivated area

It is very important to adopt an efficient irrigation strategy in arid and semi-arid areas, in order to reclaim and cultivate new land using current water resources to satisfy growing populations (Khor and Feike, 2017).

The following is presented to estimate the impact of different irrigation systems on rationalizing irrigation water and increasing in cultivated area of crops (Onions, Sugar Beet and Wheat) in Fayoum Governorate and and at the national level, as shown in Table (11).

Table 11. Impact of using modern irrigation systems on Total water saving and cultivated area in Fayoum Governorate and at the national level

item crop	Saving in water per feddan (m^3)	Total water saving (Million m^3)		Increase in area cultivated (Thousand feddan)	
		Fayoum	the national level	Fayoum	the national level
onion	600	5.32	29.3	2.9	16.3
Sugar Beet	738	2.66	329.9	1.3	167
Wheat drip	364	2.73	261.68	1.5	145
wheat sprinkle	181	1.36	130.1	6.9	65.7

Source: Computed from tables number (4), (5), (6)

Onion crop

Using of the drip irrigation system reduces the water consumption per feddan by about 600 m^3 from flood irrigation, and by generalizing the results to the cultivated area of onion, in Fayoum it is possible to saving about 5.32 million m^3, this amount of water can increasing in cultivated area of onions by about 2.9 thousand feddan. As the national level it is possible to saving about 29.3 million m^3, this amount of water can increasing in cultivated area of onions by about 16.3 thousand feddan.

Sugar Beet crop

Using of the drip irrigation system reduces the water consumption per feddan by about 738 cubic meters from flood irrigation, and by generalizing the results to the cultivated area of Sugar Beet, in Fayoum it is possible to saving about 2.66 million m^3, this amount of water can increasing in cultivated area of Sugar Beet by about 1.3 thousand feddan. As for the national level it is possible to saving about 329.9 million m^3, this amount of water can increasing in cultivated area of Sugar Beet by about 167 thousand feddan.

Wheat crop

Using of the drip irrigation system reduces the water consumption per feddan by about 364 m^3 from flood irrigation, and by generalizing the results to the cultivated area of wheat, in Fayoum it is possible to saving about 2.73 million m^3, this amount of water can increasing in cultivated area of wheat by about 1.5 thousand feddan. As for the national level it is possible to saving about 261.68 million m^3, this amount of water can increasing in cultivated area of wheat by about 145 thousand feddan.

Using of the sprinkler irrigation system reduces the water consumption per feddan by about 181 m^3 from flood irrigation, and by generalizing the results to the cultivated area of wheat, in Fayoum it is possible to saving about 1.36 million m^3, this amount of water can increasing in cultivated area of wheat by about 6.9 thousand feddan. As for the national level it is possible to saving about 130.1 million m^3, this amount of water can increasing in cultivated area of wheat by about 65.7 thousand feddan .

Impact of using irrigation systems on total net return

Table 12. Impact of using modern irrigation systems on the net revenue of crops in Fayoum Governorate and at the national level

item crop	Increase in net return (EGP \ feddan)	increase in total net return (Million EGP)	
		Fayoum Governorate	the national level
onion	9155	81.5	447.7
Sugar Beet	1498	5.3	66.9
Wheat drip	3856	28.9	277.2
wheat sprinkle	1483	11.2	106.6

Source: Computed from tables number (1), (2), (3)

The following are the results of estimating the impact of different irrigation systems on the net return of crops (Onion, Sugar Beet and Wheat) in Fayoum Governorate and at the national level, as shown in Table (12).

Onion crop

Assuming generalization the drip irrigation system on the cultivated area of the onion crop, the net return can be increased by about 81.5, 447.7 million EGP at the governorate level and at the national level respectively.

Sugar Beet crop

Assuming generalization the drip irrigation system on the cultivated area of the Sugar Beet crop, the net return can be increased by about 5.3, 66.9 million EGP at the governorate level and at the national level respectively.

Wheat crop

Assuming generalization the drip irrigation system on the cultivated area of the wheat crop, the net return can be increase by about 28.9, 277.2 million EGP at the governorate level and at the national level respectively. By generalization the sprinkler irrigation system on the cultivated area of the wheat crop, the net return can be increased by about 11.2, 106.6 million EGP at the governorate level and at the national level respectively.

Conclusions and Recommendation

Modern irrigation systems benefit for individual farmers and also be beneficial for the national economy by increasing the productivity of land units and achieving optimal use of social resources. In addition, it could lead to the efficient use of agricultural water, which is one of the most significant challenges in this time. The results of the study showed that the productivity of the feddan increased by about 3.2, 3, 2 ton, and increasing in net return value by 9155.7, 1498.1, 3856.5 EGP per feddan respectively. for crops (onion, Sugar Beet, Wheat), in comparison with the use of flood irrigation. Farmers can improve their economic efficiency if they use Modern irrigation systems in reclaimed lands to improve scale efficiency and to achieve the best return on the land and water unit.

Based on the previous results of the study, this study recommends the provision of loans, for encourage small farmers to transfer from conventional irrigation systems to Modern irrigation systems and organize training programs for small farmers by agricultural extension on how to operate and maintain the Modern irrigation systems.

These policies would help of use Modern irrigation systems, and help farmers to maximize productivity and income, reduce poverty and maintain the sustainable use of water resource.

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الكفاءة الاقتصادية والإنتاجية لاستخدام أنظمة الري الحديث في مصر (دراسة حالة محافظة الفيوم)

محمود عبدالسلام احمد *

قسم الاقتصاد الزراعي ، جامعة الفيوم ، مصر .

الملخص

استهدفت الدراسة تقدير الكفاءة الاقتصادية ومقارنة نتائج تطبيق أنظمة الري الحديثة في الأراضي الجديدة مع أنظمة الري التقليدية المستخدمة في محافظة الفيوم. واعتمدت الدراسة على أساليب التحليل الإحصائي الوصفي الذي تم استخدامه في تحليل البيانات التي تم جمعها. تم اختيار عينة مكونة من مائتي منتج عشوائياً من محافظة الفيوم.

أظهرت النتائج أن استخدام الري بالتنقيط زاد من قيمة صافى العائد بمقدار 9155.7، 1498.1، 3856.5 جنيه للفدان لمحاصيل (البصل، بنجر السكر، القمح) على التوالي. كما ادى ايضا إلى زيادة إنتاجية الفدان بمقدار 3.2 ، 3 ، 2 طن تمثل 20.9٪ ، 18.7٪ ، 13.3٪ لمحاصيل (البصل ، بنجر السكر ، القمح) على التوالي مقارنة بالري بالغمر. وانخفضت كمية مياه الري بنحو 364،738،600 م 3 للفدان تمثل 25٪ ، 27.2٪ ، 16.7٪ لمحاصيل (البصل، بنجر السكر، القمح) على التوالي.

بتعميم النتائج على المساحة المزروعة بالبصل في الفيوم يمكن توفير حوالي 5.32 مليون م^3، ويمكن لهذه الكمية من المياه أن تزيد في المساحة المزروعة للبصل بنحو 2.9 ألف فدان. أما على المستوى القومي فمن الممكن توفير حوالي 29.3 مليون م^3 وهذه الكمية من المياه يمكن أن تزيد في المساحة المزروعة بالبصل بنحو 16.3 ألف فدان. وبتعميم النتائج على المساحة المزروعة بالقمح في الفيوم يمكن توفير حوالي 2.73 مليون متر مكعب ، ويمكن لهذه الكمية من المياه أن تزيد في المساحة المزروعة بالقمح بنحو 1.5 ألف فدان. أما على المستوى القومي فمن الممكن توفير حوالي 261.68 مليون م^3 وهذه الكمية من المياه يمكن أن تزيد في المساحة المزروعة بالقمح بنحو 145 ألف فدان.

بناءاً على النتائج السابقة للدراسة، توصي هذه الدراسة بتقديم قروض لتشجيع صغار المزارعين على الانتقال من أنظمة الري التقليدية إلى أنظمة الري الحديثة وتنظيم برامج تدريبية لصغار المزارعين عن طريق الإرشاد الزراعي حول كيفية تشغيل وصيانة أنظمة الري الحديث.

الكلمات المفتاحية: *ندرة المياه، كفاءة الري، أنظمة الري الحديث، إدارة الموارد المائية، الكفاءة الاقتصادية.*