

# **An Economic Study Of Agricultural Labor Technology In Apiary Production In Egypt “A Case Study In Gharbia Governorate”**

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## **Abstract**

Bee products value was estimated at about 0.222 million pounds, for the average period (2018-2022), the research problem is the decrease in the number of hives from about 935 thousand beehives in 2018 to about 785 thousand beehives in 2022, with a decrease rate estimated at about 16.4 thousand beehives, the research aims mainly to study the role of human labor and mechanization in the production of honey bees on the research sample, which was conducted in Gharbia Governorate for the 2022/2023 season according to the random sampling method, the value of the sample was determined to be about 72 holders, and it was found that the total costs of producing a beehive in the third category decreased by about 2150 pounds/beehive and was estimated at about 2433 and 2229 pounds/beehive for both the first and second category, respectively, and found that the ratio of returns to costs for a human and mechanical labor reached a maximum in the third category at approximately 1.43 and 1.42, respectively.

**Keywords:** agricultural labor technology, honey production apiaries, economic efficiency, associated costs, deap program.

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## **I. Introduction**

The Egyptian agricultural sector is considered one of the most important sectors of the national economy, with an agricultural income amounting to about 361.53 million pounds, and an agricultural production value amounting to about 568.41 million pounds for the average period (2018-2022). The animal and insect production sector is considered one of the most important sectors of Egyptian agriculture, as the value of its production amounted to about 204.55 million pounds. One million pounds represents about 36% of the total value of agricultural production for the average of the same period. Bee products and their derivatives represent great importance in Egyptian agricultural production, as the value of their production was estimated at about 0.222 million<sup>(4)</sup> pounds, representing about 0.04%, 0.11% of the total value of agricultural production, and the value of animal production in Egypt, respectively for the average of the same period.

Gharbia Governorate is considered one of the first governorates in the production of honey and its derivatives, as honey production there reached about 523.2 tons, representing about 12.06% of the total honey production in Egypt, which amounts to about 4339.6 tons. Beeswax production in Gharbia reached about 50 tons, representing 41.95% of its total production in Egypt amounted to about 119.2 tons<sup>(3)</sup> for the average period (2018-2022).

Honey is considered an agricultural product with great nutritional and medicinal value, as it contains 40.5% fructose, 34% glucose, 1.5% sucrose, 17.5% water, 6.3% minerals, acids, daktarin, and various<sup>(2)</sup> acids.

Honey has many benefits, as it gives the body energy, calms the nerves, soothes joint pain, treats people suffering from intestinal infections, prevents the growth of bacteria and kills them with the natural antibiotics it contains, and honey is considered a natural laxative and disinfectant for the intestines and is useful in treating chest diseases in children. And adults. It also treats heart diseases and is useful in treating many skin diseases. Regular consumption of it also helps in recovery from liver infections and gallbladder pain and increases the body's resistance<sup>(1)</sup> to infection.

## **II. Research Problem**

The research problem is the decrease in the total number of apiaries in Egypt from about 12.04 thousand apiaries in 2018 to about 10.22 thousand apiaries in 2022, with a decrease rate estimated at about

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15.08%, and a decrease in the number of beehives from about 935 thousand beehives in 2018 to about 785 thousand beehives in 2022, at a rate of decrease estimated at about 16.4 thousand<sup>(3)</sup> beehives, and the many difficulties and problems faced by apiary production in Egypt, the most important of these problems is the lack of technological provision of modern mechanization and trained technical labor of beekeepers and workers specialized in the production of honey and its derivatives, and they represent the cornerstone of apiary production requirements, therefore, the research problem can be summed up in the question: Does the absence of technical labor and specialized beekeepers and the use of modern mechanization affect the production of honey bees in Egypt?

### **III. Research Objectives**

The research aims primarily to study the role of human labor and mechanization in the production of honey and its derivatives, in the research sample in Gharbia Governorate, by studying the development of the flowering crop area and bee load in Gharbia Governorate, As well as analyzing the structure of the associated production costs, construction costs, and the productive efficiency of human and Mechanical labor for the apiaries in the research sample.

### **IV. Research Method And Data Sources**

To achieve its research objectives and work to solve the research problem, the research relies on descriptive and quantitative analysis methods, using many statistical and mathematical methods to clarify the economic aspects and various statistical relationships in the research, The research also relied on estimating and measuring the economic efficiency of productive resources in general and the human and Mechanical labor resource in particular and determining the optimal combination (Targets) of these resources for the apiaries of the research sample using the data envelopment method (DEAP), to study and analyze the productive efficiency of the human labor component and the impact of the use of mechanization on (wooden) apiary production, the beekeeping operations that rely on the use of mechanization were identified to include machines used in the processes of sorting, packing, cleaning, disease treatment, pest and insect resistance, and transportation, so that the first category of the research sample represents the traditional (manual) production pattern, while the second and third categories represent production patterns that rely on I have to use the combination of mechanization, machinery, and human labor that is indispensable in apiary production processes (manual and Mechanical), in addition to studying some indicators of the productive efficiency of the human and Mechanical labor component for both manual and Mechanical apiaries to make a comparison between each of them to clarify the impact of using modern mechanization technology in those apiaries.

The research also relied on two sources of data: published and unpublished secondary data in the authorities related to the subject of the research, and primary data through a research sample and a questionnaire form that was prepared to draw the sample items from the owners of (wooden) beehives in Gharbia Governorate, being the largest honey-producing governorate in Egypt.

### **V. Selection And Description Of The Research Sample**

The research sample was conducted in Gharbia Governorate for the 2022/2023 season according to the random sampling method as a representative of the governorates of Egypt due to its greater relative importance in the total numbers of beehives and beehives and the total actual honey production, as it came in first place among the governorates of Egypt in the total numbers of apiaries and the total numbers of (wooden) beehives produced For honey, there are about 1.5 thousand apiaries and about 104 thousand beehives, representing about 14.68% and 13.25% of their total in Egypt, which amounts to about 10.22 thousand apiaries and about 785 thousand beehives, respectively, in the year 2022, and also ranks first in the total actual honey production with about 0.48 thousand tons. It represents about 12.03% of the total actual honey production in Egypt, which amounted to about 3.99 thousand tons in the<sup>(3)</sup> same year.

The centers of Tanta and Mahalla al-Kubra in Gharbia Governorate were chosen according to the relative importance of the number of beekeepers and the total numbers of (wooden) beehives producing honey in the governorate, where the total number of beekeepers reached about 293, 231 owners, representing about 19.6% and 15.4%, respectively, of their total in the governorate, which amounts to 293 and 231 owners. About 1,496 holders, and the number of (wooden) beehives reached about 23.3 and 18.2 thousand beehives, representing about 22.8% and 18.7%, respectively, of their total in the governorate, which amounts to beehives about 10.2 thousand<sup>(5)</sup> beehives.

The villages of Shibshir and Shibashir Al-Hessa were also chosen from the center of Tanta, and the villages of Dakhmis and Ayyash from the center of Mahalla Al-Kubra. The total number of villages in them is about 53 and 51 villages, respectively, according to the relative importance of the number of beekeepers and the total numbers of (wooden) beehives producing honey, as shown in Table no (1), and the sample size was

determined to be approximately 72 holders, and the sample size was calculated using the Robert Mason's equation <sup>(6)</sup> as follows:

$$n = \frac{M}{\left[ (S^2 \times (M - 1)) \div pq \right] + 1}$$

Where:

**m:** Arithmetic mean of the population = (total number of beehives / total number of Apiary owners) = 74.4.

**s:** The standard score corresponding to the significance level<sup>(7)</sup> of 0.95 = (1.96/ 0.02).

**p:** The percentage of availability of the property, which is 0.50.

**q:** The residual ratio of the characteristic, which is 0.50.

**Table no (1):** The relative importance of the number of beekeepers and the total numbers of honey-producing (wooden) beehives in the villages of the Gharbia Governorate centers selected in the sample during the agricultural season (2022-2023):

Center	village	Apiary owners number (apiary)	Relative Importance %	Wooden Beehive number (Beehive)	Relative Importance %
Tanta	Shibshir	49	16.7	3773	16.2
	Shibashir Al-Hessa	41	14	3075	13.2
Total sample villages		90	30.7	6848	29.4
Total Tanta Center		293	100	23310	100
Mahalla al-Kubra	Dakhmis	45	19.5	3330	17.4
	Ayyash	39	16.9	2769	14.4
Total sample villages		84	36.4	6099	31.8
Total Mahalla al-Kubra Center		231	100	19177	100
general total of the sample villages		174	-----	12947	-----

**Source:** Ministry of Agriculture and Land Reclamation, **Directorate of Agriculture in Gharbia, Statistics Department records**, unpublished data, 2022.

#### Distribution of the sample among the selected villages in the centers:

The research community of honey production apiary holders was divided into three categories in the two selected centers: the first ownership category (apiaries with a capacity of less than 50 beehives), the second ownership category (apiaries with a capacity of 50 beehives - less than 100 beehives), and the third ownership category (apiaries with a capacity of 100 beehives or more), and in order to distribute the selected research sample of 72 beekeepers (observed) into the ownership categories, the number of owners and the number of (wooden) beehives that they own were divided into the three aforementioned categories, Table no (2) Shows that the number of holders in the first category is 69 holders, who own about 3148 beehives.

The number of holders in the second category was about 71 holders, owning about 5,999 apiaries, while the total number of holders in the third category was about 34 holders, owning about 3,800 apiaries. The selected research sample was distributed among the sample categories, so the share of the first ownership category was (apiaries with a smaller capacity of 50 beehives) about 23 owners represent about 31.4% of the total sample size, and the sample size for the second ownership category (apiaries with a capacity of 50 beehives - less than 100 beehives) was about 32 owners representing about 44.4% of the total sample size, in When the sample size for the third holding category (apiaries with a capacity of 100 beehives or more) reached about 18 owners, representing about 24.2% of the total sample size, table no (3) also shows the number of owners selected for each of the research villages and the distribution of the research sample among the selected villages according to The size of each holding class.

## VI. Results and discussion

### First: - Development of the total flowering area in Gharbia Governorate during the period (2000-2022):

Table no (4) Indicates a fluctuation of the total flowering area in Gharbia Governorate during the research period (2000-2022) between a minimum of about 30.2 thousand feddan in 2020, with a relative importance of the total amounting to about 2.9%, and a maximum of about 78.6 thousand acres, in 2002, with a relative importance of about 7.6% of the total.

Equation (1) in Table no (5) Shows the presence of a general statistically significant decreasing trend in the total flowering area in Gharbia Governorate at a significant level (0.05) with a decreasing annual amount estimated at about 1.95 thousand feddan, representing about 4.36% of its annual average estimated at about

44.68 thousand feddan during the research period, and the coefficient of determination was about 0.73, meaning that about 73% of the changes in the total flowering area in thousand acres in the Gharbia Governorate are due to changes whose effect reflects the change in time, assuming other factors are constant.

**Table no (2):** Distribution of the selected research sample of honey-producing beekeepers among the holding categories in Gharbia Governorate during the agricultural season (2022-2023):

No	apiaries Tenure categories	Apiary owners number (apiary)	Wooden Beehive owners number (Beehive)	% holders number	% Beehive number	% holders number x % Beehive number	Geometric mean	Adjusted geometric mean	category selected holders number	sampling fraction
1	First category	69	3148	39.7	24.3	964.2	31.1	31.5	23	1/3
2	Second category	71	5999	40.8	46.3	1890.7	43.5	44.2	32	1/2
3	Third category	34	3800	19.5	29.4	573.5	23.9	24.3	18	1/2
Total		174	12947	100	100	----	98.5	100	72	----

Where:

1 - **Number of holders selected for the category** = (adjusted geometric mean for the category x total sample) ÷ 100.

2 - **Sampling fraction** = (number of holders selected for each category ÷ total number of holders in the category).

3 - **The geometric mean** = the square root of the product of multiplying the relative importance of the number of holders by the relative importance of the number of beehives.

4 - **Adjusted geometric mean for the class** = (Geometric mean for each class ÷ Total geometric mean) x 100.

Source:

1 - Ministry of Agriculture and Land Reclamation, **Directorate of Agriculture in Gharbia, Statistics Department records**, unpublished data, 2022.

2 - Table no (1) in research.

**Second - The development of the bee load in Gharbia Governorate during the period (2000-2022):**

Table no (4) Indicates the fluctuation of the bee load in Gharbia Governorate during the research period (2000-2022) between a minimum of about 1.69 beehives/ feddan in 2001, with a relative importance of about 2.4% of the total, and a maximum of about 3.85 Beehives / feddan in 2009, with a relative importance of about 5.6% of the total.

**Table no (3):** Categories of apiary owners and distribution of the research sample among the selected sample villages according to the sampling fraction by category in Gharbia Governorate during the agricultural season (2022-2023):

Center	village	First category					Second category					Third category				
		Holders number	%	Beehives number	%	Holders selected number	Holders number	%	Beehives number	%	Holders selected number	Holders number	%	Beehives number	%	Holders selected number
Tanta	Shibshir	18	26.1	780	24.8	6	19	26.8	1491	24.9	8	12	35.3	1502	39.5	6
	Shibashir Al-Hessa	18	26.1	845	26.8	6	16	22.5	1520	25.3	7	7	20.6	710	18.7	4
Mahalla al-Kubra	Dakhmis	17	24.6	774	24.6	6	19	26.8	1601	26.7	9	9	26.5	955	25.1	4
	Ayyash	16	23.2	749	23.8	5	17	23.9	1387	23.1	7	6	17.6	633	16.7	4
total		69	100	3148	3148	23	71	100	5999	100	31	34	100	3800	100	18

Where: **The holders selected number for each village** = the sampling fraction x the number of village holders for this category.

Source:

1- Ministry of Agriculture and Land Reclamation, **Directorate of Agriculture in Gharbia, Statistics Department records**, unpublished data, 2022.

2- Table no (2) in research.

Equation (2) in Table no (5) Shows that there is a general increasing trend in the bee load in Gharbia Governorate, statistically significant at a level of significance (0.05), with an increasing annual amount estimated at about 0.61 beehives/ feddan, representing about 20.4% of its annual average, estimated at about 2.99, Beehive/ feddan during the research period. The coefficient of determination was about 0.48, meaning that

about 48% of the changes in the bee load in Gharbia Governorate are attributable to changes whose effect reflects the change in time, assuming other factors are constant.

**Table no (4):** Evolution of the area of flowering crops per bee load in Gharbia Governorate during the period (2000 - 2022):

Years	crops flowering Area (thousand feddan)			Total flowering area (thousand feddan)	Beehives total numbers (thousand beehives)	Bee load (beehive/feddan)
	Cotton	clover	citrus			
2000	35.2	11	10.4	56.6	123	2.17
2001	57.5	10.6	10.1	78.2	132	1.69
2002	57.3	11.2	10.1	78.6	142	1.81
2003	37.2	11.2	10	58.5	145	2.48
2004	47.6	11.2	10.1	68.9	161	2.34
2005	38.1	10.6	10.2	58.9	170	2.89
2006	29.6	10.2	10.1	49.9	161	3.23
2007	36.4	10	10.3	56.7	150	2.65
2008	17.2	9.7	10.5	37.4	136	3.64
2009	16.9	8.5	10.5	35.8	138	3.85
2010	18.3	9.5	10.6	38.3	132	3.45
2011	25.8	7.3	10.8	43.9	118	2.69
2012	16.8	9.3	11.3	37.4	116	3.10
2013	11.6	11.3	12	34.8	110	3.16
2014	16.5	10.1	11.7	38.2	100	2.62
2015	10.1	9.6	11.7	31.4	100	3.18
2016	10	9.7	11.6	31.4	100	3.18
2017	9.9	10.5	11.5	31.9	113	3.54
2018	14.2	10.5	12	36.8	111	3.02
2019	12.1	7.1	11.9	31.1	110	3.54
2020	8.6	9.9	11.8	30.2	112	3.71
2021	12.1	7.4	12	31.6	108	3.42
2022	11.9	7.2	11.9	31.2	104	3.33
Total	-	-	-	1027.7	-	68.69
Average	23.95	9.72	11.00	44.68	125.81	2.99

Where: **Bee load** = total number of beehives / total flowering area.

**Source:**

- 1 - Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, **Bulletin of Fish and Insect Production and Food Processing Statistics**, various issues.
- 2 - Central Agency for Public Mobilization and Statistics, **Annual Bulletin of Production and Foreign Trade Movement and Food Available for Consumption**, various issues.

**Third - Average items of agricultural labor costs for the (wooden) apiaries producing honey according to the tenure categories of the research sample:**

Table no (6) Shows that the total cost of agricultural labor for the (wooden) apiary producing honey in the holding categories of the research sample was estimated at approximately 8.9 thousand pounds, 33.48 thousand pounds, and 60.34 thousand pounds for the three categories of the research sample, representing about 12.13%, 15.98%, and 24.22% of the total costs, for each of them, the amount is about 72.46 thousand pounds, 160.32 thousand pounds, and 249.07 thousand pounds, respectively, the total cost of operational labor and the total cost of permanent human labor were estimated at about 8.13 thousand pounds, 0.862 thousand pounds for the first category, and they represent about 90.41% and 9.59%, respectively, of the total cost of agricultural labor, and about 11.21% and 1.19%, respectively, of the total costs in the first category, for the second category, it was estimated at approximately 31.71 thousand pounds and 1.78 thousand pounds, representing approximately 94.69% and 5.31%, respectively, of the total cost of agricultural labor, and approximately 19.78%, 1.11%, respectively, of the total costs in the second category, for the third category, it was estimated at approximately 57.79 thousand pounds, and 2.55 thousand pounds, representing About 95.78% and 4.22%, respectively, of the total cost of agricultural labor in the third category, and about 23.2%, 1.02%, respectively, of the total costs in the third category.

**Table no (5):** General time trend equations for the development of the total flowering area and bee load in Gharbia Governorate during the period (2000 - 2022): (thousand/ feddan), (beehive/ feddan)

No	Statement Governorate	The equation	Average period	Amount annual change	% annual Change rate	R2	F
1	Gharbia Governorate total flowering area	$\hat{y} = 68.17 - 1.95 x_t$ (19.50)** (-7.68)**	44.68	- 1.95	4.36	0.48	19.37*
2	Gharbia Governorate Bee load	$\hat{y} = 2.25 + 0.61 x_t$ (11.95)** (4.13)*	2.9	0.61	20.4	0.93	278.10**

**Where:**

- $\hat{Y}$ : indicates the total flowering area and bee load in Gharbia governorates.
- $x$ : refers to the time factor,  $t: 1, 2, \dots, 23$ .
- (\*\*): Significant at 0.01. (\*) : Significant at 0.05.
- **The amount of annual change**: is the first derivative of the function when  $x$  (the arithmetic average of the length of the time series) equal  $(267/23 = 12)$ .
- **Annual rate of change (%)**: (Amount of annual change / Annual average of the variable) x 100.

**Source:** Calculated from Tables (4) and (5) in research.

Table no (6) Also shows that the cost of the beekeeper and the cost of seasonal operational labor were estimated at about 5.651 thousand pounds, 2.47 thousand pounds in the first category, representing about 69.55% and 30.45%, respectively, of the total operational labor, and about 62.88%, 27.53%, respectively, of the total agricultural labor, and about 7.8%, 3.41%, respectively, of the total costs, and that the cost of the beekeeper, the cost of seasonal operational labor, and the cost of Mechanical labor were estimated at about 28.62 thousand pounds, 2.86 thousand pounds, and 2.37 thousand pounds in the second category, representing about 90.24%, 9.01%, and 7.47%, respectively, total operating labor, about 85.45%, 8.53%, and 7.07%, respectively, of the total agricultural labor, and about 17.85%, 1.78%, and 1.48%, respectively, of the total costs, as for the third category, the cost of the beekeeper, the cost of seasonal operational labor, and the cost of Mechanical labor was estimated at approximately 52.02 thousand pounds. 2.87 thousand pounds, 2.91 thousand pounds, representing about 90.01%, 4.97%, 5.02% respectively of the total operational labor, and about 86.21%, 4.76%, 4.81% respectively of the total agricultural labor, and about 20.89%, 1.15%, 1.16% respectively, of the total costs.

Table no (7) shows that the average return for the (wooden) apiary producing honey in the three tenure categories of the research sample was estimated at approximately 11.47, 44.31 and 82.02(thousand pounds/season) for the first, second, and third category for human labor, respectively. The average return for the (wooden) apiary producing honey In the three tenure categories of the research sample, it was estimated for the second and third categories to be about 3.27, 4.13 (thousand pounds/season) for Mechanical labor, respectively, with average labor costs for each of them amounting to about 8.99, 3.57, and 60.34 (thousand pounds/season), respectively.

**Table no (6):** Averages of agricultural labor costs items for the honey-producing apiary (wooden) by the tenure categories of the research sample:

Items			First category		Second category		Third category	
			Value	%	Value	%	Value	%
Operational labor	Human	beekeeper	5651	62.88	28616	85.45	52018.3	86.21
		Seasonal operational labor	2473.9	27.53	2856.9	8.53	2873.1	4.76
	Mechanical labor		-	-	2368.1	7.07	2900.9	4.81
	Total operational labor		8124.9	90.41	31711	94.69	57792.3	95.78
Permanent human labor			861.7	9.59	1777	5.31	2548.6	4.22
Total agricultural employment <sup>(*)</sup>			8986.6	12.4	33488	20.89	60340.9	24.23
Total costs			72457.6	100	160315.2	100	249062.7	100

**Where:** (\*) **Total agricultural labor** includes (total operational labor + total permanent human labor).

**Source:** Collected and calculated from the research sample data.

**Fourth - Indicators of the productive efficiency of human and Mechanical labor for the (wooden) apiary that produces honey according to the tenure categories of the research sample:**

The cost of human and Mechanical labor in the second category represents approximately 3.33 and 2.37 (thousand pounds/season), respectively, with a net return for human labor in the first category estimated at approximately 2.48 (thousand pounds/season), and for both human and Mechanical labor in the second category

estimated at approximately 40.98, 0.90 (thousand pounds/season) in order, this has led to achieving economic returns for beekeepers in the second category as a result of the use of Mechanical work in production processes, represented by the ratio (return/labor costs), the return on the invested pound, the profit margin percentage for the product, each of them estimated at approximately 0.33%, 1.33%, 18.56% for human labor, respectively, and about 1.38%, 0.38%, and 0.41% for Mechanical labor, respectively, with a net return for both human and Mechanical labor in the third category estimated at approximately 24.58, 1.23 (thousand pounds/season) respectively, this has led to achieving economic returns for beekeepers in this category as a result of the use of Mechanical work in production processes, represented by the ratio(return/labor costs), the return on the invested pound, and profit margin percentage for the product, each of which was estimated at approximately 1.43%, 0.42%, and 6.91% for human labor, and about 1.42%, 0.42%, 0.34% for mechanized labor, respectively, while each of these indicators in the first tenure category reached about 1.28%, 0.28%, 2.68%, respectively, which shows the role of mechanized labor in honey production in the second and third categories compared to the first category in the research sample.

**Table no (7):** Indicators of productive efficiency of human and Mechanical labor for honey-producing (wooden) apiaries according to the tenure categories of the research sample:

Items	First category		Second category		Third category	
	value	%	value	%	value	%
Average human labor costs (pounds/season)	8986.6	12.4	3324.9	20.07	57440	23.06
Average mechanical labor costs (pounds/season)	-	-	2368.1	1.48	2900.9	1.16
Total labor costs (pounds/season)	8986.6	12.4	35618	22.22	60340.9	24.23
Total costs (pounds/season)	72457.6	100	160315.2	100	249062.7	100
Total return (pounds/season)	92451.6		220763.9		355688.7	
Average return (pounds/season)	Human labor	11464	44307.3		82021.8	
	Mechanical labor	-	3267.31		4126	
Net return (pounds/season)	Human labor	2477.4	40982.4		24581.8	
	Mechanical labor	-	899.21		1225.1	
Ratio (return/cost)	Human labor	1.28	1.33		1.43	
	Mechanical labor	-	1.38		1.42	
Return on invested pounds	Human labor	0.28	0.33		0.43	
	Mechanical labor	-	0.38		0.42	
Producer profit margin (%)	Human labor	2.68	18.56		6.91	
	Mechanical labor	-	0.41		0.34	

**Where:**

- **Average return** = (total return x % average labor costs) / 100.
- **Net return** = (average return - average labor costs).
- **Return on invested pounds** = (net return / average labor costs).
- **Ratio of total return to total costs** = (average return / average labor costs).
- **% profit margin percentage for the product** = (net return / total return) x 100.

**Source:** Collected and calculated from the research sample data.

**Fifth - The economic efficiency of the apiary’s productive resources (wooden) according to the tenure categories of the research sample:**

In this Part of the research, a statistical analytical study is conducted to estimate the economic efficiency of the productive resources of the apiary (wooden) in the Productive tenure categories of the research sample in Gharbia Governorate, through the use of the data encapsulation program DEAP, by describing the productive resources (inputs) of the wooden apiaries for honey production and estimating the quantities of productive resources (inputs) of the wooden beehives for honey production that are actually used and compared to the optimal use in the three categories of the research sample as follows:

**1 - Estimating the economic efficiency of the productive resources of the (wooden) apiary in the first category for the research sample:**

**A - Description of the productive resources (inputs) of the apiary (wooden) to produce honey in the first category:**

Includes the productive resources (inputs) of the apiary (Wooden) for honey production in the first category based on development raw materials pure wax balls (units: carton) (x1), amount of feed with sugar solution (units: liters) (x2), expel bees (units: expel bees) (x3), technical labor (units: beekeeper) (x4), seasonal

labor operational (units: worker) (x5), which are considered as independent variables and production inputs that affect the dependent variable (Y), which represents the quantity of honey production (units: kilograms) in the first category of the research sample in Gharbia Governorate. This production category represents the traditional production pattern of the (wooden) apiary, which relies for its production on human labor only without using mechanical labor.

It is clear from Table no (8) that the average number of pure wax chicks used was estimated at about 30.4 cartons, ranging from a minimum of 10 units to a maximum of 50 cartons. The amount of sugar solution fed was about 164.6 liters, ranging from a minimum of 55 units to a maximum of 255 liters, the average number of bee parcels was about 31.3 expel bees, ranging from a minimum of 12 units to a maximum of 48 expel bees, and the average total of technical labor (beekeeper) reached 1 beekeeper, between a minimum of 1 unit and a maximum of 1 worker. It is also clear from the same table that the average total seasonal labor reached about 2.4 workers between Minimum 1 unit and maximum 4 workers.

**B- Estimating the quantities of productive resources (inputs) for the (wooden) apiary to produce honey that are actually used and comparing them to the optimal use in the first category of the research sample:**

By comparing the current use of resources with the optimal combination (the point at which the iso-cost line touches the iso-quant curve) of the same resource, as shown in Table no (8), it was found that there was a waste of the quantities of resources used in the production process for this category, and that was estimated. The amount of wasted resources of pure wax chicks (x1) is about 10.48 cartons, the amount of sugar solution feed (x2) is about 54.37 liters, the expel bees (x3) are about 10.1 expel bees, the seasonal operating labor (x5) is about 1,006 workers, and represents the amount of waste from each Supplied, respectively, about 34.47%, 33.03%, 32.26%, 0.00%, 41.91% of the actual quantities used in production, while for the resource of technical work (x4), it was found that there is no waste in this element and that it has reached economic efficiency, and that the actual quantity is the same as the target quantity and there are no remainders, in order for the farm to achieve full economic efficiency for the current level of total production, the amount of actual resources beekeeper must be reduced, resources except for the artistic work resource, as it has reached economic efficiency according to the value of the economic efficiency index.

**Table no (8):** Economic efficiency and actual and optimal quantities of productive resources for (wooden) apiaries in the first category for the research sample using the Deap data envelopment method:

Items		Input		
		Mean	Min.	Max.
Raw materials pure wax balls (units: carton) (x <sub>1</sub> )	Original	30.4	10	50
	Targets	19.92	10	25.62
	Slacks	10.48	0.00	24.38
	(%) Slacks	34.47	0.00	48.76
Feed sugar solution (units: liters) (x <sub>2</sub> )	Original	164.6	55	255
	Targets	110.23	55	140.24
	Slacks	54.37	0.00	114.76
	(%) Slacks	33.03	0.00	45
Expel bees (units: expel bees) (x <sub>3</sub> )	Original	31.3	12	48
	Targets	21.2	12	26.4
	Slacks	10.1	0.00	21.60
	(%) Slacks	32.26	0.00	45
Technical labor (units: beekeeper) (x <sub>4</sub> )	Original	1	1	1
	Targets	1	1	1
	Slacks	0.00	0.00	0.00
	(%) Slacks	0.00	0.00	0.00
Seasonal labor operational (units: worker) (x <sub>5</sub> )	Original	2.4	1	4
	Targets	1.394	1	1.59
	Slacks	1.006	0.00	2.415
	(%) Slacks	41.91	0.00	60.38

**Source:** Collected and calculated from the results of analyzing data for the research sample in Gharbia Governorate using the DEAP program.

**2 - Estimating the economic efficiency of the productive resources of the (wooden) apiary in the second category for the research sample:**

**A- Description of the productive resources (inputs) of the (wooden) apiaries for honey production in the second category:**

The productive resources (inputs) for the wooden beehives for honey production in the second category included development raw materials (pure wax buds) (units: carton) (x1), the amount of feed with sugar solution (units: liters) (x2), expel bees (units: expel bees) (x3), and technical labor (units: beekeeper) (x4), seasonal labor by factor (x5), mechanical labor (x6) (units: hour), which are considered as independent



variables and production inputs that affect the dependent variable (Y), which represents the amount of honey production (units: kilograms) in the second category of the research sample in Gharbia Governorate. This production category represents the modern production pattern of wooden beehives whose production depends on labor, human and Mechanical work.

It is clear from Table no (9) that the average number of pure wax chicks used was estimated at about 68.2 cartons, ranging from a minimum of 50 units to a maximum of 92 cartons, the amount of sugar solution fed was about 373.9 liters, ranging from a minimum of 230 units to a maximum of 530 liters, the average number of bee parcels was about 71.1 expel bees, ranging from a minimum of 50 units to a maximum of 95 expel bees, and the average total of technical workers beekeeper reached 1.2 workers, between a minimum of 1 unit and a maximum of 2 workers, it is also clear from the same table that the average total seasonal labor amounted to about 3 workers between A minimum of 2 units and a maximum of 4 workers, and the average number of Mechanical working hours was about 6.5 hours between a minimum of 4.5 units and a maximum of 8 hours.

**Table no (9):** The economic efficiency and the actual and optimal quantities of productive resources for the (wooden) apiaries in the second category for the research sample using the Deap data envelopment method:

Items		Input		
		Mean	Min.	Max.
Raw materials pure wax balls (units: carton) (x <sub>1</sub> )	Original	68.2	50	92
	Targets	66.758	50	84.14
	Slacks	1.442	0	7.86
	(%) Slacks	2.11	0	8.54
Feed sugar solution (units: liters) (x <sub>2</sub> )	Original	373.9	230	530
	Targets	363.281	230	479.5
	Slacks	10.619	0	50.5
	(%) Slacks	2.84	0	9.52
Expel bees (units: expel bees) (x <sub>3</sub> )	Original	71.1	50	95
	Targets	69.758	50	87.76
	Slacks	1.342	0	7.24
	(%) Slacks	1.88	0	7.81
Technical labor (units: beekeeper) (x <sub>4</sub> )	Original	1.2	1	2
	Targets	1.175	1	1.514
	Slacks	0.025	0	0.486
	(%) Slacks	2.08	0	24.3
Seasonal labor operational (units: worker) (x <sub>5</sub> )	Original	3.1	2	4
	Targets	2.919	2	2.65
	Slacks	0.181	0	1.35
	(%) Slacks	5.83	0	33.75
Mechanical labor (units: hour) (x <sub>6</sub> )	Original	6.5	4.5	8
	Targets	6.189	4.5	6.62
	Slacks	0.311	0	1.38
	(%) Slacks	4.78	0	17.25

**Source:** Collected and calculated from the results of analyzing data for the research sample in Gharbia Governorate using the DEAP program.

**B - Estimating the quantities of productive resources (inputs) for the (wooden) apiary to produce honey that are actually used and comparing them to the optimal use in the second category of the research sample:**

By comparing the current use of resources with the optimal combination (the point at which the iso-cost line touches the iso-quant curve) of the same resource, as shown in Table no (9), it was found that there was a waste of the quantities of resources used in the production process for this category, and that was estimated, wasted quantities of pure wax nest resources (x<sub>1</sub>) amounted to approximately 1,442 cartons, amount of sugar solution feed (x<sub>2</sub>) approximately 10.61 liters, Expel bees (x<sub>3</sub>) approximately 1.342 expel bees, artistic work (x<sub>4</sub>) approximately 0.025 beekeeper, seasonal labor operational (x<sub>5</sub>) approximately 0.181 workers, Mechanical work (x<sub>6</sub>) for about 0.311 hours, where the amount of waste from each resource represents, respectively, about 2.11%, 2.84%, 1.88%, 2.08%, 5.83%, 4.78% of the actual quantities used in production, in order for the farm to achieve full economic efficiency for the current level of total production, the amount of actual resources must be reduced according to the value of the economic efficiency index.

**3 - Estimating the economic efficiency and the actual and optimal quantities of the farm labor resource for the (wooden) apiary in the third category for the research sample:**

**A - Description of the productive resources (inputs) of the wooden apiaries for honey production in the third category:**

The productive resources (inputs) for the wooden apiaries for honey production in the third category included development raw materials (pure wax buds) (units: carton) (x1), the amount of feed with sugar solution (units: liters) (x2), expel bees (units: expel bees) (x3), and technical labor beekeeper (units: beekeeper) (x4), seasonal labor by factor (x5), mechanical labor (x6) (units: hour), which are considered as independent variables and production inputs that affect the dependent variable (Y), which is the amount of honey production (units: kilograms) in the second category of the research sample in Gharbia Governorate. This production category represents the modern production pattern of wooden beehives whose production depends on human labor, and Mechanical work.

**Table no (10):** Economic efficiency and actual and optimal quantities of productive resources for the apiary (wooden) in the third category for the research sample using the Deap data envelopment method:

Items		Input		
		Mean	Min.	Max.
Raw materials pure wax balls (units: carton) (x <sub>1</sub> )	Original	106.1	95	125
	Targets	105.97	95	123.01
	Slacks	0.121	0	1.99
	(%) Slacks	0.114	0	1.59
Feed sugar solution (units: liters) (x <sub>2</sub> )	Original	546.1	335	620
	Targets	545.51	335	610.44
	Slacks	0.592	0	9.56
	(%) Slacks	0.108	0	1.541
Expel bees (units: expel bees) (x <sub>3</sub> )	Original	112	98	130
	Targets	111.87	98	127.89
	Slacks	0.129	0	2.114
	(%) Slacks	0.115	0	1.63
Technical labor (units: beekeeper) (x <sub>4</sub> )	Original	2.2	2	3
	Targets	2.189	2	2.8
	Slacks	0.011	0	0.201
	(%) Slacks	0.5	0	6.7
Seasonal labor operational (units: worker) (x <sub>5</sub> )	Original	3.3	3	4
	Targets	3.25	3	3.169
	Slacks	0.046	0	0.831
	(%) Slacks	1.39	0	20.78
Mechanical labor (units: hour) (x <sub>6</sub> )	Original	7.9	7	9.25
	Targets	7.89	7	9.103
	Slacks	0.009	0	0.147
	(%) Slacks	0.11	0.11	0.015

**Source:** Collected and calculated from the results of analyzing data for the research sample in Gharbia Governorate using the DEAP program.

It is clear from Table no (10) That the average number of pure wax chicks used was estimated at about 106.1 cartons, ranging from a minimum of 95 units to a maximum of 125 cartons, the amount of sugar solution fed was about 546.1 liters, ranging from a minimum of 335 units to a maximum of 620 liters, the average number of bee parcels was about 112 expel bees, ranging from a minimum of 98 units to a maximum of 130 expel bees, and the average total of technical workers beekeeper reached 2.2 workers, between a minimum of 2 units and a maximum of 3 workers. It is also clear from the same table that the average total seasonal labor amounted to about 4 workers between a maximum of The lowest 3 units and the highest 4 workers, and the average number of Mechanical working hours was about 7.9 hours between the lowest 7 units and the highest 9.25 hours.

**B - Estimating the quantities of productive resources (inputs) for the wooden apiaries to produce honey that are actually used and comparing them to the optimal use in the third category of the research sample:**

By comparing the current use of resources with the optimal combination (the point at which the symmetrical cost line touches the symmetrical production curve) of the same resource, as shown in Table no (10), it was found that there was a waste of the quantities of resources used in the production process for this category, and that was estimated. The amount of wasted resources of pure wax chicks (x1) is approximately 0.121 cartons, the amount of sugar solution feed (x2) is approximately 0.592 liters, the Expel bees (x3) are approximately 0.129 expel bees, the artistic work (x4) is approximately 0.011 beekeeper, the seasonal labor

operational (x5) is approximately 0.046 workers, Mechanical work (x6) for about 0.009 hours, where the amount of waste from each resource represents, respectively, about 0.114%, 0.108%, 0.115%, 0.5%, 1.39%, 0.11% of the actual quantities used in production, in order for the farm to achieve full economic efficiency for the current level of total production, the amount of actual resources must be reduced according to the value of the economic efficiency index.

## **VII. Recommendations**

1 - The research recommends the need to educate beekeepers about production in apiaries with a larger capacity of beehives in order to benefit from the decrease in the total costs of producing the unit (beehive) in that category, which was estimated at about 2150 pounds/beehive, whereas it was estimated at about 2433 and 2229 pounds/beehive for each category the first and second, respectively, to benefit from return to economies and achieve a higher net profit, as the third category was estimated at approximately 921 pounds/beehive, while the first and second category was estimated at approximately 671, 841 pounds/bee hive.

2 - The research recommends paying attention to a mixture of mechanical labor and trained human labor that is indispensable in the field of beekeeping, as it was found that the ratio of returns to costs for the human and mechanical labor resource reached a maximum in the third category at approximately 1.43 and 1.42, respectively, while they were estimated in the third category, the first and second category was estimated at about 1.33 and 1.38, respectively, and the human labor force only in the first category, representing the traditional mode of production, was estimated at about 1.28.

3 - The research also recommends reducing the quantities of actual productive resources according to the value of the economic efficiency index so that the apiaries achieve full economic efficiency based on the current level of production in the apiaries of the research sample, including the resource of human technical labor and mechanical labor for mechanized production modes in the second and first categories, while achieving The human technical labor resource in the first category of the traditional production model is economic efficiency.

## **The Reviewer**

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