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Socio-economic Impacts of Small Canals Maintenance (Case study Desonas Canal, Egypt)

Abd El Magid H. A. Abd El Maksoud[1*], Hala H. A. Abd Elmaksoud[2], Ahmed M. Elfarouk[1]

[1] National Water Research Center
[2] Department of Agricultural Economics and Agri-business, Faculty of Agriculture - Menoufia University
Bido_elgentl@yahoo.com

Abstract: Improving agricultural production depends on the efficient utilization of different agricultural resources. Irrigation water, as a scarce resource, is the control element among different agricultural resources. In Egypt, many irrigation canals are suffering from the deterioration of their infrastructure, which adversely affect their hydraulic performance and their ability to provide irrigation water to different regions at required time. Desonas branch canal (Behera Governorate) was an example for canals with low hydraulic performance. The canal was suffering from infrastructural problems and bad attitudes from surrounding household, such as dumping wastes and sewage into the canal. The canal was also suffering from the operation problem, as its irrigation rotation was not steady. A project was conducted for the maintenance of Desonas canal. The current study evaluated the economic and social impacts of such project. The study applied Data Envelopment Analysis (DEA) model to estimate technical efficiency, allocative efficiency and cost efficiency for different regions on the canal (head, middle and tail end) before and after the maintenance. The results referred to higher technical, distributional, and economical efficiency for agricultural utilized resources after the implementation of the maintenance project. There was a considerable increase in the yield, with the same resources, after implementing the maintenance program, and it was obvious at tail end region due to solving the irrigation problems as this region. For wheat crop, the increase ratios were between 7.8% at the head region and 24.7% at tail end region. For rice crop, the increase ratios were between 6.4% at the head region and 17.1% at tail end region. Besides the economic impact, the results referred to other social and environmental impacts. Data Envelopment Analysis model referred to the possibility of increasing the yield and decreasing the waste with the same inputs after the maintenance project.
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1: Introduction:

Agricultural production is considered one of the main sources of gross domestic product) GDP (, where the Egyptian agriculture sector contributes about 11.1% of GDP in 2016-2017 (Statistical Yearbook, 2018). The importance of agricultural production is also evident from the increasing demand for food to face the escalated population increase in Egypt. However, Egypt suffers from water scarcity as its usage and management is considered a core determinant and challenge that faces the agricultural sector.

The development and management of water resources in Egypt require a continuous provision of water needs for all sectors to meet current and future economic and social development programs and plans. Such plans include maintenance of water canals to ensure the availability and regularity of water in appropriate quantities at the proper times for crops along various locations on the canals whether at the beginning, middle or end of the canal. Hence, to ensure increasing production and productivity of crops along canals.

In Egypt, the irrigation network is composed of a group of canals and water channels that deliver water to cultivated areas. Therefore, there is a necessity to preserve and non-encroachment these water channels either by building or filling it with solid waste. In addition, rationalizing the use of water at the beginning of the canal by farmers to ensure that water reaches all crops on waterways in adequate quantities and time.

2: Study area:

Desonas canal is located within the irrigation district command area of Behera Governorate in Egypt. Its intake is located on AL-Mahmoudia canal at km (29.750), and release its water into Demian drain. Desonas canal serves command area of 2640 feddans and passing by 8 villages. Eleven bridges are constructed across Desonas canal with bridge width range between 2 and 5 meters. (Figure 1)

3: Research problem:

As mentioned earlier, Desonas canal, as most other canals, suffers in some locations from a number of encroachments such as throwing household sewage and garbage, as well as other residuals on both sides of the canal and not clearing canal branches. Such obstacles lead to narrowing the stream in these locations. In addition to, the lack of rationalization in water usage at the beginning of the canal by farmers, and insufficient days of irrigation shifts, such obstacles, lead to a change in the hydraulic balance of the canal after these narrow locations. Thus, there is a difficulty in water access to canal end, pollution of irrigation water and low quality. This creates problem of required water for crops and affect not only their productivity but also farmers' income. The problem here is that the absence of sufficient studies witch dealt with this problem from the socio-economic view.

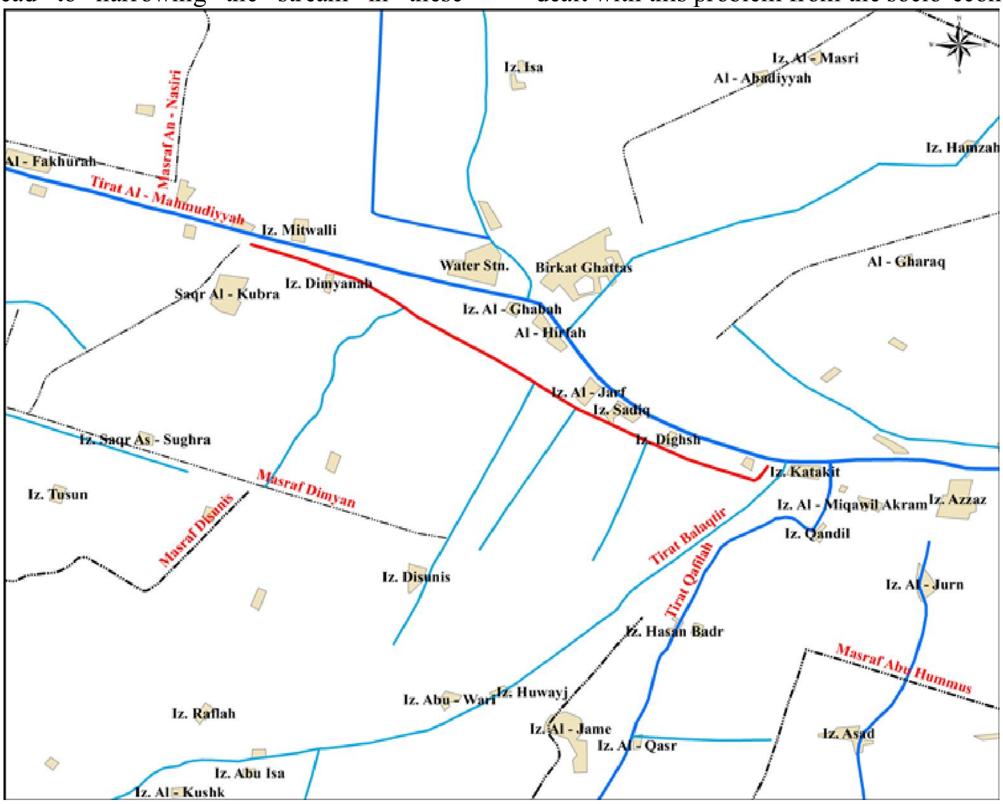

Figure (1) General layout " Desonas Canal - Al- Behera irrigation directorate

4: Study Objective:

The paper aimed to assess the economic and social implications resulted from the maintenance of Desonas canal. Such implications could be achieved via the following objectives:

- Estimating the impact of farm site along the canal (beginning, middle or end of canal) on wheat and rice productivity via employing dummy variables.
- Estimating productivity, economic and distribution efficiencies for before and after canal maintenance of each of the lands that located whether at the beginning, middle or end of the canal, in addition to, test the significant difference among these competencies for each group of these lands.

5: Data sources:

The study relied on different sources of data needed to achieve its objectives. A questionnaire was designed for this purpose where it included wheat and rice crops because there planted areas were ranked the first all over the harvested areas along the canal, constituting about 50% (each) of total winter and summer areas respectively in agricultural seasons 2014 to 2017. A random sample of 120 farms were selected along the range of the canal. However, the sample was divided into three sections, The first represented the land located at the beginning of the canal representing about 25% of the total planted area, the second section the land located at the middle of the canal area representing about 25%, While the third section located at the end of the canal representing about 50% of the total planted area. Moreover, secondary data was obtained form Statistical Yearbook, issued by Central Agency for Public Mobilization and Statistics (CAPMS).

6: Methodology

The study relied on both descriptive and quantitative methods. It employed Data Envelopment Analysis (DEA) for both Constant Return to Scale (CRS) and Variable Return to Scale (VRS) to estimate Technical Efficiency (TE), Allocative Efficiency (AE) and Cost Efficiency (CE).

Owing to Emrouznejad and Cabanda (2015), Data Envelopment Analysis is a non-parametric approach that used a linear programming to determine the efficiency DEA for a firm. DEA solves an individual linear programming problem for each firm, in which the firm's input and output data are assigned a set of weights to maximize the ratio of inputs and outputs. Under this approach, an efficient firm or a linear combination of other firms can produce more of all outputs using less of any inputs that are feasible. Hence, the DEA method can construct a non-parametric envelopment frontier over the data points of all units or observations that lie on or below the efficiency frontier (Coelli et al., 2005).

The theoretical foundation of the Data Envelopment Analysis (DEA) can be traced from economic and production theories. Production is defined as a process of transforming inputs such as land, labour, and capital or valuable resources into goods and services. The underlying issue of the efficiency of combining inputs to produce some outputs can be measured by efficient measures. Economic efficiency is achieved where production costs are lower and consumers demand the combination of goods and services to be produced. Technical efficiency and allocative efficiency are the two components of economic efficiency measure. Technical efficiency refers to the waste avoidance, either by producing much output as technology and input usage needed or by using as little input required by technology and output production (Fried et al., 2008). The analysis of technical efficiency can either have an output orientation or an input orientation. The allocative efficiency refers to the combination of inputs to produce a given quantity of outputs given the prevailing input prices (Coelli et al., 2005).

The Cobb-Douglas model is a commonly used production function and expressed in this functional form: for Q as an output, and two inputs: labour L and capital K. The non-linear equation form of this function is $Q = AL^aK^b$. A is a constant that depends on the units of measurement of output Q, and labour L and capital by K. The coefficients a and b are the elasticity of outputs with respect to labour and capital inputs, respectively. Furthermore, a and b can measure returns to scale. If $a + b = 1$, then output remains the same, and efficiency indicates constant returns to scale (CRS). If $a + b <1$, then output is lesser than input and signifies decreasing returns to scale (DRS). If $a + b >1$, then output is greater than input and indicates increasing returns to scale (IRS). The production concept of returns to scale is also considered in calculating productive efficiency of a firm using the data envelopment analysis approach. It relates to increasing and decreasing efficiency based on firm's sizes. When two extremes (IRS and DRS) are combined, it will necessitate variable returns to scale (VRS). As such, VRS is defined as the ability of the firm to catch up, given limitations such as constraints on finances, market imperfection, firm's sizes, etc. that may cause the firm not to be operating at optimal scale. On the other hand, the constant returns to scale (CRS) signify that the firm is able to scale the inputs and outputs linearly without increasing or decreasing efficiency (Ramanathan, 2003).

7: Research findings:

7.1: The Economic Impact of Desoons canal Maintenance:

Dessons area is about 2,640 Feddan planed by various winter and summer crops. There is a significant effect resulted by hydraulic problems for areas at the middle and end of the canal. Where, they suffer from lack of irrigation water in both quantities and exact time availability for planted crops.

7.1.1: the relation between farm site along the canal and productivity per Feddan

A relation between farm site whether it is located at the beginning or middle and the end of the canal and productivity per Feddan could be modelled as follows in equation 1:

$$Y = \alpha_1 + \alpha_2 D_2 + \alpha_3 D_3 \text{ eq. 1}$$

Where,

(Y) = Productivity per feddan.

(α_1) = Productivity per feddan if farm site at the beginning of canal.

(D_2) = A Dummy takes (1) if farm site at the middle of canal, (0) otherwise.

(D_3) = A Dummy takes (1) if farm site at the end of canal, (0) otherwise. (El-Shorbagy, 2000)

7.1.1.1- For Wheat Crop

$$Y = 2.553 - 0.21 D_2 - 0.523 D_3$$
$$(158.2)^{**} \quad (-9.14)^{**} \quad (-22.92)^{**}$$
$$R^2 = 0.85 \quad F = 266^{**}$$

The results showed that wheat average productivity per feddan for farms located at the beginning of the canal was estimated at 2.553 ton per Feddan. Whereas, farms located at the middle and end of the canal reached about 2.343 and 2.030 ton per Feddan respectively. The successive fall in wheat productivity per feddan for farms located at the middle and end of the canal was presumably due to the exposure of such farms to problems of water shortage. However, farms at the beginning of the canal were less vulnerable to water shortages. Moreover, coefficient of determination depicted that about 85% of the changes occurring in wheat production per feddan related to farm site on the canal.

7.1.1.2 - A crop of rice:

$$Y = 3.616 \quad - 0.284\, D_2 - \quad 0.739\, D_3$$
$$(121.8)^{**} \quad (-6.77)^{**} \quad (-17.7)^{**}$$
$$R^2 = 0.84 \quad F = 159.9^{**}$$

The results showed that rice average productivity per feddan for farms located at the beginning of the canal was estimated at 3.616 ton per Feddan. Whereas, farms located at the middle and end of the canal reach about 3.332 and 2.877 ton per Feddan respectively. The successive fall in rice productivity per feddan for farms located at the middle and end of the canal was presumably due to the exposure of such farms to problems of water shortage. However, farms at the beginning of the canal were less vulnerable to water shortages. Moreover, coefficient of determination depicts that about 84% of the changes occurring in wheat production per feddan were related to farm site on the canal.

7.1.2: Technical and Allocative Efficiency of Resources used in Wheat and Rice Production

The adopted methodology analysis employed inputs as seeds, nitrogenous fertilizer, phosphate fertilizer, labour, mechanical work and pesticides, whereas, the quantity of production was represented for output.

7.1.2.1: Technical Efficiency:

Technical efficiency results for (CRS) and (VRS) presented in Table (1) shows high efficiency scores for resources used in producing wheat and rice after applying canal maintenance for land site along the canal whether at the beginning, middle or end.

7.1.2.1.1: For Wheat

Technical efficiency for employed resources in wheat production at beginning, middle and end of the canal increased after maintenance to about 0.978, 0.964 and 0.946 respectively compared to 0.952, 0.918 and 0.853 before maintenance. Reaching an increase of about 0.026, 0.046 and 0.093 respectively, while the return to scale for each site remained constant. Moreover, (VRS) results showed an increased or same record after maintenance estimated at 0.998, 1.00 and 0.999 compared to 0.998, 0.990, and 0.972 before maintenance. In other words, an increase of about 0.000, 0.010, 0.027 respectively. Moreover, a statistical significant difference between the two competencies has been obtained, implying that canal improvements and maintenance have resulted an increase in wheat productivity per feddan.

7.1.2.1.2: For Rice

The technical efficiency of the resources used for rice production for areas at the beginning, middle and end of the canal for (CRS) increased from 0.963, 0.922 and 0.879 respectively before canal improvements and maintenance to about 0.971, 0.940 and 0.928 respectively after maintenance. With an increase of about 0.008, 0.018, 0.049 respectively. Moreover, (VRS) results showed an increased or same record after maintenance estimated at 1.00, 0.976, 1.00 compared to 1.00, 0.974, 0.990 before maintenance. In other words, an increase of about 0.000, 0.002 and 0.010 respectively. In addition, a statistical significant difference between the two competencies has been obtained, implying that canal improvements and maintenance have resulted an increase in rice productivity per feddan.

7.1.2.2: Allocative Efficiency for Wheat and Rice Production:

Table (1) shows that allocative efficiency for wheat and rice production after canal maintenance has increased for areas located at the beginning of the canal that amounted about 0.968 and 0.971 respectively, compared to about 0.935 and 0.887 respectively before maintenance, an increase of about 0:033 and 0.084 respectively**.** However, for areas located at middle of the canal, it was estimated at 0.967 and 0.951 respectively compared to 0.928 and 0.885 respectively before maintenance, i.e., an increase of about 0.039 and 0.066 respectively. The same result have been achieved for areas at the end of the canal where it was recorded after maintenance about 0.963 and 0.950 respectively compared to 0.922 and 0.873 respectively before maintenance with an increase of about 0.041 and 0.077 for both crops respectively. It was worth mentioning that, all distribution efficiencies estimated results for the difference between post and pre maintenance for both wheat and rice areas located at the beginning, middle or end of the canal were statistically significant.

This result implies that resource combinations under prevailing relative prices do not achieve cost minimization, in other words, the same amount of production can be obtained at lower costs, i.e., capital resources are wasted as a result of mismanagement. Therefore, the implementation of improvements to the canal has resulted a reduction in wasted capital resources value used at the beginning of the canal area for wheat by about 3.3%, amounting nearly 132 LE/fed and for rice by about 8.4%, amounting 420 LE/fed. While for wheat areas at the middle of the canal was about 3.9%, amounting 156 LE/fed, and for rice accounted 6.6%, amounting 330 LE/fed. As for the agricultural lands located at the end of the canal, the value of the waste in the capital resources used to produce the wheat was reduced by 4.1 %, amounting about 164 LE/fed, whereas, for rice by about 7.7 %, estimated 385 LE/fed.

7.1.2.3: Economic Efficiency for Wheat and Rice Production

Table (1) shows that wheat and rice economic efficiency (CRS) for areas located at the beginning of the canal. For pre maintenance, wheat and rice reached about 0.896 and 0.856 respectively compared to 0.947 and 0.943 respectively after canal maintenance. In other words, an increase of about 5.1% and 8.7% respectively. Such that achieving a statistically significant increase in wheat and rice returns estimated by LE 255 and LE 696 per feddan respectively as a result of the implementing canal maintenance. Despite that the cost of production of these two crops after canal maintenance is still more than the lowest point of average costs on the average cost curve that equates about 5.3 % and 5.7% for each crop respectively.

Moreover, they reached (before canal maintenance) about 0.852 and 0.817 for middle area sites compared to about 0.932 and 0.894 respectively (after making improvement, representing an increase of about 8% and 7.7% respectively. Such that achieving statistically significant increase in wheat and rice return by about LE 400 and LE 616 per feddan as a result of the implementing canal maintenance. Despite that the cost of production of these two crops after canal maintenance is still more than the lowest point of average costs on the average cost curve that equates about 6.8 % and 10.6% for each crop respectively.

Meanwhile, they reached (before canal maintenance) about 0.787 and 0.768 for farm sites located at the end of the canal compared to about 0.911 and 0.882 respectively (after making improvement, representing an increase of about 12.4% and 11.4% respectively. Such that achieving a statistically significant increase in wheat and rice return by about LE 620 and LE 912 per feddan as a result of the implementing canal maintenance. Despite that the cost of production of these two crops after canal maintenance is still more than the lowest point of average costs on the average cost curve that equates about 8.9 % and 11.8% for each crop respectively.

As mentioned above, it was obvious that the employed inputs combinations under prevailing current relative prices before making canal maintenance do not achieve either production maximization nor profit maximization.

Table (1): Technical, Allocative and Economic Efficiency for Wheat and Rice Crops before and after Canal Maintenance

Crop	Location	Before & After Canal Maintenance and Difference between them	Technical Efficiency		Allocative Efficiency	Economic Efficiency
			CRS	VRS		
Wheat	Beginning of the Canal	Before	0.952	0.998	0.935	0.891
		After	0.978	0.998	0.968	0.947
		Difference	0.026	0	0.033	0.056
		T-value	5.48**	0	6.5**	8.6**
	Middle of the Canal	Before	0.918	0.99	0.928	0.852
		After	0.964	1	0.967	0.932
		Difference	0.046	0.01	0.039	0.08
		T-value	7.45**	3.89**	6.5**	10.7**
	End of the Canal	Before	0.853	0.972	0.922	0.787
		After	0.946	0.999	0.963	0.911
		Difference	0.093	0.027	0.041	0.124
		T-value	11.9**	5.76**	7.3**	14.3**
Rice	Beginning of the Canal	Before	0.963	1	0.887	0.856
		After	0.971	1	0.971	0.943
		Difference	0.008	0	0.084	0.087
		T-value	2.24*	0	10.36**	10.56**
	Middle of the Canal	Before	0.922	0.947	0.885	0.817
		After	0.94	0.985	0.951	0.894
		Difference	0.018	0.038	0.066	0.077
		T-value	3.96**	6.44**	8.85**	9.44**
	End of the Canal	Before	0.879	0.99	0.873	0.768
		After	0.928	1	0.95	0.882
		Difference	0.049	0.01	0.077	0.114
		T-value	7.57**	3.84**	9.44**	13.96**

Source: Compiled and calculated from the questionnaire, however the study employed DEAP program for statistical analysis.
*: Significant at 5%**: Significant at 1%

7.1.3: Estimation of the possible increase in product and excess costs expenditure for wheat and rice (The DEA program is employed for this analysis)

7.1.3.1: Possible Increase in Production Yield:

7.1.3.1.1: For Wheat Farms

Efficiency analysis resulted for wheat farms presented in Table (2) indicate the possibility of increasing their production via employing same inputs and technology (before applying canal maintenance) by 0.064 ton/fed, 0.068 ton/fed and 0.104 ton/fed for location sites at the beginning, middle and end of the canal respectively compared to 0.052 ton/fed, 0.055 ton/fed and 0.069 ton/fed for the same sites after applying canal maintenance.

7.1.3.1.2: For Rice Farms

Efficiency analysis resulted for rice farms presented in Table (2) suggest the possibility of increasing their production via employing same inputs and technology (before applying canal maintenance) by 0.065 ton/fed, 0.139 ton/fed and 0.154 ton/fed respectively for location sites at the beginning, middle and end of the canal respectively compared to 0.013 ton/fed, 0.079 ton/fed and 0.095 ton/fed respectively for the same sites after applying canal maintenance.

Table (2): Possible Increment in Wheat and Rice Yields due to Canal Maintenance

Location		Before & After Canal Maintenance and Difference between them	**Wheat (ton)**			**Rice (ton)**		
			Actual	Expected	Difference	Actual	Expected	Difference
Beginning of the Canal	Yield	Before	2.553	2.617	0.064	3.62	3.685	0.065
		After	2.753	2.805	0.052	3.85	3.863	0.013
Middle of the Canal		Before	2.343	2.411	0.068	3.33	3.469	0.139
		After	2.67	2.725	0.055	3.61	3.689	0.079
End of the Canal		Before	2.03	2.134	0.104	2.87	3.024	0.154
		After	2.532	2.601	0.069	3.36	3.455	0.095

Source: Compiled and calculated from the questionnaire, however the study employed DEAP program for statistical analysis.

7.1.4: Accessing Inputs Overconsumption for Wheat and Rice:

7.1.4.1: For Wheat Farms

Results presented in Table (3) shows the overconsumption in production inputs for wheat before and after Desonas canal maintenance. In general, it depicted a considerable decline in employed inputs after canal maintenance. However, this could be discussed in details as follows:

For Seeds:

Results depicted that there was an excess in average seeds consumption per feddan before applying canal maintenance all over its sites (the beginning, middle and end) estimated at 0.53, 0.86 and 1.04 kg/feddan respectively. While after applying canal maintenance it was estimated at 0.32, 0.41 and 0.52 kg/feddan respectively for the three sites.

For Fertilizers

Nitrogen fertilizers:

Results depicted that there was an excess use in average nitrogenous fertilizer per feddan before applying canal maintenance all over its sites (the beginning, middle and end) estimated at 5.0, 5.1 and 4.8 unit/feddan respectively. While after applying canal maintenance it was estimated at 2.0, 2.2 and 0.0 unit/feddan respectively for the three sites.

Phosphate Fertilizer:

Results depicted that there was an excess use in average phosphate fertilizer per feddan before applying canal maintenance all over its sites (the beginning, middle and end) estimated at 3.2, 2.9 and 3.2 unit/feddan respectively. While after applying canal maintenance it was estimated at 1.1, 0.2 and 1.0 unit/feddan respectively for the three sites.

For Labour:

Results depicted that there was an excess use in average human labour per feddan before applying canal maintenance all over its sites (the beginning, middle and end) estimated at 3.3, 2.9 and 3.2 man working day/feddan respectively. While after applying canal maintenance it was estimated at 1.1, 0.2 and 1.0 man working day/feddan respectively for the three sites.

For Mechanical work

Results for the average amount of in mechanical work per feddan before maintenance for various locations on the canal (beginning, middle and end) is about 25.0hp, 26.1hp and 28.0hp respectively. Meanwhile, the excess in mechanical work after maintenance was estimated at 1.1hp, 3.2hp and 5.3hp respectively.

Table (3): Wheat Inputs Overconsumption by farm Site (Before and After Canal Maintenance)

Location	Inputs	Before & After Canal Maintenance	Unit	Actual	Expected	Overconsumption
Beginning of the Canal	Seeds	Before	Kg/Feddan	60.67	60.14	0.53
		After		60.03	59.71	0.32
Middle of the Canal		Before		61.12	60.26	0.86
		After		60.33	59.92	0.41
End of the Canal		Before		61.94	60.9	1.04
		After		60.71	60.19	0.52
Beginning of the Canal	Nitrogen fertilizers	Before	azote unit/Feddan	137.13	132.09	5.4
		After		136.6	134.6	2
Middle of the Canal		Before		137.3	132.2	5.1
		After		137	134.8	2.2
End of the Canal		Before		137.6	132.8	4.8
		After		137.1	137.1	0
Beginning of the Canal	Phosphate Fertilizer	Before	Phosphate unit/Feddan	48.64	45.34	3.3
		After		48.5	46.5	2
Middle of the Canal		Before		49.5	46.6	2.9
		After		49.3	49.1	0.2
End of the Canal		Before		49.7	46.5	3.2
		After		49.2	48.2	1
Beginning of the Canal	Labour	Before	Man working day/Feddan	10.18	9.68	0.5
		After		10	9.9	0.1
Middle of the Canal		Before		10.3	9.9	0.4
		After		10.1	10.1	0
End of the Canal		Before		10.5	10	0.5
		After		10.3	10.2	0.1
Beginning of the Canal	Mechanical work	Before	Horse Power/Feddan	401	376	25
		After		390	388.9	1.1
Middle of the Canal		Before		409	382.9	26.1
		After		395	391.8	3.2
End of the Canal		Before		419	390.5	28.5
		After		400	394.7	5.3

Source: Compiled and calculated from the questionnaire, however the study employed DEAP program for statistical analysis.

7.1.4.2: Rice Farms

Results presented in Table (4) shows the overconsumption in production inputs for rice before and after Desonas canal maintenance. In general, it depicted a considerable decline in employed inputs after canal maintenance. However, this could be discussed in details as follows:

For Seeds:

Results depicted that there was an excess in average seeds consumption per feddan before applying canal maintenance allover its sites (the beginning, middle and end) estimated at 2.0, 3.3 and 2.45 kg/feddan respectively. While after applying canal maintenance it was estimated at 0.05, 0.07 and 0.0 kg/feddan respectively for the three sites.

For fertilizers:

Nitrogen fertilizers:

Results depicted that there was an excess use in average nitrogenous fertilizer per feddan before applying canal maintenance allover its sites (the beginning, middle and end) estimated at 6.4, 11.0 and 11.2 unit/feddan respectively. While after applying canal maintenance it was estimated at 1.4, 1.7 and 1.3 unit/feddan respectively for the three sites.

Phosphate Fertilizer:

Results depicted that there was an excess use in average phosphate fertilizer per feddan before applying canal maintenance allover its sites (the beginning, middle and end) estimated at 5.5, 7.7 and 6.3unit/feddan respectively. While after applying canal maintenance it was estimated at 2.5, 0.5and 0.3 unit/feddan respectively for the three sites.

For Work

Mechanical work:

Results for the average amount of in mechanical work per feddan before maintenance for various locations on the canal (beginning, middle and end) was about 36hp, 46hp and 60 hp respectively. Meanwhile, the excess in mechanical work after maintenance was estimated at 1.6hp, 3.6hp and 2hp respectively.

Table (4): Rice Inputs Overconsumption by farm Site (Before and After Canal Maintenance)

Location	Inputs	Before & After Canal Maintenance	Unit	Actual	Expected	Overconsumption
Beginning of the Canal	Seeds	Before	Kg/Feddan	59	57	2
		After		56.1	56.05	0.05
Middle of the Canal		Before		59.8	56.5	3.3
		After		57.1	57.03	0.07
End of the Canal		Before		60.2	57.75	2.45
		After		58	58	0
Beginning of the Canal	Nitrogen fertilizers	Before	azote unit/Feddan	176.8	172.4	6.4
		After		173.2	171.8	1.4
Middle of the Canal		Before		178.1	167.1	11
		After		174.2	172.5	1.7
End of the Canal		Before		179.6	168.4	11.2
		After		175.2	173.9	1.3
Beginning of the Canal	Phosphate Fertilizer	Before	Phosphate unit/Feddan	47.8	42.3	5.5
		After		47	44.5	2.5
Middle of the Canal		Before		49.6	41.9	7.7
		After		47.8	47.3	0.5
End of the Canal		Before		50.1	43.8	6.3
		After		48.1	47.8	0.3
Beginning of the Canal	Labour	Before	Man working day/Feddan	13	12	1
		After		12.3	12.26	0.04
Middle of the Canal		Before		13.4	12	1.4
		After		12.5	12.48	0.08
End of the Canal		Before		13.8	12.7	1.1
		After		12.8	12.75	0.05
Beginning of the Canal	Mechanical work	Before	Horse Power/Feddan	865	829	36
		After		848	846.4	1.6
Middle of the Canal		Before		870	824	46
		After		852	848.4	3.6
End of the Canal		Before		873	813	60
		After		860	858	2
Beginning of the Canal	Animal work	Before	hour/Feddan	9.4	8.4	1
		After		8	8	0
Middle of the Canal		Before		9.7	8.2	1.5
		After		8.8	8.8	0
End of the Canal		Before		10.4	9.4	1
		After		9.2	9.2	0
Beginning of the Canal	Pesticides	Before	LE/Feddan	58	57	1
		After		53	53	0
Middle of the Canal		Before		59.5	58.2	1.3
		After		54.1	54.1	0
End of the Canal		Before		60.1	58.7	1.4
		After		55.1	55.1	0

Source: Compiled and calculated from the questioner, however the study employed DEAP program for statistical analysis.

Animal work:

Results for the average amount of excess in animal work per feddan (before and after maintenance) for various locations on the canal (beginning, middle and end), was nearly nil, that estimated at 1.0, 1.5 and 1.4 hour respectively compared to zero for all sites after canal maintenance.

For Labour

Results depicted that there was an excess use in average human labour per feddan before applying canal maintenance all over its sites (the beginning, middle and end) estimated at 1.0, 1.4 and 1.1 man working day/feddan respectively. While after applying canal maintenance it was estimated at 0.04, 0.08 and 0.05 man working day/feddan respectively for the three sites.

For Pesticides:

Results for the average amount of excess usage of pesticides per feddan for rice farms (before and after maintenance) for various locations on the canal (beginning, middle and end), was nearly nil, that estimated at LE 1.0, LE 1.3 and LE 1.4 respectively compared to zero for all sites after canal maintenance.

7.2: Social and Environmental Impacts for Desonas Canal Maintenance

7.2.1: Social Effects:

The estimated land productivity increment as a result of canal maintenance reached about 505 ton for wheat and 492 ton for rice, thus an increased possibility for more agricultural exports of the rice crop by about US $ 165300 and reduction in agricultural imports of the wheat crop by about US $ 113200 employing the same available productive resources. In other words, achieving higher level of food security and improving the individual living standards. In addition, providing employment opportunities for both canals maintenance workers by about 3500 Man working day and agricultural labour by about 4000 Man working day for every crop, thus generating incomes for individuals especially for the poor and middle class individuals. On the other hand, the increased food supply would lower its price. However, the paper estimated the increase in income per wheat and rice feddan by about LE 3500 on average (relying on farm market prices).

7.2.2: Environmental Impacts:

Environmental protection and preservation from various types of pollution became the most important contemporary issues facing both developed and developing countries alike, particularly after the aggravation of climate change and global warming problems, hence it is important to identify the positive effects of maintain water canals in general and Desonas in particular:

- The use of plant and animal production residuals and non-solid waste in the producing of organic fertilizers, compost and biogas, which leads to safe use of waste as well as an increase in net farm income by about LE 500 per feddan.
- Increasing of agricultural production for various crops and livestock fodders which leads to higher levels of food security and thus improving human living and lack of exposure to infections, particularly anaemia and food deficiency diseases. Where the average cost of treating these diseases for the family annually about LE 2000 according to the study sample data.
- Preventing desertification of some lands due to the lack of water needed for cultivation.
- Improving agricultural land levels as a result of reducing the usage of chemical fertilizers and use organic fertilizer (compost) and thus produce healthy food. As well as cut production costs by an estimated LE 400 per feddan according to the study sample data.

8: Conclusion & Recommendations

The current study evaluated the impact of implementing a maintenance project in Desonas branch canal (El-Behara governorate) on improving the efficiency of utilizing different agricultural resources. Before the maintenance project, Desonas canal was suffering from different infrastructural and environmental problems.

The results referred to a significant change in the utilization efficiency of agricultural resources as the yield increased for both wheat and rice crops after the maintenance project using the same resources. Based on collected samples of the questionnaires, the increase in the yield was obvious at tail end region due to solving the irrigation problems as this region. For wheat crop, average yield values before the maintenance were 2.553 ton at head region, 2.343 ton at middle region, and 2.030 ton at tail end region. After the maintenance project, average yield increased to 2.753, 2.670 and 2.532 tons at head, middle and tail end regions respectively. The increase ratios were between 7.8% at the head region and 24.7% at tail end region. For rice crop, average yield values before the maintenance were 3.616, 3.332 and 2.877 tons at head, middle and tail end regions respectively. After the maintenance project, average yield increased to 3.85, 3.61 and 3.36 tons at head, middle and tail end regions respectively. The increase ratios were between 6.4% at the head region and 17.1% at tail end region.

Based on the statistical analysis, there was a significant evidence that the technical efficiency was higher after the maintenance project considering both Constant Return Scale (CRS) and Variable Return Scale (VRS) for wheat and rice crops. Distribution and economic efficiencies were significantly higher after the maintenance project considering Constant Return Scale (CRS) for wheat and rice crops.

Data Envelopment Analysis model was used to assess the change in the utilization efficiency after implementing the maintenance project and the study was applied for wheat and rice crops, and the results referred to the possibility of increasing the yield and decreasing the input waste with the same inputs after the maintenance project.

Other important impacts for the maintenance project were the social and environmental impacts. Regarding the social impacts, there was an increase of the income equals 3500 L.E/feddan, which resulted in an improvement in life standard. Another social impact was providing employment chance during the maintenance project. The project offered 3500 man working days besides 4000 man working days for agricultural.

The environmental impacts included using plants and animal production residuals for the production of organic fertilizer, compost and biogas. This leads to increasing the income by 500 L.E/feddan, increasing agricultural production and decrease food deficiency diseases. As well as cut production costs by an estimated LE 400 per feddan and decrease family expenditure by 2000 L.E/year from the total money they were spending for the therapy of infection diseases, according to the study sample data.

In general, the results referred to significant improvement of different agricultural aspects after the maintenance of Desonas canal.

The study recommended the following

- There is a high importance of implementing the maintenance programs to the irrigation canals in Egypt. The proper maintenance program should be selected based on canals characteristics. With the maintenance program, water availability will improve at different regions of the canals, which will increase farmers' incomes with about 3500 L.E/feddan and providing more work opportunities with about 3 working days/ feddan/crop.
- The maintenance system should be associated with a program for environmental protection. This includes conducting a recycling program to collect and recycle solid waste, garbage, and plants wastes. This could improve the farmers' income by about 500 L.E/fed and providing more work opportunities with about 4 working days/ feddan/crop.
- The rotation system should be adapted to provide the sufficient water for different regions of the canal.

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