Egyptian Sugar Journal (2025), 24: 25 – 40
https://doi.org/10.21608/esugj.2025.422716.1088

RESEARCH ARTICLE

# Study on the most important indicators of productive and economic efficiency of sugarcane in Egypt.

**Nora Sweify[1*], Talaat Hafiz Isamil[2], Galal Abdel Fattah El-Sogheer[2], Dalia Hamed El-Shoeikh[2]**

Received: 11 Sep 2025\ Revised: 20 Nov 2025\ Accepted: 27 Nov 2025\ Published online: 04 Dec 2025

## Abstract

Sugarcane represents one of the most significant sugar-producing crops and serves as a cornerstone for numerous Agri-industrial sectors in Egypt. The study addresses the sugar supply gap in the country, which arises from insufficient domestic sugarcane production relative to growing local demand for sugar. A descriptive and quantitative analytical methodology was employed, relying on secondary data obtained from publications issued by the Ministry of Agriculture and Land Reclamation. The analysis produced several noteworthy findings that contribute to a more profound understanding of the factors influencing sugarcane production and the national sugar balance. This research seeks to examine the underlying causes of this production–consumption imbalance and to evaluate its implications for the national sugar economy. To achieve these objectives, the study employed a descriptive, quantitative analytical framework, using secondary data published by the Ministry of Agriculture and Land Reclamation. The analytical approach enabled the identification of production trends, consumption patterns, and the key determinants influencing sugarcane productivity over time. The findings revealed many significant insights into the structural and policy-related factors contributing to the sugar gap, thereby providing a basis for developing evidence-based strategies aimed at enhancing sugarcane efficiency, improving self-sufficiency rates, and reducing reliance on imported sugar. The productivity per acre of sugarcane recorded a slight but consistent decline, decreasing annually by approximately 0.383% over the study period. The net return per acre per season showed a notable increase of about 10.3% annually at both current and constant prices. The return on the invested pound per month also improved, increasing by approximately 2.66% and 3.36% at current and constant prices, respectively. Overall, the findings suggest that the improvements observed in profitability were primarily driven by rising prices rather than productivity growth.

**Keywords**: Sugarcane production, Sugar supply -Productivity Trends-Profitability analysis -Self-sufficiency implications.

[1] Department of Science and Technology of Sugar Industry, Faculty of Sugar and Integrated Industries Technology. Assiut University, Assiut, Egypt.
[2] Department of Agricultural Economics, Faculty of Agriculture, Assiut University, Assuit, Egypt.
***Corresponding author:** nnwrabdr@gmail.com

## Introduction

One of the most significant strategic commodities in the world is sugar. garnering a lot of attention from planners and politicians because Egypt's indigenous supply cannot keep up with demand. Due to population increase and shifting consumer eating habits, there is now a food gap and a decrease in self-sufficiency rates. even though Egypt's sugar crop yield and planted area have increased (El-Tanahy and Mahmoud, 2020). Egypt is seeing a widening disparity between sugar output and consumption despite the growth of sugarcane planting regions, which calls for an examination of economic resources and production efficiency. According to research, sugar consumption is rising while sugarcane production varies. (Abdelkhalek et al., 2025).

The issue of productive and economic efficiency in sugarcane cultivation is of great importance, encompassing an examination of indicators such as yield per acre, production costs, net profit, return on investment, and the efficiency of agricultural resource utilization. A study in Minya Governorate found that the efficiency of resources used in sugarcane production was low, necessitating their rationalization (Ahmed, S., Ibrahim et al., 2022).

The importance of focusing on these indicators lies in their role as the foundation for developing strategies aimed at improving production efficiency, increasing sugar self-sufficiency, and reducing reliance on imports.

A comparative study of sugarcane and sugar beet crops in Egypt indicated that production and economic efficiency still need improvement (Mohamed, M. Z. E. A. 2020).

Therefore, studying the productive and economic efficiency of the resources used in producing these crops has become of great importance in this field. especially sugarcane. Sugarcane is one of the most important sugar crops, supporting many Egyptian industries (Abd-El Maksoud and Ghaly 2021).

Contributing about 49.1% of the total quantities delivered for sugar production in Egypt. which amounted to about 14.3 million tons in 2023. The average production of sugarcane per feddan in 2023 was about 45.3 tons/feddan (Central Agency for Public Mobilization and Statistics (CAPMAS, 2024)). Consequently, this study aims to analyze the productive and economic efficiency indicators of sugarcane in Egypt and identify the factors influencing them, using a descriptive quantitative methodology based on published secondary data. It also seeks to provide practical, evidence-based recommendations for improving the efficiency of this strategic crop.

## The research problem

The research problem addressed in this study stems from the noticeable fluctuations in sugarcane productivity in Egypt over the past two decades, where average yields per feddan reached 49.86 tons in 2000, rising to 51.2 tons in 2006, and declined to 49.1 tons in 2023 (Ministry of

Agriculture and Land Reclamation, 2023). These variations underscore the necessity of analyzing the productive and economic efficiency indicators of sugarcane cultivation, including yield trends, production costs, net returns, and return on investment.

The research problem is further intensified by a production-consumption gap, driven by population growth and increasing per capita sugar demand, resulting

in Egypt's substantial reliance on sugar imports. Consequently, the study aims to evaluate both the efficiency of sugarcane production and the current levels of self-sufficiency, providing insights for policy measures to enhance the sustainability and economic performance of the sugar sector.

In light of these challenges, the present study aims to analyze the main indicators of productive and economic efficiency of sugarcane in Egypt, including yield trends, production costs, net returns, and return on investment. Additionally, the research seeks to assess the current levels of self-sufficiency in sugar production, considering the ongoing changes in production and consumption patterns, thereby providing a foundation for evidence-based policy recommendations to enhance the sustainability and efficiency of the sugarcane sector.

## Research Objectives

The main objective of this study is to evaluate the key indicators of productive and economic efficiency of sugarcane in Egypt, through a detailed analysis of the following aspects

The development of the key indicators of productive and economic efficiency of sugarcane in Egypt.

1. Reviewing and analyzing the actual production and consumption of sugar in Egypt.
2. Highlighting the food gap – the dietary deficit – of sugar in Egypt and identifying

   The self-sufficiency ratios and the degree of dependency on imports.

3. Analyzing exports and imports and estimating the daily domestic consumption of sugar in Egypt.
4. Estimating the sufficiency period of both production and imports for domestic consumption and estimating the surplus and deficit in domestic consumption as well as their sufficiency periods for sugar in Egypt.
5. Estimating the size of the strategic stockpile, the sufficiency period of the stockpile for daily consumption, and estimating the food security coefficient of sugar in Egypt.

## Research Methodology and Data Sources

The research relied on both descriptive and quantitative statistical analysis methods. Using some percentages and arithmetic means, as well as employing the simple linear regression model. In addition. index numbers were used to convert current values into real values. along with some economic efficiency indicators and food security measures. The research also relied on secondary data issued by the Ministry of Agriculture and Land Reclamation, as well as studies related to the subject of the research.

## Results and Discussion

First: The Development of Indicators of Cultivated Area. Delivered Area. Yield per Feddan. Delivered Production and Total Production of Sugarcane in Egypt during the period (2000–2023)

### Cultivated Area

From the data in Table (1). The cultivated area of sugarcane during the period (2000–2023) ranged between a minimum of about 311.99 thousand feddans in 2001 and a maximum of about 342.38 thousand feddans in 2021. with the average of the period being about 326.08 thousand feddans. From the data in Table (2). It is clear from Equation (1) that the area showed a generally increasing trend. statistically significant at the 0.05 level. with an annual.

## Supplied Area and Its Ratio

Increase of about 0.477 thousand feddans. representing an annual growth rate of about 0.146% of the average during the period. The coefficient of determination indicates that about 24.1% of the changes in the cultivated area of sugarcane are explained by factors associated with the element of time.

From the data in Table (1). The delivered area of sugarcane during the period (2000–2023) ranged between a minimum of about 227.5 thousand feddans. Representing about 72% of the total cultivated area in 2023. and a maximum of about 265.5 thousand feddans. Representing about 85.1% of the total cultivated area in 2001. while the average of the period was about 245.6 thousand feddans.

**Table 1.** Development of the Cultivated Area. Yield per Feddan. and Total Production of Sugarcane in Egypt during the Period (2000–2023)

| Years | Cultivated area | Supplied area | % of the supplied area from cultivated area | Feddan productivity | Total production | Supplied production | % of supplied production from total production |
|---|---|---|---|---|---|---|---|
| | One thousand feddans | One thousand feddans | | ton per Feddan | One million tons | One million tons | |
| 2000 | 318.9 | 255.2 | 80.0 | 49.3 | 15.7 | 10.0 | 63.7 |
| 2001 | 312.0 | 265.5 | 85.1 | 49.9 | 15.6 | 10.1 | 64.9 |
| 2002 | 323.4 | 250.2 | 77.4 | 49.5 | 16.0 | 9.7 | 60.5 |
| 2003 | 327.2 | 250.6 | 76.6 | 49.9 | 16.3 | 9.4 | 57.6 |
| 2004 | 327.2 | 245.9 | 75.1 | 49.7 | 16.3 | 9.3 | 57.2 |
| 2005 | 322.0 | 242.5 | 75.3 | 50.4 | 16.2 | 9.6 | 59.1 |
| 2006 | 321.4 | 239.1 | 74.4 | 50.8 | 16.3 | 9.5 | 58.2 |
| 2007 | 326.9 | 245.7 | 75.2 | 51.0 | 16.7 | 9.9 | 59.4 |
| 2008 | 335.1 | 255.8 | 76.3 | 50.8 | 17.0 | 9.9 | 58.2 |
| 2009 | 323.6 | 233.1 | 72.0 | 50.9 | 16.5 | 9.0 | 54.7 |
| 2010 | 316.7 | 233.9 | 73.9 | 48.9 | 15.5 | 8.9 | 57.5 |
| 2011 | 320.3 | 240.2 | 75.0 | 49.0 | 15.7 | 9.3 | 59.2 |
| 2012 | 325.5 | 236.5 | 72.7 | 48.4 | 15.8 | 8.9 | 56.4 |
| 2013 | 325.7 | 238.8 | 73.3 | 47.7 | 15.6 | 8.5 | 54.7 |
| 2014 | 329.2 | 246.8 | 75.0 | 47.9 | 15.8 | 9.3 | 58.9 |
| 2015 | 332.0 | 254.1 | 76.5 | 48.4 | 16.1 | 9.3 | 57.9 |
| 2016 | 328.1 | 250.1 | 76.2 | 48.5 | 15.9 | 9.1 | 57.2 |
| 2017 | 326.2 | 243.4 | 74.6 | 47.2 | 15.4 | 8.4 | 54.6 |
| 2018 | 327.4 | 242.7 | 74.1 | 48.3 | 15.8 | 8.2 | 51.8 |
| 2019 | 329.2 | 248.2 | 75.4 | 46.6 | 15.3 | 8.6 | 56.1 |
| 2020 | 336.1 | 250.6 | 74.6 | 47.2 | 15.9 | 7.9 | 49.8 |
| 2021 | 342.4 | 251.8 | 73.5 | 46.6 | 16.0 | 8.3 | 52.0 |
| 2022 | 333.2 | 245.7 | 73.7 | 46.7 | 15.6 | 7.8 | 50.1 |
| 2023 | 316.1 | 227.5 | 72.0 | 45.3 | 14.3 | 7.0 | 49.1 |
| Average | 326.1 | 245.6 | 75.3 | 48.7 | 15.9 | 9.0 | 56.6 |

**Source:** Compiled and calculated from the data of the Ministry of Agriculture and Land Reclamation. Economic Affairs Sector. *Agricultural Economics Bulletin*.

## Yield per Feddan

From the data of Table (1). The yield per feddan of sugarcane during the period (2000–2023) ranged between a minimum of about 45.1 tons/feddan in 2023 and a maximum of about 51 tons/feddan in 2007. with an average of about 48.7 tons/feddans for the period.

From the data in Table (2). It is evident from Equation (2) that the yield per feddan of sugarcane showed a generally decreasing trend. statistically significant at the 0.01 level. The annual decrease amounted to about 0.190 tons/feddan. representing an annual decline rate of about 0.39% of the average during the period. The coefficient of determination indicates that about 70.1% of the changes in sugarcane yield per feddan are explained by factors associated with the element of time.

## Total Production of Sugarcane

From the data in Table (1). The total production of sugarcane during the period (2000–2023) ranged between a minimum of about 14.25 million tons in 2023 and a maximum of about 17.01 million tons in 2008. with the average of the period being about 15.87 million tons.

From the data of Table (2). it is clear from Equation (3) that the total production of sugarcane showed a generally decreasing trend. statistically significant at the 0.05 level. The annual decrease amounted to about 0.039 million tons. representing an annual decline rate of about 0.024% of the average during the period. The coefficient of determination indicates that about 22.3% of the changes in the total production of sugarcane are explained by factors associated with the element of time.

## Supplied Production of Sugarcane and Its Ratio

From the data in Table (1). The Supplied production of sugarcane during the period (2000–2023) ranged between a minimum of about 7 million tons. representing about 49.1% in 2023. and a maximum of about 10.1 million tons. representing about 64.9% in 2001. with the average of the period being about 9 million tons.

**Table 2.** Estimated Trend Equations of the Cultivated Area. Yield per Feddan. and Total Production of Sugarcane in Egypt during the Period (2000–2023)

| S.No | Phenomenon | Equation | $R^2$ | F | Mean | Amount of change | Change |
|---|---|---|---|---|---|---|---|
| ١ | Cultivated Area (thousand feddans) | $\hat{Y}t$= ٣٢٠,١٢+ ٠,٤٧٧$X_t$ (٢,٦٥)* | ٠,٢٤١ | ٦,٩٩٤* | 326.08 | ٠,٤٧٧ | ٠,١٤٦ |
| 2 | Productivity (tons/feddan) | $\hat{Y}t$= -51.07 -0.190 $X_t$ (7.18-)** | 0.701 | 51.554** | 48.7 | 0.190- | 0.390- |
| 3 | Production (thousand tons) | $\hat{Y}t$= 16.36 - 0.039$X_t$ (2.76-)* | 0.223 | 7.59* | 15.87 | 0.039- | 0.024- |

**Where:**

- **$\hat{Y}t$**: Refers to the estimated value of the dependent variable indicated.
- **Xt**: Refers to the time element (trend order). where h = 1. 2. 3. …. 24 years.
- Values in parentheses under the regression coefficients indicate the calculated *t* values.
- (**): Statistically significant at the 0.01 level.
- (*): Statistically significant at the 0.05 level.
- **Annual rate of change** = (Annual change / Mean of the dependent variable) × 100.

**Source:** Calculated from the data of Table 1.

### These results are consistent with the following studies

In the Economic Analysis of Sugarcane Production in Egypt, Abdelkhalek, Moursi, El-Saba, and Sarhan (2025) also report a decreasing trend in both productivity (yield per feddan) and total production, statistically significant at the 0.01 level, over their study period (2005–2022).

They highlight that, despite increasing cultivated areas and rising net returns, the productivity drop is a central constraint. They further recommend that improving that yield should be a top priority through the development or adoption of high-yielding sugarcane varieties (Abdelkhalek et al., 2025).

## Second: Development of the Economic Efficiency Indicators of Sugarcane during the Period (2000–2023)

### Farm-Gate Price

### At Current Prices

The data in Table (3) indicate the development of economic efficiency indicators in sugarcane production during the period (2000–2023). It was found that the minimum current farm-gate price of sugarcane was about 95 EGP/ton in 2000 and 2001. While the maximum reached about 1.200 EGP/ton in 2022. This means that the current farm-gate price has more than doubled. increasing by about 1263% compared to 2000. The average current farm-gate price of sugarcane for the period was **about 425.06 EGP/ton.**

By estimating the trend equation of the economic efficiency indicators in sugarcane production during the period (2000–2023), as shown in Table (4).

It was found that the current farm-gate price of sugarcane followed a generally increasing trend of about 42.906 EGP annually. with an annual growth rate of about 10.094% of the average current farm-gate price (425.06 EGP/ton).

This model was statistically significant at the 1% level. The coefficient of determination ($R^2$) indicated that about 87.4% of the variations in the current farm-gate price of sugarcane were explained by factors associated with the time element.

### At Constant (Real) Prices

The data in Table (3) also shows that the real farm-gate price of sugarcane reached a minimum of about 58.83 EGP/ton in 2021 and a maximum of about 119.29 EGP/ton in 2017. meaning that the real price increased by about 26% compared to 2000. The average real farm-gate price of sugarcane during the period was about 90.91 EGP/ton.

By estimating the trend equation of the economic efficiency indicators in sugarcane production during the period (2000–2023). as shown in Table (4). it was found that the real farm-gate price of sugarcane followed a generally **decreasing trend** that was not statistically significant. indicating that the real farm-gate price of sugarcane was not significantly affected by the time element.

### Total Revenue per Feddan

### At Current Prices

The data in Table (3) indicates that the total revenue per feddan of sugarcane at current prices reached a minimum of about 4.736.3 EGP/feddan in 2000 and a maximum of about 56.047 EGP/feddan in 2022.

This means that the total revenue at current prices more than doubled. Increasing by about 183% compared to 2000. The average total revenue per feddan at current prices during the period was about 20.229.36 EGP/feddan.

By estimating the trend equation of the economic efficiency indicators in sugarcane production during the period (2000–2023), as shown in Table (4).

It was found that the total revenue per feddan at current prices followed a generally increasing trend of about 1.972.658 EGP annually. with an annual growth rate of about 9.751% of the average total revenue per feddan at current prices (20.229.36 EGP/feddan).

This model was statistically significant at the 1% level. The coefficient of determination ($R^2$) indicated that about 88.1% of the variations in total revenue per feddan at current prices were explained by factors associated with the time element.

**Table 3.** Development of the Economic Efficiency Indicators of Sugarcane under Study during the Period (2000–2023) at Current and Constant Prices (Base Year 2000)

| Years | Average yield per ton | Farm-gate price (L.E.) | | Total revenue per feddan (L.E.) | | Total cost per feddan (L.E.) | | Net return per feddan (L.E.) | | Net return per feddan / month | | Return on invested pound | | Return per pound / month | | Cost per ton (L.E.) | | % of cost per ton to farm-gate price | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Current | Real | Current | Real | Current | Real | Current | Real | Current | Real | Current | Real | Current | Real | Current | Real | Current | Real |
| 2000 | 49.86 | 95.00 | 00.95 | 4736.30 | 4736.30 | 2332.40 | 2332.40 | 1226.90 | 1226.90 | 102.24 | 102.24 | 0.53 | 0.53 | 0.04 | 0.04 | 46.78 | 46.78 | 49.24 | 49.24 |
| 2001 | 49.90 | 95.00 | 93.11 | 4740.50 | 4451.90 | 3519.00 | 4324.79 | 1221.50 | 1147.13 | 101.79 | 95.59 | 0.35 | 0.27 | 0.03 | 0.02 | 70.52 | 86.67 | 74.23 | 93.09 |
| 2002 | 49.53 | 105.00 | 94.91 | 5201.00 | 4515.53 | 3700.00 | 4132.81 | 1501.00 | 1303.17 | 125.08 | 108.60 | 0.41 | 0.32 | 0.03 | 0.03 | 74.70 | 83.44 | 71.14 | 87.92 |
| 2003 | 49.68 | 105.00 | 82.91 | 5216.00 | 4018.15 | 3600.00 | 3215.74 | 1616.00 | 1244.89 | 134.67 | 103.74 | 0.45 | 0.39 | 0.04 | 0.03 | 72.46 | 64.73 | 69.01 | 78.07 |
| 2004 | 50.43 | 130.00 | 87.57 | 6556.00 | 4259.46 | 4131.00 | 3356.76 | 2425.00 | 1575.53 | 202.08 | 131.29 | 0.59 | 0.47 | 0.05 | 0.04 | 81.92 | 66.56 | 63.01 | 76.01 |
| 2005 | 50.81 | 160.00 | 97.57 | 8129.00 | 4900.31 | 4302.00 | 2772.67 | 3827.00 | 2306.99 | 318.92 | 192.25 | 0.89 | 0.83 | 0.07 | 0.07 | 84.68 | 54.57 | 52.92 | 55.93 |
| 2006 | 51.02 | 170.00 | 95.06 | 8673.00 | 4731.96 | 4412.00 | 2789.02 | 4261.00 | 2324.79 | 355.08 | 193.73 | 0.97 | 0.83 | 0.08 | 0.07 | 86.48 | 54.67 | 50.87 | 57.51 |
| 2007 | 50.82 | 182.00 | 88.82 | 9250.00 | 4381.40 | 5348.00 | 3037.24 | 3902.00 | 1848.24 | 325.17 | 154.02 | 0.73 | 0.61 | 0.06 | 0.05 | 105.23 | 59.76 | 57.82 | 67.28 |
| 2008 | 50.94 | 200.00 | 80.72 | 10189.00 | 3999.76 | 5640.00 | 2617.53 | 4549.00 | 1785.74 | 379.08 | 148.81 | 0.81 | 0.68 | 0.07 | 0.06 | 110.71 | 51.38 | 55.36 | 63.66 |
| 2009 | 48.91 | 234.50 | 87.53 | 11468.00 | 4166.46 | 6031.00 | 2580.04 | 5437.00 | 1975.33 | 453.08 | 164.61 | 0.90 | 0.77 | 0.08 | 0.06 | 123.32 | 52.76 | 52.59 | 60.27 |
| 2010 | 49.51 | 280.00 | 82.68 | 13863.00 | 3888.29 | 6606.00 | 2585.11 | 7257.00 | 2035.44 | 604.75 | 169.62 | 1.10 | 0.79 | 0.09 | 0.07 | 133.42 | 52.21 | 47.65 | 63.15 |
| 2011 | 48.49 | 335.00 | 91.36 | 16242.00 | 4237.98 | 6691.00 | 2308.88 | 9551.00 | 2492.11 | 795.92 | 207.68 | 1.43 | 1.08 | 0.12 | 0.09 | 00.138 | 47.62 | 41.19 | 52.13 |
| 2012 | 47.79 | 360.00 | 95.66 | 17205.00 | 4374.31 | 7755.00 | 2607.47 | 9450.00 | 2402.63 | 787.50 | 200.22 | 1.22 | 0.92 | 0.10 | 0.08 | 162.27 | 54.56 | 45.07 | 57.03 |
| 2013 | 48.03 | 360.00 | 92.34 | 17290.00 | 4264.79 | 7590.00 | 2390.43 | 9700.00 | 2392.63 | 808.33 | 199.39 | 1.28 | 1.00 | 0.11 | 0.08 | 158.03 | 49.77 | 43.90 | 53.90 |
| 2014 | 48.25 | 380.00 | 94.29 | 18341.00 | 4344.52 | 8163.00 | 2598.59 | 10178.00 | 2410.91 | 848.17 | 200.91 | 1.25 | 0.93 | 0.10 | 0.08 | 169.17 | 53.85 | 44.52 | 57.12 |
| 2015 | 48.48 | 400.00 | 88.78 | 19392.00 | 4170.90 | 8736.00 | 2276.34 | 10656.00 | 2291.93 | 888.00 | 190.99 | 22.1 | 1.01 | 0.10 | 0.08 | 180.19 | 46.95 | 45.05 | 52.89 |
| 2016 | 47.33 | 620.00 | 105.45 | 29346.00 | 4825.18 | 13451.00 | 2722.41 | 15895.00 | 2613.51 | 1324.58 | 217.79 | 1.18 | 0.96 | 0.10 | 0.08 | 284.18 | 57.52 | 45.84 | 54.55 |
| 2017 | 47.16 | 720.00 | 119.29 | 33956.00 | 5501.86 | 14579.00 | 2698.38 | 19377.00 | 3139.64 | 1614.75 | 261.64 | 1.33 | 1.16 | 0.11 | 0.10 | 309.13 | 57.22 | 42.94 | 47.96 |
| 2018 | 48.33 | 720.00 | 110.34 | 34795.00 | 5187.30 | 18251.00 | 3214.28 | 16544.00 | 2466.41 | 1378.67 | 205.53 | 0.91 | 0.77 | 0.08 | 0.06 | 377.66 | 66.51 | 52.45 | 60.28 |
| 2019 | 46.59 | 720.00 | 98.13 | 33543.00 | 4486.30 | 17678.00 | 2642.22 | 15865.00 | 2121.91 | 1322.08 | 176.83 | 0.90 | 0.80 | 0.07 | 0.07 | 379.46 | 56.72 | 52.70 | 57.80 |
| 2020 | 47.18 | 720.00 | 77.70 | 33972.00 | 3739.20 | 18903.00 | 1870.28 | 15069.00 | 1658.60 | 1255.75 | 138.22 | 0.80 | 0.89 | 0.07 | 0.07 | 400.62 | 39.64 | 55.64 | 51.01 |
| 2021 | 46.61 | 810.00 | 58.83 | 37757.00 | 2802.09 | 22322.00 | 1475.11 | 15435.00 | 1145.49 | 1286.25 | 95.46 | 0.69 | 0.78 | 0.06 | 0.06 | 478.88 | 31.65 | 59.12 | 53.79 |
| 2022 | 46.71 | 1200.00 | 85.42 | 56047.00 | 4097.53 | 29707.00 | 1883.93 | 26340.00 | 1925.69 | 2195.00 | 160.47 | 0.89 | 1.02 | 0.07 | 0.09 | 636.04 | 40.34 | 53.00 | 47.22 |
| 2023 | 45.09 | 1100.00 | 78.30 | 49596.80 | 3625.96 | 30480.00 | 1932.95 | 6905.00 | 504.82 | 575.42 | 42.07 | 0.23 | 0.26 | 0.02 | 0.02 | 676.01 | 42.87 | 61.46 | 54.75 |
| Average | 48.64 | 425.06 | 90.91 | 20229.26 | 4321.14 | 10580.31 | 2681.89 | 9091.18 | 1930.85 | 757.60 | 160.90 | 0.88 | 0.75 | 0.07 | 0.06 | 222.50 | 54.95 | 53.61 | 60.52 |

**Source:** Ministry of Agriculture and Land Reclamation. Economic Affairs Sector. *Agricultural Statistics*. various issue.

**Table 4.** General Time Trend Equations of Sugarcane Production Efficiency Indicators at Current and Constant Prices during the Period (2000–2023).

| S.No | Phenomenon | Equation | R2 | F | Mean | The amount of change | %Change |
|---|---|---|---|---|---|---|---|
| ١ | Farm-gate price (Current. L.E.) | $\hat{Y}t = -111.27+42.906\ Xt$ $(12.366)^{**}$ | 0.874 | $152.924^{**}$ | 425.06 | 42.906 | 10.094 |
| 2 | Farm-gate price (Real. L.E.) | $\hat{Y}t = 93.383-0.198\ Xt$ (0.199-) | - | 0.31 | 91.91 | - | - |
| 3 | Total revenue per feddan (Current. L.E.) | $\hat{Y}t = -4428.87+658.1972\ Xt$ $(12.788)^{**}$ | 0.881 | $163.540^{**}$ | 20.229.36 | 1972.658 | 9.751 |
| 4 | Total revenue per feddan (Real. L.E.) | $\hat{Y}t = 4578.353-20.577\ Xt$ (١,٣٠٤-) | 0.072 | 1.700 | 4.321.14 | - | - |
| 5 | Total cost per feddan (Current. L.E) | $\hat{Y}t = -2555.375 + 1050.855\ Xt$ $(9.731)^{**}$ | 0.811 | $94.690^{**}$ | 10.580.31 | 1050.855 | 9.932 |
| 6 | Total cost per feddan (Real. L.E.) | $\hat{Y}t = 3471.039-63.132\ Xt$ $(4.381-)^{**}$ | 0.466 | $19.193^{**}$ | 2681.89 | 63.132- | 2.316- |
| 7 | Net return per feddan (Current. L.E.) | $\hat{Y}t = -011.1052 + 811.456\ Xt$ $(7.77)^{**}$ | 0.733 | $60.373^{**}$ | 9.091.18 | 811.456 | 8.92 |
| 8 | Net return per feddan (Real. L.E.) | $\hat{Y}t = 1731.931 + 15.914\ Xt$ (0.882) | 0.034 | 0.778 | 1.930.85 | - | - |
| 9 | Monthly net return per feddan (Current. L.E.) | $\hat{Y}t = -87.669 + 67.621\ Xt$ $(7.77)^{**}$ | 0.733 | $60.373^{**}$ | 60.757 | 67.621 | 8.926 |
| 10 | Monthly net return per feddan (Real. L.E.) | $\hat{Y}t = 144.325 + 1.326\ Xt$ (0.882) | 0.034 | 0.778 | 160.90 | - | - |
| 11 | Return on invested pound (Current. L.E.) | $\hat{Y}t = 0.695 + 0.015\ Xt$ (1.524) | 0.095 | 2.323 | 0.88 | - | - |
| 12 | Return on invested pound (Real. L.E.) | $\hat{Y}t = 0.528 + 0.018\ Xt$ $(2.620)^{*}$ | 0.238 | $6.866^{*}$ | 0.75 | 0.018 | 2.400 |
| 13 | Monthly return on invested pound (Current. L.E.) | $\hat{Y}t = 0.057 + 0.001\ Xt$ (1.600) | 0.104 | 2.561 | 0.07 | - | - |
| 14 | Monthly return on invested pound (Real. L.E.) | $\hat{Y}t = 0.044 + 0.001\ Xt$ $(4.612)^{**}$ | 221.0 | $6.235^{*}$ | 0.06 | 0.001 | 1.667 |
| 15 | Cost per ton (Current. L.E.) | $\hat{Y}t = -64.199 + 22.935\ Xt$ $(9.470)^{**}$ | 0.803 | 89.685 | 222.50 | 22.935 | 10.308 |
| 16 | Cost per ton (Real. L.E.) | $\hat{Y}t = 68.447 - 1.080\ Xt$ $(3.619-)^{**}$ | 0.373 | $13.092^{**}$ | 54.95 | 1.080- | 1.965- |
| 17 | Cost per ton as % of farm-gate price (Current. L.E.) | $\hat{Y}t = 59.571 - 0.477\ Xt$ (0.477-) | 0.138 | 3.522 | 53.61 | - | - |
| 18 | Cost per ton as % of farm-gate price (Real. L.E.) | $\hat{Y}t = 74.084 - 1.085\ Xt$ $(3.889-)^{**}$ | 0.407 | $15.125^{**}$ | 60.52 | 1.085- | 1.793- |

$\hat{Y}t$ = the estimated value of the dependent variable.
Xt = time variable.
h = (1. 2. 3. …. 23).
(**) Significant at the 0.01 level.
(*) Significant at the 0.05 level.
The numbers in parentheses refer to the calculated t-value.
**Source:** Data from Table (3)

### At Real Prices

The data in Table (3) indicates the development of economic efficiency indicators in the production of sugarcane during the period (2000–2023). It was found that the total revenue at real prices for sugarcane reached its minimum at about 2802.09 EGP per ton in 2021. and its maximum at about 5501.86 EGP per ton in 2017. The average total revenue at real prices for sugarcane during that period was about 4321.14 EGP per ton. By estimating the time trend equation of the economic efficiency indicators for sugarcane production during the period (2000–2023). as shown in Table (4). it was found that the total revenue at real prices for sugarcane took a general decreasing trend. which was not statistically significant. indicating that the total revenue at real prices for sugarcane was not affected by the time factor.

## Total Costs

### At Current Prices

The data in Table (3) indicates the development of economic efficiency indicators in sugarcane production during the period (2000–2023). It was found that the total costs at current prices for sugarcane reached their minimum at about 2332.40 EGP per ton in 2000. and their maximum at about 30.480.00 EGP per ton in 2023. meaning that total costs at current prices multiplied by more than 1307% compared to the year 2000. The average total costs at current prices during that period were about 10.580.31 EGP per ton.

By estimating the time trend equation of the economic efficiency indicators for sugarcane production during the period (2000–2023). as shown in Table (4). it was found that total costs at current prices for sugarcane took a general increasing trend estimated at about 1050.855 EGP. with an annual increase rate of about 9.932% of the average total costs at current prices. which amounted to about 10580.31 EGP per ton. This model was statistically significant at the 1% level. with the coefficient of determination ($R^2$) indicating that about 81.1% of the changes in total costs at current prices were explained by time-related factors.

### At Real Prices

The data in Table (3) indicates the development of economic efficiency indicators in sugarcane production during the period (2000–2023). It was found that the total costs at real prices for sugarcane reached their minimum at about 1475.11 EGP per ton in 2021. and their maximum at about 4324.79 EGP per ton in 2001. The average total costs at real prices during that period were about 2681.89 EGP per ton. By estimating the time trend equation of the economic efficiency indicators for sugarcane production during the period (2000–2023). as shown in Table (4). it was found that total costs at real prices for sugarcane took a general decreasing trend estimated at about 63.132 EGP. with an annual decrease rate of about 2.316% of the average total costs at real prices. which amounted to about 2681.89 EGP per ton. This model was statistically significant at the 1% level. with $R^2$ indicating that about 46.6% of the changes in total costs at real prices were explained by time-related factors.

These results are consistent with the following studies: Qutb & El-Bahyeri (2024) analyzed cost structure for sugarcane in Egypt and found that post-harvest costs (bundling, breaking, transport, and loading) are very large shares of the total cost. Their study also documented a decline in the proportion of cane area delivered to factories in recent years, linked to low procurement prices, in addition to A region-specific study in Minya Governorate by Bakar (2024) shows that the average production cost and total revenue per feddan are high, but economic pressures and cost escalation limit farmers' net returns. A very recent analytical study by Al-Toukhi & Khattab (2025) compared economic-efficiency indicators for sugarcane and sugar beet. They found a *general declining trend* in sugarcane's yield per feddan (productivity), while key economic indicators increase, but the return on invested capital (per pound spent) shows a downward trend, aligning with concerns about real profit erosion.

## Net Return per Feddan per Season

### At Current Prices

The data in Table (3) indicates the development of economic efficiency indicators in sugarcane production during the period (2000–2023). It was found that the net return per feddan per season at current prices reached its minimum at about 1221.50 EGP per ton in 2001. and its maximum at about 26.340.00 EGP per ton in 2022. The average net return per feddan per season during that period was about 9091.18 EGP per ton. By estimating the time trend equation of the economic efficiency indicators during the period (2000–2023). as shown in Table (4). it was found that the net return per feddan per season at current prices took a general increasing trend estimated at about 811.456 EGP. with an annual increase rate of about 8.92% of the average net return (9091.18 EGP per ton). This model was statistically significant at the 1% level. with $R^2$ indicating that about 73.3% of the changes in net return per feddan per season at current prices were explained by time-related factors.

### At Real Prices

The data in Table (3) indicates the development of economic efficiency indicators in sugarcane production during the period (2000–2023). It was found that the net return per feddan per season at real prices reached its minimum at about 504.82 EGP per ton in 2023. and its maximum at about 3139.64 EGP per ton in 2017. The average was about 1930.85 EGP per ton. By estimating the time trend equation as shown in Table (4). it was found that the net return per acre for one season at real prices took a generally upward trend that was not statistically significant.

## Net Monthly Return per Feddan

### At Current Prices

The data in Table (3) indicates (Minimum 101.79 EGP per ton in 2001. maximum 2195.00 EGP per ton in 2022. average 757.60 EGP per ton). Generally increasing trend: 67.621 EGP. annual growth 8.926%. $R^2$ = 73.3%. statistically significant at 1%.

**At Real Prices**

(Minimum 42.07 EGP per ton in 2023. maximum 261.64 EGP per ton in 2017. average 160.90 EGP per ton). Generally increasing trend: It took a generally upward trend that was not statistically significant.

### Return on the Invested Pound per Season

### At Current Prices

(Minimum 0.23 EGP in 2023. maximum 1.43 EGP in 2011. average 0.88 EGP).
It took a generally upward trend that was not statistically significant.

### At Real Prices

(Minimum 0.26 EGP in 2023. maximum 1.16 EGP in 2017. average 0.75 EGP).
Trend: +0.018 EGP. annual growth 2.400%. $R^2$ = 23.8%. significant at 5%.

### Return on the Invested Pound per Month

**At Current Prices**

(Minimum 0.02 EGP in 2023. maximum 0.12 EGP in 2011. average 0.07 EGP).
It took a generally upward trend that was not statistically significant.

**At Real Prices**

(Minimum 0.02 EGP in 2001.2023 maximum 0.10 EGP in 2017. average 0.06 EGP).
Trend: + 0.001 EGP. annual growth 1.667%. $R^2$ = 22.1%. significant at 1%.

### Cost per Ton

**At Current Prices**

(Minimum 46.78 EGP in 2000. maximum 636.04 EGP in 2022. average 222.50 EGP).
Trend: +22.935 EGP. annual growth 10.308%. $R^2$ = 80.3%. significant at 1%.

### At Real Prices

(Minimum 31.65 EGP in 2001. maximum 86.67 EGP in 2001. average 54.95 EGP).
Trend: −1.080 EGP. annual decrease 1.965%. $R^2$ = 37.3%. significant at 1%.

### Cost per Ton as a Percentage of Farm Price

**At Current Prices**

(Minimum 41.19 EGP in 2001. maximum 74.23 EGP in 2011. average 53.61 EGP).
It took a generally upward trend that was not statistically significant.

**At Real Prices**

(Minimum 47.22 EGP in 2022. maximum 93.09 EGP in 2001. average 60.52 EGP).
Trend: −1.085 EGP. annual decrease 1.793%. $R^2$ = 40.7%. significant at 1%.

These results are consistent with the study. Furthermore, empirical work by Elasraag (2019) in the *Zagazig Journal of Agricultural Research* showed positive associations between area cultivated, revenue, and costs in sugarcane, implying that rising costs are indeed a structural feature of the Egyptian sugarcane sector، A comparative economic study of sugarcane and sugar beet in Egypt (Darwesh, 2020) found instability in the return on the invested pound for sugarcane, supporting your finding that ROI is volatile and not consistently strong.

**Third Development of the Gap. Self-Sufficiency Ratio and Import Dependence Ratio of Sugar in Egypt**

**Domestic Production**

From Table (5). it is shown that Egypt's sugar production during the period (2000–2023) ranged between a minimum of 1285 thousand tons in 2003. and a maximum of 2712 thousand tons in 2021. with an average of about 2002.6 thousand tons. From Table (6) and Equation (1). sugar production in Egypt took a statistically significant increasing trend at the 0.01 level. with an annual increase of about 45.88 thousand tons. equivalent to 2.29% of the average. and $R^2$ = 65.6%.

## Availability for Consumption

Sugar consumption in Egypt during (2000–2023) ranged between 1433 thousand tons in 2003 and 3335 thousand tons in 2020. with an average of about 2659 thousand tons. According to Equation (2) in Table (6). sugar consumption also showed a statistically significant increasing trend at the 0.01 level. with an annual increase of about 61.11 thousand tons. equivalent to 2.3%. and $R^2$ = 84.8%.

### Exports

Sugar exports ranged between 62 thousand tons in 2007 and 830 thousand tons in 2011. with an average of about 280.4 thousand tons. According to Equation (3). exports showed a significantly increasing trend at the 0.01 level. with an annual increase of about 23.28 thousand tons. or 8.3% of the average. and $R^2$ = 52.5%.

## Imports

Sugar imports ranged between 103 thousand tons in 2000 and 1678 thousand tons in 2017. with an average of about 897.1 thousand tons. According to Equation (4). Imports showed a significant increasing trend at the 0.01 level. with an annual increase of about 36.05 thousand tons. or 4.02% of the average. and $R^2$ = 41.5%.

### Food Gap

From the data in Table (5). it was found that the sugar food gap in Egypt during the period (2000–2023) ranged between a minimum value of about 102 thousand tons in the year 2000. and a maximum of about 1.253 thousand tons in 2008. with the period's average amounting to about 656.4 thousand tons.From the data in Table (6). it is obvious from Equation (5) that the amount of the sugar food gap in Egypt took a generally increasing trend. although it was not statistically significant.

**Table (5):** Development of Sugar Food Security Indicators in Egypt during the Period (2000–2023).

| Years | Domestic production | Available for consumption | Export quantity | Import quantity | Food gap | Self-sufficiency ratio* | Foreign dependency ratio |
|---|---|---|---|---|---|---|---|
| | One thousand ton | | | | | % | % |
| 2000 | 1768 | 1870 | 0 | 103 | 102.0 | 94.5 | 5.5 |
| 2001 | 2102 | 2535 | 0 | 426 | 433.0 | 82.9 | 17.1 |
| 2002 | 1970 | 2414 | 0 | 464 | 444.0 | 81.6 | 18.4 |
| 2003 | 1285 | 1433 | 72 | 339 | 148.0 | 89.7 | 3.10 |
| 2004 | 1370 | 1590 | 68 | 288 | 220.0 | 86.2 | 13.8 |
| 2005 | 1497 | 1941 | 109 | 555 | 444.0 | 77.1 | 22.9 |
| 2006 | 1575 | 1936 | 97 | 384 | 361.0 | 81.4 | 18.6 |
| 2007 | 1579 | 2386 | 62 | 832 | 807.0 | 66.2 | 33.8 |
| 2008 | 1582 | 2835 | 26 | 1279 | 1253.0 | 55.8 | 44.2 |
| 2009 | 1610 | 2720 | 191 | 1301 | 1110.0 | 59.2 | 40.8 |
| 2010 | 1991 | 2761 | 447 | 1217 | 770.0 | 72.1 | 27.9 |
| 2011 | 1898 | 2868 | 830 | 1120 | 970.0 | 66.2 | 33.8 |
| 2012 | 2005 | 2900 | 233 | 1273 | 895.0 | 69.1 | 30.9 |
| 2013 | 1998 | 3090 | 316 | 1059 | 1092.0 | 64.7 | 35.3 |
| 2014 | 2298 | 3040 | 332 | 1074 | 742.0 | 75.6 | 24.4 |
| 2015 | 2372 | 2991 | 302 | 921 | 619.0 | 79.3 | 20.7 |
| 2016 | 2197 | 2734 | 656 | 1209 | 537.0 | 80.4 | 19.6 |
| 2017 | 2249 | 2893 | 488 | 1678 | 644.0 | 77.7 | 22.3 |
| 2018 | 2163 | 3046 | 436 | 1116 | 883.0 | 71.0 | 29.0 |
| 2019 | 2458 | 3270 | 349 | 1160 | 812.0 | 75.2 | 24.8 |
| 2020 | 2282 | 3335 | 368 | 949 | 1053.0 | 68.4 | 31.6 |
| 2021 | 2712 | 3153 | 378 | 868 | 441.0 | 86.0 | 14.0 |
| 2022 | 2543 | 3119 | 363 | 939 | 576.0 | 81.5 | 18.5 |
| 2023 | 2558 | 2956 | 606 | 976 | 398.0 | 86.5 | 13.5 |
| Mean | 2002.6 | 2659.0 | 280.4 | 897.1 | 656.4 | 76.2 | 23.8 |

*Self-sufficiency = Production / Consumption × 100
**Dependency ratio on imports = Imports / Consumption × 100

**Source:** Collected and calculated from: Ministry of Agriculture and Land Reclamation. Economic Affairs Sector. Central Administration for Agricultural Economics. *Food Balance Bulletin*. various issues.

**Table 6.** The general time trend of the food gap. Self-sufficiency ratio. and dependency ratio on imports of sugar in Egypt during the period (2000–2023).

| S.No | Phenomenon | Equation | ٢R | F | Mean | Amount of change | The % change |
|---|---|---|---|---|---|---|---|
| 1 | Domestic Production (thousand tons) | Ŷt =1429.1+45.88 Xt (6.51)** | 0.656 | **36.42 | 2002.6 | 45.88 | 2.29 |
| 2 | Available for Consumption (thousand tons) | Ŷt = 1895.13 + 61.11Xt (6.36)** | 0.848 | **40.47 | 2659.0 | 61.11 | 2.30 |
| 3 | Export quantity (thousand tons) | Ŷt = -10576.4 + 23.28Xt (4.93)** | 0.525 | **24.29 | 4.280 | 23.28 | 8.3 |
| 4 | Import quantity (thousand tons) | Ŷt = 446.34 + 36.05 Xt (3.95)** | 0.415 | **15.61 | 897.1 | 36.05 | 4.02 |
| 5 | Food gap quantity (thousand tons) | Ŷt = 466.08 +15.23 Xt (1.70) | 0.116 | 2.88 | 656.4 | - | - |
| 6 | Self-sufficiency ratio (%) | Ŷt = 78.47 + 0.183Xt (0.63-) | 0.02 | 0.399 | 76.2 | - | - |
| 7 | Foreign dependency ratio (%) | Ŷt = 21.53 + 0.183 Xt (0.534) | 0.018 | 0.399 | 23.8 | - | - |

Where:
**Ŷt** : Refers to the estimated value of the dependent variable indicated.
X**t** : Refers to the time element. where t = 1. 2. 3. …. 23 years.
The values in parentheses below the regression coefficients refer to the calculated "t" value.
(**): Significant at the 0.01 level.
(*): Significant at the 0.05 level.
Annual rate of change = (Amount of annual change / Mean of the dependent variable) × 100

**Source:** Calculated from the data in Table (5).

### Self-sufficiency ratio

From the data in Table (5). The self-sufficiency ratios of sugar in Egypt during the period (2000–2023) ranged between a minimum of about 55.8% in 2008 and a maximum of about 94.5% in 2000. with the average for the period being about 76.2%. From the data in Table (6). it appears from Equation (6) that the self-sufficiency ratios of sugar in Egypt took a general decreasing trend. though it was not statistically significant.

## Dependence on foreign sources

From the data in Table (5). the ratios of dependence on foreign sources of sugar in Egypt during the period (2000–2023) ranged between a minimum of about 5.5% in 2000 and a maximum of about 44.2% in 2008. with the average for the period being about 23.8%. From the data in fTable (6). it appears from Equation (7) that the ratios of dependence on foreign sources of sugar in Egypt followed a generally increasing trend. statistically significant at the 0.05 level. The annual increase amounted to about 0.183%. although the annual growth rate itself was not statistically significant.

**Fourth: Development of daily domestic consumption. production adequacy period. import coverage period. and total coverage period of sugar in Egypt during the period (2000–2023)**

### Daily domestic sugar consumption

From the data in Table (7). daily domestic sugar consumption in Egypt during the period (2000–2023) ranged between a minimum of about 3.9 thousand tons in 2003 and a maximum of about 9.1 thousand tons in 2020. with the average for the period being about 7.3 thousand tons. From the data in Table (8). it appears from Equation (1) that daily domestic sugar consumption in Egypt followed a general increasing trend. statistically significant at the 0.01 level. The annual increase amounted to about 0.167 thousand tons. representing an annual growth rate of about 2.28% of the average during that period. The adjusted coefficient of determination indicates that about 65.4**%** of the changes in daily domestic sugar consumption in Egypt are explained by the factors reflected in the time element.

## Production adequacy period for sugar consumption

From the data in Table (7). The production adequacy period for sugar consumption in Egypt during the period (2000–2023) ranged between a minimum of about 203.7 days in 2008 and a maximum of about 345.1 days in 2000. with the average for the period being about 278.1 days. From the data in Table (8). It appears from Equation (2) that the production adequacy period for sugar consumption in Egypt followed a general decreasing trend. though it was not statistically significant.

**Table 7.** Development of daily domestic consumption. production adequacy period. import coverage period. and total coverage period of sugar in Egypt during the period (2000–2023).

| Years | Daily Local Consumption (thousand tons) | Production Adequacy Period for Consumption (days) | Imports Coverage Period for Consumption (days) | Total of Both Periods (days) |
|---|---|---|---|---|
| | One thousand ton | | Days | |
| 2000 | 5.1 | 345.1 | 20.1 | 365.2 |
| 2001 | 6.9 | 302.7 | 61.3 | 364.0 |
| 2002 | 6.6 | 297.9 | 70.2 | 368.0 |
| 2003 | 3.9 | 327.3 | 86.3 | 413.6 |
| 2004 | 4.4 | 314.5 | 66.1 | 380.6 |
| 2005 | 5.3 | 281.5 | 104.4 | 385.9 |
| 2006 | 5.3 | 296.9 | 72.4 | 369.3 |
| 2007 | 6.5 | 241.5 | 127.3 | 368.8 |
| 2008 | 7.8 | 203.7 | 164.7 | 368.3 |
| 2009 | 7.5 | 216.0 | 174.6 | 390.6 |
| 2010 | 7.6 | 263.2 | 160.9 | 424.1 |
| 2011 | 7.9 | 241.6 | 142.5 | 384.1 |
| 2012 | 7.9 | 252.4 | 160.2 | 412.6 |
| 2013 | 8.5 | 236.0 | 125.1 | 361.1 |
| 2014 | 8.3 | 275.9 | 129.0 | 404.9 |
| 2015 | 8.2 | 289.5 | 112.4 | 401.9 |
| 2016 | 7.5 | 293.3 | 161.4 | 454.7 |
| 2017 | 7.9 | 283.7 | 211.7 | 495.5 |
| 2018 | 8.3 | 259.2 | 133.7 | 392.9 |
| 2019 | 9.0 | 274.4 | 129.5 | 403.8 |
| 2020 | 9.1 | 249.8 | 103.9 | 353.6 |
| 2021 | 8.6 | 313.9 | 100.5 | 414.4 |
| 2022 | 8.5 | 297.6 | 109.9 | 407.5 |
| 2023 | 8.1 | 315.9 | 120.5 | 436.4 |
| Mean | 7.3 | 278.1 | 118.7 | 396.7 |

Daily local consumption = Total local consumption ÷ 365 days.
• Production sufficiency period for consumption = Total local production ÷ Total daily local consumption.
• Import coverage period for consumption = Annual import quantity ÷ Total daily local consumption.
• Total of the two periods = Production sufficiency period for consumption + Import coverage period for consumption.
**Source:** Compiled and calculated from: Table (5) data.

## Import coverage period for sugar consumption in Egypt

From the data of Table (7). it was found that the import coverage period for sugar consumption in Egypt during the period (2000–2023) ranged between a minimum of about 20.1 days in 2000 and a maximum of about 211.7 days in 2017. with an average period of about 118.7 days.

Revising the data of Table (8). it is clear from Equation (3) that the import coverage period for sugar consumption in Egypt took an overall increasing trend. statistically significant at the 0.05 level. The annual increase amounted to about 2.91 days. with an annual growth rate of about 2.45% of the average during that period.

The adjusted coefficient of determination indicates that about 22.9% of the changes in the import coverage period for sugar consumption in Egypt are explained by factors reflected in the element of time.

### The total production sufficiency period and import coverage period for sugar consumption

From the data of Table (7). it was found that the total of the two periods (the production sufficiency period for sugar consumption and the import coverage period for sugar consumption in Egypt during the period (2000–2023) ranged between a minimum of about 353.6 days in 2020 and a maximum of about 495.5 days in 2017. with an average period of about 396.7 days. Revising the data of Table (8). it is clear from Equation (4) that the total of the two periods (the production sufficiency period for sugar consumption and the import coverage period for sugar consumption in Egypt) took an overall increasing trend. statistically significant at the 0.05 level. The annual increase amounted to about 2.24 days. with an annual growth rate of about 0.61% of the average during that period. The adjusted coefficient of determination indicates that about 22.7% of the changes in the total of the two periods (the production sufficiency period for sugar consumption and the import coverage period for sugar consumption in Egypt) are explained by factors reflected in the element of time.

**Table 8.** The general time trend of daily local consumption. production sufficiency period. import coverage period for consumption. and the total of the two periods for sugar in Egypt during the period (2000–2023).

| S.No | Phenomenon | Equation | ٢R | F | Mean | The amount | The % change |
|---|---|---|---|---|---|---|---|
| 1 | Daily Local Consumption (thousand tons) | $\hat{Y}t = 5.19 + 0.167Xt$ (6.32)** | 0.654 | **39.94 | 7.3 | 0.167 | 2.28 |
| 2 | Production Adequacy Period for Consumption (days) | $\hat{Y}t = 286.4 - 0.667\ X_t$ (0.629-) | 0.02 | -0.395 | 278.1 | - | - |
| 3 | Imports Coverage Period for Consumption (days) | $\hat{Y}t = 82.32 + 2.91\ X_t$ (2.56)* | 0.229 | *6.53 | 118.7 | 2.91 | 2.45 |
| 4 | Total of Both Periods (days) | $\hat{Y}t = 368.7 + 2.24\ X_t$ (2.54)* | 0.227 | *6.46 | 396.7 | 2.24 | 0.61 |

Where:
Ŷt : refers to the estimated value of the dependent variable mentioned.
Xt: refers to the time element. where t = 1. 2. 3. …. 23 years.
The values in parentheses below the regression coefficients refer to the calculated "t" value.
(**): significant at the 0.01 level.
(*): significant at the 0.05 level.

### 4-Total of the two periods (days)

$\hat{Y} = 368.7 + 2.24\ Xt$
(2.54)* 0.227 6.46* 396.7 2.24 0.61

Annual rate of change = Amount of annual change ÷ Average of the dependent variable × 100
**Source:** Calculated from Table (7) data.

**Fifth: Development of the sugar food security coefficient during the period (2000–2023)**

**A- The surplus quantity in local consumption**

From the data of Table (9). it was found that the surplus quantity in local sugar consumption in Egypt during the period (2000–2023) ranged between a minimum with negative values of about 104 thousand tons in 2020. and a maximum with positive value of about 1.034 thousand tons in 2017. with an average for the period of 240.7 thousand tons.

**Table 9.** Development of the sugar food security coefficient in Egypt during the period (2000–2023).

| Years | Local Consumption Surplus Quantity | Surplus Adequacy Period for Local Consumption | Deficit Quantity in Local Consumption | Deficit Period for Local Consumption | Strategic Stock Quantity | Stock Adequacy Period for Local Consumption | Food Security Coefficient |
|---|---|---|---|---|---|---|---|
| | **One thousand ton** | **Day** | **One thousand ton** | **Day** | **One thousand ton** | **Day** | |
| 2000 | 1.0 | 0.2 | -1.0 | -0.2 | 2.0 | 0.39 | 0.00 |
| 2001 | -7.0 | -1.0 | 7.0 | 1.0 | -14.0 | -2.02 | -0.01 |
| 2002 | 20.0 | 3.0 | -20.0 | -3.0 | 40.0 | 6.05 | 0.02 |
| 2003 | 191.0 | 48.6 | -191.0 | -48.6 | 382.0 | 97.30 | 0.24 |
| 2004 | 68.0 | 15.6 | -68.0 | -15.6 | 136.0 | 31.22 | -0.15 |
| 2005 | 111.0 | 20.9 | -111.0 | -20.9 | 222.0 | 41.75 | 0.04 |
| 2006 | 23.0 | 4.3 | -23.0 | -4.3 | 46.0 | 8.67 | -0.09 |
| 2007 | 25.0 | 3.8 | -25.0 | -3.8 | 50.0 | 7.65 | 0.00 |
| 2008 | 26.0 | 3.3 | -26.0 | -3.3 | 52.0 | 6.69 | 0.00 |
| 2009 | 191.0 | 25.6 | -191.0 | -25.6 | 382.0 | 51.26 | 0.12 |
| 2010 | 447.0 | 59.1 | -447.0 | -59.1 | 894.0 | 118.19 | 0.19 |
| 2011 | 150.0 | 19.1 | -150.0 | -19.1 | 300.0 | 38.18 | -0.21 |
| 2012 | 378.0 | 47.6 | -378.0 | -47.6 | 756.0 | 95.15 | 0.16 |
| 2013 | -33.0 | -3.9 | 33.0 | 3.9 | -66.0 | -7.80 | -0.27 |
| 2014 | 332.0 | 39.9 | -332.0 | -39.9 | 664.0 | 79.72 | 0.24 |
| 2015 | 302.0 | 36.9 | -302.0 | -36.9 | 604.0 | 73.71 | -0.02 |
| 2016 | 672.0 | 89.7 | -672.0 | -89.7 | 1344.0 | 179.43 | 0.27 |
| 2017 | 1034.0 | 130.5 | -1034.0 | -130.5 | 2068.0 | 260.91 | 0.25 |
| 2018 | 233.0 | 27.9 | -233.0 | -27.9 | 466.0 | 55.84 | -0.53 |
| 2019 | 348.0 | 38.8 | -348.0 | -38.8 | 696.0 | 77.69 | 0.07 |
| 2020 | -104.0 | -11.4 | 104.0 | 11.4 | -208.0 | -22.76 | -0.27 |
| 2021 | 427.0 | 49.4 | -427.0 | -49.4 | 854.0 | 98.86 | 0.34 |
| 2022 | 363.0 | 42.5 | -363.0 | -42.5 | 726.0 | 84.96 | -0.04 |
| 2023 | 578.0 | 71.4 | -578.0 | -71.4 | 1156.0 | 142.74 | 0.15 |
| Mean | 240.7 | 31.7 | -240.7 | -31.7 | 481.3 | 63.5 | 0.02 |

• Annual surplus in local consumption = (Total of production sufficiency period for consumption + imports coverage period for consumption – 365) × daily local consumption.
• Surplus sufficiency period for local consumption = Surplus quantity ÷ daily local consumption.
• Deficit quantity in local consumption = (365 – Total of production sufficiency period for consumption + imports coverage period for consumption) ÷ daily local consumption.
• Deficit period in consumption = Deficit quantity ÷ daily local consumption.
• Strategic stock quantity = Surplus quantity in local consumption – Deficit quantity in local consumption.
• Strategic stock sufficiency period = Strategic stock quantity × daily local consumption.

• Food security coefficient = Annual change in strategic stock ÷ annual local consumption. or net change in strategic stock ÷ average annual local consumption.

**Source:** Compiled and calculated from Table (5) data.

**Surplus sufficiency period of local consumption**

From the data in Table (9). it was found that the surplus sufficiency period of local sugar consumption in Egypt during (2000–2023) ranged between a minimum with negative values of about 11.4 days in 2020 and a maximum with positive values of about 130.5 days in 2017. with an average of about 31.7 days.

**Deficit quantity in local sugar consumption**

From the data in table (9) data shows that the deficit quantity in local sugar consumption in Egypt during (2000–2023) ranged between a minimum with negative values of about 1.034 thousand tons in 2017 and a maximum with positive values of about 104 thousand tons in 2020. with an average negative value of about 240.7 thousand tons.

**Deficit period in local sugar consumption**

Table (9) shows that the deficit period in local sugar consumption in Egypt during (2000–2023) ranged between a minimum with negative values of about 130.5 days in 2017 and a maximum with positive values of about 11.4 days in 2020. with an average of about 31.7 days.

**Strategic stock quantity of sugar**

Revising Table (9). it was found that the strategic stock quantity of sugar in Egypt during (2000–2023) ranged between a minimum negative value of about 208 thousand tons in 2020 and a maximum negative value of about 2.068 thousand tons in 2017. with an average of about 481.3 thousand tons.

**Strategic stock sufficiency period of sugar**

Table (9) shows that the strategic stock sufficiency period of sugar in Egypt during (2000–2023) ranged between a minimum negative value of about 22.8 days in 2020 and a maximum positive value of about 260.9 days in 2017. with an average of about 63.5 days.

**Sugar food security coefficient in Egypt**

By estimating the sugar food security coefficient in Egypt during the study period. as in Table (9). it was found that the coefficient decreased relatively. with an average of about 0.02. This indicates a noticeable decline in the sugar food security coefficient in Egypt. mainly due to the deficit in the strategic stock.

## Summary

Sugar is one of the most important strategic commodities worldwide. and it receives special attention from policymakers because local production does not meet consumption needs in Egypt, leading to a food gap. Sugarcane is also one of the most important sugar crops. forming the basis of many industries in Egypt.

The research problem lies in the existence of a sugar food gap in Egypt due to the insufficiency of local sugarcane production to cover the growing local demand. This may be attributed to fluctuations in sugarcane productivity. which was about 49.86 tons/feddan in 2000. rose to 51.2 tons/feddan in 2006. then declined to 45.09 tons/feddan in 2023. Added to this is the continuous annual increase in demand for sugar due to population growth and changes in consumption patterns.

Therefore, the problem of the study is how to overcome this food gap or at least mitigate it. The research relied on applying descriptive and quantitative statistical analysis. as well as using percentages. arithmetic means. simple regression models. and index numbers. The research was also based on secondary data issued by the Ministry of Agriculture and Land Reclamation and related studies.

## Conclusions

The feddan productivity of sugarcane showed a general declining trend. with an annual decrease rate of about 0.390% of the average productivity during the study period. The current farm price of sugarcane showed a general increasing trend. with an annual increase rate of about 10.094% of the annual average during the study period. but this was not statistically significant in real prices. The total revenue at current prices doubled by more than 183% from 2000 during (2000–2023). but this was not significant in real prices. Total costs at current prices of sugarcane showed a general increasing trend with an increase of about 9.86% of the average during the period. while in real terms they showed a decreasing trend with an annual decline of about 2.32% of the average. The net feddan return per season at both current and real prices showed a general increasing trend. The monthly net feddan return at both current and real prices showed a general increasing trend. The monthly return on the invested pound at both current and real prices showed a general increasing trend. The monthly return on the invested pound at both current and real prices showed a general increasing trend. By estimating the sugar food security coefficient in Egypt. it was found that it declined relatively. indicating crises of sugar shortages or abnormally high prices. mainly due to the deficit in the strategic stock.

## Recommendations

Strengthen Productivity and Yield Enhancement Measures. The persistent decline in yield per feddan underscores the need to accelerate the adoption of improved sugarcane varieties, optimize fertilization and irrigation practices, and expand farmer-oriented training programs through the agricultural extension system.

Improve Supply Chain Coordination and Delivered Area Efficiency
The fluctuation and decline in the ratio of delivered to cultivated area call for improved contracting systems, enhanced transportation and collection infrastructure, and stronger incentives for farmers to supply higher-quality cane. Stabilize Real Farm-Gate Prices and Protect Farmers' Income

The non-significant decline in real farm-gate prices, despite a sharp rise in nominal prices, indicates the need for cost-reflective pricing mechanisms, inflation-adjusted support policies, and targeted subsidies for key production inputs. Control Rising Production Costs and Enhance Cost Efficiency

Given the substantial increase in production costs, measures such as promoting mechanization, improving irrigation efficiency, and supporting competitive input markets should be prioritized to reduce cost pressures on farmers. Enhance Farm Profitability and Net Returns

The stagnation of real net returns highlights the importance of expanding access to affordable credit, encouraging diversification and intercropping, and supporting value-added small-scale processing to improve farmers' economic resilience. Improve Return on Investment and Resource Use Efficiency.

The inconsistent trends in the return on the invested pound suggest the need for stronger dissemination of best farm management practices, adoption of precision agriculture technologies, and expanded cooperative-based input procurement and marketing. Strengthen Integration Between Research, Extension, and Industry
Enhancing coordination among research institutions, extension services, and sugar mills is essential for addressing yield decline, rising costs, and low extraction efficiency through joint research programs, farmer education, and industrial modernization. Develop Long-Term Policies for Sectoral Sustainability
To secure the future of the sugarcane sector, long-term strategies should focus on modernizing irrigation systems, preserving sugarcane areas with comparative advantage, and upgrading milling technologies to improve efficiency and reduce waste.

## References

Abd-El Maksoud MM, Ghaly MS (2021) Evaluation of productive efficiency for sugarcane varieties in Upper Egypt. Journal of Plant Production, 12 (5): 567-573.

Abdelkhalek, SM, Moursi, BEDM, El-Saba, AR, Sarhan, HESH (2025) Economic Analysis of Sugarcane Production in Egypt. Alexandria Journal of Agricultural Sciences, 475-485.

Arab Organization for Agricultural Development (2024) Agricultural Statistics Yearbook. www.aoad.org.

Bakr A (2024) An economic study of sugarcane production in Egypt: A case study of Minya Governorate. *Egyptian Journal of Agricultural Economics, 34*(2): 811–828.

CAPMAS (2000 to 2023) Annual bulletin of production, foreign trade, and available consumption of industrial commodities.

Central Agency for Public Mobilization and Statistics (2024) Annual bulletin of sugar crops and sugar statistics 2023. Arab Republic of Egypt.

Central Agency for Public Mobilization and Statistics (2000 to 2023) Annual bulletin of production. foreign trade. and available consumption of agricultural commodities.

Darwesh, MZEAM (2021) An economic comparative study of the most important productivity and economic indicators of the sugar cane and beet crops in Egypt.

El-Tanahy AA, Mahmoud MA (2020) Analysing the impact of sugar pricing policies on the Egyptian economy. Egyptian Journal of Agricultural Economics, 30 (2), 45-62.

Elasraag, YH (2019) Economic analysis of sugarcane and sugar beet in Egypt. Zagazig Journal of Agricultural Research, 46(1), 209-215.

El-Tokhy M, Khattab A, Manal, M (2025) An analytical economic study comparing the efficiency and preference of sugar crops for both farmers and the national economy. *Egyptian Journal of Agricultural Economics, 35*(2), 453–479.

Gamal MA (2015) Economic analysis of sugar crop production and consumption in Egypt. Egyptian Journal of Agricultural Economics. Vol. 25. Issue 4. Dec (B).

Gomez KA, Gomez AA (1984) Statistical procedures for agricultural research. John Wiley & sons.

Kotb, MM, El-Behairy, A, Abdelkhaleq, A (2024) The impact of changes in production costs on the productive and economic efficiency indicators of sugarcane in Egypt. Zagazig Journal of Agricultural Research, 51(6), 2295–2304.

Ministry of Agriculture and Land Reclamation (2023) Economic Affairs Sector, Agricultural.

Nasser MAA, Faten MK (2015) Economic analysis of sugar production and consumption potentials in Egypt. Egyptian Journal of Agricultural Economics. Vol. 25. Issue 3. Sept.

Sarhan AS, Nadia FG (2018) Analytical study of the current and future situation of sugar food security in Egypt. Egyptian Journal of Agricultural Economics. Vol. 28. Issue 1. March.