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A Comparative Economic Study of the Production of Sugar Cane and Sugar Beet in Egypt

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ABSTRACT

Sugar production in Egypt depends mainly on sugar cane and sugar beet crops, and the expansion of their cultivation in Egypt faces some challenges. With regard to the productive indicators of the sugarcane crop, the results of the research, as shown by the results of the general time trend analysis, indicate that there is a statistically significant increase in the annual cultivated area, which is estimated at about 1.186.87 feddan. This is equivalent to about 0.36% of the average, and there is a statistically significant annual decrease in the average. The productivity is estimated at about 0.224 tons/ feddan, representing about 0.47% of the average. It was also found that there is a statistically insignificant annual decline in total production. As for the productivity indicators for the sugar beet crop in Egypt, the results indicate that there is a statistically significant increase in the annual cultivated area, estimated at about 26,486.91 feddan, representing about 5.62% of the average. It also turns out that there is a statistically non-significant annual decrease in the average productivity of the sugar beet crop in Egypt. It was found that there was a statistically significant annual increase in total production, estimated at approximately 539,079.13 tons, representing approximately 50.5% of the average. According of the development of economic indicators for sugar cane and sugar beet crops in Egypt during the period research, the results of the general time trend analysis showed that there was a statistically significant increase in the price of a ton of sugar cane and sugar beet annually, estimated at about 31.47, 49.57 pounds per ton, representing about 10.08%, 7.28% of the average respectively. This research also showed a statistically significant increase in the costs of producing feddan of sugar cane and sugar beet annually, estimated at about 693.62 and 1179.79 pounds, representing about 10.42% and 11.73% of the average respectively.

Keywords: sugar cane, sugar beet, expansion, Economic Study, Egypt

1. Introduction

Sugar production in Egypt depends mainly on sugar cane and sugar beet crops, and the expansion of their cultivation in Egypt faces some challenges, including: the inability to horizontally expand sugarcane cultivation, as well as limited subscription. There are several other factors, including: limited water, and the high rate of population growth. It is wonderful that there are many forces in the population of the Arab Republic of Egypt, and it represents something reasonable on the land's own natural resources, suppliers, diversity. The increase in supply prices for competitive agricultural crops and the rise in the value of investments in the sugar industry are other factors.

1.1.Problem of the study

The problem of the research is the increasing demand for sugar, and since sugar cane is absolutely the main crop of production in Egypt, in addition to the increasing interest in the sugar beet crop as a diversified product, it was necessary to conduct a comparison between the economics of producing sugar in the two crops to determine the capacity and weakness. Everything we have is produced. This is because they are considered two leading producers of sugary products in Egypt.

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1.2.Objective of the study

This research aims to make a comparison between the economics of sugar cane and sugar beet production in terms of cultivated area, productivity, total production, costs, net return, net return of the invested pound, and net return per unit of water, at current prices.

2. Research methodology

This research was based on both descriptive and quantitative economic analysis methods. Where general time trend equations and some other economic indicators were used, one-way analysis of variance was also used for the differences between averages of productivity and between producing governorates, and the application of Duncan's Multiple Range Test (DMRT) was also used to test the least significant difference to test significance. The difference between average productivity for sugar cane and sugar beet crops according to the differences in the most important producing governorates. In order for the research to achieve its objectives, it has depended on secondary data from its various sources, and studies related to the subject of the research, each of which was referred to at the time, also, the research depended on Nerlov model (the Partial Adjustment Model) to estimate Targeted production volume for sugar cane and beet.

3. Results

Some productivity and economic indicators for sugar cane and sugar beet crops in Egypt during the period (2008-2021)

First: Development of production indicators for sugar cane and sugar beet crops in Egypt during the period (2008-2021)

The area allocated for cultivated any crop is determined by many economic, legal, political and natural factors. From the individual point of view, the area allocated for growing a particular crop depends on its relative profitability compared to other competing crops.

1- Production indicators of sugar cane crop in Egypt

A- Development of the area cultivated with sugarcane

Data from Table (1) indicate that the cultivated area of sugar cane amounted to about 327,746 acres in Egypt as an average for the period (2008-2021), and the cultivated area of the same crop ranged between about 316.712 feddan in 2009 as a minimum and about 342.380 feddan as a maximum in 2021. From the results of the general time trend analysis shown in Table (2), it was found that there was a statistically significant increase in the annual cultivated area, estimated at about 1186.87 feddan, representing about 0.36% of the general average of the area cultivated with the sugarcane crop in Egypt during the average period under study, as the results of the analysis indicate and from The value of the coefficient of determination "R^2" indicates that about 62% of the change may be due to factors reflected by the time element.

B- Development of the average productivity of the sugar cane crop

From the data in Table (1), it is clear that the average productivity of the sugarcane crop reached about 48.06 tons/ feddan as an average for the period (2008-2021) in Egypt, and the average productivity ranged between about 46.58 tons/ feddan in 2019 as a minimum and 50.89 tons/ feddan as a maximum in 2008. It is clear from the results of the general time trend analysis shown in Table (2) that there is a statistically significant annual decrease in the average productivity of the sugarcane crop, estimated at about 0.224 tons/ feddan equivalent to about 0.47% of average productivity in Egypt. It is estimated at about 48.06 tons/ feddan during the average period. The results of the analysis and the value of the coefficient of determination "R^2" also indicate that about 69% of the change may be due to factors reflected by the time element.

C- Development of the total production of the sugar cane crop

From the data in the same table (1), it was shown that the total production of sugarcane in Egypt amounted to about 15.749.,916 tons on average for the period (2008-2021), and the total production ranged between about 15.335.972 tons in 2019 as a minimum and 16.470.221 tons as a maximum in

2008, and from the results of the analysis The general time trend shown in Table (2) is that there is a statistically insignificant annual decrease in the total production of the sugar cane crop in Egypt.

Table 1: Development of production indicators for sugar cane and sugar beet crops in Egypt during the period (2008-2021).

Year	Sugar cane crop			Sugar beet crop		
	Cultivated area(feddan)	productivity (ton/feddan)	Production (ton)	Cultivated area(feddan)	productivity (ton/feddan)	Production (ton)
2008	323590	50.89	16470221	257667	19.91	5132589
2009	316712	48.88	15482170	264595	25.15	5333513
2010	320329	49.04	15708879	385686	20.32	7840304
2011	325498	48.43	15765213	361896	20.68	7486101
2012	325742	47.73	15550476	423756	21.53	9126058
2013	329153	47.94	15780005	460488	21.81	10044266
2014	332025	48.35	16055013	504299	21.90	11045639
2015	328116	48.46	15903336	554941	21.59	11982946
2016	325912	47.32	15422473	559744	20.02	11209160
2017	326236	47.15	15382211	523382	20.75	10860921
2018	327421	48.32	15823103	492708	21.06	10377371
2019	329190	46.58	15335972	605252	20.23	12247170
2020	336140	47.18	15860450	517947	19.85	10284087
2021	342380	46.61	15959305	682771	20.79	14195489
Average	**327746**	**48.06**	**15749916**	**471081**	**21.11**	**9797544**

Source: Ministry of Agriculture and land reclamation, Economics Affairs sector, Agricultural statistical Bulletin, different numbers.

Table 2: Trend for development of cane sugar and beet sugar crops in Egypt during (2008-2021)

Item		Trend equation	R^2	F	Average	Annual change rate %
Sugar cane	**Cultivated area(feddan)**	$Yt=318844.47+1186.87xt$ (4.44) *	0.62	*19.67	327746	0.36
	Productivity (ton/ feddan)	$Y_t=49.74 - 0.224x_t$ (5.11-) *	0.69	*26.10	48.06	0.47
	Production (ton)	$Y_t=15873499.05-16477.71x_t$ (- 0.80)	0.05	0.64	15749916	-
Sugar beet	**Cultivated area(feddan)**	$Y_t=272429.07+26486.91x_t$ (7.47) *	0.82	*55.75	471081	5.62
	Productivity (ton/ feddan)	$Y_t= 22.1 - 0.120\ x_t$ (1.38-)	0.14	1.91	21.11	-
	Production(ton)	$Y_t=5754450.42 +539079.13\ x_t$ (6.20) *	0.76	*38.45	9797544	5.50

(*): significant at level 0.01
Source: collected and calculated from table (1)

2- Production indicators of sugar beet crop in Egypt

A- Development of the area cultivated with sugar beet

Data from Table (1) indicate that the cultivated area of the sugar beet crop amounted to about 471,081 feddan in Egypt as an average for the period (2008-2021), and the cultivated area of the same crop ranged between about 257,667 feddan in 2008 as a minimum and about 682,771 feddan as a maximum in 2021. From the results of the general time trend analysis shown in Table (2), it was found that there was a statistically significant increase in the area cultivated with sugar beet crops annually,

estimated at about 26,486.91 feddan, representing about 5.62% of the general average of the area cultivated with the crop in Egypt during the average period under study, as the results of the analysis indicate and from The value of the coefficient of determination "R^2" indicates that about 82% of the change may be due to factors reflected by the time component.

B- Development of the average productivity of the sugar beet crop:

From the data in Table (1), it is clear that the average acre productivity of the sugar beet crop amounted to about 21.11 ton/ feddan as an average for the period (2008-2021) in Egypt, and the average of productivity ranged between about 19.85 tons/ feddan in 2020 as a minimum and 25.19 ton/ feddan. Acres as a maximum in 2009. It is clear from the results of the general time trend analysis shown in Table (2) that there is a statistically insignificant annual decrease in the average acre productivity of the sugar beet crop in Egypt.

C- Development of the total production of the sugar beet crop:

From the data in the same table (1), it was shown that the total production of sugar beets in Egypt amounted to about 9,797,544 tons on average for the period (2008-2021), and the total production ranged between about 5,132,589 tons in 2008 as a minimum and 14,195,489 tons as a maximum in 2021, and from the results of the analysis The general time trend shown in Table (2) is that there is a statistically significant annual increase in the total production of the sugar beet crop in Egypt, estimated at about 539,079.13 tons, equivalent to about 50.5% of the general average of total production in Egypt, which is estimated at about 9,797,544 tons during the average period, as indicated by The results of the analysis and the value of the coefficient of determination "R^2" indicate that about 76% of the change may be due to factors reflected by the time component.

Second: The development of economic indicators for sugar cane and beet crops in Egypt during the period (2008-2021):

It includes the development of the price of a ton, costs, the net return of production per acre, and the net return of the pound invested in production from sugarcane and sugar beet crops in Egypt at constant prices during the period (2008-2021).

The prices of supplied quantities of sugar cane and sugar beet are determined in the same manner, in that this is done by government decisions, and through a contractual system between producers and factories. However, beet pricing differs from cane pricing in that it is done according to weight, sugar content, and earliness, while beet pricing is Reeds are based on weight only.

Production costs generally refer to the amounts of money paid for the services of factors of production. Short-term productive costs are divided into two basic types of costs: fixed costs and variable costs. The study of production costs represents one of the studies that aim to know the factors responsible for increasing production efficiency, or thus reducing the average total costs per unit of production[(1)].

The net return of the crop means the difference between the total production of the crop and the total costs. The net return obtained is used as an important criterion for measuring and determining the economic efficiency of resources in producing a good or service, and it also gives an indication of the extent to which any economic project can continue or not.

While the net return of the pound invested in the production of sugar crops is meant by dividing the value of the net return of an acre of the crop by its production costs. The net monthly return of the pound invested in production is meant by dividing the value of the net return of an acre of the crop by (its production costs for the duration of the crop's stay in the ground).

1- Development of agricultural prices of sugar cane and sugar beet

It is clear from the data in Table (3) that the price of a ton of sugarcane in Egypt reached its minimum, which is about 200 pounds per ton in 2008, while it reached its maximum, which is about 814 pounds per ton in 2021, and from the results of the general time trend analysis shown in Table (4), it was shown that there is a statistically significant increase in the price of a ton of sugarcane annually,

[1] [(1)]Ragab Mohamed Ahmed, Economics of By-Products of the Sugar Industry, PhD thesis, Department of Agricultural Economics, Faculty of Agriculture, Minya University, 2008, p. 140.

estimated at about 49.57 pounds, representing about 10.08% of the general average price of a ton of sugarcane in Egypt during the average period research. The results of the analysis and the value of the coefficient of determination "R^2" also indicate that about 93% of the change may be due to factors reflected by the time element.

While it is clear that the price of a ton of sugar beet in Egypt reached its minimum, which is about 231 pounds per ton in 2008, while it reached its maximum, which is about 625 pounds per ton in 2021, 2020, and 2019. By estimating the general trend equation for the price of a ton, it was possible to obtain Based on the results shown by the equations in Table (4), which represent a trend in the price of a ton to increase by a statistically significant amount of about 31.47 pounds, the rate of increase reached about 7.28% of the average price during the study period, and the adjusted coefficient of determination (R^2) reached about 88%. Of the change may be due to factors reflected by the time element.

2- Development of costs of sugar cane and sugar beet

The data in Table (3) indicate that the costs of producing the sugarcane crop reached their minimum, which is about 5,640 pounds in 2008, while they reached their maximum, which is about 18,991 pounds in 2021, and from the results of the general time trend analysis Shown in Table (4), it appears that there is a statistically significant increase in the costs of producing an acre of sugarcane crop annually, estimated at about 1,179.79 pounds, representing about 10.42% of the general average price of a ton of sugarcane in Egypt during the average period under study, which amounts to about 11,322 pounds, as the results of the analysis indicate. The value of the coefficient of determination "R^2" indicates that about 90% of the change may be due to factors reflected by the time element.

It is also clear from the data contained in Table (3) that the costs of producing the sugar beet crop reached their minimum which is about 2,368 pounds in 2008, while they reached their maximum, which is about 11,321 pounds in 2021, and from the results of the trend analysis The general timeline shown in Table (4) shows that there is a statistically significant increase in the costs of producing the sugar beet crop annually, estimated at about 693.62 pounds, representing about 11.73% of the general average price of a ton of sugar beet in Egypt during the average period under study, which amounts to about 5915 pounds, as the results of the analysis indicate. From the value of the coefficient of determination "R^2", about 94% of the change may be due to factors reflected by the time element.

3- Development of the net return of sugarcane and sugar beet crops

The data presented in Table (3) Indicate that the net return of the sugarcane crop reached its minimum of about 5,437 pounds in 2009, while its maximum reached about 19,377 pounds in 2017, and from the results of the general time trend analysis shown in Table (4). It was found that there is a statistically significant increase in the net return of an acre of sugarcane crop annually, estimated at about 1078.05 pounds, representing about 8.81% of the general average of the net return of a ton of sugarcane in Egypt during the average period under study, which amounts to about 12,231 pounds, as indicated by the results of the analysis and the value of the coefficient of determination. (R^2) About 87% of the change may be due to factors reflected by the time element.

It is clear from the data in Table (3) that the net return of the sugar beet crop reached its minimum, which is about 2,260 pounds in 2008, while its maximum reached about 5,414 pounds in 2018, and from the results of the general time trend analysis shown In Table (4), it was shown that there is a statistically significant increase in the costs of producing the sugar beet crop annually, estimated at about 91.98 pounds, representing about 2.24% of the general average of the net return of a ton of sugar beets in Egypt during the average period under study, which amounts to about 4103 pounds, as the results of the analysis indicate and the value The coefficient of determination "R^2" indicates that about 20% of the change may be due to factors reflected by the time element.

4- The development of the net return on the invested pound for sugar cane and sugar beet

The data in Table (3) indicate that the net return of the pound invested in the sugarcane crop reached its minimum of about 0.89 pounds in 2020, while its maximum reached about 1.43 pounds in 2011, and from the results of the general time trend analysis shown in the table (4), It was found that there is a statistically insignificant decrease in the net return of the pound invested per acre of sugarcane crop.

It is also clear from the data in Table (3) that the net return of the pound invested in the sugar beet crop reached its minimum of about 0.32 pounds in 2021, while it reached its maximum, which is about 1.57 pounds in 2009, and from the results of the time trend analysis The year shown in Table (4) shows that there is a statistically significant increase in the costs of producing the sugar beet crop annually, estimated at about 0.07 pounds, representing about 8.43% of the general average net return of a ton of sugar beet in Egypt during the average period under study, which amounts to about 0.83 pounds, as the results of the analysis indicate. From the value of the coefficient of determination "R^2", about 78% of the change may be due to factors reflected by the time element.

Table 3: Development of economic indicators for sugar cane and sugar beet crops in Egypt during the period (2008-2021). (Pound)

Year	The price of ton		The costs		Net return		Net return of the pound invested	
	Sugar cane	Sugar beet	Sugar cane	Sugar beet	Sugar cane	Sugar beet	Sugar cane	Sugar beet
2008	200	231	5640	2368	5449	2260	0.97	0.95
2009	235	317	6031	2697	5437	4230	0.90	1.57
2010	280	263	6606	3003	7257	3051	1.10	1.02
2011	335	355	6691	3457	9551	3964	1.43	1.15
2012	360	363	7755	4092	9450	4628	1.22	1.13
2013	360	387	7590	4393	9700	4959	1.28	1.13
2014	400	370	8591	4869	10762	4170	1.25	0.86
2015	400	379	8736	5316	10656	3838	1.22	0.72
2016	620	379	13451	5494	15895	3169	1.18	0.58
2017	720	534	14579	7394	19377	4797	1.33	0.65
2018	720	600	18251	8613	16544	5414	0.91	0.63
2019	720	625	17678	9075	15865	5024	0.90	0.55
2020	720	625	17924	10716	16048	4281	0.89	0.40
2021	814*	625	18991*	11321	19238*	3663	1.06*	0.32
Average	**492**	**432**	**11322**	**5915**	**12231**	**4103**	**1.12**	**0.83**

Source: Ministry of Agriculture and land reclamation, Economics Affairs sector, Costs and net return statistical Bulletin, different numbers.
(*): refer to expected value.

Table 4: Trend for development of sugar cane and sugar beet crops in Egypt during (2008-2021)

Item		Trend equation	R^2	F	The average	Annual change rate %
Sugar cane	**The price of ton**	Y_t=119.87+49.57 x_t (9.60) *	0.93	*160.60	492	10.08
	The costs	Y_t=1179.79– 2474.04x_t * (10.56)	0.90	111.57*	11322	10.42
	Net return	Y_t=4145.23+1078.05x_t (9.09)*	0.87	82.58*	12231	8.81
	Net return of the pound invested	Y_t=1.19 - 0.009 x_t (-0.76)	0.05	0.57	1.12	-
Sugar beet	**The price of ton**	Y_t=196.32+31.47 x_t (9.60) *	0.88	92.25*	432	7.28
	The costs	Y_t= 712.69 + 693.62 x_t (13.70)	0.94	*187.58	5915	11.73
	Net return	Y_t= 3413.59+ 91.98 x_t (1.72)	0.20	2.94*	4103	2.24
	Net return of the pound invested	Y_t=1.38 - 0.07x_t (- 6.46) *	0.78	41.77*	0.83	8.43

(*): significant at level 0.01, **Source:** collected and calculated from table (3)

Some economic indicators and indicators for the water unit during the period (2017-2021)

Although the cane crop is the most developed crop in Egypt, in light of its large needs during the main growth period (which are estimated at 9000-12400 m^3), and in light of the limited water, it is difficult to expand its cultivation. It was necessary to determine the efficiency of obtaining reeds in exploiting irrigation water. Because obtaining reeds is more light-intensive. Cigarette beets are also distinguished by their advantages, including that they are grown in the sugar section of the plate, modern lands with good drainage, in addition to their limited water needs (which are estimated at 3,500 m^3) compared to the sugar cane [(2)]. It is necessary to determine the efficiency of obtaining beets in exploiting irrigation water.

1- The amount of water used to irrigate the feddan

When considering irrigation water as a limited resource, and its importance in bringing about agricultural development; especially the increase in the reclaimed area in Egypt, the expansion of the area of sugar cane is considered difficult, due to its large water needs[(3)], which amounted to about 10,563.25 m^3. As is clear from the data in Table (5), while it amounted to about 2957.75 m^3 for beets, which is much less than the amount used to irrigate feddan of sugar cane, taking into account the duration of the crop's stay in the ground.

2-Average crop production per unit of water

It is clear from the data in Tables (5) that the average crop production per acre was about 47.31, 20.48 tons/feddan. Accordingly, the average crop production from a unit of water (1000 m^3) was about 4.48, 7.08 tons, which means that the average crop production from a unit of water used Per month it is about 1.01, 037 tons, this assumes that the duration of the crop's stay in the ground is about 12 months, 7 months for cane and beet crops, respectively.

Table 5: Some of production and economic indicators for cane and beet sugar crops at current prices in Egypt during the period (2017-2021).

Item	The unite	Sugar cane	Sugar beet
Productivity	Ton/feddan	47.31	20.48
The amount of sugar from feddan in season	Ton/feddan	3.71	2.62
Value of production (total revenue)	Pound	34066.50	13554.75
Duration of the crop in the land	Month	12.00	7.00
Average of total production costs	Pound	17352.75	8949.50
Net return	Pound	16713.75	4879.00
Profitability of pounds spent in year	Pound	0.98	0.56
Profitability of pounds spent in month	Pound	0.082	0.08
Profitability of feddan in month	Pound	1392.85	697.00
%(total revenue/total costs)	%	198.26	153.21
The amount of water used to irrigate the feddan	m^3/ feddan	10563.25	2957.75
Average of production of crop per unit of water	Ton/1000m^3	4.48	7.08
Average of production of sugar per unit of water	Ton/1000m^3	0.35	0.91
Net return per unit of water used	Pound/1000m^3	1583	1674.50

Source: 1-collected and calculated from Ministry of Agriculture and land reclamation, Economics Affairs sector, Agricultural statistical Bulletin, different numbers.
2- Central Agency for Public Mobilization and Statistics, Annual Bulletin of Irrigation and Water Resources Statistics, different numbers.

[2(1)] Thanaa Al-Noubi Ahmed (Doctor), A comparative study between cane and sugar beet crops in Egypt, Egyptian Journal of Agricultural Economics, Volume Eighteen, Issue Four, December, 2008, p. 1372.

[3 (1)] Thanaa Al-Noubi Ahmed (Doctor), a comparative study between cane and sugar beet crops in Egypt, The previous reference, p.1374.

3-Average sugar production per unit of water

It is clear from Table (5) that the amount of sugar produced from an acre per season amounted to about 3.71 and 2.62 tons. Accordingly, the average sugar production from a unit of water (1000 m^3) amounted to about 0.42 and 0.91 tons during one season, which means that the average sugar production from the unit of water used per month is about 0.03 and 0.13 tons for cane and beet crops, respectively.

4-Net return from water unit

It is clear from the data in Table (5) that the net return per feddan amounted to about 16713. 75, 4879 pounds. Accordingly, the net return per season from the unit of water (1000 m^3) amounted to about 1,583, 1674.50 pounds, which means that the net return from the unit of water used per month is about 131.9, 239.2 pounds, this assumes that the duration of the crop's stay in the ground is about 12 months, 7 months for cane and beets, respectively.

It is clear from the above that the sugar beet crop during the period (2017-2021) was more efficient than the sugar cane crop in exploiting irrigation water in terms of average crop production per unit of water and average sugar production per unit of water, and it was less efficient with regard to the net return per unit of water. Water during the season, while it was more efficient with regard to the net return from the unit of water used per month.

One-way analysis of variance for the differences between average productivity and governorates producing sugar cane and sugar beet for the average period (2019-2021)

In this part, we will study the effect of maintaining the productivity of sugar cane and sugar beet crops through the use of one-way analysis of variance. The statistical assumption is that there are no significant differences between the average productivity of the governorates producing these crops.

1- One-way analysis of variance for the differences between average productivity and the governorates producing sugar cane crop for the average period (2019-2021)

A one-way analysis of variance test was conducted to determine whether there were significant differences in the effect of differences between governorates and some on the average per-acre productivity of the sugarcane crop, which explains the presence of real differences between those governorates, as shown in Table (6).

Table 6: One-way analysis of variance to test the significance of the effect of sugar cane producing governorates on average productivity for the average period (2019-2021).

The source	Sum of squares of deviations	Degrees of freedom	Average sum of squares of deviations	F
Between the governorates	50.93	11	4.63	*5.22
The error	20.88	24	0.87	
total summation	71.81	35		

(*): significant at level 0.01

Source: collected and calculated from data of Ministry of Agriculture and land reclamation, Economics Affairs sector, Costs and net return statistical Bulletin, different numbers.

Also, an application test was used. Duncan's Multiple Range Test (DMRT) to test the least significant difference to test the significance of the difference between the average productivity of the sugarcane crop according to the differences in the most important provinces producing it, shown in Table (7), where it became clear that the value of (F) amounted to about 5.22 which is significant Statistically, The least significant test (L, S, R) was tested and identified the differences between the averages of productivity in each governorate, as it is known that the differences between the averages of various acres of sugarcane crop are statistically significant differences between Qena Governorate and each of Assiut, Beni Suef, Sharkia, and Dakahlia. , Minya, Giza, Kafr El-Sheikh, and this means a high mean and significance of the differences between the averages of grapes and sugar per acre for cane crop. The presence of significant differences between Aswan Governorate and each of Assiut, Beni Suef, Sharkia, Qalyubia, Dakahlia, and Minya also succeeded. There are no significant differences between Luxor Governorate and the governorates of Assiut, Beni Suef, Sharkia, Qalyubia, Dakahlia,

Table 7: Results of the test of the least significant range (L, S, R) for the significance of the differences between the average productivity of the most important sugar cane producing governorates for the average period (2019-2021).

Average productivity	**48.72**	**47.95**	**46.69**	**44.69**	**41.26**	**39.93**	**39.92**	**38.81**	**34.47**	**34.33**	**34.24**	**31.99**
Governorates	**Qena**	**Aswan**	**Luxor**	**Sohag**	**Kafr El-Sheikh**	**Giza**	**Minya**	**Dakahlia**	**Qalyubia**	**Sharqia**	**Beni-Suef**	**Assiut**
Assiut	*3.84	*3.48	*3.28	*3.03	*3.02	*2.83	*2.16	**1.98	1.85	1.80	1.62	1.36
Beni Suef	*3.37	*3.01	*2.81	*2.56	*2.55	*2.36	1.72	1.45	1.38	1.33	1.32	0.00
Sharqia	*3.04	*2.58	*2.38	**2.13	**2.12	**1.99	1.26	1.22	0.96	0.07	0.00	
Qalyubia	*2.93	*2.57	*2.36	**2.11	**2.10	1.73	1.25	0.83	0.36	0.00		
Dakahlia	*2.88	*2.51	*2.31	**2.06	**2.05	1.87	1.20	0.08	0.00			
Minya	*2.81	*2.45	*2.24	**2.03	**1.98	0.80	0.13	0.00				
Giza	*2.57	*2.21	**2.00	1.76	1.53	0.72	0.00					
Kafr El-Sheikh	**1.97	1.54	1.33	1.08	0.36	0.00						
Sohag	1.71	1.35	1.15	0.42	0.00							
Luxor	1.70	1.34	0.22	0.00								
Aswan	1.46	0.84	0.00									
Qena	1.25	0.00										
L.S.R 0.05	1.35	1.42	1.47	1.50	1.53	1.55	1.57	1.58	1.59	1.59	1.61	1.81
L.S.R 0.01	2.44	2.73	2.92	3.03	3.07	3.12	3.11	3.13	3.15	3.16	3.17	3.21

(*): significant at level 0.01, (**): significant at level 0.05

Source: collected and calculated from data of Ministry of Agriculture and land reclamation, Economics Affairs sector, Costs and net return statistical Bulletin, different numbers.

and Minya, it was found that there were significant differences between Sohag Governorate and Assiut, Beni Suef, Sharkia, Qalyubia, Dakahlia, and Minya. As for Kafr El-Sheikh Governorate, significant differences were found between it and each of Assiut, Beni Suef, Sharkia, Qalyubia, Dakahlia, and Minya. Significant differences were also found. There was also a significant difference between Giza Governorate and the governorates of Assiut, Beni Suef, and Sharqia. There was also a significant difference between Minya Governorate and Assiut Governorate, and between Dakahlia and Assiut Governorates. As for the rest of the governorates, there were no significant differences between them.

2- One-way analysis of variance for the differences between average productivity and the governorates producing sugar beet crop for the average period (2019-2021)

A one-way analysis of variance test was conducted to determine whether there were statistically significant differences in the effect of differences between the governorates and some of them on the average productivity per acre of the sugar beet crop, which explains the presence of real differences between those governorates. As shown in Table (8).

Table 8: One-way analysis of variance to test the significance of the effect of sugar beet producing governorates on average productivity for the average period (2019-2021)

The source	Sum of squares of deviations	Degrees of freedom	Average sum of squares of deviations	F
Between the governorates	45.78	14	7.27	*7,64
The error	18.3	30	0.61	
total summation	64.08	34		

(*): significant at level 0.01
Source: collected and calculated from data of Ministry of Agriculture and land reclamation, Economics Affairs sector, Costs and net return statistical Bulletin, different numbers.

Application testing was also used. Duncan multiple range test (DMRT) to test the least significant difference to test the significance of the difference between the average productivity per acre for the sugar beet crop according to the difference in the most important producing governorates as shown in Table (9), where it was found that the value of (F) was about 7.64, which is significant Statistically, The least significant test (L, S, R) was evaluated and the differences between averages of productivity in each governorate were determined. It was noted that the differences between the averages of different acres of sugar beet yield were statistically significant differences between Assiut Governorate and each of Matrouh, Fayoum, Kafr El-Sheikh, and Menoufia. Beheira, Qalyubia, Sharqia, Ismailia, Giza, Dakahlia, Beni Suef, and Gharbia. This means a moderate and significant increase in the difference between the averages of productivity acres of sugar beet crop, there are also significant differences between Al-Minya Governorate and between Matrouh, Fayoum, Kafr El-Sheikh, Menoufia, Beheira, Qalyubia, Sharqia, Ismailia, and Damietta. There are also significant differences between Gharbia Governorate and the governorates of Matrouh, Fayoum, Kafr El-Sheikh, Menoufia, and Beheira., Qalyubia, Sharqia, Ismailia, and Ismailia. It was found that there were significant differences between Beni Suef Governorate and each of Matrouh, Fayoum, Kafr El-Sheikh, Menoufia, Beheira, Qalyubia, Sharqia, and Al-Khaleej. For Dakahlia Governorate, significant differences were found including both Assiut and Beni Suef. Sharqia, Qalyubia, Significant differences were also found between Giza Governorate and the governorates of Matrouh, Fayoum, Kafr El-Sheikh, Menoufia, and Beheira. Likewise, significant differences were found between Damietta Governorate and Matrouh, Fayoum, and Kafr El-Sheikh. There are also two significant differences between Ismailia Governorate and Matrouh and today. A significant difference was found only between Sharkia Governorate and Matrouh Governorate, while for the rest of the provinces there were no significant differences.

Table 9: Results of the test of the least significant range (L. S. R) for the significance of the differences between the average productivity of the most important sugar beet producing governorates for the average period (2019-2021).

Average productivity	**28.42**	**24.71**	**23.15**	**22.089**	**21.74**	**21.582**	**20.41**	**20.14**	**20.14**	**20.03**	**19.95**	**19.92**	**19.34**	**18.91**	**18.34**
Governorates	**Assiut**	**Minya**	**Gharbia**	**Beni-Suef**	**Dakahlia**	**Giza**	**Damietta**	**Ismailia**	**Sharkia**	**Qalyubia**	**Beheira**	**Menoufia**	**Kafr El-Sheikh**	**Fayoum**	**Matrouh**
Matrouh	*4.81	*4.00	*3.74	*3.63	*3.64	*3.23	*2.67	*2.35	*2.04	1.90	1.88	1.78	0.34	0.23	0.04
Fayoum	*4.45	*3.78	*3.42	*3.42	*3.44	*3.00	*2.46	*2.15	1.61	1.89	1.67	0.89	0.32	0.0	0.0
Kafr El-Sheikh	*4.21	*3.63	*3.23	*3.23	*3.22	*2.84	*2.25	1.61	1.57	1.67	1.15	1.04	0.0		
Menoufia	*3.78	*3.10	*2.79	*2.77	*2.75	*2.34	1.73	1.42	1.37	1.32	0.91	0.0			
Beheira	*3.74	*3.12	*2.78	*2.71	*2.76	**1.96	1.71	1.45	1.04	0.79	0.0				
Qalyubia	*3.56	*2.89	*2.53	*2.52	*2.51	1.71	1.53	1.21	0.69	0.0					
Sharkia	*3.34	*2.67	*2.33	*2.23	1.42	1.19	1.21	0.73	0.0						
Ismailia	*3.23	*2.56	*2.24	1.77	1.39	1.07	0.48	0.0							
Damietta	*3.00	*2.34	1.55	1.56	1.12	0.82	0.0								
Giza	*2.34	1.76	1.45	1.34	0.33	0.0									
Dakahlia	**2.06	1.34	1.00	0.61	0.0										
Beni Suef	**2.02	1.55	1.02	0.0											
Gharbia	**2.00	1.31	0,0												
Minya	0.8	0.0													
Assiut	0.0														
L,S,R 0,05	0.88	0.97	0.98	1.00	1.12	1.13	1.17	1.22	1.35	1.39	1.42	1.47	1.48	1.48	1.52
L,S,R 0,01	3.23	3.32	3.32	3.45	3.46	3.56	3.56	3.55	3.53	3.52	3.66	3.64	3.64	3.62	3.61

(*): significant at level 0.01, (**): significant at level 0.05
Source: collected and calculated from data of Ministry of Agriculture and land reclamation, Economics Affairs sector, Costs and net return statistical Bulletin, different numbers.

Targeted production for sugar cane and sugar beet

In this part of the research, we relied on Nerlov model (the Partial Adjustment Model), which is one of the long-term strategic strategic links and can be formulated as follows:

$$Y^{\wedge}_t = a + b_1 X_{1t} + b_2 X_{2t} + \ldots\ldots\ldots\ldots\ldots\ldots + bn\, Xn_t + D_t$$

Where Y ^ e represents the target production of the sugar cane and sugar beet crops, X_{1t}, X_{2t},,,,,,,, year represents the preferred values of the explanatory variables specified for the sugar cane and beet industry, d_t represents the error limit, and this is considered a diversified expansion estimation model. During the short working model it completely forms the following:

$$Y^{\wedge}_t = \lambda a + (1- \lambda) Y_{t-1} + b_1 X_{1t} + b_2 X_{2t} + D_t$$

λ : Adjustment factor, its value is between from 0 to 1, this value determined speed of Adjustment.

Adjustment lag = $\dfrac{\lambda - 1}{\lambda}$

$$\frac{\lambda\ b1^{\wedge}}{\lambda} = b2^{\wedge} \qquad \frac{\lambda\ b2^{\wedge}}{\lambda} = {\wedge}b1 \qquad \frac{(\lambda\ a)}{\lambda} = a^{\wedge}$$

Therefore, the partial adjustment model can be formulated as follows:

$$Y^{\wedge}_t = a^{\wedge} + b^{\wedge}_n X_n + ,,,,,,,,,,,,,,,,,,,,,,,, + d_n$$

1- Targeted production of sugarcane crop:

The literature on multi-translational polymer analysis during the study period in its linear, half-logarithmic and half-logarithmic forms, and it was found that the linear form is the same as follows:

$$Y^{\wedge}_t = 8652365.72 + 0.462\ Y_{t-1} + 7911.23\ X_t$$
$$(7.91)^* \qquad (3.28)^*$$

F= 210 $R^2 = 0.95$ (*): significant at level 0.01

Where: $Y^{\wedge}_t$: Target Production of sugarcane crop.

X_{1t}: The actual value of the area cultivated with sugar cane crop (feddan)

From Previous equation we find that the Partial Adjustment factor (λ) is about 0.538, and therefore that the Partial Adjustment model for production of sugar cane can be formulated as follows:

$$Y^{\wedge}_t = 16082464,\ 16 + 14704,\ 89Xt$$

The target production of the sugarcane crop was estimated by forecast with the Independent variable included in the econometric model, the long target for the cultivated area, and therefore Table (10) indicates that it will gain an increase in the volume of sugarcane from the month of July, 340,208 feddan in 2025, to about 346,143 feddan in the year. 2030, with an annual average amounted 343,175 feddan. It is also clear from the same table that the targeted production volume for cane from about 16,347,152 tons in 2025 to about 16,420,676 tons in 2030, with an annual average estimated at about 16,383,914 tons, during the period (2025- 2030).

Second: Targeted production of sugar beet crop

The literature on multi-translational polymer analysis during the study period in its linear, half-logarithmic and half-logarithmic forms, and it was found that the linear form is the same as follows:

$$Y^{\wedge}_t = 8236182{,}11 + 0{,}375\ Y_{t-1} + 75216{,}63X_t$$
$$(6.33)^* \qquad (5.47)^*$$

F= 174 $R^2 = 0.92$ (*): significant at level 0.01

Where: $Y^{\wedge}_t$: Target Production of sugar beet crop.
X_{1t}: The actual value of the area cultivated with sugar cane crop (feddan)

From Previous equation we find that the Partial Adjustment factor (λ) is about 0,625, and therefore that the Partial Adjustment model for production of sugar cane can be formulated as follows:

$$Y^{\wedge}_t = 13177891.38 + 120346{,}61X_t$$

The target production of the sugar beet crop was estimated by forecast with the Independent variable included in the econometric model, the long target for the cultivated area, and therefore Table (10) indicates that it will gain an increase in the volume of sugar beet from the month of July, 749194 feddan in 2025, to about 881628 feddan 2030, with annual average amounted 815411 feddan. It is also clear from the same table that the targeted production volume for cane from about 15344130 tons in 2025 to about 15945863 tons in 2030, with an annual average estimated at about 15644996 tons, during the period (2025- 2030).

Table 10: Targeted production and expected cultivated area of sugarcane and sugar beet crops during the period (2025-2030)

Year	Sugar cane		Sugar beet	
	Expected cultivated area(feddan)	Targeted production (ton)	Expected cultivated area(feddan)	Targeted production (ton)
2025	340208	16347152	749194	15344130
2026	341395	16361857	775680	15464476
2027	342582	16376562	802167	15584823
2028	34369	16391267	828654	15705170
2029	344956	16405972	855141	15825516
2030	346143	16420676	881628	15945863
Average	**343175**	**16383914**	**815411**	**15644996**

Source: calculated from tables (1, 2), results of the partial adjustment model

Summary

The results also indicate that there is a statistically significant increase in the net return of an acre of cane and sugar beet crops annually, estimated at about 91.98 and 1078.05 pounds, representing about 8.81% and 2.24% of the average, respectively. It also shows that there is a statistically insignificant decrease in the net return of the pound invested per acre of the sugarcane crop. While it was found that there was a statistically significant increase in the costs of producing the sugar beet crop annually, estimated at about 0.07 pounds, representing about 8.43% of the general average of the net return of a ton of sugar beets in Egypt during the research period.

Regarding the productivity and economic indicators of the water unit during the period (2017-2021), the research results indicated that expanding the area of sugar cane is considered difficult, due to its large water needs, which amounted to about 10,563.25 m3, while it amounted to about 2,957.75 m3 for sugar beets, which is much less than the equivalent used to irrigate an acre of cane, taking into account the duration of the crop's stay in the ground, and thus It is clear that the sugar beet crop during the period (2017-2021) was more efficient than the sugar cane crop in exploiting irrigation water in terms of average crop production per unit of water.

The average sugar production per unit of water was less efficient with regard to the net return from the unit of water during the season, while it was more efficient with respect to the net return from the unit of water used per month.

The results of conducting a one-way analysis of variance test to determine whether there are significant differences in the effect of differences between governorates and some on the average productivity per feddan for sugar cane and sugar beet crops show that the value of (F) amounted to about 5.22 and 7.64, which is statistically significant. The test was estimated the lowest significant range (L, S, R) to determine the significance of the differences between the average productivity of each governorate, as it was found that the differences between the average productivity per acre for cane and sugar beet crops are statistically significant.

It was also shown from the results of the research that the target production volume of the sugarcane crop, by predicting the explanatory variable included in the long-term econometric model for the cultivated area, 2030, was estimated at approximately 16.347.152 tons in 2025 to approximately 16.420.676 tons in 2030, with an annual average estimated at approximately 16,383,914 tons, during The period (2025-2030), and that the targeted production volume of the sugar beet crop through forecasting the explanatory variable included in the long-term econometric model for the cultivated area was estimated at about 15.344.130 tons in 2025 to about 15.945.863 tons in 2030, with an annual average estimated at about 15.644.996 tons, during the period. (2025-2030)

Recommendations

1- Focus on developing new varieties of sugarcane and sugar beets that are highly productive, water-efficient and characterized by high sugar content, in order to increase our sugar production.

2- Encouraging farmers to expand sugar beet cultivation, by raising the supply price for sugar beet crops, and preserving the area cultivated with sugar cane.

3- Reducing the costs of producing a ton of sugar cane and beet crops, and increasing the ratio of total revenue to costs, the return on the invested pound, and the net return per acre by increasing the size of farmers' holdings.

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