Evaluation of Economic Efficiency, productivity Indicators, and Determinants of Supply Response for local Broad Beans Crop in Egypt and Fayoum Governorate

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Abstract: Broad beans are a vital food source for a large segment of the Egyptian population, especially among middle- and low-income households. In 2023, the area cultivated with broad beans in Egypt reached 246,700 acres, with Fayoum Governorate contributing 3,300 acres, producing 372,500 and 4,818 thousand tons, respectively. The study addresses a critical issue: the growing food gap in broad beans production, which necessitated the import of 1,115 thousand tons in 2023. This research evaluates the indicators of productive and economic efficiency and analyzes the patterns of supply response in the Fayoum sample study. The analysis of food security during the period 2004-2023 revealed a coefficient of 0.392, indicating low levels of food security. The statistical analysis of the production function identified the main factors affecting broad beans production, which are mechanized working hours, application of local fertilizers, and use of irrigation water. The overall elasticity value of 1.503 illustrates the increased returns on a wide scale. Based on these findings, the research recommends: ensuring affordable and accessible production inputs for farmers, setting higher per ton prices for faba beans to enhance producers' profit margins and encourage expanded cultivation, and implementing effective strategies to rationalize consumption and reduce storage losses to increase overall faba beans.

Keywords: Food security , supply response

I. INTRODUCTION

The Local beans stand out as an important legume crop, characterized by its exceptional nutritional value, with a protein content of about 29%, carbohydrates of 58%, and phosphorus of 0.7%, in addition to a rich set of essential nutrients and vitamins. Its culinary importance in many popular dishes, the bean crop provides remarkable agricultural benefits, as its straw is considered the ideal fodder for livestock and plays a crucial role in improving the soil, fixing atmospheric nitrogen, and fertilizing the soil. Strategically, the local bean crop represents a pivotal element in agricultural development in Egypt, as it seeks horizontal expansion by increasing cultivated areas and land reclamation, and vertical expansion by applying advanced technology such as developing high-yield varieties per acre to alleviate the national food gap. Statistical data for the period 2004-2023 indicate that the average area planted with local beans amounted to about 157.52 thousand acres in Egypt and 2.71 thousand acres in Fayoum, with corresponding production levels of about 226.57 and 3.83 thousand tons, respectively, accompanied by an average energy consumption of about 754.6 thousand tons during the study period.

Research problem: The Fava beans have long been a cornerstone of food crops in Egypt, but recent years have seen a significant decline in cultivated areas in both Egypt and Fayoum Governorate, leading to a significant decline in total fava bean production. This trend coincides with rapid population growth and growing consumer preference for fava beans as an alternative to increasingly expensive animal protein, leading to a significant increase in fava bean imports to meet growing domestic demand. The economic implications are profound, with an average food gap for fava beans of around 528,000 tons and a self-sufficiency rate declining to around 31% over the period 2004–2023. As a result, the country has had to import an average of 542.8 thousand tons of fava beans annually, putting significant pressure on the national trade balance and highlighting the relatively low importance of fava bean cultivation in the region. This complex scenario underscores the critical challenges facing Egypt's agricultural sector, particularly in maintaining food security and sustainable agricultural production.

Research objectives: The research aims primarily to study the economic and productive efficiency of the local bean crop in Fayoum Governorate through:

1) Studying the productive and economic indicators of the local bean crop in Egypt and Fayoum during the study period.

2) Estimating the productive and economic efficiency indicators of the local bean crop in the study sample in Fayoum.
3) Estimating the extent of supply response to the local bean crop in the study sample in Fayoum.
4) Identifying the most important difficulties facing producers and the most important proposed solutions for the local bean crop in the study sample in Fayoum.

II. Methodology

The research relied on descriptive and quantitative analysis to describe the study variables related to the economic and productive effects, using simple regression and some economic indicators to estimate the supply response in its linear form. Production functions were also estimated for the data collected through the questionnaire form in the study sample using many forms of functions and choosing the best of them whose results are consistent with economic and statistical logic, and using some indicators of economic efficiency to produce the study crop in Fayoum Governorate.
-The research also relied on two types of data: the first is secondary data published from its various sources, represented by the Economic Affairs Sector of the Ministry of Agriculture and Land Reclamation, the Information Center of the Fayoum Agriculture Directorate, the Ministry of Irrigation and Water Resources, and the Fayoum Irrigation Directorate. The second is primary data obtained through a questionnaire form for a multi-stage stratified random sample.

III. Results and Discussion

1.1. Study the current status of production and energy of the local bean crop in Egypt and Fayoum.
- A comprehensive analysis of Table (1) in the appendix reveals a complex and dynamic landscape of faba bean production and economic viability in Egypt, characterized by significant fluctuations throughout the period from 2004 to 2023. A close examination of the total area planted with the crop reveals significant variation, with the overall average hovering around 157.52 thousand feddans, fluctuating between a maximum of about 246.7 thousand feddans and a minimum of about 83.4 thousand feddans. The statistical assessment, derived specifically from the general time trend equation presented in Equation (1) in the reference table, indicates a statistically significant downward trend in the total planted area, indicating an annual decrease of about -9.91 thousand feddans. This close view of the dynamics of faba bean cultivation highlights the complex interaction between the factors affecting agricultural land use and crop production in Egypt, highlighting the challenges and potential transformations within the agricultural sector during the time frame studied.
- As the data of the same table indicate, the general average of productivity per acre ranged around 1.44 tons per acre, with a maximum of around 1.51 tons per acre, and a minimum of around 1.28 tons per acre. Equation No. (2) also shows that it took a general trend of statistically significant increase of around 0.032 tons per acre, with an annual increase rate of around 2.2% of the general average, and the coefficient of determination (R2) was estimated at around 65% for the same study period.
- It is clear from the data of the same table that the general average of total production ranged around 226.57 thousand tons, with a maximum of around 372.5 thousand tons, and a minimum of around 121.4 thousand tons. It is also clear from equation No. (3) of the same table that it took a general decreasing trend that was statistically insignificant by around 15.57 thousand tons annually.
- It is clear from the data in Table No. (1) the economic energy indicators of the local bean crop in Egypt during the study period, as it was shown from the study of the development of the total costs of local beans in Egypt that the general average amounted to about 6425.8 pounds per acre, and the highest value amounted to about 14655 pounds per acre, and the lowest value amounted to about 1700 pounds per acre, and by estimating the general time trend equation, Equation No. (4) for the same table indicates that the total costs took a general trend that increased statistically significantly, as it amounted to about 675.2 pounds per acre, at an annual increase rate of about 15.2% for the general average, and the coefficient of determination (R2) was estimated at about 91% for the same study period.
- As it is clear from the data of the same table that the farm price developed as the general average reached about 7138 pounds per acre with a maximum of about 20150 pounds per acre and a minimum of about 2106 pounds per acre. By estimating the general time trend equation, equation No. (5) of the same table indicates that the farm price took a general trend of increasing with statistical significance as it reached about 813.7 pounds per acre with an annual increase rate of about 11.33% for the general average. The coefficient of determination (R2) was estimated at about 83% for the same study period.
-The analysis of total revenues for the local bean crop reveals a dynamic and complex financial landscape characterized by significant fluctuations and steady growth. A comprehensive examination of the

indicated table highlights an average overall total revenue of approximately EGP 10,350.2/acre, showing significant fluctuations between the maximum of EGP 30,426.5/acre and the minimum of EGP 3,032.6/acre. Equation (6) provides crucial insights into the revenue trajectory, indicating a statistically significant increasing trend of approximately EGP 1,202/acre, accompanied by an annual growth rate of 11.6% compared to the overall average. The strength of this financial trend is further demonstrated by the coefficient of determination (R2) of approximately 82% throughout the study period.

-As the data of the same table shows, the net return has developed, as the general average reached about 3924.5 pounds per acre, with a maximum of about 15771.5 pounds per acre, and a minimum of about 965.4 pounds per acre. Equation No. (6) of the same table also shows that it took a statistically significant upward trend of about 526.9 pounds per acre, with an annual increase rate of about 13.5% of the general average. The coefficient of determination (R2) was estimated at about 65% for the same study period.

- Where the average rate of return on costs was about 1560 pounds, and the average profitability of the invested pound was about 0.560 pounds per acre, it is also clear that the average rate of producer incentive was about 34.85%, and the average rate of economic efficiency was about 155.7% during the same period.

- The analysis of Table No. (1) in the appendix provides a comprehensive view of the productive and economic potential of the local bean crop in Fayoum Governorate, revealing a complex pattern of fluctuations throughout the period from 2004 to 2023. As for the total area planted with the crop, it shows a large variation, as the general average stabilized around 2.71 thousand acres, fluctuating between a maximum of about 3.3 thousand acres and a minimum of about 1.8 thousand acres. The statistical assessment, derived from the general time trend equation presented as equation No. (1) in the appendix table, indicates a statistically insignificant downward trend in the total cultivated area, indicating an annual decrease of about 0.15 thousand acres. This fine-grained view of the dynamics of local bean cultivation in Fayoum Governorate sheds light on the complex challenges and subtle transformations within the agricultural sector in the region during the studied time frame, reflecting the delicate balance between agricultural production, land use, and economic constraints.

- A comprehensive analysis of the indicated table reveals complex details about the productivity of the local bean crop, providing an accurate perspective on the agricultural performance of the region. The productivity per acre shows a relatively stable pattern, with an annual average of about 1410 tons per acre, fluctuating within a narrow range between a maximum of 1480 tons per acre and a minimum of 1380 tons per acre. Equation (2) provides crucial insights into the productivity trajectory, indicating a statistically significant upward trend of about 0.005 tons per acre, which corresponds to a modest annual increase rate of 0.36% compared to the overall average. The coefficient of determination (R2), estimated at about 48% for the study period, indicates a moderate level of explanatory power for the observed trend, reflecting the complex and multifaceted nature of agricultural productivity. This analysis highlights the subtle and sustained growth in the productivity of the local bean crop, highlighting the potential for incremental improvements in agricultural performance despite the inherent variability and challenges of the agro-ecosystem.

- It is clear from the data in the same table that the general average of total production amounted to about 3,830 thousand tons, with the highest level being about 5,658 thousand tons, and the lowest level being about 2,484 thousand tons. It is also clear from equation No. (3) of the same table that it took a general downward trend that was not statistically significant, as it amounted to about 0.17 thousand tons annually.

-The comprehensive analysis of Table (1) reveals the complex energy economic indicators of the local bean crop in Fayoum Governorate during the study period, providing an accurate perspective on the financial dynamics of agricultural production. Examination of the total costs of local beans reveals an overall average of about EGP 6422.7 per acre, characterized by a large variation ranging from a minimum of EGP 1690 per acre to a maximum of EGP 14620 per acre. The general time trend equation, specifically Equation (4), shows a statistically significant upward trend in total costs, with an annual increase of about EGP 676.8 per acre, translating into an annual growth rate of 10.54% relative to the overall average. The robustness of this financial path is also demonstrated by the coefficient of determination (R2) of about 67%, indicating a significant explanatory power for the observed trend. This sophisticated analysis not only captures the economic complexities of local faba bean production in Fayoum, but also highlights the financial evolution of the sector, reflecting the interplay between agricultural costs, market dynamics and economic factors over the period studied.

- A comprehensive analysis of the aforementioned table reveals the complex dynamics of farmers' prices for the local bean crop in Fayoum Governorate, providing an accurate perspective on agricultural economic trends. The average price per acre was found to be about EGP 7131.4 per acre, showing a wide variation with a maximum of EGP 20120 per acre and a minimum of EGP 2100 per acre. The general time

trend equation, specifically Equation No. (5), reveals a statistically significant upward trajectory in farmers' prices, with an annual increase of about EGP 813.3 per acre, which corresponds to an impressive annual growth rate of 11.41% compared to the general average. The strength of this financial progress is confirmed by the coefficient of determination (R2) of about 83%, indicating a very reliable and consistent trend throughout the study period. This sophisticated analysis not only captures the economic complexity of local bean pricing in Fayoum, but also highlights the sector's financial resilience and potential for sustainable growth, reflecting the complex interplay between agricultural market dynamics, economic factors and production challenges over the time frame studied.

- A comprehensive analysis of the indicated table reveals the complex financial landscape of the total revenues of the local bean crop in Fayoum Governorate, providing a sophisticated perspective on the agro-economic dynamics. The total revenues showed an overall average of about EGP 10,111.1 per acre, characterized by a large variability ranging from a minimum of EGP 2,898 per acre to a maximum of EGP 29,375.2 per acre. Equation (6) provides crucial insights into the revenue trajectory, indicating a statistically significant upward trend with an annual increase of EGP 1,165.7 per acre, translating into an impressive annual growth rate of 11.54% compared to the overall average. The reliability of this financial progress is reinforced by a strong coefficient of determination (R2) of about 81%, indicating a consistent and highly interpretable trend throughout the study period. This in-depth analysis not only captures the economic complexities of fava bean revenues in Fayoum, but also highlights the sector's potential for sustainable financial growth, reflecting the complex interplay between agricultural productivity, market conditions and economic factors over the time frame studied.

- As the data of the same table shows, the net return has developed, with the general average reaching about 3688.8 pounds per acre, with a maximum of about 14755.2 pounds per acre, and a minimum of about 1041.5 pounds per acre. Equation No. (6) of the same table also shows that it took a statistically significant increasing trend of about 488.9 pounds per acre, with an annual increase rate of about 13.3% of the general average, and the coefficient of determination (R2) was estimated at about 64% for the same study period.

- Where the average rate of return on costs was about 1.531 pounds, and the average profitability of the invested pound was about 0.531 pounds per acre, and it is also clear that the average rate of incentive for producers was about 33.82%, and the average rate of economic efficiency was about 153.2% during the same period.

Table No. (1) General time trend equations for the development of the productive and economic capacity of the faba bean crop, the development of consumption and imports, the size of the food gap, and the self-sufficiency rate in Egypt and Fayoum during the period.(2004-2023)

Development of the productive and economic capacity of the local bean crop in Egypt and Fayoum								
Statement	**Equation Number**	**Variable**	**General Time Trend Equation**	**T**	**R2**	**F**	**Average**	**Annual change rate%**
Egypt	**1**	Total Area	Ŷi= 4047.1-9.91Xi	**(-6.8)	0.65	**46.24	157.5	-3.8
	2	Acre Productivity	Ŷi= 31.392 +0.032Xi	**(2.81)	0.55	**7.9	1.44	2.2
	3	Total Production	Ŷi= 395.1 - 15.57 Xi	**(-6.91)	0.71	**47.8	226.6	-6.9
	4	Total Costs	Ŷi= 135297 + 675.2 Xi	**(14.4)	0.91	**208.1	6425.8	10.5
	5	Farm Price	Ŷi= 1631142+ 813.7 Xi	**(9.5)	0.83	**90.5	7183	11.33
	6	Total Revenue	Ŷi= 2409804 + 1202 Xi	**(9.1)	0.82	**82.4	10350.2	11.6
	7	Net Return	Ŷi= 105664 + 526.9 Xi	**(5.8)	0.65	**33.6	3924.5	13.5
Fayoum	**8**	Total Area	Ŷi=108.4 – 0.15 Xi	**(-6.11)	0.53	**37.34	2.71	-5.54
	9	Acre Productivity	Ŷi= 1.42 +0.005Xi	**(2.82)	0.48	**7.95	1.41	0.36
	10	Total Production	Ŷi= 159.6 - 0.17 Xi	**(-5.3)	0.67	**28.1	3.83	-4.44
	11	Total Costs	Ŷi= 1356276 +676.8Xi	**(14.6)	0.92	**213.2	6422.7	10.54
	12	Farm Price	Ŷi= 16303.5+813.3Xi	**(9.53)	0.83	**90.8	7131.4	11.41
	13	Total Revenue	Ŷi = 2337008 +1165.7Xi	**(9.2)	0.81	**84.6	10111.4	11.54
	14	Net Return	Ŷi= 980732+488.9Xi	**(5.7)	0.64	**32.5	3688.8	13.3

Development of consumption, imports, size of food gap and self-sufficiency rate in Egypt								
Egypt	15	Total domestic consumption	Ŷi= 490011 + 64.7 Xi	**(7.22)	0.84	**52.2	754.6	8.6
	16	Import volume	Ŷi= 104091 + 61.99 Xi	**(7.82)	0.74	**61.2	542.8	11.4
	17	Food gap volume	Ŷi= 537622 + 36.96 Xi	**(6.11)	0.68	**37.33	528	7
	18	Daily consumption	Ŷi= 133.9 + 0.077 Xi	**(4.13)	0.49	**17.1	2.07	3.7
	19	Production sufficiency period for consumption	Ŷi= 9725.3 - 5.8 Xi	**(-4.3)	0.84	**18.5	113.2	5.2
	20	Import sufficiency period for consumption	Ŷi= 30941 + 15.5 Xi	**(5.1)	0.59	**26.1	247.8	6.3

Where : yi is the estimated value of the dependent variable represented by the variables (total area of the local bean crop, productivity per acre, total production, total costs, farm price, total revenue, net return, consumption, imports, size of the food gap, daily consumption, production sufficiency period for consumption, import sufficiency period for consumption)
xi: time factor in years as an independent variable, where i (1, ..., 20) The numbers in parentheses below the estimates indicate the calculated (t) value
**Indicates significance at the (0.01) level *Indicates significance at the (0.05) level
Source: Collected and calculated from the data included in Table No. (1) in the appendix

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2. Study of the current status of energy consumption, food gap and self-sufficiency of fava beans in Egypt.

- The comprehensive analysis of Table (2) provides an in-depth look at the dynamics of fava bean energy consumption in Egypt during the study period, revealing a complex landscape of local consumption patterns. Local fava bean consumption showed an overall average of about 754.6 thousand tons, characterized by significant variation ranging from a minimum of 464 thousand tons to a maximum of 1184 thousand tons, representing a significant increase of 720 thousand tons over the baseline. Equation (15) provides crucial insights into the consumption trajectory, indicating a statistically significant upward trend with an annual increase of about 64.7 tons, translating into an impressive annual growth rate of 8.6% compared to the overall average. The strength of this consumption pattern is confirmed by the coefficient of determination (R2) of about 84%, indicating a very stable and reliable trend throughout the study period. This sophisticated analysis not only captures the complex dynamics of domestic bean consumption in Egypt, but also highlights the evolving food landscape in this sector, reflecting the complex interplay between agricultural production, dietary preferences, population growth, and economic factors over the time frame studied.

- As is clear from the data of the same table, the quantity of imports has developed, with the general average reaching about 542.8 thousand tons, with a minimum of about 169.3 thousand tons, and a maximum of about 1024.2 thousand tons, with an increase of 854.39 thousand tons over the minimum. Equation No. (16) of the same table shows that it took a statistically significant upward trend towards 61.99 thousand tons, with an annual increase rate of about 11.4% of the general average. The coefficient of determination (R2) was estimated at about 74% for the same study period.
- The data in the same table also shows the development of the size of the food gap, where the general average reached about 528- thousand tons, with a minimum of about 291.2- thousand tons and a maximum of about 874.4- thousand tons, an increase of 583.2- thousand tons over the minimum, as Equation No. (17) of the same table shows that it took a statistically significant upward trend of about 36.96 thousand tons at an annual increase rate of about 7% of the general average, and the coefficient of determination (R2) was estimated at about 68% for the same study period.
- It is clear from the data in the same table that the self-sufficiency rate has developed, as the general average reached about 31%, with a maximum of about 48.6%, and a minimum of about 14.8%, an increase of 33.8% over the minimum.
- It is also clear from the data in the same table that the average per capita share has developed, as the general average reached about 6.8 kg/year, with a maximum of about 8.7 kg/year, and a minimum of about 4.6 kg/year, an increase of 4.1 kg/year over the minimum.

3.Estimating the strategic stock and food security factor for the local bean crop in Egypt

- This part of the research deals with the exposure to the results of the economic equations used in estimating the strategic stock and food security coefficient in Egypt by estimating the size of the surplus and deficit of local beans allocated for local consumption in light of the data on Egyptian production, consumption and imports of local beans during the period (2004-2023). The following is a presentation of the results of the following equations:

3.1. Daily domestic consumption quantity.

-An in-depth analysis of Table (2) reveals the complex patterns of daily domestic consumption of the local bean crop in Egypt throughout the period from 2004 to 2023, presenting a dynamic trajectory of consumption behaviors. The data show a remarkable variation, with daily domestic consumption reaching its lowest point at 1.27 thousand tons in 2014, then rising later to a peak of 3.24 thousand tons by 2023, with an average of about 2.07 thousand tons across the entire study period. Through equation (18) in Table (1), which indicates a statistically significant upward trend of about 0.077 thousand tons, which corresponds to an annual growth rate of 3.7% relative to the general average. The moderate coefficient of determination (R2) of about 49% indicates reasonable explanatory power for the observed trend throughout the study period. Reflecting the complex interplay of socio-economic and demographic factors that influence daily consumption patterns, this comprehensive analysis not only captures the evolving nature of local bean consumption in Egypt, but also highlights the significant shifts in dietary preferences and consumption behaviors over the time frame studied.

3.2. Production sufficiency period for domestic consumption.

-A comprehensive analysis of the above table reveals crucial insights into the dynamics of Egypt's faba bean production sufficiency during the period 2004-2023, highlighting worrying patterns in food security. The data show significant variation in the ability of local production to meet consumption requirements, with the coverage period ranging from a worrying minimum of about 54.2 days (1.81 months) in 2018 to a more significant maximum of 185.2 days (6.2 months) in 2009, with an average of about 113.2 days (3.8 months) across the study period. This fluctuation pattern, which is particularly evident from Equation (19), indicates a statistically insignificant downward trend of about 5.8 thousand tons per year, raising significant concerns about the food security status of the Egyptian economy with regard to faba bean. The declining trend in production adequacy is a critical indicator of the growing challenges in maintaining adequate levels of food security for faba bean in Egypt, reflecting the complex interplay between agricultural productivity, consumption patterns and economic factors that affect the country's self-sufficiency in this staple crop.

3.3. Import coverage period for local consumption.

-The same table data shows that the import coverage period for local consumption of the local bean crop during the study period (2004-2023) ranged between a minimum of about 90 days (3 months) in 2008, and a maximum of about 326.5 days (10.9 months) in 2016, while the annual average for the study period was about 247.8 days (8.3 months). From the above, it is clear that the period of covering the quantity of imports for local consumption has increased and the period of sufficiency of local production for local consumption of local beans has decreased. This is considered a bad indicator for the Egyptian economy because it leads to increased dependence on the outside to meet the consumption needs of local beans, and thus an increase in the deficit in the state's balance of payments, in addition to the exposure of Egyptian food security to the political, economic and climatic effects of countries that monopolize the production and export of local beans in the world. Equation No. (20) of the same table shows that it has taken a statistically significant increasing trend of about 15.5 thousand tons at an annual increase rate of about 6.3% of the general average, and the coefficient of determination (R2) was estimated at about 59% for the same study period.

4. 3. The size of the strategic stockpile.

-In light of the data on the quantity of production, consumption and import of the local bean crop contained in Table No. (2), the size of the surplus and deficit of the study crop allocated for consumption during the period (2004-2023) was estimated, which shows the existence of a surplus of the study crop over local consumption, sourced from imports during the years (2005, 2006, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023), where the total size of the study crop surplus over local consumption was estimated at about 1979.1 thousand tons, sufficient for consumption for approximately 165 days (5.5 months), where this surplus is directed to developing the strategic stock of local beans for withdrawal during the years in which there is a deficit in local beans allocated for local consumption, while it was found that there is a deficit in local beans during the rest of the other years during the period (2004-2023), where the total deficit was estimated at about 1683.4 thousand tons With a deficit period estimated at about 140.3 days (4.7 months), this deficit is covered by withdrawal from the strategic stock and imports from abroad. According to the concept of strategic stock as the sum of both surplus and deficit during the study period, the strategic stock of local beans in Egypt was estimated at about 295.7 thousand tons, sufficient to cover local consumption for about 24.7 days (0.822 months). This indicates the absence of an appropriate strategic stock of local beans in Egypt, which requires the state to work on providing a strategic stock of local beans to achieve the concept of food security.

3.5. Food security factor.

- The data in the same table indicate an estimate of the food security factor for the local bean crop, as a ratio between the total strategic stock size of about 295.7 thousand tons and the average annual local consumption estimated at about 754.6 thousand tons, as the food security factor for local beans reached about 0.392, indicating a low food security factor. Therefore, it is necessary to work on increasing the food security factor for the local bean crop until it reaches about 0.5, by expanding its cultivation, especially in new lands, in addition to focusing on rationalizing consumption, all to create an accumulation in the strategic stock sufficient for local consumption to achieve food security for local beans in Egypt for a period of about 6 months at least, according to food security considerations.

Table No. (2) Development of production, consumption, imports, size of the food gap, self-sufficiency rate, amount of strategic stock, and food security indicators for the local bean crop during the period(2004-2023)

Year	Total local production thousand tons	Total local consumption thousand tons	Import volume thousand tons	Food gap volume thousand tons	%Self-sufficiency ratio	Per capita kg/year	Daily consumption thousand tons	Production sufficiency period for consumption (day)	Import coverage period	Total of the two periods (day)	Amount of change in strategic stock (thousand tons)				Exports thousand tons	Amount of strategic stock thousand tons
											Surplus		Deficit			
											Quantity Thousand Tons	Sufficient period of surplus for local	Quantity Thousand Tons	Deficit sufficiency period for domestic		
2004	345.7	711	237.8	-365.3	48.6	6.9	1.95	177.5	122.1	299.6	---	---	-127.456	-65.43	25	-102.46
2005	291.0	644	371.3	-353.0	45.2	6.9	1.76	164.9	210.4	375.4	18.315	10.38	---	---	15	3.260
2006	252.1	634	417.4	-382.0	39.8	7.1	1.74	145.1	240.3	385.4	35.450	20.41	---	---	22	13.450
2007	304.0	653	301.2	-349.0	46.6	6.1	1.79	169.9	168.4	338.3	---	---	-47.782	-26.71	28	-19.780
2008	251.6	695	169.3	-443.4	36.2	8.7	1.90	132.1	88.9	221.0	---	---	-274.142	-143.97	29	-245.1
2009	299.8	591	197.5	-291.2	50.7	7.8	1.62	185.2	122.0	307.1	---	---	-93.692	-57.86	13	-80.69
2010	237.3	622	180.3	-384.7	38.2	6.7	1.70	139.3	105.8	245.1	---	---	-204.388	-119.94	22	-183
2011	184.6	630	203.7	-445.4	29.3	6.1	1.73	106.9	118.0	225.0	---	---	-241.708	-140.04	21	-220.71
2012	142.4	710	242.7	-567.6	20.1	4.6	1.95	73.2	124.8	198.0	---	---	-324.884	-167.02	14	-310.88
2013	156.0	727	288.4	-571.0	21.5	6.7	1.99	78.3	144.8	223.1	---	---	-282.608	-141.89	15	-267.61
2014	134.0	464	308.6	-330.0	28.9	4.9	1.27	105.4	242.8	348.2	---	---	-21.372	-16.81	12	-9.37
2015	121.8	568	380.9	-446.2	21.4	4.6	1.56	78.2	244.8	323.0	---	---	-65.336	-41.99	13	-52.34
2016	121.4	589	688.2	-467.6	20.6	8.5	1.61	75.2	426.5	501.7	220.610	136.71	---	---	11	209.61
2017	177.9	653	738.4	-475.1	27.2	6.5	1.79	99.4	412.7	512.2	263.315	147.18	---	---	16	247.32
2018	148.0	997	1010.1	-849.0	14.8	8.4	2.73	54.2	369.8	424.0	161.105	58.98	---	---	11	150.11
2019	257.8	800	911.7	-542.2	32.2	7.7	2.19	117.6	416.0	533.6	369.510	168.59	---	---	10	359.51
2020	174.1	954	964.2	-779.9	18.2	8.1	2.61	66.6	368.9	435.5	184.292	70.51	---	---	14	170.29
2021	240.6	1115	1024.2	-874.4	21.6	6.7	3.05	78.8	335.3	414.0	149.824	49.05	---	---	19	130.82
2022	318.6	1151	1104.8	-832.4	27.7	6.2	3.15	101.0	350.3	451.4	272.444	86.40	---	---	26	246.44
2023	372.5	1184	1115.7	-811.5	31.5	7.2	3.24	114.8	343.9	458.8	304.217	93.78	---	---	20	284.22
Total	-----	----	----	----	----	----	---	----	----	----	1979.1	842	-1683.4	-922	356	295.7
Average	226.6	754.6	542.8	-528.0	31.0	6.8	2.07	113.2	247.8	361.0	99.0	42.1	-84.2	-46.1	17.8	
Strategic stock amount = 295.7 thousand tons Food security factor = 0.392																

Source: 1 - Central Agency for Public Mobilization and Statistics - Agricultural Crops Statistics - Various Issues
2 - Central Agency for Public Mobilization and Statistics, Annual Bulletin of Production Movement, Foreign Trade and Available for Consumption of Agricultural Commodities, Various Issues.
3 - International Monetary Fund Website www.imf.org/external/data.htm
4-Food and Agriculture Organization Website www.fao.org.

4. Estimating the supply response function for local beans using the most important variables in the linear form.

-Mark Nerlov's dynamic supply response model for local beans was estimated. This model is one of the most famous statistical models in estimating supply response functions. This model deals with the statistical estimation of the relationship between the area planted with local beans in the current year as a dependent variable, and the most important explanatory variables in their absolute form. The model was applied in its linear form. It was possible to estimate the supply response function for the local bean

crop in Fayoum Governorate, by studying the relationship between the area planted with local beans in the current year as a dependent variable and the area planted with local beans in the previous year and other price and non-price variables that may affect the area planted with local beans such as productivity and the price of local beans on the farm and the net return of beans and the net return of competing crops such as wheat, clover, winter tomatoes, sugar cane, onions and garlic as independent variables with a difference of one year prior during the period.(2004−2023) .

−The statistical estimation model of multiple linear regression was described to study the relationship between the dependent variable and the price and non-price variables, and many attempts were made with the aim of reaching the best models to estimate the factors that determine the cultivated area, and a correlation matrix was created between all the factors included in the study in order to avoid the problem of multicollinearity between the independent variables included in the model and each other, and the stepwise regression method was used along with the simple correlation coefficient matrix to select the most important explanatory factors in the model, while the results of the analysis proved the effect of the current cultivated area of local beans on the net return of competing crops, including wheat, clover, winter tomatoes, sugar beets, onions and garlic.

−The supply response functions were estimated using the modified Nerlov model, which relied on measuring the relationship between the future and past behavior of producers, considering that the area planted with local beans in the current year (yt) is a function of the area planted with beans in the previous year with a one-year lag (1) and with each of:

y_t :Area planted with local beans (thousand acres) for the current year t
y_{t-1}: Area planted with local beans (thousand acres) for the previous year t-1
D_{t-1}: Productivity per acre of local beans (thousand/ton) for the previous year t-1
P_{t-1}: Farm price of local beans (lb/ton) for the previous year t-1
R_{2t-1}: Net yield per acre of local beans (lb/acre) for the previous year t-1
R_{3t-1}: Net yield per acre of sugar beets (lb/acre) for the previous year t-1
R_{4t-1}: Net yield per acre of onions (lb/acre) for the previous year t-1
R_{5t-1}: Net yield per acre of garlic (lb/acre) for the previous year t-1
the most important factors affecting the cultivation of local beans in Egypt. The results shown in Table (3) showed clear statistical significance, as the cultivated area in the current year is affected by several main factors: the cultivated area in the previous year, productivity, farm price, and net return from competing crops. Equation No. (1) confirmed the response of producers to the productivity of the local beans per acre in the previous year. The value of (F) proved the significance of the model as a whole at the probability level (0.01), as its value reached about 42.11. The modified coefficient of determination of about 76% also indicates that a large proportion of the changes in the current area are attributed to the change in the previous year's area, with the presence of other factors outside the model. It was found that increasing the productivity of the acre by 1% leads to an increase in the cultivated area for the current year by about 0.512 thousand acres, assuming that other factors remain constant at a certain level. The elasticity of the response of the bean supply in the short term was about 0.11, and in the long term about 0.08, while the annual response coefficient was about 0.22, while the period required to achieve the full response of producers was about 6.82 years starting from the year following planting.

−Equation No. (2) of the same table indicates the producers' response to the farm price of local beans in the previous year, as the results showed and the value of (F) showed statistical significance for the model as a whole at the probability level (0.01) as its value reached about 44.92, and the adjusted coefficient of determination of about 82% indicates that a large percentage of the changes in the currently cultivated area are due to the change in the area in the previous year, while the rest of the changes are attributed to other factors outside the model, and the results showed that increasing the farm price by 1% leads to an increase in the cultivated area of local beans in the current year by 7,612 thousand acres, which is consistent with economic logic. The elasticity of supply response in the short run was measured at about 13.67, as it was shown that increasing the farm price for the previous year by 1% leads to increasing the area planted with local beans in the current year by 13.67%, and in the long run it amounted to about 0.08, while the annual response coefficient amounted to about 0.18, while the period required to achieve the full response of producers amounted to about 6.51 years starting from the year following production.

−The data in the table for equation No. (3) indicate the producers' response to the net productivity per acre of local beans in the previous year, and the value of (F) indicates the significance of the model as a whole at the probability level (0.01), where its value reached about 47.36, as the coefficient of

determination explains about 86% of the changes that occur in the area of local beans due to this variable, while the rest of the changes are attributed to other factors that the model did not realize. The significance of the increase in the net yield per acre of local beans for the previous year by one pound was proven, which results in an increase in the area planted with local beans in the current year by about 3455 thousand acres, and this is consistent with economic logic. The elasticity of response of local bean supply in the short term was about 5.91, and the analysis results indicate that increasing the net return of local beans in the previous year by 1% leads to increasing the area planted with beans in the current year by 5.91%, and in the long term by about 0.64, while the annual response coefficient was about 0.14, while the period required to achieve full response between producers is about 7.82 years starting from the year following planting.

-It is clear from the data of the same table for equation No. (4) for the most important competing crops that are believed to affect the area of local beans in the current year, as the results of the data show the extent of the response of the area planted with local beans with a direct relationship between the area planted with local beans in thousand acres in the current year (t) (as a dependent variable) and the net productivity per acre of local beans in pounds in the previous year (R_{1t-1}) (t-1). This means that the area planted with beans changes in a direct direction to the area of beans in the previous year. The same model also shows an inverse relationship between the area planted with local beans for the current year and the net productivity per acre of sugar beets in pounds in the previous year (R_{2t-1}) (t-1), and the net yield per acre of garlic (R_{4t-1}) (t-1). This means that the area planted with local beans changes in the opposite direction to the net return per acre of sugar beets, the net return per acre of winter onions, and the net return per acre of garlic, which is consistent with economic logic, i.e. increasing the net return per acre of sugar beets, the net return per acre of winter onions, and the net return per acre of garlic by one pound leads to a decrease in the area currently planted with local beans by about 8,354, 5,561, and 0.425 thousand acres, respectively. The value of (F) indicates the importance of the model as a whole at the probability level (0.01), as its value reached about 22.47, and the adjusted coefficient of determination indicates that about 80% of the changes that occur in the area of local beans are due to these variables present in the response model.

-To promote the cultivation of local beans in Fayoum Governorate, it is necessary to implement a set of integrated measures, the most important of which is activating the role of agricultural guidance to guide producers to the optimal dates for planting and harvesting, which helps in preventing diseases and pests, especially the tooth insect and brown spot. It is also necessary to focus on organizing the irrigation process on a regular basis to avoid problems of water shortage or over-irrigation. Expanding the cultivation of local beans in reclaimed lands in the governorate is an important strategic option, given its role in improving soil fertility for subsequent crops. It is also necessary to work on integrating and developing small holdings to improve their production efficiency and benefit from the advantages of large-scale production. Focus should be placed on horizontal expansion of cultivated areas, especially in the Youssef El-Siddiq area, to increase the area cultivated with local beans as a strategic crop.

Table No. (3) Statistical estimation of the supply response function for local beans for the current and future situation in Fayoum using the Nerlov model during the period (2004-2023).

Equation number	Equation	R^2	F	Flexibility of response		Annual response rate	Full response period	D.W
				short term	Long term			
1	$y_t^{\wedge} = -394 + 0.873\, y_{lt-1} + 0.512 D_t$ **(7.85) (0.54)	0.76	**42.11	0.11	0.08	0.22	6.82	2.91
2	$y_t^{\wedge} = -295 + 0.884\, y_{lt-1} + 7.612_{t-1}$ ** (5.26) ** (6.52)	0.82	**44.92	13.67	2.39	0.18	6.51	2.88
3	$y_t^{\wedge} = -247 + 0.891\, y_{lt-1} + 3.455_{t-1}$ ** (5.73) ** (3.14)	0.86	**47.36	5.91	0.64	0.14	7.82	2.84
4	$y_t^{\wedge} = -1.524 + 0.627\, y_{lt-1} + 7.912_{2ylt-1} - 8.354R_{3lt-1}$ ** (3.24) (0.854) (-0.47) $- 5.561R_{4lt-1} - 0.425R_{5lt-1}$ (-0.721) (-0.254)	0.80	**22.47	9.48	3.24	0.48	7.85	2.79

Where::yt The cultivated area of the local beans (thousand acres) for the current year t,
yt-1: The cultivated area of the local beans (thousand acres) for the previous year t-1,
Dt-1: The productivity per acre of the local beans (thousand/ton) for the previous year t-1,

Pt-1: The farm price of the local beans (pound/ton) for the previous year t-1,
R2t-1: The net yield per acre of the local beans (pound/acre) for the previous year t-1,
R3t-1: The net yield per acre of sugar beets (pound/acre) for the previous year t-1,
R4t-1: The net yield per acre of onions (pound/acre) for the previous year t-1,
R5t-1: The net yield per acre of garlic (pound/acre) for the previous year t-1 **Significant at 0.01 level, *Significant at 0.05 level
Source: Collected and calculated from data from the Fayoum Agriculture Directorate, Information and Decision Making Center - unpublished data 2023.

5. Summer study sample:

The research used the multi-stage stratified random sample method and the questionnaire form was collected during the agricultural season (2023-2024). Table No. (4) shows that Fayoum Governorate includes six administrative centers: Abshway, Fayoum, Tamia, Atsa, Senuris, and Youssef El-Siddiq. The cultivated area of the local bean crop for these centers, according to relative importance, amounted to about 30.5%, 25.5%, 16.7%, 11%, 8.6%, and 7.7%, respectively, of the total cultivated area of the study sample crop in Fayoum Governorate. The same table also shows the number of holders and the cultivated area, so the two largest centers were chosen according to the relative importance of the area, as the centers of Abshway and Fayoum represent about 30.5% and 25.5% of the total cultivated area in the governorate. The same table also shows the selection of the two largest villages from each center according to the relative importance of the cultivated area, which are the villages of Sanhour al-Qibliya and Abu Kahsa from the Abshway Center, which represent about 34.1% and 24.7% of the total cultivated area in the Abshway Center, and the villages of Disia and Manshiyat al-Khatib from the Fayoum Center, which represent about 21.9% and 16.7% of the total cultivated area in the Fayoum Center. The same table also shows the distribution of sample items among the selected centers, which amounted to about 52 and 38 items for the centers of Abshway and Fayoum, respectively. The distribution of sample types for the selected villages was approximately 24, 28, 23, and 15 items, respectively, and the number of sample types was 90 products

Table No. (4) The relative importance of describing the study sample for the cultivated area and the number of holders of local beans 2023

Centers	cultivated area -	%	Number of	Geometric	Average	Centers	Villages	Number of	%	Area (acres)	%	Geometric	Average	Sample size
Abshway	1006	30.48	385	30.45	30.50	**Abshway**	**Snur Al-Qabliyyah**	142	34.1	450	35.6	34.83	34.84	24
Fayoum	842	25.52	276	23.59	23.62		**Abuksah**	103	24.7	325	25.7	25.21	25.22	28
Tamia	551	16.70	205	16.44	16.47	**Total of the two villages**		245	58.5	775	61.3	61.36	60.04	52
Atsa	364	11.03	164	11.95	11.97	**Fayoum**	**Dessia**	108	25.9	277	21.9	23.83	23.84	23
Senuris	282	8.55	127	9.26	9.27		**Menashe Al Khatib**	64	15.4	211	16.7	16.01	16.02	15
Youssef El-Siddiq	255	7.73	109	8.16	8.17	**Total of the two villages**		172	41.3	488	38.7	38.64	39.92	38
Total	3300	100	1266	99.84	100	**Total study villages**		417	100	1263	100	100	99.96	90

Source: Compiled and calculated from data from Fayoum Agriculture Directorate - Information and Decision Support Center - Unpublished data 2023

6. Describe the production variables, costs and economic indicators of the local bean crop in the study sample.

- Table No. (5) shows a description of the production variables, costs and economic indicators of the local bean crop in the study sample, as it was shown that the number of sample observations for the Abshway Center amounted to about 52 observations, while the average area observed was about 1 acre. The same table data indicates that the average productivity per acre was about 1,490 tons per acre, and the average official water share was about 2,225 cubic meters per acre, while the average amount of irrigation water actually used per acre was about 2,485 cubic meters per acre, and the average amount of irrigation water loss was about 260 cubic meters per acre, and the percentage of deviation from the water share was about 11.7%, while the productivity of the water unit was about 1.67 cubic meters per acre, and the cost of the water unit was about 0.80 pounds per m^3 per acre, and the total revenues from the irrigation water unit were about 19.2 pounds per m^3 per acre, while the efficiency rate of irrigation water use was about 89.54% m^3 per acre, and the cost of irrigation as a percentage of total costs was about 80.5% Egyptian

pounds. - Per acre. It is clear that the average cost of the amount of irrigation water actually used, m^3 per acre, amounted to about 2000 pounds/acre.
While the average number of mechanical work hours was about 7.5 hours/acre, at a cost of about 1,250 pounds/acre, it is also clear that the average quantity of organic fertilizer was about 10 m3/acre, at a cost of about 1,150 pounds/acre, and the average quantity of seeds was about 35 kg/acre, at a cost of about 1,400 pounds/acre, and the average quantity of phosphate fertilizer was about 58 units/acre, at a cost of about 1200 pounds/acre. The average amount of nitrogen fertilizer was about 105 units/acre at a cost of about 1450 EGP/acre, while the average amount of potassium fertilizer was about 32.6 units/acre at a cost of about 1650 EGP/acre, the average human labor was about 30 men/acre at a cost of about 4850 EGP/acre, while the average value of pesticides was about 650 EGP/acre, the average rent was about 5300 EGP/acre, while the average expenses were about 480 EGP/acre, and the average total costs were about 32100 EGP/acre. It was found that the average farm price was about 21380 EGP/ton, while the average total revenue was about 47829 EGP/acre, the average net return was about 26449 EGP/acre, and the average return-to-cost ratio was about 2.237, while the average profitability was The invested pound is about 1.237, and the average net monthly return is about 4408 pounds/acre, and it turns out that the average producer incentive rate is about 55.30%, and it is clear that the average economic efficiency rate is about 223.71%.

−The same table shows the description of the production variables, costs and economic indicators of the local bean crop in the study sample, as it was shown that the number of sample observations for Fayoum Center amounted to about 38 observations, while the average area observed was about 1 acre. The data of the same table indicate that the average productivity per acre amounted to about 1,410 tons per acre, and the average official water quota amounted to about 2,225 m^3 per acre, while the average amount of irrigation water actually used per acre amounted to about 2,675 m^3 per acre, and the average amount of waste in irrigation water amounted to about 450- m^3 per acre, and the percentage of deviation from the water quota amounted to about 20.2%, while the productivity of the water unit amounted to about 1.90 m^3 per acre, and the cost of the water unit amounted to about 0.82 pounds m^3 per acre, and the total revenue from the irrigation water unit amounted to about 16.5 pounds m^3 per acre, while the percentage of irrigation water use efficiency amounted to about 83.2% m^3 per acre, and the irrigation cost as a percentage of total costs amounted to about 82.2% pounds per acre. It is clear that the average cost of the amount of irrigation water actually used m^3 per acre amounted to about 2200 pounds/acre.
While the average number of mechanical working hours was about 8 hours/acre at a cost of about 1350 pounds/acre, it is also clear that the average amount of organic fertilizer was about 11 m3/acre at a cost of about 1250 pounds/acre, and the average amount of seeds was about 35 kg/acre at a cost of about 1450 pounds/acre, and the average amount of phosphate fertilizer was about 60 units/acre at a cost of about 1300 pounds/acre, and the average amount of nitrogen fertilizer was about 115 units/acre at a cost of about 1550 pounds/acre, while the average amount of potassium fertilizer was about 41 units/acre at a cost of about 1750 pounds/acre, and the average amount of human labor was about 32 men/acre at a cost of about 5250 pounds/acre, while the average value of pesticides was About 730 pounds/acre, and the average rent was about 5000 pounds/acre, while the average expenses were about 560 pounds/acre, and the average total costs were about 31350 pounds/acre, and it was found that the average farm price was about 22390 pounds/ton, while the average total revenue was about 44204 pounds/acre, and the average net return was about 21814 pounds/acre, and the average rate of return to costs was about 1.974, while the average profitability of the invested pound was about 0.974, and the average net monthly return was about 3636 pounds/acre, and it was found that the average rate of producer incentive was about 49.35%, and it is clear that the average rate of economic efficiency was about 197.43%.
- The same table indicates the description of the production variables, costs and economic indicators of the local bean crop in the study sample, as it was shown that the number of sample observations for the total sample amounted to about 90 observations, while the average area observed was about 1 acre. The data of the same table indicate that the average productivity per acre amounted to about 1,440 tons per acre, and the average official water quota amounted to about 2,225 m^3 per acre, while the average amount of irrigation water actually used per acre amounted to about 2,515 m^3 per acre, and the average amount of waste in irrigation water amounted to about 290- m^3 per acre, and the percentage of deviation from the water quota amounted to about 13%, while the productivity of the water unit amounted to about 1.75 m3 per acre, and the cost of the water unit amounted to about 0.83 pounds per m^3 per acre, and the total revenue from the irrigation water unit amounted to about 18.2 pounds per m^3 per acre, while the percentage of irrigation water use efficiency amounted to about 88.5% per m^3 per acre. The cost of irrigation as a percentage of total costs amounted to about 83.5% of the acre. It is clear that the

average cost of the amount of irrigation water actually used (m^3) per acre amounted to about 2100 pounds/acre.

while the average number of mechanical working hours amounted to about 8 hours/acre at a cost of about 1300 pounds/acre. It is also clear that the average amount of local fertilizer amounted to about 11 m3/acre at a cost of about 1200 pounds/acre. The average amount of seeds amounted to about 35 kg/acre at a cost of about 1430 pounds/acre. The average amount of phosphate fertilizer amounted to about 60 units/acre at a cost of about 1250 pounds/acre. The average amount of nitrogen fertilizer amounted to about 115 units/acre at a cost of about 1500 pounds/acre, while the average amount of potassium fertilizer amounted to about 41 units/acre at a cost of about 1700 EGP/acre, while the average human labor was about 32 men/acre at a cost of about 5150 EGP/acre, while the average value of pesticides was about 690 EGP/acre, and the average rent was about 5150 EGP/acre, while the average expenses were about 510 EGP/acre, while the average total costs were about 31725 EGP/acre, and it was found that the average farm price was about 21980 EGP/ton, while the average total revenue was about 45684 EGP/acre, and the average net return was about 23704 EGP/acre, and the average rate of return to costs was about 2.078, while the average profitability of the invested pound was about 1.078, and the average net monthly return was about 3951 EGP/acre, and it was found that the average producer incentive rate was About 51.89%, and it is clear that the average economic efficiency rate reached about 207.84%.

Table No. (5) Description of production variables, costs and economic indicators for the local bean crop in the study sample in Fayoum for the agricultural season.(2023-2024)

Variables	Abshway Center		Fayoum Center		Total Sample	
	Quantity	Value	Quantity	Value	Quantity	Value
First: Water quota indicators						
1) Number of observations in the sample	52		38		90	
2) Average cultivated area (acres)	1		1		1	
3) Average productivity (sesame kg, peanuts tons/acre)	1490		1410		1440	
4) Average official water quota (m3) per acre	2225		2225		2225	
(5) Average amount of irrigation water actually used in irrigation (m3) per acre	2485		2675		2515	
(6) Deviation from water quota = (4 – 5) (m3) per acre	-260		-450		-290	
(7) Percentage of deviation from water quota % = (6/4*100)	-11.7		-20.2		-13.0	
(8) Water unit productivity per acre = (3/5) (m3) per acre	1.67		1.90		1.75	
(9) Cost of water unit m3 per acre = (13/5) pounds (m3) per acre	0.80		0.82		0.83	
(10) Revenue from irrigation water unit = (25/5) pounds (m3) per acre	19.2		16.5		18.2	
(11) Efficiency rate of irrigation water use per acre % = (4/5*100) (12) Irrigation cost as a percentage of total costs per acre = (13/24*100) pounds per acre	89.54		83.2		88.5	
(12)Irrigation cost as a percentage of total costs per acre = (13/24*100) pounds per acre	80.5		82.2		83.5	
(13)Total irrigation cost actually used (m3) per acre	2000		2200		2100	
Second: Productive and economic indicators						
(14) Average mechanical labor hour/acre for the season	7.5	1250	8	1350	8	1300
(15) Average amount of organic fertilizer m3 per acre	10	1150	11	1250	11	1200
(16) Average amount of seeds kg per acre	35	1400	35	1450	35	1430
(17) Average phosphate fertilizer unit per acre	58	1200	60	1300	60	1250
(18) Average nitrogen fertilizer unit per acre	105	1450	115	1550	115	1500
(19) Average potassium fertilizer unit per acre	32.6	1650	41	1750	41	1700
(20) Average human labor per acre (man/season)	30	4850	32	5250	32	5150
(21) Average value of pesticides EGP per acre	650		730		690	
(22) Average rent EGP per acre	5300		5000		5150	
(23) Average expenses EGP per acre	480		560		510	
(24) Average total costs EGP per acre	32100		31350		31725	
(25) Farm price EGP per ton	21380		22390		21980	
(26) Average total revenue EGP per acre	47829		44204		45684	
(27) Average net return EGP per acre	26449		21814		23704	
(28) Average rate of return to costs	2.237		1.974		2.078	
(29) Average profitability EGP Investor	1.237		0.974		1.078	
(30) Average Net Monthly Return	4408		3636		3951	

(31) Average Product Incentive Rate %	55.30	49.35	51.89
(32) Average Economic Efficiency Rate %	223.71	197.43	207.84

Source: Study sample data in Fayoum Governorate for the 2023 season....*Average official water classification (m3) (2225 m3) for the local bean crop.

7. Statistical estimation of production functions for the local bean crop in the study sample in Fayoum.

7.1. Statistical estimation of production functions for the local bean crop in the study sample.

This part of the study includes the results of the statistical estimation of production functions for the local bean crop in the study sample, by studying the relationship between (y) the amount of local bean production in the study sample as a dependent variable, and the most important independent factors affecting the dependent variable, represented by (x_1) the number of mechanical work hours/acre, (x_2) the amount of local fertilizer m3/acre, (x_3) the amount of seeds kg/acre, (x_4) the amount of irrigation water per meter. Cube/acre, (X_5) phosphate fertilizer unit/acre, (X_6) nitrogen fertilizer unit/acre, (X_7) potassium unit/acre, (X8) amount of nutrients per liter in the sample, (X_9) value of pesticides in pounds/acre in the sample, (X_{10}) human labor man/day/acre, and stepwise regression was used, which indicates the superiority of the double logarithm image in determining the most important factors affecting production in the study sample.

7.2. Statistical estimation of the local bean production function for Abshway Center in the study sample.

-The study indicates the stability of the statistical significance of the model as the value of (F) reached about 96.6 at the probability level of 0.01. The coefficient of determination (R2) shows that about 81% of the changes in the model occurred. The estimated function showed a positive and statistically significant effect for each of the number of mechanical working hours (X_1), the amount of organic fertilizer m3/acre (X_2), the amount of seeds kg/acre (X_3), the amount of irrigation water in cubic meters/acre (X_4), and the amount of potassium fertilizer unit/acre (X_8). That is, increasing the units used from the independent factors by 1% leads to an increase in the production of local beans by percentages of about 0.611%, 0.557%, 0.528%, 0.594%, and 0.615%, respectively, with the remaining factors constant. The total elasticity reached about 2.905, which indicates an increase in the return on production energy, as increasing the aforementioned production elements by 1% leads to an increase in the production of local beans by 2.905%.

$$LogYi=-2.345+ 0.611Logx_1+0.557Logx_2+0.528LogX_3+0.594Logx_4+0.615LogX_8 \text{.....(1)}$$

** (5.97) **(4.84) **(4.51) **(4.89) **(5.11)

$R^2 = 0.81$ F = 96.6**

7.3. Statistical estimation of the local bean production function for Fayoum Center in the study sample.

−The study of the local bean production function indicates the stability of the statistical significance of the model, as the value of (F) reached about 71.2 at the probability level of 0.01. The coefficient of determination (R^2) shows that about 65% of the changes in the model occurred. The estimated function showed a positive and statistically significant effect for each of the number of automated working hours (X_1), the amount of organic fertilizer m3/acre (X_2), and the amount of seeds kg/acre (X_3). That is, by increasing the units used from the independent factors by 1%, this leads to an increase in the local bean production by percentages of about 0.584%, 0.438%, and 0.385%, respectively, with the remaining factors constant. The total elasticity reached about 1.407, which indicates an increase in the return on energy, as increasing the aforementioned production elements by 1% leads to an increase in the local bean production by 1.407%.

$$LogYi=-1.935+0.584Logx_1+0.438Log\ x_2+0.385Log\ X_3 \text{.....(2)}$$

** (4.68)**(3.11) **(2.87)

$R^2 = 0.65$ F = 71.2**

7.4. Statistical estimation of the local bean production function for the total study sample.

-The study of the local bean production function indicates the stability of the statistical significance of the model, as the value of (F) reached about 86.2 at the probability level of 0.01. The coefficient of determination (R2) also shows that about 77% of the changes in the model occurred. The estimated function also showed a positive and statistically significant effect for each of the number of automated working hours (X_1), the amount of organic fertilizer m^3/acre (X_2), and the amount of irrigation water per m3/acre (X_5), meaning that increasing the units used from the independent factors by 1% leads to an

increase in the local bean production by about 0.601%, 0.517%, and 0.385%, respectively, with the remaining factors constant. The total elasticity also reached about 1.503, which indicates an increase in the return on energy, as increasing the aforementioned production elements by 1% leads to an increase in the local bean production by 1.503%.

$$LogYi=-2.164+0.601Logx_1+0.517Log\ x_2+0.385Log\ X_5 \ldots\ldots\ldots\ldots\ldots(3)$$

** **(5.45)(4.57) **(2.87)**

$R^2 = 0.77$ F = 86.2**

8.Indicators of productive and economic efficiency of the production elements of local beans in the study sample.

-A comprehensive analysis of the relationship between marginal product value and input prices for local bean production in Abshway Center reveals complex insights into production and economic efficiency. The study, as shown in Table (5), reveals subtle differences in marginal product across different inputs. The marginal product values of machine hours, local fertilizers, seeds, irrigation water, and potassium fertilizers were calculated to be approximately 0.158, 0.108, 0.025, 0.369, and 0.028, respectively. Thus, the marginal product value of these inputs was EGP 3294, EGP 2310, EGP 480, EGP 7884, and EGP 600, compared to their input prices of EGP 1250, EGP 1150, EGP 1400, EGP 2100, and EGP 1650.

The economic efficiency analysis reveals a complex landscape for improving agriculture. Elements such as irrigation water, local fertilizers, and machine hours showed economic efficiency values greater than one (2.7, 2, and 3.8, respectively), indicating a significant potential for profit maximization through increased resource allocation. These positive values suggest that producers can enhance farm profitability by gradually increasing the amount of these resources. Conversely, the economic efficiency of seeds and potash fertilizers falls below optimal levels, indicating suboptimal resource utilization and highlighting the need for more strategic management of these production inputs. This rigorous assessment provides critical insights into agricultural production dynamics, providing farmers with a sophisticated framework for resource allocation, cost management, and potential productivity improvements in local bean cultivation within the Abshway Center area.

- A comprehensive analysis of the modern table provides complex insights into the marginal product dynamics of faba bean in Fayoum Center, revealing subtle patterns of factor efficiency. The marginal product values of mechanical labor hours, local fertilizers, and seeds were calculated to be around 0.103, 0.059, and 0.0156, respectively, providing a sophisticated perspective on resource utilization. Similarly, the marginal product values of these factors were 2,293, 1,321, and 347.3 pounds, compared to their factor prices of 1,350, 1,250, and 1,450 pounds.

The economic efficiency analysis reveals a complex landscape of agricultural resource optimization. Mechanical labor hours and local fertilizers showed economic efficiency values of 1.7 and 1.1, respectively—both positive and above the optimal. These values indicate that the marginal product value of these factors significantly exceeds their prices, providing producers with a strategic opportunity to enhance farm profitability by gradually increasing resource allocation. Conversely, the economic efficiency of seed quantity is below the optimal level, indicating suboptimal resource utilization and highlighting the urgent need for more strategic management of seed inputs. This sophisticated assessment provides producers with a precise framework for understanding resource allocation, cost management and potential productivity improvements in local faba bean cultivation within the Fayoum Center area, emphasizing the delicate balance between input resources and agricultural production.

- A comprehensive marginal analysis of local bean production across the total sample reveals an evolving landscape of resource utilization and economic efficiency. The marginal product values of mechanical labor hours, local fertilizers, and irrigation water were calculated to be around 0.109, 0.068, and 0.222, respectively, providing insights into the dynamics of the inputs. Similarly, the marginal product values of these inputs were 2,396, 1,479, and 4,874 pounds, compared to their input prices of 1,300, 1,200, and 2,100 pounds.

The economic efficiency analysis reveals a complex framework for improving agriculture. Mechanical labor hours, local fertilizers, and irrigation water showed economic efficiency values of 1.9, 1.2, and 2.3, respectively—all positive and well above the optimum of one. These values indicate that the marginal product value of these inputs significantly exceeds their prices, providing farmers with a strategic opportunity to enhance farm profitability by allocating resources incrementally.

The analysis suggests that producers can maximize the profits of faba bean farmers by strategically increasing the amount of mechanical labor hours, local fertilizers, and irrigation water. This sophisticated assessment provides a robust framework for understanding the complex relationships between production inputs and agricultural output, providing farmers with critical insights to optimize resources and improve potential productivity in faba bean cultivation.

Table No. (6) Indicators of productive and economic efficiency of production elements for local beans in the study sample in Fayoum

Center	Variable	Production efficiency			Economic efficiency	
		Production elasticity	Marginal product	Value of marginal product	Unit price of the item	Economic return
Abshway	Number of automated working hours	0.611	0.158	3294	1250	2.7
	Quantity of organic fertilizer	0.557	0.108	2310	1150	2
	Quantity of seeds	0.528	0.025	480	1400	0.44
	Quantity of irrigation water	0.594	0.369	7884	2100	3.8
	Quantity of potassium fertilizer	0.615	0.028	600	1650	0.38
Fayoum	Number of automated working hours	0.581	0.103	2293	1350	1.7
	Quantity of organic fertilizer	0.438	0.059	1321	1250	1.1
	Quantity of seeds	0.385	0.0156	347.3	1450	0.33
Total sample	Number of automated working hours	0.601	0.109	2396	1300	1.9
	Quantity of organic fertilizer	0.514	0.068	1479	1200	1.2
	Quantity of irrigation water	0.385	0.222	4874	2100	2.3

Source: Collected and calculated from the questionnaire form for local beans for the agricultural season 2023/2024.

9.The most important production problems facing producers of local beans in the study sample in Fayoum Governorate for the agricultural season 2023/2024:

Table No. (7) shows the most important production problems facing local bean producers, using a questionnaire form. The study relied on the assumption that half of the producers acknowledge the existence of problems while the other half deny them, and using the chi-square (χ^2) to choose the extent of agreement between the results collected from the study sample producers and the expected results obtained for the study sample.

- The problems were arranged according to their importance, where the problem of low productivity of local beans came in first place in terms of its impact on the sample producers, while the problem of the spread of the corona parasite in local beans came in second place, and it was found that the problem of high wages of human labor came in third place, and it was found that the problem of high prices of chemical fertilizers came in fourth place, and the same table indicates that high seed prices came in fifth place, and the problem of high prices of pesticides and their ineffectiveness came in sixth place, and the problem of shortage of production requirements came in seventh place, and the problem of the unavailability of recommended varieties came in eighth place, and the problem of high costs of mechanical labor came in ninth place, and the problem of infection with fungal and insect diseases came in tenth place, and the problem of the spread of dwarf crops came in eleventh place, and the problem of the weak role of agricultural guidance came in twelfth and last place.

Table No. (7) shows the relative importance ranking of the most important production problems facing local bean producers and the calculated (Ka) value for each problem in the study sample.

The most important production problems		There is		There is no		Calculated value of K^2
		Repetition	%	Repetition	%	
1	Low productivity	66	95	5	5	**58.55
2	Spread of the halok parasite	60	88	12	16	**35.93
3	High wages of human labor	60	85	16	13	**39.75
4	High prices of chemical fertilizers	56	76	22	30	*37.54
5	High prices of seeds	48	70	30	35	**13.24
6	High prices of pesticides and their neffectiveness	44	60	45	62	**11.67
7	Lack of production requirements	32	40	56	80	**19.65
8	Lack of recommended varieties	17	22	50	73	**24.91
9	High costs of mechanized labor	18	24	55	78	**16.25
10	Infection with fungal and insect diseases	15	21	54	75	*25.58

11	Spread of dwarf crops	17	23	54	75	**22.32
12	Weak role of agricultural extension	12	18	60	83	**24..26

source: Collected and calculated from the questionnaire questionnaire of the study sample in Fayoum for the agricultural season 2023/2024.

Recommendations:

1- Expand the area planted with local beans through horizontal expansion of new reclaimed lands with increasing the productivity of the acre by developing high-yielding varieties.

2- Use modern technology and diverse agricultural methods.

3- Work to increase the role of agricultural guidance to guide producers on how to load local beans on some winter crops to increase the productivity of the acre by using appropriate resistance and not overusing pesticides and fertilizers in growing local beans, which leads to not harming production, which leads to increasing productivity.

4- Work to follow contract farming systems to encourage producers and provide high-yielding seeds to producers and ensure an appropriate and fair price, which achieves a high profit margin, which encourages producers to increase the area planted with local beans.

5- Provide production requirements and the necessary quantities of them at fair prices, which leads to reducing production costs.

6- Work to regulate the import of local beans at planting and harvesting dates to enable producers to sell the crop at appropriate prices, which leads to increasing the areas planted with it.

7- Rationalizing consumption and reducing the loss of local beans through proper storage, which reduces loss and increases total production.

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APPENDIX

Table No. (1) Development of production and economic indicators of the local bean crop in Egypt and Fayoum during the period(2004-2023)

Egypt											
Year	Total area (thousand/ acre)(1)	Feed productivit y	Total production (thousand/	Total costs (thousand pounds)	Farm price (thousand pounds)	Total revenue (thousand pounds)	Net return (thousand pounds) (7	Rate of return to costs (8	Profitabilit y per pound for	Producer incentive rate (10)	Economic efficiency rate (11) (6/4)*100
2204	240.1	1.44	345.7	1770	2106	3032.64	1262.64	1.713	0.713	41.635	171
2005	200.7	1.45	291.0	1800	2140	3103	1303	1.724	0.724	41.992	172
2006	177.5	1.42	252.1	2018	2245	3187.9	1169.9	1.580	0.580	36.698	158
2007	212.6	1.43	304.0	2295	2280	3260.4	965.4	1.421	0.421	29.610	142
2008	172.3	1.46	251.6	3300	3755	5482.3	2182.3	1.661	0.661	39.806	166
2009	208.2	1.44	299.8	3530	3710	5342.4	1812.4	1.513	0.513	33.925	151
2010	185.4	1.28	237.3	3580	3725	4768	1188	1.332	0.332	24.916	133
2011	132.8	1.39	184.6	4105	3850	5351.5	1246.5	1.304	0.304	23.293	130
2012	98.9	1.44	142.4	4510	4640	6681.6	2171.6	1.482	0.482	32.501	148
2013	105.4	1.48	156.0	4750	4722	6988.56	2238.56	1.471	0.471	32.032	147
2014	91.8	1.46	134.0	4855	4791	6994.86	2139.86	1.441	0.441	30.592	144
2015	83.4	1.46	121.8	5191	5210	7606.6	2415.6	1.465	0.465	31.757	147

2016	85.5	1.42	121.4	6788	5880	8349.6	1561.6	1.230	0.230	18.703	123
2017	122.7	1.45	177.9	8362	8312	12052.4	3690.4	1.441	0.441	30.620	144
2018	103.5	1.43	148.0	9480	11550	16516.5	7036.5	1.742	0.742	42.603	174
2019	177.8	1.45	257.8	10445	12135	17595.7	7150.75	1.685	0.685	40.639	168
2020	122.6	1.42	174.1	10710	12100	17182	6472	1.604	0.604	37.667	160
2021	167.1	1.44	240.6	12450	12935	18626.4	6176.4	1.496	0.496	33.159	150
2022	215.3	1.48	318.6	13921	16524	24455.5	10534.5	1.757	0.757	43.076	176
2023	246.7	1.51	372.5	14655	20150	30426.5	15771.5	2.076	1.076	51.835	208
Average	246.7	1.51	372.5	14655	20150	30426.5	15771.5	2.076	1.067	51.835	208
Highest	83.4	1.28	121.4	1700	2106	3032.64	965.4	1.230	0.230	18.703	123
Lowest	157.52	1.44	226.57	6425.75	7138.00	10350.2	3924.47	1.56	0.56	34.85	155.69
Fayoum											
2204	4.1	1.38	5.658	1690	2100	2898	1208.00	1.715	0.715	41.7	171
2005	3.6	1.41	5.076	1788	2135	3010.35	1222.35	1.684	0.684	40.6	168
2006	2.9	1.43	4.147	2000	2240	3203.2	1203.20	1.602	0.602	37.6	160
2007	3.3	1.46	4.818	2280	2275	3321.5	1041.50	1.457	0.457	31.4	146
2008	2.8	1.44	4.032	3290	3750	5400	2110.00	1.641	0.641	39.1	164
2009	2.9	1.39	4.031	3520	3700	5143	1623.00	1.461	0.461	31.6	146
2010	2.7	1.31	3.537	3580	3720	4873.2	1293.20	1.361	0.361	26.5	136
2011	2.5	1.42	3.550	4105	3845	5459.9	1354.90	1.330	0.330	24.8	133
2012	3.1	1.43	4.433	4500	4636	6629.48	2129.48	1.473	0.473	32.1	147
2013	2.2	1.46	3.212	4720	4720	6891.2	2171.20	1.460	0.460	31.5	146
2014	2.7	1.37	3.699	4850	4788	6559.56	1709.56	1.352	0.352	26.1	135
2015	1.9	1.38	2.622	5190	5205	7182.9	1992.90	1.384	0.384	27.7	138
2016	2.4	1.41	3.384	6780	5874	8282.34	1502.34	1.222	0.222	18.1	122
2017	2.1	1.42	2.982	8650	8310	11800.2	3150.20	1.364	0.364	26.7	136
2018	1.8	1.38	2.484	9480	11544	15930.7	6450.72	1.680	0.680	40.5	168
2019	1.9	1.42	2.698	10400	12125	17217.5	6817.50	1.656	0.656	39.6	166
2020	2.4	1.43	3.432	10700	12100	17303	6603.00	1.617	0.617	38.2	162
2021	2.9	1.39	4.031	12400	12930	17972.7	5572.70	1.449	0.449	31.0	145
2022	2.7	1.44	3.888	13910	16510	23774.4	9864.40	1.709	0.709	41.5	171
2023	3.3	1.48	4.818	14620	20120	29375.2	14755.2	2.009	1.009	50.2	201
Average	3.3	1.48	5.658	14620	20120	29375.2	14755.2	2.009	1.009	50.2	201
Highest	1.8	1.38	2.484	1690	2100	2898	1041.50	1.222	0.222	18.1	122
Lowest	2.71	1.41	3.83	6422.65	7131.35	10111.4	3688.77	1.531	0.531	33.82	153.134

Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration for Agricultural Economics, Agricultural Economics Bulletins, various issues.