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The Productive and Economic Efficiency of Major Cereal Crops in Menoufia Governorate, Egypt

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Abstract: The research problem centers on the need for metrics or indicators to assess the efficiency of production and marketing activities, ultimately serving the interests of both producers and consumers. Given the observed decline in the production and marketing efficiency of these crops, reflected in fluctuations in cultivated areas, this research aims to determine the productive and economic efficiency of the two crops under study. and identifying the key factors influencing each case, as well as specific economic indicators to analyze and present the primary findings. These data were gathered from two sources: secondary data, both published and unpublished, obtained from various entities; and primary data, collected through personal interviews with the study sample using a questionnaire specifically designed for this research. The study also analyzed the temporal trends in the evolution of cultivated area, productivity, and total production for wheat and maize crops in Menoufia Governorate during the period (2012–2023), employing linear, quadratic, and cubic regression models. The results indicated that the area cultivated with wheat followed a significant downward trend, decreasing at a rate of approximately 3.773 thousand feddans annually. Wheat production declined at an annual rate of 90.145 thousand ardabs, whereas wheat productivity followed a significant quadratic trend, reflecting a gradual improvement following a period of decline. Additionally, the area cultivated with maize exhibited a significant cubic trend with a coefficient of determination of 64.5%; conversely, no significant time trend was observed for either yield per feddan or total production volume during the study period, reflecting the persistent gap between domestic production and consumption, as well as the local market's reliance on imports to meet a portion of food requirements. The study of the productive and economic efficiency of the crops under analysis revealed that the production elasticities for wheat are positive across the various factors of production; wheat output is positively correlated with the quantities of these factors employed. The sum of the elasticities for the production factors involved in wheat cultivation was approximately 1.01, reflecting constant returns to scale, meaning that an increase in the combined quantities of production factors results in a proportional increase in output. Regarding the maize crop, the study results indicated that production elasticities for production inputs were positive, with the exception of human labor and seeds. This is attributed to farmers' reliance on family labor driven by high hired labor costs and the prevalence of small landholdings in the governorate, as well as the crop's low profitability and its cultivation primarily for feeding the farm's livestock and poultry amidst rising feed prices; this suggests an excessive use of human labor resulting from the reliance on family labor.

Keywords: Productive efficiency, Food security, Economic efficiency, Wheat, Maize, Menoufia Governorate, Egypt.

INTRODUCTION

The agricultural sector is considered one of the most important drivers of economic and social development in Egypt, holding a distinctive position among the nation's economic sectors. It is entrusted with achieving several vital objectives, most notably providing food

and clothing for the entire population. It provides the primary livelihood for most rural residents and employs a significant share of the workforce. At the same time, it supplies essential raw materials to non-agricultural sectors and serves as a thriving market for their products. Furthermore, the sector is a source of foreign currency; its exports, comprising both fresh and processed agricultural goods, generate approximately $ 9 billion, representing about 52.3% of the country's non-petroleum exports. It also contributed approximately 15% to the Gross Domestic Product (GDP) in 2023.

Agricultural economic development in Egypt depends on two fundamental pillars: the first is vertical agricultural expansion, which entails increasing the productivity of each unit of agricultural land by enhancing the efficiency of production input utilization; the second is horizontal expansion, which involves increasing the total agricultural land area through the reclamation and cultivation of new lands. The State attaches great importance to this latter approach to strengthen Egypt's agricultural policy, reduce reliance on food imports, and boost agricultural exports, thereby increasing foreign currency earnings and lowering the import bill, which reached about $ 39.1 billion in 2023. Wheat is considered a primary food grain crop in Egypt, as the majority of the population relies on it for energy and protein. It serves as a fundamental source of daily caloric intake—whether consumed as bread or in other products—contributing approximately 65% of the average individual's total calorie consumption and about 40–45% of their total protein intake. Furthermore, wheat is one of the most widely cultivated cereal crops globally; demand for it is rising in developing nations, including Egypt, driven primarily by high population growth rates and the bread subsidy policy implemented in the country.

Wheat stands at the forefront of grain crops where domestic production falls short of meeting the population's consumption needs. Consequently, large quantities must be imported to bridge the supply and demand gap. This imposes a significant burden on the government regarding the procurement of the hard currency required for imports, while also impacting Egypt's agricultural trade balance, which has suffered from a persistent deficit since the 1970s. Although wheat production has increased in recent years, this growth has not kept pace with the rising needs of the population. Nevertheless, the state is striving to adopt agricultural policies aimed at achieving self-sufficiency, thereby closing the food gap and helping to resolve the challenge of food security in Egypt.

Wheat is considered one of Egypt's most important strategic food crops. Agricultural statistics for the 2024/2025 season indicate that the planted area with wheat reached approximately 3.404 million feddans, with an average yield of 2.926 tons per feddan, resulting in a total domestic production of 9,958.189 thousand tons (Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin: Winter Crops – Part I, 2025). Regarding consumption, data from the 2024 food balance sheet indicated that the total wheat available for consumption amounted to 20.474 million tons; domestic production covered only about 47.5% of food consumption needs, with an average per capita consumption of 160.7 kg/year (Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Food Balance Sheet Bulletin 2024). Reflecting this gap between available production and rising consumption, the state relied on imports to meet domestic requirements; wheat imports in 2025 totalled approximately 11.985 million tons, valued at EGP 183.70 billion, whereas exports were limited to a negligible 16.9 thousand tons, valued at EGP 0.624 million (Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Foreign Trade Bulletin 2025).

Increasing maize production in Egypt is a primary objective for meeting rising domestic demand. Maize is a key strategic summer crop, ranking second only to wheat in terms of economic and nutritional importance. It is used for human consumption, with flour milled from the kernels for bread and confectionery, and contributes at least 20% to the blend used for baladi bread, thereby helping to narrow the gap between wheat production and consumption. It is also vital for animal feed, with yellow maize serving as a primary ingredient in poultry and livestock rations. The grains and green stalks are used as feed for livestock and poultry; they are also utilized in various other industries, such as paper and starch production, and corn oil is extracted from them.

RESEARCH PROBLEM

Undoubtedly, current trends favour the simultaneous pursuit of production and marketing activities; consequently, understanding the relationship between the economic and marketing efficiencies of a given crop is a crucial first step toward improvement. This highlights the need for metrics or indicators to assess the efficiency of these activities in a manner that ultimately serves the interests of both producers and consumers. Furthermore, the efficiency of producing and marketing these crops has declined, a trend reflected in the fluctuations of their cultivated areas.

RESEARCH OBJECTIVES

The research primarily aims to study certain economic aspects of wheat and maize crops in Egypt, with a specific focus on Menoufia Governorate. This objective is pursued through the following sub-objectives:

1- Conducting an economic analysis of food security indicators for wheat and maize crops during the period (2012–2023).

2- Statistically estimating production functions for wheat and maize crops within the study sample during the 2024/2025 agricultural season.

3- Estimating specific indicators of productive and economic efficiency for wheat and maize crops within the study sample during the 2024/2025 agricultural season.

4- Surveying farmers' opinions regarding production and marketing issues related to wheat and maize crops within the study sample during the 2024/2025 agricultural season.

RESEARCH METHODOLOGY AND DATA SOURCES

This research employs both descriptive and quantitative analysis methods. The quantitative approach involves estimating trend models in both linear and semi-logarithmic forms for the economic variables under study to calculate their annual growth rates. Additionally, multiple regression analysis is used to estimate production functions for wheat and maize crops. The study relies on two types of data: secondary data published in various issues of the Agricultural Economics Bulletin (issued by the Ministry of Agriculture and Land Reclamation) and reports from the Central Agency for Public Mobilization and Statistics (CAPMAS) and the Food and Agriculture Organization of the United Nations (FAO). The

second source consists of primary data obtained through personal interviews with the study sample; a research-specific questionnaire was designed to collect this data. Additionally, the study drew upon relevant research papers, academic theses, and foreign references, alongside the use of the Internet to gather information pertinent to the research topic.

RESEARCH RESULTS AND DISCUSSION

Economic Analysis of Food Security Indicators for Wheat and Maize Crops in Egypt

Analysis of Food Security Indicators for the Wheat Crop in Egypt

Trends in Food Security Indicators for Wheat (2012–2023):

Data from Table (1) and Figure (1) indicate that food security indicators for wheat in Egypt showed variation during the study period 2012–2023. Domestic production remained relatively stable, averaging approximately 9,121.2 thousand tons with an annual growth rate of 0.3%. Conversely, imports trended upward at an annual growth rate of 4.7%, contributing to an increase in the quantity available for consumption to an average of 19,109.6 thousand tons. Per capita consumption also rose to an average of 141.13 kg. Meanwhile, consumption growth outpacing domestic production growth led to a widening food gap, with the average self-sufficiency ratio standing at approximately 53%. The average import dependency rate stood at approximately 48%, reflecting the local market's continued reliance on imports to meet a portion of consumption needs, alongside the contribution of domestic production in supplying more than half of total consumption.

Table (1): Evolution of food security indicators for the wheat crop in Egypt during the period (2012–2023)

Year	Production (10^3 tons)	Imports (10^3 tons)	Consumption (10^3 tons)	Per capita consumption (Kg)	Food gap (10^3 tons)	Self-suffiency (%)	Import dependency rate (%)
2012	8795	6549	15657	121.7	6862	42	56
2013	9460	7878	17210	132.5	7750	46	55
2014	9280	8126	17025	127.5	7745	48	55
2015	9608	9001	18411	128.8	8803	49	52
2016	9345	10820	19410	133	10065	56	48
2017	8421	12061	20019	151	11598	60	42
2018	8349	12390	19714	149.7	11365	63	42
2019	8559	12493	20847	149.5	12288	60	41
2020	9102	12864	21482	154.9	12380	60	42
2021	9842	11116	21121	150.4	11279	53	47
2022	9623	9177	18691	137.4	9068	49	51
2023	9070	10857	19728	157.1	10658	55	46
Average	9121.17	10277.67	19109.58	141.13	9988.42	53	48
Growth rate %	%0.3	%4.7	%2.1	%2.3	%4.1	2.5	1.8-
Instability rate	0.054	0.157	0.062	—	0.139	0.092	—

Source: Compiled from the Food Balance Sheet bulletin, Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration for Agricultural Economics; various issues, 2012–2023.

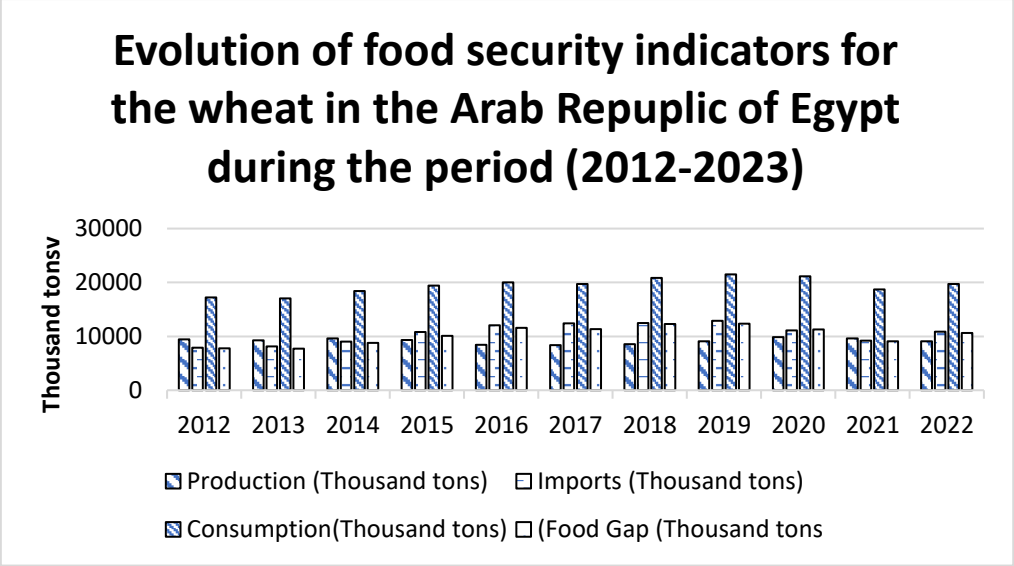

Figure (1): Evolution of food security indicators for the wheat crop in Egypt during the period (2012-2023)

Source: Table (1) in the study.

Figure (1) shows that the increase in the quantity available for wheat consumption during the study period was driven more by rising imports than by growth in domestic production.

General Temporal Trend of Food Security Indicators for Wheat

The results in Table (2) indicate that domestic wheat production did not exhibit a statistically significant temporal trend during the study period; the average annual rate of change was approximately 0.1%, suggesting relative production stability and the absence of any significant increase in production volumes.

Table (2): Results of estimating general time-trend equations for wheat food security indicators in the Arab Republic of Egypt during the period (2012-2023)

Item	Model	Annual growth rate (%)	Determination Coefficient (R^2)	F-Stat
Production (10^3 tons)	Y = 9042.29+12.12 X (0.279)	0.1	0.008	0.078
Imports (10^3 tons)	Y=7898.76+365.99X (2.59)*	3.6	0.402	*6.709
Consumption (10^3 tons)	Y=16697.24+359.01X (3.6)**	1.9	0.564	12.959**
Food gap (10^3 tons)	Y=7654.85+271013X (2.9)**	3.6	0.464	8.672**
Self-sufficiency (%)	Y=0.54 - 0.01X (-2.43)*	2-	0.372	5.92*

* Significant at 0.05. ** Significant at 0.01.

Source: Compiled and calculated from Table (1) in the study.

In contrast, the quantity of imports, the quantity available for consumption, and the food gap all showed a statistically significant upward trend, with average annual rates of change of approximately 3.6%, 1.9%, and 3.6%, respectively. This reflects an increasing reliance on imports to meet the growing domestic demand for wheat.

Analysis of Food Security Indicators for Maize in Egypt

Trends in Food Security Indicators for Maize (2012–2023):

Data from Table (3) and Figure (2) indicate that food security indicators for maize in Egypt showed variation during the 2012–2023 period. Average domestic production stood at approximately 7,793.6 thousand tons with an annual growth rate of 0.03%, reflecting relative stability in production. Meanwhile, imports rose to an average of 7,591 thousand tons with an annual growth rate of 1%, contributing to an increase in the quantity available for consumption to an average of 15,376.3 thousand tons. Additionally, the average per capita consumption was approximately 39.83 kg, while the average food gap amounted to approximately 7,582.75 thousand tons. This resulted in an average self-sufficiency rate of approximately 50.69%, compared to an average import dependency rate of about 49%. Figure (2) confirms the persistence of a food gap for maize, as well as the local market's reliance on imports alongside domestic production to meet a portion.

Table (3): Evolution of food security indicators for the maize crop in Egypt during the period (2012-2023

Year	Production (10^3 tons)	Imports (10^3 tons)	Consumption (10^3 tons)	Per capita consumption (Kg)	Food gap (10^3 tons)	Self-sufficiency (%)	Import dependency rate (%)
2012	6876	6523	13381	60.9	6505	51.39	49
2013	8094	5833	13925	65.4	5831	58.13	42
2014	7957	4361	12313	58.1	4356	64.62	35
2015	8060	6820	14877	48.5	6817	54.18	46
2016	7803	6112	13909	39.9	6106	56.10	44
2017	7818	8815	16627	37.1	8809	47.02	53
2018	8543	8454	16988	35.9	8445	50.29	50
2019	8261	10076	18322	35.1	10061	45.09	55
2020	7593	9371	16952	25.9	9359	44.79	55
2021	7586	8928	16504	23.7	8918	45.96	54
2022	8036	8524	16555	19.4	8519	48.54	51
2023	6896	7275	14163	28	7267	48.70	51
Average	7793.6	7591	15376.3	39.83	7582.75	50.69	49
Growth rate (%)	0.03	1	0.5	6.8-	1	0.5-	0.5
Instability rate (%)	0.064	0.169	0.097	—	0.168	0.086	—

Source: Compiled from the Food Balance Sheet bulletin, Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration for Agricultural Economics; various issues, 2012–2023.

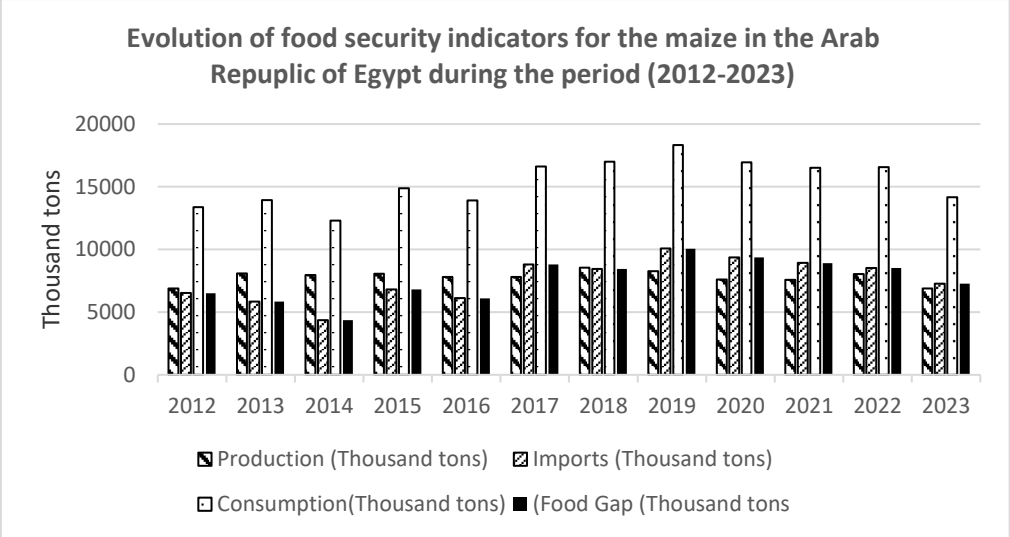

Figure (2): Evolution of food security indicators for the maize crop in the Arab Republic of Egypt during the period (2012-2023)

Source: Table (3) in the study.

General Temporal Trend of Food Security Indicators for the Maize Crop:

The results in Table (4) indicate that domestic maize production did not exhibit a significant temporal trend during the study period; the average annual rate of change was approximately -0.1%, reflecting relative stability in domestic production. In contrast, the import quantity, the quantity available for consumption, and the food gap all showed a statistically significant upward trend, with annual rates of change of approximately 4.1%, 1.9%, and 4.1%, respectively. This indicates an increasing reliance on imports to meet the growth in domestic demand for maize. The self-sufficiency ratio also exhibited a significant downward trend of 1%, with an annual rate of change of approximately 2.2%; this reflects the inability of domestic production to keep pace with rising consumption and the continued reliance on imports to meet a portion of domestic needs.

Table (4): Results of estimating general time-trend equations for food security indicators for the maize crop in Egypt during the period (2012-2023)

Item	Model	Annual growth rate (%)	Determination Coefficient (R^2)	F-Stat
Production (10^3 tons)	Y=7864.83+10.96X (0.25)	0.1-	0.006	0.63
Imports (10^3 tons)	Y=5574.05+310.3X (2.76)**	4.1	0.433	**7.64
Consumption (10^3 tons)	Y=13431.24+299.24X (2.29)*	1.9	0.343	*5.222
Food gap (10^3 tons)	Y=5566.41+310.21X (2.77)**	4.1	0.434	**7.665
Self-sufficiency (%)	Y=0.01 – 0.59X (2.91)**	2.2-	0.458	**8.461

Source: Compiled and calculated from Table (3) in the study.

Description of the Study Sample:

Two crops were selected for the study. The first is wheat, which accounts for 16.37% of the total cropped area (approximately 608.9 thousand feddans) and 40.34% of the total grain crop area (estimated at around 274 thousand feddans). The second is maize, which accounts for approximately 24.13% of the total cropped area and 59.47% of the total grain crop area.

The study sample was selected based on the relative importance of the crops within the governorate's administrative centers, as shown in Table (5). For wheat, the Quwaysna and Ashmoun centers were selected because the crop is relatively important during the winter season, accounting for 16.1% and 15.5% of the total, respectively. For maize, the Ashmoun and Al-Shuhada centers were selected based on the crop's importance during the summer season, representing 25.86% and 13.63% of the total, respectively. A purposive random sample was collected from villages within the Ashmoun, Quwaysna, and Al-Shuhada centers, comprising 100 questionnaires for each crop.

Table (5): Relative importance of the study crops for the 2024/2025 agricultural season

Administrative Centre	Wheat crop	%	maize crop	%
	feddan		feddan	
Ashmoun	15533.04	15.54	46385	25.86
Al-Bajour	9814.88	9.82	10639	5.93
Al-Shuhada	7060.54	7.06	24450	13.63
Barkat Al-Sab'	10654.58	10.66	9894	5.52
Tala	9405.54	9.41	21090	11.77
Shebin El Kom	11337.88	11.34	19824	11.05
Quwaysna	16104.21	16.1	13066	7.28
Menouf	13434.20	13.44	18959	10.57
Sadat	2223.00	2.22	8050	4.49
Governorate Total	99967.88	100	179360	100

Source: Menoufia Directorate of Agriculture, Agricultural Affairs Sector, Agricultural Statistics Bulletin, various issues.

Development of Wheat Cultivated Area, Productivity, and Production in Menoufia Governorate:

a-Development of Wheat Cultivated Area in Menoufia Governorate (2012–2023):

Data in Table (5) indicate that the average wheat cultivated area in Menoufia Governorate during the period (2012–2023) was 119.46 thousand feddans. The area ranged from a minimum of 63.08 thousand feddans in 2020 to a maximum of 144.13 thousand feddans in 2013, reflecting fluctuations in the cultivated area throughout the study period. Estimating the general time trend of the cultivated area using a linear regression model revealed a statistically significant downward trend at the 0.05 level; the time coefficient indicates an annual decrease of approximately 3.773 thousand feddans in the cultivated area during the study period. Furthermore, the coefficient of determination ($R^2 = 0.389$) implies that about 38.9% of the variations in the cultivated area are attributable to the time factor, while the remaining proportion is due to other factors not included in the model.

$$\hat{Y}_i = 143.981 - 3.773X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

(13.09) * * (-2.52)*

R^2 =0.389 $R^{2\backslash}$ = 0.328 F = 6.37

Where:

$\hat{Y}_i$: Estimated wheat area in Menoufia Governorate for year (i) (in thousand feddans)

X: Time variable during the study period.

* Significant at the 0.05 level. ** Significant at the 0.01 level.

(i) = 1, 2, ..., 14

b- Development of Wheat Productivity in Menoufia Governorate (2012-2023):

Data from Table (6) indicate that the average wheat productivity in Menoufia Governorate was approximately 20.28 ardab/feddan during the period (2012–2023). Productivity ranged from a minimum of 18.25 ardab/feddan in 2020 to a maximum of 20.58 ardab/feddan in 2013, reflecting relatively limited fluctuation in yield per feddan throughout the study period. An analysis of the general time trend of productivity revealed that a quadratic model best represents its evolution during the study period; the model was found to be statistically significant at the 0.05 level. The signs of the time coefficients indicate that productivity declined early in the period before gradually improving in subsequent years, reflecting a turning point in its temporal trajectory. The coefficient of determination (R^2 = 0.487) indicates that approximately 48.7% of the variations in wheat productivity during the study period can be explained by changes associated with the time factor, while the remaining proportion is attributable to other factors such as climatic conditions, the extent of improved variety adoption, fertilization levels, and the efficiency of agricultural operations.

$$\hat{Y}_i = 22.649 - 0.813X_i + 0.0539X_i^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

(26.85) ** (-2.73)* (2.41)*

R^2 =0.487 R^{-2}= 0.373 F = 4.27

Where $\hat{Y}_i$: It refers to the estimated wheat productivity in Menoufia Governorate for year (i) in Ardebs/feddan.

Table (6): Development of area, productivity, and production of the wheat crop in Menoufia Governorate during the period 2012-2023

Year	(feddan) Area	Productivity (Ardebs/feddan)	Production (Ardebs)
2012	126.59	21.47	2717.7
2013	144.13	21.58	3110.02
2014	137.897	20.26	2794.3
2015	135.137	20.5	2770.1
2016	129.88	20.2	2623.7
2017	113.11	20.22	2287.5

2018	123.91	20.88	2586.8
2019	127.63	18.77	2395.63
2020	63.798	18.25	1164.64
2021	126.67	19.7	2498.97
2022	105.02	20.1	2104.5
2023	99.69	21.46	2142.3
Average	**119.46**	**20.28**	**2433.01**

Source: Ministry of Agriculture and Land Reclamation, Agricultural Affairs Sector, Agricultural Statistics Bulletin, various issues.

c- Development of Wheat Production in Menoufia Governorate (2012-2023):

Data from Table (6) indicate that the average wheat production in Menoufia Governorate during the period (2012–2023) was approximately 2,433.01 thousand ardabs. Production ranged from a minimum of 1,167.64 thousand ardabs in 2020 to a maximum of 3,110.02 thousand ardabs in 2013, reflecting fluctuations in production volume throughout the study period. An analysis of the general time trend for wheat production revealed that a linear model was the most suitable for representing production trends during the study period; the model was found to be statistically significant at the 0.01 level. The time coefficient indicates a decline in wheat production of approximately 90.415 thousand ardabs annually during the study period. The coefficient of determination (R^2) was 0.438, indicating that approximately 43.8% of the variations in production volume can be explained by the time factor, while the remaining proportion is attributable to other factors not included in the model—such as changes in cultivated area and yield per feddan, as well as climatic conditions, agricultural policies, and the level of input usage.

$$\hat{Y}_i = 3020.71 - 90.415X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

(12.66) ** (-2.79)**

R2 =0.438 R-2= 0.381 F = 7.78

Where $\hat{Y}_i$: It refers to the estimated wheat production in Menoufia Governorate for year (i) in 103 Ardebs

Development of Maize Cultivated Area, Productivity, and Production in Menoufia Governorate:

a-Development of Maize Cultivated Area in Menoufia Governorate (2012-2023):

Data from Table (7) show that the average cultivated area with maize in Menoufia Governorate during the period (2012–2023) was approximately 184.97 thousand feddans. The cultivated area ranged from a minimum of 31.03 thousand feddans in 2020 to a maximum of 266.58 thousand feddans in 2015, reflecting a clear fluctuation in the cultivated area throughout the study period.

An assessment of the general time trend for the cultivated area revealed that a cubic model was the most suitable for representing its evolution during the study period; the model was found to be statistically significant at the 0.05 level. The model's coefficients indicate that the cultivated area did not follow a steady linear trend but rather underwent

phases of increase and decrease, reflecting changes in maize cultivation patterns in Menoufia Governorate. Furthermore, the coefficient of determination (R^2) was 0.645, implying that approximately 64.5% of the variation in cultivated area can be explained by the time factor, while the remaining proportion is attributable to other factors—such as changes in agricultural policies, crop composition, the relative prices of competing crops, and economic and production conditions.

$$\hat{Y}_i = 67.861 + 141.44Xi - 28.23Xi^2 - 1.34Xi^3 \quad \text{.....(4)}$$

$$(0.71)\ (2.32)^*\ (-2.64)^*\ (-2.65)^*$$

$$R^2 = 0.645\ R^{-2} = 0.513\ F = 4.86$$

Where $\hat{Y}_i$: Estimated annual maize cultivation area in Menoufia Governorate (in year i) in thousand feddans.

Table (7): Development of Maize Cultivated Area, Productivity, and Production in Menoufia Governorate during the period 2012-2023.

Year	(feddan) Area	Productivity (Ardebs/feddan)	Production (Ardebs)
2012	213.904	23.48	5022.21
2013	204.521	21.4	4376.4
2014	266.195	21.67	5768.06
2015	266.58	20.47	4547.3
2016	257.84	20.66	5326.02
2017	251.17	24.36	6119.5
2018	238.71	25.92	6187.9
2019	46.38	22.64	1049.9
2020	31.03	22.11	685.97
2021	112.696	24.71	2787.5
2022	183.63	21.94	4027.12
2023	146.95	22.97	3377.9
Average	184.97	22.69	4106.32

Source: Ministry of Agriculture and Land Reclamation, Agricultural Affairs Sector, Agricultural Statistics Bulletin, various issues.

Regarding the yield per feddan and total production of Maize, and analysis of the general time trend using linear cubic model reveled that the estimated models lacked statistical significance. This indicate the absence of a consistent general time trend for these two variables during the study period, consequently, the time trend model for them are not presented.

Selected Indicators of Economic Production Efficiency for the Wheat Crop:

a) Wheat Production Elasticities:

Estimates indicate that the most important factors driving changes in wheat production are cultivated area, human labor, seeds, mechanized labor, and organic manure. Specifically,

a 10% change in the quantity of any of these inputs results in a production change of approximately 8.5%, 0.11%, 0.88%, 1.1%, and 0.02%, respectively.

The significance of human labor stems from the importance of essential agricultural operations for the wheat crop such as sowing seeds and fertilizer, weeding, irrigation, and harvesting, while the importance of mechanized labor is attributed to its diverse applications throughout the production cycle, from initial land preparation to the final harvest.

Data in Table (8) indicate that production elasticities are positive for the production factors of land area, human labor, machine labor, and seeds; this implies a direct relationship between wheat output and the quantities of these inputs used, meaning that as the usage of these factors increases, wheat production rises, and vice versa.

Conversely, wheat production exhibits an inverse relationship with the quantity of organic manure used, as the elasticity was negative; increasing the application of organic manure leads to a decrease in wheat output. This is attributed to the crop's susceptibility to lodging caused by elevated nitrogen levels in the soil.

b) Returns to Scale for the Wheat Crop:

Sum of the elasticities of the production inputs involved in the wheat production process was approximately 1.01. This reflects constant returns to scale, meaning that if the quantities of production inputs are increased collectively by a certain percentage, output increases by the same percentage.

Second: Maize Production Function:

Multiple regression analysis was used to estimate the maize production function, thereby identifying the impact of each independent variable on the quantity of maize production (measured in ardabs) and enabling the use of economic efficiency indicators. The results are presented in the following equation:

$$\hat{Y}_i = 3.1 + 0.84X_1 - 0.24X_2 + 0.13X_3 - 0.088X_4 + 0.06X_5$$

(3.4)** (3.1)** (-2.5)* (2.3)* (-0.76) (0.66)

$R^{2\backslash}$ = 70 F =.40.5.

(Y): Maize production quantity (ardab/feddan).

(X_1): Area planted with maize (feddan).

(X_2): Human labor (labor-days).

(X_3): Value of mechanical labor (EGP).

(X_4): Seed quantity (kg).

(X_5): Nitrogen fertilizer (effective units).

(i): 1, 2, 3, 4, ..., 100.

Some Indicators of Economic Production Efficiency for the Maize Crop:

a) Production Elasticities for Maize:

Data in Table (8) indicate that production elasticities for production inputs were positive, with the exception of human labor and seeds. This is attributed to farmers' reliance on family labor, driven by high hired labor wages and the prevalence of small landholdings in the governorate, as well as the crop's low profitability; maize is often cultivated solely to feed the farm's livestock and poultry amidst rising commercial feed prices. This suggests an excessive use of human labor resulting from the reliance on family labor. Regarding the variables of land area, mechanized labor, and nitrogen fertilizer, production output responds positively to increases in these inputs. where 10% increase in any of these factors leads to an increase in production of approximately 8.4%, 1.3%, and 0.6%, respectively; the effect of phosphate fertilizer was excluded because the maize crop follows winter crops such as wheat, fava beans, and clover none of which deplete the soil.

b) Returns to Scale for the Maize Crop:

Sum of production elasticities for the inputs involved in the maize production process was approximately 0.71. This reflects decreasing returns to scale, meaning that a 1% increase in the combined quantities of production inputs results in an increase in output of less than 1%, specifically, 0.71%.

Table (8): Production elasticities of inputs for wheat and maize crops during the 2022/2023 agricultural season

Element	Production Elasticity for wheat crop	Production Elasticity for maize crop
Area (thousand feddans)	0.85	0.84
Human labor (work/days)	0.011	-0.24
Machine labor (in pounds)	0.13	0.13
Seeds (kilograms)	0.088	-0.088
Organic manure (cubic meters)	-0.002	0.001
Nitrogen fertilizer (active units)	0.0002	0.06
Phosphate fertilizer (active units	-	0.002

Source: Compiled and calculated from sample data

Economic Indicators for the Study Sample Crops During the 2024/2025 Agricultural Season:

Data in Table (9) illustrate some economic indicators regarding the economic efficiency of the study sample crops, calculated based on farm budget figures. The data indicate that wheat productivity reached 27.1 ardabs (after converting the by-product straw into units of the main product grain). Furthermore, the net return was approximately 3,835 EGP, while the return above variable costs stood at 14,235 EGP. The return to cost ratio was 1.25, the profit per pound of variable cost was 0.81 EGP, and the profit per ardab of wheat was estimated at approximately 141.5 EGP. These figures demonstrate the profitability of wheat cultivation for the 2024/2025 agricultural season.

Regarding the maize crop, Table (9) indicates that the yield reached 25.6 ardabs (after converting the by-product stalks into main product units (grain). The net return was estimated at a negative 100 EGP, while the return over variable costs stood at 4,700 EGP. The return-to-cost ratio was 0.99, and the profitability per pound of variable cost was -0.02 EGP. Profitability per ardab of maize was also negative, estimated at -3.97 EGP. These figures suggest that cultivating maize was unprofitable for the 2024/2025 agricultural season; nevertheless, farmers continue to grow it due to economic and social considerations.

Table (9): Economic indicators per feddan of harvested crop (wheat and maize) for the sampled farms in Menoufia Governorate during the 2024/2025 agricultural season

Indicator	Unit	Wheat crop	Maize crop
Fixed cost	EGP	10400	4800
Variable cost	EGP	4735	4860
Total cost	EGP	15135	9660
Productivity/feddan	Ardeb/ton	27.1	25.16
Total revenue	EGP	18970	9560
Net revenue	EGP	3835	-100
Return over variable costs	EGP	14235	4700
Return over fixed costs	EGP	8560	4760
Relative revenue to cost	EGP	1.25	0.99
Profitability per Pound of Variable Costs	EGP	0.81	-0.02
Ardab profitability	EGP	141.5	-3.97

Source: Compiled and calculated from sample data, Total Net Return = Total Revenue – Total Costs, Return Over Variable Costs = Total Revenue – Variable Costs, Profitability per Pound of Variable Costs = Net Return per Feddan / Variable Costs, Profitability per Unit of Output = Net Return per Feddan / Productivity per Feddan

Survey of Farmers' Opinions on Production and Marketing Issues:

Issues Related to Production Inputs:

Tables (10) and (11) present the perspectives of the sampled farmers regarding issues related to production inputs for the two crops under study. For the wheat crop, these issues ranked in descending order of relative frequency are: the unavailability of chemical fertilizers when needed, the unavailability of potassium fertilizers at agricultural cooperatives, the high price of potassium fertilizer, the unavailability of improved seeds, and the unavailability of pesticides at agricultural cooperatives; these account for 14.68%, 14.4%, 13.7%, 13.05%, and 12.21% of the responses, respectively.

Table (10): Relative importance of farmers' opinions regarding problems related to production inputs for the wheat crop

No.	Problem	Relative frequency (%)
1	Unavailability of chemical fertilizers when needed	14.68%
2	Unavailability of potassium fertilizers at agricultural cooperatives	14.4%
3	High price of potassium fertilizer	13.7%
4	Unavailability of improved seeds	13.05%
5	Unavailability of pesticides at agricultural cooperatives	12.21%

6	Poor seed quality	10.76%
7	High fertilizer prices	8.97%
8	High pesticide prices	8.16%
9	Pesticide adulteration	4.07%
Total		%100

Source: Compiled and calculated from sample data.

Table (11): Relative importance of farmers' opinions regarding problems related to production inputs for the maize crop

No.	Problem	Relative frequency (%)
1	Unavailability of improved seeds	14.04%
2	Poor seed quality	13.48%
3	High fertilizer prices	12.77%
4	High price of potassium fertilizers	12.77%
5	Unavailability of potassium fertilizers at agricultural cooperatives	12.10%
6	Unavailability of pesticides at agricultural cooperatives	12.10%
7	Unavailability of chemical fertilizers when needed	11.49%
8	High pesticide prices	7.00%
9	Pesticide adulteration	4.25%
Total		100%

Source: Compiled and calculated from sample data.

Regarding the maize crop, respondents identified issues related to production inputs, noting the unavailability and poor quality of improved seeds (cited by 14.04% and 13.48% of the sample, respectively). These were followed by the high cost of fertilizers in general and potassic fertilizers specifically (each cited by 12.77%). Additionally, 12.77% of the farmers pointed to the unavailability of potassic fertilizers and pesticides at agricultural cooperatives. The unavailability of chemical fertilizers when needed was cited by 11.49% of the farmers, while high pesticide prices and pesticide adulteration were mentioned by 7.0% and 4.25% of the sample, respectively.

It is evident from the foregoing that the role of the agricultural cooperative society in supplying production inputs, particularly potassic fertilizers, to the farmers in the sample has diminished regarding the crops under study. Consequently, farmers are compelled to purchase from the open market, where they face the challenges of high prices and a lack of available market information.

It has also become evident that the agricultural cooperative plays no role in supplying improved seeds and that the seeds it does stock are of poor quality, particularly for maize, which explains the low yield per feddan for this crop.

Furthermore, the failure of cooperatives to provide pesticides, combined with the prevalence of adulterated products, explains why wheat crops suffer from aphid infestations and maize crops from fall armyworm attacks, resulting in significant losses despite farmers' pest control and spraying efforts.

Therefore, agricultural cooperatives must fulfil their role by providing farmers with all necessary production inputs.

RECOMENDATIONS

1. Expand the production of wheat and maize by disseminating high-yielding varieties and improving the efficiency of agricultural resource use.
2. Adopt policies aimed at narrowing the food gap, increasing self-sufficiency, and reducing reliance on imports.
3. Support agricultural extension programs and expand the adoption of modern technologies to boost productivity and improve production efficiency.
4. Continue monitoring food security indicators and utilize them in formulating agricultural and food policies.
5. It is essential to revitalize the role of agricultural cooperative societies in supplying production inputs to farmers; the diminished role of these societies forces farmers to purchase from the open market, where they face high prices and a lack of market information.
6. Emphasis should be placed on contract farming for crops to mitigate the risks and financial losses farmers incur when crop prices drop.

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