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An Economic Study of the Sugar Nutritional Gap and the Possibilities to overcome it in Egypt

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Abstract: Egypt is suffering from an increase in the size of the food gap besides the inability of the available local production to face the domestic consumption as a result of the increase in population growth rates further more the changes that is happening in the consumption pattern, and since the domestic production of sugar is not sufficient for the consumption needs, so the country is working on the filling of the deficit in consumption through import This represents an over load in the balance of payments. The aim of the research is the possibility of increasing sugar production and reducing the food gap in Egypt. The study of the nutritional gap of sugar in Egypt shows during the study period that it is not steady and characterized by relative stability around the arithmetic mean, as it reaches an average around about 852.59 thousand tons. The food gap of sugar in Egypt increased by a statistically insignificant quantity estimated as about 10.46 thousand tons annually. Whereas, the quantity of sugar imports in Egypt reducing d by a statistically insignificant quantity estimated as about 17.12 thousand tons per year, and the value of imports and the import price of sugar has been increased by a statistically significant quantity estimated at about $ 30.69 million and $ 119.18 / ton per year for each, respectively. The results showed that the sugar cane exceeds the sugar beet in the contribution in the total production of sugar in Egypt over sugar beet during the study period, as the average contribution of sugar cane is about 55.44%, while sugar beet contributed about 44.56% of the total production of sugar in Egypt during the study period. The contribution of sugar beet is greater than sugar cane in recent years beginning from 2014. The results also shows a higher amount of leakage from the production and production wastage of sugar cane compared to sugar beet, and this may be due to the consuming of a part from the total sugar cane production quantities in the production of black honey, fresh consumption and other uses rather than using it in sugar factories, or the decrease in the income that producers get from selling their production to factories compared to the income of selling the cane to the owners of juicers.
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Key words: The nutritional gap -Average per capita - leakage from production -Losses from production

1. Introduction:

Sugar crops in Egypt are considered as one of the important strategic agricultural industrial crops, and they are considered the main pillar in the sugar industry because it is one of the foodstuffs that gain the interest to all countries, whether that whos producing raw material or that manufacturing and consuming it and that is because of its importance to people in all life stages, and the importance of sugar as a strategic commodity is reflected in The international trade movement and the special importance it poses on the balance of payments is of great importance in the components of national food security.

Agricultural estimates indicate that the cultivated area of the sugar cane crop in Egypt is about 334 thousand feddans, producing about 15.50 million tons, while the cultivated area of the sugar beet crop is about 545.25 thousand feddans producing about 11.17 million tons, and the sugar cane contributes in about 40.80% of the production. Total sugar, which is about 2.27 million tons, while sugar beet contributes about 59.20% of total production during the average period (2016-2019).

Price policies are considered one of the most important mechanisms used by the government in order to increase agricultural production and that is by providing remunerative price incentives to producers, which ensure their response to the expansion of the cultivated area of agricultural crops in general and sugar beet in particular as it is considered one of the strategic crops that the government wishes to meet the consumption needs of it m, raise Self-sufficiency ratio, and work in the reducing of the volume of imports to reduce the foreign currency.

Research problem:

Egypt suffers from an increase in the size of the food gap and the supply deficit of local production in the face of domestic consumption as a result of the increase in population growth rates on the one hand and changing consumption patterns on the other hand, and since the domestic production of sugar is not sufficient for the consumption needs, the country is working on filling the deficit in consumption through import which represents a burden on the balance of payments. The Available statistics indicate that there is an increase in the food gap of sugar from about 728 thousand tons in 2015 to about 1.14 million tons in 2018, as an increase of about 410 thousand tons, which leads to dependence on imports from abroad and this represents a burden on the balance of payments As the quantity of sugar imports amounted to about 253.27 thousand tons with a value representing about 455.82 million dollars in 2015 to about 501.24 thousand tons with a value representing about 592 million dollars in 2018 to fill bridge the food gap of sugar in Egypt, furthermore the decrease in the rate of self-sufficiency from 76.53% in 2015 to about 65.53% in 2018, the matter that required to study the current status of sugar crops in Egypt and the methods reducing the food gap from them.

Research Objective:

The main objective of the research is the possibility of increasing sugar production and reducing the food gap in Egypt, and this is done by studying the following axes: -

1- Knowing the current status of the production capacities of sugar crops in Egypt.

2- Knowing the current status of the evolution of the food gap from sugar in Egypt.

3- Knowing the most important economic indicators of sugar crops in Egypt.

4- Identify the development of production dropouts and production losses of sugar crops.

2. Research method and data sources:

The research used the descriptive and quantitative economic analysis method, using mathematical and statistical methods to process the data, including simple regression analysis, and some economic indicators of sugar crops. The research based on obtaining published and unpublished secondary data from its various sources, such as the Ministry of Agriculture and Land Reclamation, the Central Administration of Agricultural Economics, the Council of Sugar Crops, and the Central Agency for Public Mobilization and Statistics. In addition to references, periodicals and reports related to the research topic.

3. Research results:

First: The productive capacities of sugar crops in Egypt

The following is a study and analysis of the development of the productive capacities of sugar crops during the period (2004-2019), and by extrapolating the data of tables No. (1) and (2) the following becomes clear:

The production capacity of the sugar cane crop in Egypt

Evolution of the cultivated area of sugar cane:

It is evident from the study of the development of the area cultivated with sugar cane during the study period in Table (1) that the annual average of the cultivat area of the sugar cane crop in Egypt has reached about 337.75 thousand feddans during the study period (2004-2019), representing about 46.93% of the total area cultivated with sugar crops in Egypt, amounting to about 719.69 thousand feddans. It is evident from Table (2) that the cultivated area reducing d by a statistically insignificant quantity that amounted which is estimated by around 0.26 thousand feddans annually during the study period, which indicates the relative stability of it around its arithmetic mean.

Evolution of Sugar Cane Feddan Productivity:

The average productivity per feddan of sugar cane crop in Egypt was about 49.13 tons/feddan. Comparing the productivity at the end of the period from its beginning shows that it has not changed significantly. Feddan productivity has been reducing d by a statistically significant quantity estimated by 0.27 tons / feddan annually during the study period. The coefficient of determination was about 0.74, which means that 74% of the changes in feddan productivity are due to changes reflected in time.

Evolution of total production of sugar cane:

By studying the total production of sugar cane in Egypt during the study period as shown in Table (1) it reveals that it is unstable but relatively steady, as the average total production has reached to about 16.67 million tons, perhaps the production reducing d by the end of the period from its beginning by about 764 thousand tons, in comparison to its beginning, and this could be due to the diminishing of acres productivity during the study period. The total production reducing d by a statistically insignificant quantity estimated by 106.52 thousand tons.

Evolution of the supplied area of sugar cane:

The average resource area of the sugar cane crop in Egypt was about 243.09 thousand feddans. The resource area increased by a statistically insignificant quantity estimated at 0.54 thousand feddans annually. The average production supplied from the crop reached about 9.16 thousand tons. This production has been reducing d at the end of the study period from its

beginning, by about 1.03 million tons, and this may be due to the decrease in the area supplied by sugar cane. The results of Table (2) also indicate that the supplied production reducing d by a statistically significant quantity estimated at 74.78 thousand tons annually, and the determination coefficient reached about 0.53, which means that 53% of the changes in the supplied production of cane are due to changes that are reflected time.

The average ratio of the supplied production to the total production of sugar cane crop in Egypt during the study period was about 55.22%. The ratio of the supplied production in comparison to the total production has been reducing d by a statistically significant quantity estimated at 0.09% annually.

Table (1): Development of cultivated area, total production, resource, quantity of sugar produced, and production losses from the sugar cane crop in Egypt during the period (2004-2019).

Years	Area (thousand Fed)	Yield (Ton/Fed.)	Production (thousand tons)	Supplied area (thousand Fed)	Supplier Production (thousand tons)	The ratio of the resource production to the total (%)	Quantity of sugar produced (thousand tons)	Quantity of sugar that can be produced (thousand tons)	Production loss (thousand tons)
2004	322	50	16100	243	9635	59.84	1002	1674.39	672.4
2005	321	50.8	16371	239	9483	57.92	1048.3	1809.83	761.5
2006	327	51	16677	246	9910	59.42	1072.2	1804.35	732.1
2007	335	50.8	17085	256	9926	58.1	1075.3	1850.92	775.6
2008	355	51	17750	223	9004	50.73	1075.3	2119.69	1044.4
2009	334	49	17034	233	9024	52.98	1174.7	2217.38	1042.7
2010	360	49.1	18360	234	8993	48.98	1185	2419.25	1234.3
2011	360	50.3	18105	241	9102	50.28	1274.7	2535.45	1260.8
2012	396	50.1	19720	244	8999	45.63	1099.3	2408.96	1309.7
2013	326	47.7	15550	246	9563	61.5	1127.6	1833.64	706
2014	332	48.4	16055	247	9314	58.01	1024.5	1765.94	741.4
2015	328	48.5	15903	254	9320	58.61	1025.1	1749.16	724.1
2016	326	47.3	15422	250	9064	58.77	931.3	1584.65	653.4
2017	326	47.2	15382	243	8442	54.88	923.9	1683.38	759.5
2018	327	48.3	15823	243	8198	51.81	914.5	1764.99	850.5
2019	329	46.6	15336	248	8600	56.08	930	1658.39	859.7
Average	**337.75**	**49.13**	**16667.06**	**243.09**	**9161.04**	**55.22**	**1055.23**	**1930.02**	**883**

Source: Collected and calculated from the data of:
1-Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economy, Agricultural Economy Bulletin, miscellaneous issues for the period (2004-2019).
2- Ministry of Agriculture and Land Reclamation, Council of Sugar Crops, Annual Report Bulletin, separate issues for the period (2004-2019).

Table (2): Equations for the general temporal direction of area development, total production, resource, quantity of sugar produced and production losses from the sugar cane crop in Egypt during the period (2004-2019).

Variables	Average	Coefficient (a)	Coefficient (b)	R Square	Annual rate of change	Significance	
						(t)	(F)
Area (thousand Fed.)	337.75	339.93	-0.26	0.003	-0.08	-0.22	0.05
Yield (Ton/Fed.)	49.13	51.4	-0.27	0.74	-0.55	-6.32**	39.90**
Production (thousand tons)	16667.06	17572.5	-106.52	0.16	-0.64	-1.63	2.68
Supplied area (thousand Fed.)	243.09	238.48	0.54	0.1	0.22	1.23	1.52
Supplier Production (thousand tons)	9161.04	9796.68	-74.78	0.53	-0.82	-4.01**	16.13**
The ratio of the resource production to the total (%)	55.22	56.05	-0.09	0.01	-0.16	-0.38	0.14
Quantity of sugar produced (thousand tons)	1055.23	1137.77	-9.27	0.2	-0.88	-1.85	3.42
Quantity of sugar that can be produced (thousand tons)	1930.02	2057.84	-14.26	0.05	-0.74	-0.87	0.75
Production loss (thousand tons)	883	909.47	-3.11	0.004	-0.35	0.25-	0.06

Source: It was collected and calculated from the data of Table No. (1) by research.

Evolution of the quantity of sugar produced from sugar cane:

The average quantity of sugar produced from the cane crop in Egypt during the study period was about 1.06 thousand tons. The quantity of sugar produced at the end of the study period has been reducing d by about 72 thousand tons. The estimation of the general time trend equations showed a decrease in the quantity of sugar produced from the cane crop by a statistically insignificant quantity estimated by 9.27 thousand tons annually.

Evolution of the quantity of sugar that can be produced from sugar cane:

Table (2) data indicate that if the total production of cane is directed entirely to sugar production, an quantity of sugar estimated by about 1.93 million tons can be produced during the average study period, and the quantity of sugar that can be produced at the end of the study period has been increased from its beginning by an quantity of 16 thousand tons. The quantity of sugar that could be produced from the cane crop reducing d by a statistically significant quantity estimated at 14.26 thousand tons annually.

Evolution of the quantity of sugar cane wastage:

The average quantity of production losses of the cane crop in Egypt during the study period was about 883 thousand tons. The quantity of lost production of the cane crop has been increased at the end of the study period, its beginning, by about 187 thousand tons. The estimation of the general time trend equations showed a decrease in the quantity of production losses of the cane crop by a statistically insignificant quantity estimated at about 3.11 thousand tons annually, which indicates the relative stability of the quantity of losses around its arithmetic mean.

Production capacity of sugar beet crop in Egypt

Evolution of the cultivated area of sugar beet:

Table No. (3) data indicates that the average area cultivated from the sugar beet crop has reached about 381.94 thousand feddans during the study period (2004-2019), representing about 53.07% of the total area cultivated with sugar crops in Egypt, which is about 719.69 thousand feddans. This the area. Cultivated by sugar beet in 2019 (the end of the study period) has increased by about 464acre from 2004 (the beginning of the period) and this is an important indicator for the expansion of sugar beet cultivation. The cultivated area increased by a statistically significant quantity during the study period, amounting to about 31.15 thousand feddans per year as shown in Table (4), and the determination coefficient was about 0.94, which means that 94% of the changes that occurred in the area cultivated with beets are due to changes that are reflected by time.

Evolution of productivity per feddan of sugar beet:

The average productivity per feddan of sugar beet crop in Egypt was about 20.65 ton /feddan. By comparing the productivity at the end of the period from its beginning, the evident shows that it has not changed significantly, the matter that need to work on increasing productivity to achieve an increase in the volume of production to reduce the gap between production and consumption, especially in the presence of a limitation in water resources available in Egypt. Feddan productivity reducing d by a statistically insignificant quantity estimated at about 0.001 tons/feddan annually, indicating the relative stability around its arithmetic mean.

Evolution of total production of sugar beet:

The average total production of sugar beet crop in Egypt was about 7.89 million tons, and this total production has been increased in 2019 (the end of the study period) compared to 2004 (the beginning of the study) by about 9.39 million tons. The estimation of the general time trend equations showed that total production reducing d by a statistically significant quantity estimated at about 644.44 thousand tons annually, and the coefficient of determination was about 0.91, which means that 91% of the changes in beet production are due to changes that are reflected by time.

Evolution of the supplied area of sugar beet:

The average area supplied from the crop was about 368.03 thousand feddans, and the area supplied at the end of the period increased by about 444.3 thousand feddans. The area supplied has increased by a statistically significant quantity estimated by about 30.73 thousand tons annually, and the coefficient of determination was about 0.93, which means that 93% of the changes that occurred in the area supplied from beets are due to changes that are reflected by time.

Evolution of the supplier production of sugar beet:

The average production supplied from the crop reached about 6.76 thousand tons. This production has been increased by the end of the study period from its beginning, by about 6.56 million tons. The supplied production increased by a statistically significant quantity estimated at 479.23 thousand tons annually, and the determination coefficient reached 0.87, which means that 87% of the changes in the imported production of beets are due to changes that are reflected by time. The average ratio of the supplied production to the total production of sugar beet crop in Egypt during the study period was about 87.30%. The ratio of the supplied production to the total production has been reducing d by a statistically significant quantity estimated at about 1.01% annually, and the determination coefficient reached about 0.38, which means that 38% of the changes in the ratio of the

supplied production to the total production of beet are due to changes that are reflected by time.

Evolution of the quantity of sugar produced from sugar beet:

Table (3) shows an increase in the quantity of sugar produced from beets during the study period, as the average quantity of sugar produced was about 949.34 thousand tons, and the quantity of sugar produced at the end of the study period has been increased by about 1.16 million tons. The quantity of sugar produced from the beet crop increased by a statistically significant quantity estimated by about 69.51 thousand tons annually, and the determination coefficient was about 0.91, which means that 91% of the changes in the quantity of sugar produced from beets are due to changes that are reflected by time.

Evolution of the quantity of sugar that can be produced from sugar beet:

Table (3) data indicate that if the total production of beets is directed entirely to sugar production, an quantity of sugar estimated at about 1.08 million tons can be produced during the average study period, and the quantity of sugar that can be produced at the end of the study period has increased from its beginning by an quantity of about 1.17 million tons. Table (4) also shows the increase in the quantity of sugar that can be produced from the beet crop by a statistically significant quantity estimated at about 89.47 thousand tons annually, and the determination coefficient was about 0.91, which means that 91% of the changes in the quantity of sugar that can be produced from beets are due to the changes that are reflected by time.

Table (3): Development of area, total production, resource, quantity of sugar produced, and production losses from sugar beet crop in Egypt during the period (2004-2019).

Years	Area (thousand Fed.)	Yield (Ton/Fed.)	Production (thousand tons)	Supplied area (thousand Fed.)	Supplier Production (thousand tons)	The ratio of the resource production to the total (%)	Quantity of sugar produced (thousand tons)	Quantity of sugar that can be produced (thousand tons)	Production loss (thousand tons)
2004	141	20.29	2861	139.7	2579.56	90.16	367.6	407.71	34.3
2005	167	20.49	3430	166.8	3213.8	93.7	449.4	479.63	17.6
2006	186	20.95	3905	184	3600.98	92.21	503.3	545.79	42.5
2007	249	21.98	5458	247.4	5225.71	95.74	682.6	712.94	30.1
2008	258	19.91	5133	230.4	4860.6	94.69	635.4	671.01	5.4
2009	265	20.16	5333	227.9	4087.46	76.64	597.3	779.31	206.4
2010	386	20.33	7840	364.3	7507.06	95.75	989.8	1033.7	-145.3
2011	362	20.69	7486	359	6923.2	92.48	912.6	986.79	-40.6
2012	424	21.54	9126	403.6	7641.81	83.74	1003.5	1198.4	81.8
2013	433	18.9	8072	423.1	7613.77	94.32	1060.2	1124.01	63.8
2014	504	21.9	11045	480.3	9198.66	83.28	1273.8	1529.48	255.7
2015	555	21.6	11983	540.1	9524.2	79.48	1347.3	1695.12	347.8
2016	560	20	11209	545.2	9090.9	81.1	1265.6	1560.47	294.9
2017	523	20.46	10861	511.6	9104.1	83.82	1325.2	1580.94	255.7
2018	493	20.99	10377	481	8826.5	85.06	1247.9	1467.11	219.3
2019	605	20.22	12247	584	9136.43	74.6	1528	1575.91	279.425
Average	**381.94**	**20.65**	**7897.88**	**368.03**	**6758.42**	**87.3**	**949.34**	**1084.27**	**121.8**

Source: Collected and calculated from the data of:

1- Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economy, Agricultural Economy Bulletin, miscellaneous issues for the period (2004-2019).

2- Ministry of Agriculture and Land Reclamation, Council of Sugar Crops, Annual Report Bulletin, separate issues for the period (2004-2019).

Table (4): Equations for the general temporal trend of development of area, total production, resource, quantity of sugar produced and production losses from sugar beet crop in Egypt during the period (2004-2019).

Variables	Average	Coefficient (a)	Coefficient (b)	R Square	Annual rate of change	Significance	
						(t)	(F)
Area (thousand Fed.)	381.94	117.18	31.15	0.94	8.16	14.23**	202.50**
Yield (Ton/Fed.)	20.65	20.66	-0.001	0.02	-0.005	-0.02	0.00004
Production (thousand tons)	7897.88	2420	644.44	0.91	8.16	12.17**	148**
Supplied area (thousand Fed.)	368.03	107.68	30.73	0.93	8.33	13.95**	194.59**
Supplier Production (thousand tons)	6758.42	2684.93	479.23	0.87	7.1	9.72**	94.45**
The ratio of the resource production to the total (%)	87.3	96.64	-1.01	0.38	-1.16	-2.90**	8.43**
Quantity of sugar produced (thousand tons)	949.34	344	69.51	0.91	7.93	11.72**	137.37**
Quantity of sugar that can be produced (thousand tons)	1084.27	315.97	89.47	0.91	8.79	12.14**	147.43**
Production loss (thousand tons)	121.8	58.45	21.21	0.5	17.41	3.72**	13.82*

Source: It was collected and calculated from the data of Table No. (3) by research.

Evolution of sugar beet losses quantity:

The average production loss from sugar beet crop in Egypt during the study period was about 121.80 thousand tons. The quantity of lost production of the beet crop increased at the end of the study period, from its beginning, by about 245.42 thousand tons. The quantity of production loss of the beet crop increased by a statistically significant quantity estimated by about 21.21 thousand tons annually, and the determination coefficient reached about 0.50, which means that 50% of the changes in the quantity of production loss of beet crop are due to changes that are reflected by time.

Second: The evolution of the food gap of sugar in Egypt

By studying the development of the total production of sugar in Egypt during the study period, it becomes clear from Table (5) that the average domestic production of sugar in Egypt amounted to about 1.97 million tons, and the local production has been increased in 2019 (the end of the study period) compared to 2004 (the beginning of the study).) By about 1.09 million tons. The results of Table (6) indicate an increase in the domestic production of sugar in Egypt by a statistically significant quantity estimated at about 60.24 thousand tons annually, and the determination coefficient was about 0.79, which means that 79% of the changes in the local production of sugar are due to the changes that are reflected by Time.

While the average domestic consumption of sugar in Egypt during the study period was about 2.83 million tons, and this domestic consumption has been increased in 2019 (end of the study period) compared to 2004 (the beginning of the study) by about 1.18 million tons. While the average per capita consumption of sugar per capita in Egypt was about 33.60 kg / year during the study period. The estimation of the general chronological trend equations showed an increase in the domestic consumption of sugar in Egypt by a statistically significant quantity estimated at about 70.70 thousand tons annually, as shown in Table (6), and the determination coefficient was about 0.97, which means that 97% of the changes that occurred in the local consumption Of sugar is due to changes that are reflected by time, while the consumption of sugar per capita in Egypt increased by a statistically insignificant amount, estimated at 0.01 kg / year annually.

The study of the nutritional gap of sugar in Egypt during the study period shows that it is not steady but characterized by relative stability around the arithmetic mean, with an average of about 852.59 thousand tons. The results of the general chronological trend equations indicate an increase in the size of the food gap of sugar in Egypt by a statistically insignificant quantity estimated at 10.46 thousand tons annually.

By studying the self-sufficiency rate of sugar in Egypt during the study period, it reached about 69.54%, and there was no improvement was noted in the rate of self-sufficiency in sugar during the study period. The rate of self-sufficiency of sugar in Egypt increased by a statistically insignificant quantity estimated at about 0.48% annually, which indicates the relative stability around the arithmetic mean during the study period.

As shown in Table (5), the quantity of imports fluctuated between increase and decrease during the study period, as the average quantity of imports

reached about 597.21 thousand tons with a value of about 430.92 million$ and an import price estimated at about 898.07$ /ton during the average study period. The results of Table (6) indicate that the quantity of imports from sugar in Egypt reducing d by a statistically insignificant quantity estimated at about 17.12 thousand tons per year, which indicates the relative stability around its arithmetic mean during the study period, while the increase in the value of imports and the import price of sugar by a significant quantity Statistically, it was estimated at 30.69 million$ and 119.18 $/ton annually for each, respectively.

From what is shown above it is evident that the contribution of sugar cane to the total production of sugar in Egypt exceeds that of sugar beet during the study period, as the average contribution was about 55.44%, while sugar beet contributes by about 44.56% of the total production of sugar in Egypt during the study period, but it is noticeable that the percentage of The contribution of sugar beet is greater than sugar cane in recent years, beginning from 2014, The reasons for this may be due to several things, including the low price of supply of the sugar cane crop, or the use of sugar cane for other purposes such as molasses juicers, fresh consumption and other uses, or the low revenue that producers get from selling their production to factories compared to the return from selling the cane to the owners of juicers, or a decrease in the Efficiency of running the factories, which leads to leakage of a large part of production, which leads to a large loss in sugar production.

Table (5): Development of total production and consumption, average per capita share, self-sufficiency rate and sugar imports in Egypt during the period (2004-2019).

Years	sugar cane		Sugar beet		Total local sugar production (thousand tons)	Total sugar consumption (thousand tons)	Average per capita sugar consumption (kg / year)	Sugar gap (thousand tons)	Percentage of self-sufficiency in sweetened sugar (%)	Sugar imports		
	Quantity of sugar produced (thousand tons)	Contribution percentage to total production (%)	Quantity of sugar produced (thousand tons)	Contribution percentage to total production (%)						Quantity (thousand tons)	Value (million dollars)	Price per ton ($ / ton)
2004	1002	73.16	368	26.84	1370	2200	32	830	62.25	292.33	62.49	213.77
2005	1048	69.99	449	30.01	1498	2432	33	934	61.58	577.97	145.07	251
2006	1072	68.05	503	31.95	1576	2553	34	978	61.71	394.22	148.01	375.45
2007	1075	61.17	683	38.83	1758	2600	34	842	67.61	432.44	134.9	311.95
2008	1075	62.86	635	37.14	1711	2564	34	853	66.72	1321.5	550.96	416.93
2009	1175	66.29	597	33.71	1772	2720	34	948	65.15	416.75	281.72	675.99
2010	1185	54.49	990	45.51	2175	2795	34	620	77.81	868.84	470.72	541.78
2011	1275	58.28	913	41.72	2187	2750	34	563	79.54	1248.5	879.87	704.76
2012	1099	52.28	1004	47.72	2103	2900	34	797	72.51	891.67	787.51	883.18
2013	1128	51.54	1060	48.46	2188	3000	35	812	72.93	825.96	179.66	217.52
2014	1025	44.58	1274	55.42	2298	3100	35	802	74.14	347.92	306.1	879.79
2015	1025	43.21	1347	56.79	2372	3100	33	728	76.53	253.27	455.82	1799.74
2016	931	42.39	1266	57.61	2197	3160	32	963	69.52	267.51	668.82	2500.17
2017	924	41.08	1325	58.92	2249	3230	33	981	69.63	317.73	800.58	2519.67
2018	915	42.29	1248	57.71	2162	3300	33	1138	65.53	501.64	592	1179
2019	930	37.8	1530	62.2	2460	3375	34	915	72.89	291.11	369	1267
Average	**1063.6**	**55.44**	**910.77**	**44.56**	**1974.35**	**2826.93**	**33.6**	**852.59**	**69.54**	**597.21**	**430.92**	**898.07**

Source: Collected and calculated from data:

1- Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economy, Agricultural Economy Bulletin, miscellaneous issues for the period (2004-2019).

-2Ministry of Agriculture and Land Reclamation, Council of Sugar Crops, Annual Report Bulletin, separate issues for the period (2004-2019).

3- The website of the global trade map on the Internet. www.trademap.org

4- The United Nations website on the Internet. www.comtrade.un.org

Table (6): Equations for the general temporal trend of the development of total production and consumption, average per capita share, self-sufficiency ratio, and sugar imports in Egypt during the period (2004-2019).

Variables	Average	Coefficient (a)	Coefficient (b)	R Square	Annual rate of change	Significance	
						(t)	(F)
Total production (thousand tons)	1974.35	1481.77	60.24	0.79	3.05	7.15**	51.14**
Total consumption (thousand tons)	2826.93	2261.33	70.7	0.97	2.5	22.97**	527.61**
Average per capita (Kg / year)	33.6	33.53	0.01	0.002	0.02	0.17	0.03
The nutritional gap (thousand tons)	852.59	779.57	10.46	0.1	1.23	1.26	1.6
Percentage of self-sufficiency in sweetened sugar (%)	69.54	65.35	0.48	0.16	0.69	1.62	2.64
Quantity imports (thousand tons)	597.21	723.62	-17.12	0.1	-2.87	-0.9	0.81
Imports value (million dollars)	430.92	166.13	30.69	0.3	7.12	2.47*	6.11*
Import price ($ / ton)	898.07	91.95	119.18	0.56	13.27	4.22**	17.80**

Source: It was collected and calculated from the data of Table No. (5) by research.

Third: The development of some economic indicators of sugar crops in Egypt

1- The price per supplied ton:

It is clear from Table (7) that the general average price per ton of sugar cane crop in Egypt during the study period (2004-2019) amounted to about 361.50 pounds / ton compared to about 340.38 pounds / ton for sugar beet during the study period. This there is an increase in the price per ton supplied At the end of the period from the beginning of the period, about (590,470) pounds / ton for each, respectively, at a rate of about 453.85% and 303.23% for each, respectively, of the price at the beginning of the period. By estimating the directional relationship of the economic indicators of sugar crops in Egypt during the study period. Table No. (8) shows that the price of a ton of sugar crops supplied in Egypt increased by about (42.79, 29.82) pounds / ton annually for both sugar cane and sugar beet during the study period, and this increase is statistically significant, and the value of the determination factor indicates that the time factor explains About 89%, 91% of the total changes in the price of the ton of sugar crops supplied in Egypt.

Table (7): The evolution of the price of the supplied ton, the production costs, the net revenue per feddan, and the profitability of the invested pound for sugar crops in Egypt during the period (2004/2019).

Years	sugar cane				Sugar beet			
	Supplier tonne price (Pounds /tons)	Total cost Feddan (Pound)	The net return (Pound)	Return on the invested pound	Supplier tonne price (Pounds /tons	Total cost Feddan (Pound)	The net return (Pound)	Return on the invested pound
2004		4131	2425	0.59	155	1857	1365	0.74
2005	130	4302	3827	0.89	153	1856	1755	0.95
2006	160	4412	4261	0.97	178	1886	1722	0.91
2007	180	5348	3902	0.73	179	1959	2489	1.27
2008	200	5640	4549	0.81	231	2386	2560	1.07
2009	234	6031	5437	0.9	317	2697	4230	1.57
2010	235	6606	5002	0.76	269	3003	3051	1.02
2011	280	6691	9551	1.43	325	3457	4729	1.37
2012	335	7755	9450	1.22	364	4092	4628	1.13
2013	360	7590	9700	1.28	387	4393	4959	1.13
2014	360	8591	10762	1.25	371	4869	4170	0.86
2015	400	8736	10656	1.22	379	5316	3838	0.72
2016	620	13451	15895	1.18	379	6853	1810	0.26
2017	720	14579	19377	1.33	534	7394	4797	0.65
2018	720	18251	16544	0.91	600	8613	5414	0.63
2019	720	14780	17582.5	1.33	625	9075	5024	0.55
Average	**361.5**	**8140.93**	**8755.87**	**1.05**	**340.38**	**4356.63**	**3533.81**	**0.93**

Net acre revenue = Total revenue - Total costs

Profit for the invested pound = Net acre revenue ÷ total costs x 100

Source: Data collected and calculated from the Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economy, Agricultural Economy Bulletin, separate issues for the period (2004-2019).

2- Production costs:

It is also clear from Table (7) that the general average of production costs from the sugar cane crop in Egypt amounted to about 8.14 thousand pounds /feddan compared to about 4.36 thousand pounds / acre for sugar beet during the study period, and this production costs has been increased at the end of the period from the beginning of the period by about (10.65 and 7.22) thousand pounds /feddan each, respectively, at a rate of about 257.78% and 388.69% for each, respectively, of the price at the beginning of the period. It is evident from the results of Table (8) that the production costs of sugar crops in Egypt increased by about (829.89, 495.47) pounds/feddan annually during the study period and this increase is statistically significant, and the value of the determination factor indicates that the time factor explains about 83%, 92% of Total changes in productive costs of sugar crops in Egypt.

3- Net Return:

It is also evident from Table (7) that the general average of the net yield per feddan of sugar cane crop in Egypt was about 8.75 thousand pounds /feddan compared to about 3.53 thousand pounds /feddan for sugar beet during the study period, and this has increased the net return per feddan at the end of the period from the beginning The period is about (15158,3659) pounds /feddan each, respectively, at a rate that represents about 625.10% and 268.10% each, respectively, of the net return at the beginning of the period. The results of Table (8) showed that the net yield per feddan of sugar crops in Egypt has been increased by a statistically significant quantity amounting to about (1103, 212.40) pounds /feddan annually for each of them, respectively, during the study period. The value of the determination factor indicates that the time factor explains about 90%, 52% of the total changes in net yield per acre of sugar crops in Egypt.

4- Profit of the invested pound:

It is evident from Table (7) that the general average profitability of the invested pound from the sugar cane crop in Egypt amounted to about 1.05 pounds compared to about 0.93 pounds for sugar beet during the study period. Table (8) shows an increase in the profitability of the invested pound from sugar cane in Egypt by a statistically significant quantity of about 0.04 pounds annually, while the profit of the invested pound from the sugar beet crop has been reducing d by a statistically significant quantity of about 0.04 pounds during the study period.

Table (8): Equations for the general time trend for the development of the price of the supplied ton, production costs, net revenue and profitability of the invested pound for sugar crops in Egypt during the period (2004-2019)

Crop	Variables	Average	Coefficient (a)	Coefficient (b)	R Square	Annual rate of change	Significance	
							(t)	(F)
sugar cane	Supplier tonne price (Pounds /tons)	361.5	2.25	42.79	0.89	11.84	10.60**	112.28**
	Total cost Feddan (Pounds /Fed.)	8140.93	1501.82	829.89	0.83	10.19	8.29**	68.71**
	The net return (Pounds)	8755.87	70.76	1103.33	0.9	12.6	11.46**	131.22**
	Return on the invested pound (Pounds)	1.05	0.73	0.04	0.47	3.81	3.55**	12.59*
Sugar beet	Supplier tonne price (Pounds /tons)	340.38	86.93	29.82	0.91	8.76	11.88**	141.11**
	Total cost Feddan (Pounds /Fed.)	4356.63	145.13	495.47	0.92	11.37	12.69**	161**
	The net return (Pounds)	3533.81	1728.38	212.4	0.52	6.01	3.91**	15.29**
	Return on the invested pound (Pounds)	0.93	1.23	-0.04	0.27	-4.32	-2.27*	5.18*

Annual rate of change = Slope (B value) / Arithmetic mean X 100

Source: It was collected and calculated from the data of Table No. (7) by research.

Fourth: The evolution of production leakage and production loss of sugar crops

Table (9) shows that the average production leakage ranges between a minimum of 5.99 million tons in 2013, and a maximum of 10.72 million tons in 2012 with an average of about 7.54 million tons, representing about 45.24% of the total production of sugar cane during the period of The study, while the average quantity of lost sugar cane production amounted to about 883 thousand tons, representing about 5.30% of the sugar cane production, and it is also clear from the table that the total quantity lost from sugar cane is about 8.42 thousand tons, representing about 50.54% of the total production from sugarcane during the average study period.

Table (9): The development of leakage and lost production from sugar crops in Egypt during the period (2004/2019).

Years	sugar cane						Sugar beet					
	Dropout production (thousand tons)	The relative importance of leakage production from total production (%)	Production loss (thousand tons)	The relative importance of total production (%)	The lost production quantity	The relative importance of total production (%)	Dropout production (thousand tons)	The relative importance of leakage production from total production (%)	Production loss (thousand tons)	The relative importance of total production (%)	The lost production quantity	The relative importance of total production (%)
2004	6465	40.16	672	4.18	7137.7	44.33	240	8.4	34.3	1.2	275	9.6
2005	6889	42.08	762	4.65	7650	46.73	126	3.68	17.6	0.51	144	4.19
2006	6767	40.58	732	4.39	7499.1	44.97	304	7.78	42.5	1.09	347	8.87
2007	7159	41.9	776	4.54	7935	46.44	230	4.22	30.1	0.55	260	4.77
2008	8746	49.27	1044	5.88	9790	55.15	41.4	0.81	5.4	0.11	46.8	0.91
2009	8010	47.02	1043	6.12	9052.6	53.14	1413	26.49	206	3.87	1619	30.36
2010	9367	51.02	1234	6.72	10601	57.74	1102	14.06	145	1.85	1247	15.91
2011	9003	49.72	1261	6.96	10264	56.69	308	4.12	40.6	0.54	349	4.66
2012	10721	54.37	1310	6.64	12031	61.01	623	6.83	81.8	0.9	705	7.73
2013	5988	38.5	706	4.54	6693.5	43.05	458	5.68	63.8	0.79	522	6.47
2014	6741	41.99	741	4.62	7482.2	46.6	1846	16.72	256	2.32	2102	19.03
2015	6583	41.4	724	4.55	7307.4	45.95	2459	20.52	348	2.9	2807	23.42
2016	6359	41.23	653	4.24	7012.4	45.47	2118	18.9	295	2.63	2413	21.53
2017	6940	45.12	760	4.94	7699.5	50.06	1757	16.18	256	2.35	2013	18.53
2018	7625	48.19	851	5.38	8475.2	53.56	1551	14.95	219	2.11	1770	17.06
2019	7282	47.49	860	5.61	8142	53.09	1809	14.77	279	2.28	2088	17.05
Average	**7540**	**45.24**	**883**	**5.3**	**8423.3**	**50.54**	**1024**	**12.97**	**145**	**1.84**	**1169**	**14.8**

Source: Data collected and calculated from the data of:

1- Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economy, Agricultural Economy Bulletin, separate issues for the period (2004-2019).

2- Ministry of Agriculture and Land Reclamation, Council of Sugar Crops, Annual Report Bulletin, separate issues for the period (2004-2019).

It is also evident from the previous table that the quantity of production leakage ranges from a minimum amounting to about 41.4 thousand tons in 2008, and a maximum of about 2.46 million tons in 2015, with an average of about 1.02 million tons, representing about 12.97% of the total production of sugar beet during the study period. While the average quantity of lost production for the sugar beet crop was about 145 thousand tons, representing about 1.84% of the total production of sugar beet, and the total lost quantity of beet was about 1.17 thousand tons, representing about 14.80% of the total production of sugar beet during the average period studying.

Scenarios and possibilities of decrease the food gap from sugar in Egypt:

First scenario:

The economic and agricultural policy in Egypt aims to the possibility of decrease the gap of sugar due to the burden that it represents on the balance of payments, and the food gap of sugar can be decrease through the policy of vertical expansion through the development of new high-productivity varieties, which in turn lead to increase the local production of sugar cane crop in the governorates pioneer in its production, and the policy of horizontal expansion in the cultivation of the sugar beet crop by increasing the cultivated area, especially as it is one of the crops that can be well cultivated in the new lands on the other hand and increasing the feddan productivity by developing new high-yield varieties on the other hand, especially after the difficulty of horizontal expansion in the cultivation of the sugar cane crop due to the limitations of Water Resources. Have been targeted Sustainable Agricultural Development Strategy 2030 had a target to reach the productivity of sugar beet to about 35 tons/feddan and thus increasing the production of sugar to fill the sugar gap with the presence of the difficulties facing the cultivation of the sugar cane crop in due to water scarcity and the inability to expand its cultivation.

Second scenario:

This scenario is based on reducing the food gap of sugar by educating citizens to decrease consumption of sugar, especially that the sugar average per capita in Egypt is higher than its global counterpart, as the statistics indicate that the average per capita share of sugar in Egypt amounted to about 33.6 kg / year Compared to its global counterpart,

which was estimated at 25 kg / year. The research assumes that the average per capita share of sugar in Egypt should be about 25 kg /year, as it is at the world level. The research assumes that the average per capita share of sugar in Egypt is about 25 kg /year, as it is at the world level. Table (10) shows that the average potential consumption of sugar as a result of decreasing the consumption amounted to about 2.11 million tons during the study period (2004-2019), and thus the volume of savings as a result of decreasing consumption is about 756 thousand tons, and this is due to the citizens' awareness of decreasing consumption of sugar This achieves a reduction in the food gap from about 856.49 thousand tons for the current gap to about 100.78 thousand tons for the potential future gap during the study period, which indicates that the scenario of decreasing consumption of sugar will lead to a decrease in the food gap of sugar by about 755.70 thousand tons. This represents about 88.64% of the sugar food gap during the average study period.

Table (10): The proposed increase in the total production of sugar as a result of educating citizens about decreasing the consumption of sugar in Egypt during the period (2004/2019).

Years	Total production (thousand tons)	Population (million people)	Average per capita (kg/year)	Potential consumption (thousand tons)	Actual consumption (thousand tons)	Potential saving in consumption (thousand tons)	Current food gap (thousand tons)	Potential food gap (thousand tons)
2004	1370	70.67	25	1766.75	2200	433	-830.4	-397.15
2005	1498	72.01	25	1800.25	2432	632	-934.3	-302.55
2006	1576	73.64	25	1841	2553	712	-977.5	-265.5
2007	1758	75.19	25	1879.75	2600	720	-842.1	-121.85
2008	1711	76.93	25	1923.25	2564	641	-853.3	-212.55
2009	1772	69.87	25	1746.75	2720	973	-948	25.25
2010	2175	80.53	25	2013.25	2795	782	-620.2	161.55
2011	2187	82.55	25	2063.75	2750	686	-562.7	123.55
2012	2103	84.63	25	2115.75	2900	784	-797.2	-12.95
2013	2188	86.81	25	2170.25	3000	830	-812.2	17.55
2014	2298	88.96	25	2224	3100	876	-801.7	74.3
2015	2372	93.78	25	2344.5	3100	756	-727.6	27.9
2016	2197	95.69	25	2392.25	3160	768	-963.1	-195.35
2017	2249	97.55	25	2438.75	3230	791	-980.9	-189.65
2018	2162	98.9	25	2472.5	3300	828	-1137.6	-310.1
2019	2460	99.8	25	2495	3375	880	-915	-35
Average	**2005**	**84**	**25**	**2105**	**2861**	**756**	**-856.49**	**-100.78**

Source: Data collected and calculated from the Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economy, Agricultural Economy Bulletin, separate issues for the period (2004-2019).

Third scenario:

This scenario depends on filling the food gap from sugar by overcoming the leakage from production and the production loss of sugar crops during the study period, as the results of Table (11) indicate that the average quantity of sugar that can be produced from the leakage of production from sugar cane during the study period amounted to about 878.49 One thousand tons could fill about 102.57% of the food gap in Egypt during the study period, While the quantity of sugar that could be produced from the productive loss of the sugar cane crop during the study period was about 103.72 thousand tons, that could fill about 12.11% of the size of the food gap in Egypt during the study period, and it is clear from this that if the leakage from production and the loss in production of the cane crop are treated Sugar, by this we can overcome the problem of sugar nutritional gap in Egypt.

Table (11): The proposed increase in the total production of sugar as a result of overcoming the leakage production and the quantity of lost production for sugar crops in Egypt during the period (2004/2019).

Years	sugar cane						Sugar beet						Quantity of sugar that can be produced from sugar crops (thousand tons) (13)	Sugar gap (thousand tons)(14)	Contribution of the quantity of sugar that can be produced to the current food gap(%)(15)	Quantity of change in potential gap (thousand tons)(16)
	Production leakage (thousand tons)(1)	Extraction rate (%)(2)	Quantity of sugar that can be produced (thousand tons) (3)	Production loss (thousand tons)(4)	Quantity of sugar that can be produced (thousand tons) (5)	Total quantity of sugar that could be produced (thousand tons) (6)	Production leakage (thousand tons)(7)	Extraction rate (%)(8)	Quantity of sugar that can be produced (thousand tons) (3)	Production loss (thousand tons)(10)	Quantity of sugar that can be produced (thousand tons) (5(	Total quantity of sugar that could be produced (thousand tons) (6)				
2004	6465.3	10.4	672.39	672.4	69.93	742.31	240.4	14.25	34.26	34.3	4.89	39.15	781.46	830.4	94.11	-48.94
2005	6888.5	11.06	761.53	761.5	84.18	845.72	126.2	13.98	17.65	17.6	2.46	20.11	865.82	934.3	92.67	-68.48
2006	6767	10.82	732.15	732.1	79.21	811.36	304	13.98	42.49	42.5	5.94	48.43	859.79	977.5	87.96	-117.71
2007	7159.4	10.83	775.62	775.6	84.03	859.65	230.3	13.06	30.08	30.1	3.93	34.01	893.66	842.1	106.12	51.56
2008	8745.6	11.94	1044.39	1044.4	124.72	1169.12	41.4	13.07	5.41	5.4	0.71	6.12	1175.23	853.3	137.73	321.93
2009	8009.9	13.02	1042.68	1042.7	135.73	1178.41	1412.5	14.61	206.41	206.4	30.16	236.57	1414.98	948	149.26	466.98
2010	9366.9	13.18	1234.25	1234.3	162.64	1396.9	1102.1	13.18	145.31	145.3	19.16	164.47	1561.36	620.2	251.75	941.16
2011	9002.7	14	1260.75	1260.8	176.56	1437.32	308.2	13.18	40.63	40.6	5.35	45.98	1483.29	562.7	263.6	920.59
2012	10721	12.22	1309.66	1309.7	159.99	1469.65	623.2	13.13	81.84	81.8	10.74	92.58	1562.22	797.2	195.96	765.02
2013	5987.5	11.79	706.04	706	83.25	789.29	458.2	13.92	63.8	63.8	8.88	72.69	861.98	812.2	106.13	49.78
2014	6740.8	11	741.44	741.4	81.55	822.99	1846.3	13.85	255.67	255.7	35.41	291.08	1114.07	801.7	138.96	312.37
2015	6583.3	11	724.09	724.1	79.64	803.74	2458.7	14.15	347.81	347.8	49.2	397.01	1200.75	727.6	165.03	473.15
2016	6359	10.28	653.41	653.4	67.14	720.54	2118.3	13.92	294.9	294.9	41.05	335.96	1056.5	963.1	109.7	93.4
2017	6940	10.94	759.5	759.5	83.12	842.62	1756.8	14.56	255.72	255.7	37.22	292.94	1135.56	980.9	115.77	154.66
2018	7624.7	11.15	850.51	850.5	94.87	945.38	1550.9	14.14	219.27	219.3	31	250.27	1195.65	1137.6	105.1	58.05
2019	7282.35	10.81	787.49	859.65	92.96	880.45	1808.67	16.72	302.49	279.43	46.73	349.22	1229.67	915	134.39	314.67
Average	7540.25	11.53	878.49	883	103.72	982.21	1024.14	13.98	146.48	145.04	20.8	167.29	1149.5	856.49	140.89	293.01

14-13=(16) 100×14÷13 =(15) 12+9 =(13) 11+9 =(12) 10×8 =(11) 8×7 =(9) 5+3 =(6) 4×2 =(5) 2×1 =(3)

Source: Data collected and calculated from:

1- Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economy, Agricultural Economy Bulletin, separate issues for the period (2004-2019).

2- Ministry of Agriculture and Land Reclamation, Council of Sugar Crops, Annual Report Bulletin, separate issues for the period (2004-2019).

It is also evident from the table that the average quantity of sugar that could be produced from the production leakage of sugar beet during the study period amounted to about 146.48 thousand tons, which could fill about 17.10% of the size of the food gap in Egypt during the study period, while the quantity of sugar that could be produced from the productive loss of the Sugar beet crop, during the study period, about 20.80 thousand tons could fill about 2.43% of the size of the food gap in Egypt during the study period, It is clear from this that if production leakage and production loss of the sugar cane crop are addressed, an estimated 19.53% of the sugar food gap in Egypt will be filled. It is noted from the previous survey that the quantity of leakage from production and the production loss of sugar cane crop is increased compared to sugar beet. If this can be treated, the food gap of sugar in Egypt will be closed.

Recommendations:

1- Adopting a price policy that motivates farmers to increase the supply of sugar crops from cane and beet to factories so that the production leakage can be reduced or overcome.

2- Adopting a policy of vertical expansion of sugar cane by developing new varieties with higher productivity and better extraction rate, and the policy of vertical and horizontal expansion of sugar beet crop by increasing the cultivated area of sugar beet, especially in newly reclaimed lands and areas where it is well cultivated, in addition to using new high-productivity varieties.

3- Drawing up a production policy for beet harvest that works on encourage the farmers based on linking prices with production costs to achieve a rewarding return for farmers.

4- Getting the advantage of exploiting the large quantities leaked from production and lost production, which work to fill the food gap from sugar crops.

5- Rationalizing the individual's sugar consumption by changing the dietary pattern through awareness and counseling through various communication sites programs, and introducing other alternatives to sugar in manufacturing, which contributes to raising the rate of self-sufficiency.

6- Activating the role of contractual agriculture, which has the greatest impact on motivating farmers to increase production and treat the dropout.

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