

## An Economical Study of the Most Important Egyptian Aromatic Plants

Hany M. Shabbara and Akila E. Taha

Department of Agricultural Economics, National Research Center, Egypt.

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**Abstract:** As Egypt is considered one of the most important producers of aromatic and medicinal plants, because of its suitable environment, this study concentrated on studying some main aromatic crops at Assuit, Menia, Monofia and Fayoum governorates. These governorates are the main producers for coriander, cumin, caraway and anise. The study used quantitative and qualitative analysis to identify main problems and challenges facing their production. The aromatic plant cultivated area in Egypt, total production and export values in Egypt for the period 1988-2004 were studied. Also, production and cost functions for aromatic crops production were estimated by using the double logarithmic equations. It was shown from the analysis of production functions of cumin and coriander crops, in Assuit and Menia governorates respectively, that increasing manure fertilizer, nitrate quantities and human labor by 1% leads to increase crop production by 53 % and 51% respectively. Also, increasing nitrate fertilizer and human labor for caraway crop in Monofia by 1% leads to increase the crop by 65%, while increasing them, in addition of phosphate fertilizer for anise crop in Fayoum by 1% leads to increase the crop by 58%. It was shown also, by using production and cost functions as double logarithmic form, that there was an analytical significant relationship at 0.01 level between productive costs and average feddan productivity of studied aromatic crops. The determinant coefficients  $R^2$  were ca. 0.84, 0.71, 0.74, 0.79 for cumin, coriander, caraway and anise crops respectively. and it is obvious from equations that, the lowest production size of average costs which maximize profit were ca. 0.47, 0.96, 0.95, 0.72 tons for the previous mentioned crops respectively. Finally, its production efficiency for the studied sample was estimated and the research suggested some solutions for aromatic plant challenges and problems. They were; supplying farmers by loans from agricultural banks, sustainable irrigation and saving selected clean seeds, low price effective pesticides, by production inputs with suitable price and finally, supplying them by trained specialized agricultural guides in the field of aromatic and medicinal plants.

**Key words:** Agriculture, aromatic plants, cumin, coriander, caraway, anise, production function, cost function, production efficiency.

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### INTRODUCTION

The aromatic plants are in great demand both in Egypt and abroad, for its multiple uses. The demand for these plants is increasing continuously in many important fields e.g. medicinal cure, perfume production, soap and cosmetics, refreshing beverages and nutritious such as hibiscus, mint, anise, caraway.... etc. Also, it is used as spices such as, cumin, coriander, fennel fruits and in natural flavor and aroma additives in food industries, that in addition of its using as insecticides<sup>[1,10]</sup>.

Therefore, the demand for these plants is increasing in both industrialized and developed countries which leads to increase their prices. This in turn, raised the carefully of the agricultural policy planners towards these plants as being one of the most important high returns exporting corps and an important source of increasing the national income<sup>[5]</sup>.

The medicinal and aromatic plants are considered one of the most important untraditional agricultural commodities which can be used as a base for Egyptian national income development, where it obtained increasing demand inside and outside markets<sup>[3]</sup>.

Although Egypt is one of the countries having favorable conditions for the production of aromatic plants e.g. suitable environment and available low wages manpower (essential for service procedures, agriculture, collection and marketing) the cultivated area of these plants is not satisfactory.

Medicinal and aromatic plants cultivated area reached the average of 57.4 thousand feddans during the period (1990-2005), representing 0.43% of the total cultivated areas at the Arab Republic of Egypt<sup>[7]</sup>. However, their total production value reached 396.715 million L.E. as an annual average for the period (1990-2005) and their exporting value reached 94.71 million L.E. representing ca. 6.08 % from the

total Egyptian agricultural export value ( 1.557 milliard L.E.) and 0.75% of the total Egyptian export value which represents the average of 12.659 milliard L.E. during the period ( 1990- 2005)<sup>[8]</sup>.

This paper focused on studying some medicinal and aromatic plant production efficiency and problems of their production in order to know the possibility of their production expansion. Although, aromatic plant production is of high economic importance it has no enough care from farmers, producers and state which led to the hesitation of its cultivated areas from year to another.

The study aimed at identifying the main determinants of producing the most important medicinal and aromatic plants through studying their productivity status. To achieve this aim the study used the production costs function and the efficiently criteria used for their production. It focused on some important plants such as cumin, coriander, caraway and anise. Their productivity, production and cultivated areas were studied, in addition, their cost structure were highlighted. Also, the most important production and marketing problems were illustrated in the study. Finally, the study was concerned with suggesting some solutions and recommendations to increase their production for the local market in appropriate price.

### MATERIALS AND METHODS

The study used the quantitative, qualitative analysis and statistical analysis to study the concentration percentages of the studied corps; cumin, coriander, caraway, anise and identify their geographical distribution. The study also used the production criteria standards to identify the feasibility of cultivating such crops and the possibility of their cultivation expansion. The cultivation of these crops is concentrated in Monofia, Menia, Assuit, Fayoum, Bani-Souafe and Behera governorates<sup>[9]</sup>. Field data for the studied crops were collected by questionnaires, (35 questionnaires for each crop) for the season (2005-2006). Cumin crop questionnaires were collected from Assuit governorate (where cumin crop was concentrated) as its cultivated area was 51.50 % of cumic total cultivated area in Egypt for the studied period (1998-2004). While, coriander questionnaires were collected from El-Menia governorate, where 93% of the total crop cultivated area was found during the study period (1998-2004). And caraway crop questionnaires were collected from Monofia governorate which has 18.5% of its total cultivated

area. But, anise crop questionnaires were collected from Fayoum governorate which has 63% of its total cultivated area during the study period. The study also depended on published details from the Ministry of Agriculture and Central Agency for Public Mobilization and Statistics<sup>[4]</sup>.

### RESULTS AND DISCUSSIONS

I- The development of economic variables of total cultivated area, total production value and export value of medicinal and Aromatic plants in Egypt through the period (1990-2005):

This part deals with the analysis of economic variables (Table 1) of total cultivated area, total production value and export value of studied medicinal and aromatic plants during the period (1990-2005). A statistical estimation for trend equations was also used for these variables.

**The Development of Medicinal Aromatic Plants Cultivated Area in Egypt:** Table (2) showed that the trend of medicinal and aromatic plants cultivated area (thousands feddans) was increasing during the study period with growth rate reached to 2.5% of the average 57.4 thousand feddans. The determinant coefficient reached 0.58 with statistical significance during the study period (1990-2005).

**Table 1:** The development of total cultivated area, total production value and export value of medicinal and Aromatic plants in Egypt through the period (1990-2005):

Years	Total medicinal and aromatic area (thousand Feddans)	Production value (thousand L.E.)	Exports value (million L.E.) <sup>[11]</sup>
1990	43.28	150514	44.8
1991	47.23	272531	56.1
1992	40.18	178755	57.6
1993	53.41	235784	51.3
1994	57.40	289168	69.6
1995	56.0	428068	72.4
1996	64.21	472548	87.4
1997	52.30	438511	74.2
1998	68.41	499007	74.8
1999	65.13	497702	83.53
2000	52.91	435022	90.8
2001	55.14	435310	111.34
2002	62.17	433375	133.86
2003	64.15	485269	156.4
2004	66.27	523418	161.6
2005	70.0	572463	166.7
Average	57.4	396715.3	93.28

**Source:** data collected and computed from the Ministry of Agriculture and land Reclamation, Economic Affairs Sector, central division for agricultural planning, different issues.

**Table 2:** Trend equations for aromatic cultivated area, total production value and export value of medicinal and aromatic plants in Egypt during the period (1990-2005).

Equation no.	Variables	Equations	R <sup>2</sup>	F	Growth rate%	Significance
1	cultivated area (thousand feddans)	$\hat{y}_t = 45.1565 + 1.4388 X_t$ (4.44)	0.58	19.8	2.5	**
2	total production value (thousand L.E.)	$\hat{y}_t = 197534.6 + 23433.03 X_t$ (6.5)	0.86	42	5.9	**
3	exports value (million L.E.)	$\hat{y}_t = 25.7 + 7.9456 X_t$ (9.8)	0.87	95.2	8.52	**

Where  $\hat{y}_t$  = Estimated value of the dependent variable at the year t  
 $X_t$  = time variable of the year t, where, t = 1,2,3, 4, 5.....16 year  
 Numbers between brackets indicate “t” value \*\*indicates significance at 0.01 level

Source: computed from table (1)

**Table 3:** Aromatic crop geographical distribution of the average cultivate areas (feddan), its percentage of the total area and its total production( tons) during the comparable studied periods ( 1988-1997) and (1998-2004).

Governorates	Studied periods	Coriander				Cumin			
		Area		Production (tons)	Area		Production (tons)		
		Feddan	%		Feddan	%			
		in studied region	in Egypt	in studied region	in Egypt				
Bahera	1990-1997	-	-	-	-	-	-	-	-
	1998-2004	-	-	-	-	-	-	-	-
Monofia	1990-1997	-	-	-	-	-	-	-	-
	1998-2004	-	-	-	-	-	-	-	-
Bani- Souif	1990-1997	342.3	10047.6	3	342.3	-	-	-	-
	1998-2004	407.9	26553.3	1.5	407.9	-	-	-	-
Fayum	1990-1997	-	-	-	-	-	-	-	-
	1998-2004	-	-	-	-	-	-	-	-
El-Menia	1990-1997	9336.8	10047.6	92.9	9336.8	2143.6	8279	26	1071.8
	1998-2004	13094	26553.3	93	1309.4	3026.6	7304	41.4	1513.3
Assuit	1990-1997	300.9	10047.6	3.4	300.9	6028.8	8279	72.8	3014.4
	1998-2004	123.9	26553.3	0.4	123.9	3760	7304	51.5	1880
Governorates	Studied periods	Caraway				Anise			
		Area		Production (tons )	Area		Production (tons )		
		Feddan	%		Feddan	%			
		in studied region	in Egypt	in studied region	in Egypt				
Bahera	1990-1997	507.9	2886.4	16.8	507.9	-	-	-	-
	1998-2004	483.3	2615.1	18.5	483.3	-	-	-	-
Monofia	1990-1997	497	2886.4	16.5	497	-	-	-	-
	1998-2004	465	2615.1	17.8	465	-	-	-	-
Bani- Souif	1990-1997	-	-	-	-	-	-	-	-
	1998-2004	-	-	-	-	-	-	-	-
Fayum	1990-1997	-	-	-	-	349.3	868.6	40.2	279.44
	1998-2004	-	-	-	-	1099.4	1743.4	63	879.52
El-Menia	1990-1997	-	-	-	-	463	868.6	53.3	370.4
	1998-2004	-	-	-	-	613	1743.4	35.2	490.4
Assuit	1990-1997	-	-	-	-	-	-	-	-
	1998-2004	-	-	-	-	-	-	-	-

Source: gathered and computed data extracted from the Ministry of Agricultural and Land Reclamation – Economic affairs sector, Agricultural Economic Central Division. Agricultural statistics. Different Issues.

**The Development of the Total Production Value of Medicinal and Aromatic Plants in Egypt:** The total production value of the aromatic plants in Egypt (thousand L.E.) showed steady increase during the study period (1990-2005), with significant annual rate of 5.9 % of the average 396715.3 and estimated determinant coefficient equal to 0.86.

**The Development of the Export Value of Medicinal and Aromatic Plants in Egypt:** The export value of aromatic plants showed an increasing trend during the study period (1990-2005) with significant annual rate and annual growth rate 9.1% of the average of 111 million L.E. and determinant coefficient 0.88.

**Ii-geographical Distribution of the Most Important Studied Aromatic Plants in Egypt:** According to the data at table (3) which represent the geographical distribution of the cultivated areas of the studied aromatic plants in their main producing governorates during the period (1990-1997) compared by the period (1998-2004), it showed the concentration of these plant cultivation was at middle and upper Egypt governorates. As for coriander crop, its cultivation was concentrated at El-Menia, Assuit and Bani-Souif governorates, where, its average cultivated area at El-Menia governorate was 9336.8 Feddans with representing 92.9% of its average of total cultivated area in Egypt during the period (1990-1997). It increased to 13094 Feddans with representing 93% of its average of total cultivated area in Egypt during the period (1998-2004). The average coriander crop production was 9336.8 tons during the period (1990-1997) and increased to 13094 tons during the period (1998- 2004).

In addition, the average cultivated area for coriander at Assuit governorate was 300.9 Feddans representing 3.4 % of the average of total cultivated areas of coriander in Egypt during the period (1990- 1997). And its production average reached to 300.9 tons during the same period.

While the average cultivated area for coriander at this governorate was 123.9 Feddans representing 0.4% of the average of total cultivated areas of coriander in Egypt during the period (1998- 2004). And its production average reached to 123.9 tons during the same period.

At Bani-souif governorate, the cultivated area with coriander was 342.3 Feddans representing 3% of the average of total cultivated area of coriander in Egypt during the period (1990-1997). It increased to 407.9 Feddans during the period (1998- 2004) representing 1.5% of the average of its total cultivated areas in Egypt. Furthermore, the coriander production

average was 342.3 tons during (1990-1997), on the other side, it increased to reach 407.9 during (1998-2004).

While for cumin crop at Assuit and El-Menia governorates, its average cultivated area at Assuit was 6028.8 Feddans representing 72.8% of its average cultivated area in Egypt during the studied period (1990-1997). It was decreased to 3760 representing 51.5 % of its average cultivated area in Egypt during the study period (1998-2004). The cumin production was from 3014.4 to 1880 tons during (1990-1997) and (1998-2004) respectively.

In addition, the cumin crop cultivated area at El-Menia governorate reached 2143.6 Feddans representing 26% of the total average of its cultivated area in Egypt during the study period (1990-1997), its registered increase reached 3026.6 Feddans representing 41.4% of the average of total of its cultivated area in Egypt during the study period (1998-2004). The average production was 1071.8 tons during the period (1990-1997) and increased to 1513.3 tons during the period (1998-2004).

Comparing that with caraway crop, it was seen that its cultivated area was concentrated at Monofia and Bahera governorates, where, its average cultivated area was 507.9 Feddans at Bahera representing 16.8% of the total cultivated area in Egypt for the study period (1990-1997), whereas, it decreased to 483 Feddans, representing 18.5% of the total cultivated area in Egypt for the study period (1998-2004). Its average production was 507.9 tons during the period (1990-1997) and decreased to 483.3 tons during the period (1998-2004).

Along with that, Caraway cultivated area reached 497 Feddans at Monofia governorate, representing 16.5% of the average of the total cultivated area in Egypt for the period (1990-1997) and decreased to 465 Feddans, representing 17.8% of the average of the total cultivated area in Egypt for the period (1998-2004). Its average production was 497 and 465 tons for the first and second studied periods respectively.

As for anise crop, its cultivated areas were concentrated at El-Menia and Fayum governorates. In El-Menia governorate, its cultivated area was 463 Feddan, equivalent to 53.3% of the average of the total cultivated area in Egypt, during the studied period (1990-1997) and increased to 613 Feddan, equivalent to 35.2% of the average of the total of cultivated area in Egypt, for the period (1998-2004). While its average production in the governorate was 370.4 and 490.4 tons for the first and second studies periods, respectively.

At the same time, Anise crop cultivated area at Fayum governorate was 349.3 Feddan representing 40.2% of the average of its total cultivated area in

**Table 4:** Average values of production function factors of aromatic crops for the farmers steadied sample

Variables	Cumin	Coriander	Caraway	Anise
observations	35	35	35	35
average cultivate area (feddan)	8.26	12.85	2.05	0.490
average production (feddan /ton)	0.50	1.00	1.00	0.70
average seed quantity (kg)	7	10	8	9
average manure fertilizer (m <sup>3</sup> /feddan)	20	10	25	15
average quantity of phosphate fertilizer (kg.)	200	200	200	200
average quantity of nitrogenous fertilizer (kg.)	150	200	150	200
average quantity of potassium fertilizer (Kg.)	100	100	100	100
average used labour (man/day/work)	17	18	17	18
average mechanical labour hours (hour)	2.5	2.5	2.5	2.5
average agricultural land rent (L.E./Feddan)	1200	1200	1200	1200

**Source:** studied sample data at Assiut, El-Menia, Monofia and Fayum Governorate (in 2005).

Egypt for the period (1990-1997) and increased to 1099.4 feddans, repressing 63% of the average of its total cultivated area in Egypt for the period (1998-2004). Its production in the governorate was 279.44 and 879.52 tons for the first and second studied periods, respectively.

**Production and Cost Functions for Aromatic Crops of Studied Samples:** Production functions concerning the studied aromatic crops were estimated as double logarithmic form. The crop production quantity was the dependent variable (y) and all production factors were independent variables ( $X_i$ ). Such factors were quantities of manure ( $X_1$ ) m<sup>3</sup>, Nitrogen ( $X_2$ ) kg. units, phosphate ( $X_3$ ) kg. units fertilizers and human labour quantity, man / day/labour ( $X_4$ ).

It was clear from table (4) that, there was similarity in most used treatments in aromatic crop production and there were small differences in gathering processes. For example, the average of the nitrogenous fertilizer quantity used in producing cumin in Assuit and caraway in Monofia.

Monofia were 150 kg. (by percentage of 33%) per Feddan each. It was noticed that this quantity have decreased in these two plants by using manure fertilizer which already has high quantity of nitrogenous compounds, in contrary of the quantities used in coriander and anise.

It was obvious also that, the average quantity of phosphate fertilizer was 200 kg. (by percentage 15%) per Feddan in all studies while these crops need huge quantity of potassium fertilizer (85-100 kg./feddan) for the shortage of this element in the soil. It was observed that, there was relative increase in used labour man/day/labour, for studied crops where the average

labour used in cumin crop production in Assuit and also in caraway production in Monofia was about 17 man/day/labour; 10 of them were used in crop gathering, 3 in sifting and sorting processes, in addition of 8 children, with an average wage 20 L.E. per day / man and 10 L.E. per child. It was also observed that, coriander crop Feddan (in Menia) and anise (in Fayum) used 14 men and 8 children; used in land preparation, fertilization, irrigation, crop gathering, sifting and crop preparation. Also, it was obvious that, the aromatic crop farms did not use herbicides because of its negative effect on plant marketing and exporting. And for mechanical labour which was used in land plowing before its cultivation, where the average cost of Feddan plowing was 70 L.E. that along with the irrigation machines which were used in irrigating coriander crop in Menia governorate and anise crop in Fayoum, using 3 irrigations, each one coasted 20 L.E. while the cumin crop in Assiut governorate and caraway in Monofia needed only 2 irrigations. It was noticed also that the fuel cost was 20 L.E. per feddan. That in addition of the presence of another spent money was about 3-5% of variable costs of crop product.

**Production and Cost Functions for Cumin at Assiut Governorate:** Table (5) illustrated the relationship between production quantity of an aromatic crop and its inputs factors by using double logarithmic model. Equation (1) showed cumin crop function at Assiut governorate where  $R^2$  was 0.8 which means 80% of the changes of production quantity to changes in manure fertilizer quantity ( $X_1$ ) m<sup>3</sup>, quantity of nitrogenous fertilizer ( $X_2$ ) by kg. and labour ( $X_4$ ) by man/day/work. It was of statistical fertilizer significant at 0.01 level

**Table 5:** Aromatic crop production functions for the studied sample at Assiut, El –Menia, Monofia and Fayoum Governorate

Equation No.	Crops	Equations	F	R <sup>2</sup>	Elasticity
1	Cumin	Log $\hat{y}_t = 1.81 + 0.2 \text{ Log } X_1 + 0.13 \text{ Log } X_2 + 0.2 \text{ Log } X_4$ (13.7) (5.6) (9.8)	92.1	0.8	0.53
2	Coriander	Log $\hat{y}_t = 2.1 + 0.18 \text{ Log } X_1 + 0.11 \text{ Log } X_2 + 0.22 \text{ Log } X_4$ (12.6) (9.8) (10.5)	138.7	0.89	0.51
3	Caraway	Log $\hat{y}_t = 1.78 + 0.13 \text{ Log } X_2 + 0.36 \text{ Log } X_4$ (14.7) (6.6)	91	0.98	0.49
4	Anise	Log $\hat{y}_t = 2.6 + 0.1 \text{ Log } X_2 + 0.2 \text{ Log } X_3 + 0.5 \text{ Log } X_4$ (12.7) (9.9) (11)	70.9	0.9	0.8

Where:  $\hat{y}_t$  = Estimated Crop Production quantity by ton in the observation t  
 $X_1$  = Manure fertilizer quantity by M<sup>3</sup> in the observation t  
 $X_2$  = Nitrogen fertilizer (conc. 33%) by kg. in the observation t  
 $X_3$  = Phosphate fertilizer (conc. 15 %) by kg. in the observation t  
 $X_4$  = Human labour by man / day / labour in the observation t

**Source:** Data of the sample at Assiut, El –Menia, Monofia and Fayoum Governorate.

was done, production elasticity for cumin was 0.53. It was shown that, the increase of the three factors by 1% may cause increase in crop production by 0.53%, this meant that, the farmers produced the crop at the economic production stage.

On the other hand, the relation between the total production cost and cumin production for the sample at Assuit governorate (which was represented by 35 farmers) has been estimated and the best efficient estimation form was the quadratic form, Table (6).

It was shown that, 84% of changes in production costs of the cumin sample were because of the changes in such factors, but the rest of changes were because of unmeasured factors of the function. And, it was of statistical significant at 0.01 level.

Also, it was obvious from the derived average cost function that, the lowest production size of average cost which maximize profit was 0.473 ton/ Feddan which achieved by 37% of the farmers sample for cumin crop (13 out of 35 farmers). The Actual production average for cumin farmers at Assuit governorate was 0.5 ton / Feddan.

**Coriander Production and Cost Functions for the Studies Farmers Sample at El Menia Governorate:**

Equation (2) in table (5) showed the production function of coriander crop at El- Menia governorate. The determinant factor (R<sup>2</sup>) was 0.89 which showed that, 89% of the changes of production referred to changes in the manure fertilizer ( $X_1$ ) M<sup>3</sup>, Nitrogenous fertilizer quantity ( $X_2$ ) and human labour ( $X_4$ ) by man/day/labor. It was of statistical significant at 0.01 level and production elasticity for such elements was 0.51 which indicate that, the increase of these three factors by 1% may cause increase in crop production by 0.51%, this meant that the farmers produced the crop in the economic production stage.

As well, the estimated relation between production cost and coriander crop production for the farmers sample at Menia governorate (35 farmers), showed that the quadratic form was the best efficient estimation one. Table (6) showed the changes in production (y) and its determinant factor was 0.71, it was illustrated that 71% of changes in production costs of the farmers sample were because of the changes in such factors while the rest of changes were because of unmeasured factors of the function. It was of statistical significant at 0.1 level. The derived average cost function which maximize profit showed the shortage in the lowest production size, it was 0.959 ton/Feddan for the farmers sample, this size was achieved by 45% of the farmers sample for coriander crop (17 out to 35 farmers). The average actual production of farmers at the governorat was 1 ton/ feddan.

**Caraway Production and Cost Functions for the Studies Farmers Sample at Monofia Governorate:**

Equation (3) in table (5) showed the production function of caraway crop at Monofia governorate, the determinant factor (R<sup>2</sup>) was 0.98 which reflected that 98% of the change in nitrogenous fertilizer quantity ( $X_2$ ) by pack and human labour ( $X_4$ ) by man/day/labor. It was of statistical significant at 0.01 level and production elasticity for these two factors was 0.49 which indicate that, the increase of these factors by 1% may cause increase in crop production by 0.49%, this meant that the farmers produced the crop in the economic production stage.

On the other hand for the farmer sample of Monofia governorate (35 farmers), it showed that quadratic form was the best efficient estimation form to estimate the relationship between the total production cost and Caraway production in Monofia. Table (6) showed the changes in production (y) and the

**Table 6:** Functions of total costs for producing aromatic crops by studied farmer sample at Assuit, El –Menia, Monofia and Fayum governorate.

Equation no.	Crops	Equations	R <sup>2</sup>	F
1	Cumin	$CQ_1 = -6738.86 + 35.75 y_1 - 0.04 y_1^2$ (8.577) (-8.506)	0.84	37.8
2	Coriander	$CQ_2 = -16575 + 36.7 y_2 - 0.018 y_2^2$ (4.215) (-4.088)	0.71	18.866
3	Caraway	$CQ_3 = -20771.4 + 45.85 y_3 - 0.023 y_3^2$ (11.503) (-10.968)	0.74	21.819
4	Anise	$CQ_4 = -41897.1 + 140.47 y_4 - 0.08 y_4^2$ (5.582) (-5.609)	0.79	18.26

Where: CQ1= Total costs of cumin feddan by L.E. in the observation t  
 CQ2= Total costs of coriander feddan by L.E. in the observation t  
 CQ3 = Total costs of caraway feddan by L.E. in the observation t  
 CQ4= Total costs of anise feddan by L.E. in the observation t  
 Y<sub>1</sub>= Cumin feddan production (ton) in the observation t  
 Y<sub>2</sub>= Coriander feddan production (ton) in the observation t  
 Y<sub>3</sub>= Caraway feddan production (ton) in the observation t  
 Y<sub>4</sub>= Anise feddan production (ton) in the observation t  
**Source:** Data of the sample at Assiut, El –Menia, Monofia and Fayoum Governorate.

determinant factor was 0.74 which illustrated that, 74% of changes in production costs of the caraway sample were because of the changes in the production. It was of statistical significant at 0.01 level. The derived average cost function declared that the lowest production size of average cost which maximize profit was 0.950 ton / Feddan for the farmers sample, this size was achieved by 34% of the farmer sample for caraway crop (12 out of 35 farmers) while. The actual production average for caraway farmers at the governorate was 1 ton/ feddan.

**Anise Production and Cost Functions for the Studied Farmers Sample at Fayum Governorate:**

Equation (4) in table (5) showed the determinant factor was 0.9 which indicates that 90% of the changes of anise production in Fayoum referred to changes in nitrogenous fertilizer quantity (X<sub>2</sub>) by kg., phosphate fertilizer quantity (X<sub>3</sub>) by kg. and human labour (X<sub>4</sub>) by man /day/labor. And it was of statistical significant at 0.01 level and production elasticity for such crop was 0.8 where the increase in such factors by 1% may cause increasing in crop production by 0.8%, this meant that, the farmers produced the crop at the economic production.

Hence, the relation between production cost and anise crop production for the farmers sample at Fayum governorate (35 farmers) had been estimated and it was shown that the quadratic form was the best efficient estimation one.

Table (6) showed the determinant factor was 0.79 which indicate that changed in production (y) explained 79% of changes in production costs of the anise sample of changes were because of unmeasured factors of the function. It was of statistical significant at 0.01

level. The lowest production size of average cost which maximize profit was 0.723 ton /Feddan for the farmer sample, this size was achieved by 40% of the farmers sample for Anise crop (14 out of 35 farmers. The actual production average for Anise farmers at the governorate was 0.7 ton/ feddan.

**Aromatic Crops Production Efficiency for the Studies Sample:**

**Some Efficiency Indicators:** Efficiency indicates the relationship between inputs and outputs and this concept will be applied on different relations according to the considered problem. It may consider the ideal combination between inputs which give the maximum product in economy by using available sources and not harm them. Thus, it achieves, the maximum benefit<sup>[6]</sup>. The study used some efficiency indicators such as:

- Total production value per area unit (Feddan): It is computed by multiplying total product quantity by market prices.
- Net revenue per area unit (Feddan): It is considered as total indicators for the economic efficiency, it is computed by subtracting total cost per area unit from total revenue per area unit.
- Total revenue to total cost ratio: It is considered as total economic efficiency criteria, this criterion is the ratio between production value to the cost of the used production factors in production processes.
- Variable costs to total revenue ratio: this indicator is used to identify the efficiency of only variable production factors especially when the constant costs are considered to be very large, if compared by the total costs <sup>[2]</sup>.

**Table 7:** Production Efficiency Of The Studied Crops

Crops	Farmgate Price/ L.E. ton	Total revenues (L.E.)	Variable costs (L.E.)	Total costs (L.E.)	Net returns (L.E.)	Average production Ton/ Feddan	Total revenues/ total costs Ratio	Total revenues/ variable costs Ratio	Average variable costs per ton	Average total costs per ton production	L.E. Profitability
Coriander	5000	5000	1101	2301	2699	1	2.17	4.54	1101	2301	1.17
Cumin	11500	5750	1050	2250	3500	0.5	2.55	5.48	2100	4500	1.56
Caraway	6000	6000	1272	2472	3528	1	2.43	4.72	1272	2472	1.42
Anise	8500	5950	1240	2440	3510	0.7	2.44	4.8	1771.43	3485.7	1.43

**Source:** Data extracted from the field study at Assuit, El-Menia, Monofia and Fayoum governorates (2005)

- Average variable cost for producing one ton of the crop: this criterion is used to identify the variable costs for produced unit of a crop. Thus, judging on the economic efficiency in the absence of constant costs and on the extent of goodness of used productive combination. It is computed by dividing variable cost over the physical production quantity.
- Average total costs for producing one ton: it is computed by dividing total costs per feddan over the average production of the crop per Feddan.
- Net revenue of spent Egyptian pound (L.E.): It is used to identify the achieved net revenue value by piaster/pound which has been spent as productive costs. It is calculating by dividing the feddan net revenue (by pound) over feddan total costs (by pound)<sup>[11]</sup>.

**Coriander Crop Production Efficiency:** By studying revenues, costs and production efficiency indicators and evaluating results of feddan production efficiency of coriander crop (Table 7), it was seen that, total revenues were 5000 L.E./feddan, variable costs were 1101 L.E./feddan and net return per feddan was 2699 L.E./feddan. The table shows also that the ratio between total revenues and variable costs was 4.54. and the average variable costs per ton, it registered 1101 and finally, the profitability of Egyptian pound / Feddan was 1.17.

**Cumin Crop Production Efficiency:** By studying revenues, costs and production efficiency indicators and evaluating results of feddan production efficiency of cumin crop (Table 7), it was shown that the total revenues reached to 5750 L.E./feddan and for variable costs, it were 1050 L.E. / Feddan. The total costs were 2250 L.E., net returns per feddan was 3500 L.E./ Feddan, net returns were 3500 L.E. per feddan, total revenues/ total costs ratio registered 2.55 and the ratio between total revenues and variable costs was 5.48. As for the average variable costs per ton, it registered 2100 and finally, the profitability of Egyptian pound/ Feddan was 1.56.

**Caraway Crop Production Efficiency:** By studying revenues, costs and production efficiency indicators and evaluating results of feddan production efficiency of caraway crop (Table 7), it was seen that, total revenues were 6000 L.E./feddan, variable costs were 1272 L.E./feddan and net returns per feddan was 3528 L.E./feddan. The table shows also that the total revenues/ total costs ratio registered 2.43 and ratio between total revenues and variable costs was 2.72 and finally, the profitability of Egyptian pound / Feddan was 1.42.

**Anise Crop Production Efficiency:** By studying revenues, costs and production efficiency indicators evaluating results of feddan productive efficiency of anise crop (Table 7), it was illustrated that, total revenues were 5950 L.E./ feddan, as for variable costs, it registered 1240 L.E./ feddan, net returns per feddan was 3510 L.E./feddan, total revenues/ total costs ratio registered 2.44. The table shows also that the ratio between total revenues and variable costs was 4.8, the average variable costs per ton was 1771.43 and finally, the profitability of Egyptian pound / feddan was 1.43.

**The Production Problems of Aromatic Crop Farmer in the Studied Sample:**

**1-coriander Crop Farmer’s Production Problems:** All participants in the field study showed that, the main problem facing coriander crop was plant disease. The second problem is increasing labor costs, then ineffective pesticides and increasing production costs come, where participants in the studies sample assured that by 100%, 80%, 60% and 45% respectively. Also, 65% of participants assured that the crop traders’ monopoly was one of the main problems facing the production of this crop. Therefore, the plant disease problem was considered the main problem facing coriander cultivation.

**2- Cumin Crop Farmer’s Production Problems:** It was shown from the field study that the first production problem facing the cumin farmers was the increase of labor cost, where the farmers in the studied sample

assured that by 85%. The second problem was the increase of production costs then, ineffective pesticides, where, the cumin farmers in the studied sample assured that by 60% and 72%, respectively. As for the absence of the suitable prices, because of the monopoly statuses of the crop traders, 65% out of participants assured that it was one of the most important problems facing cumin production. Therefore, the main problem in producing cumin was the increase of labor cost.

**3- Caraway Crop Farmer's Production Problems:** It was seen from the field study that, the first production problem facing the caraway farmers was the increase of labor wages, particularly during crop harvesting, besides the disease diffusion, where, the farmers assured that by 68% for the first problem and 27% for the second. Therefore, it was considered that the main problem in producing caraway crop was the increase of labor wages.

**4- Anise Crop Farmers Production Problems:** The filed study showed that, the first production problem facing the anise farmers was the increase of labor wages, where, the farmers assured that by 95%. Then the second problem, as shown by results, was the infection by different diseases, the absence of effective pesticides and the increase of production costs by percentage of 80%, 75% and 60%, respectively of total participants. Then it was clear that, the main production problem facing the anise farmers was the increase of labor wages.

#### **Suggested Solutions for Production Problems of the Studied Aromatic Corps:**

**1- Suggested Solutions for the Studied Coriander Crop Farmers' Sample:** The study showed that, the most important solutions for such farmers were supplying them by loans from agricultural banks, sustainable irrigation and by selected clean seeds, low price effective pesticides and finally by production inputs with suitable price. These solutions registered acceptance from coriander farmers by 40%, 20%, 10%, 100% and 60% of the total studied coriander farmers sample.

**2- Suggested Solutions for the Studied Cumin Crop Farmers' Sample:** The study showed that, the most important solutions for such farmers were supplying them by selected clean seeds and production inputs, where the farmers assured that by 100% and 55%, respectively. Also, supplying them by trained specialized agricultural guides in the field of aromatic and medicinal plants, besides, establishing societies for aromatic and medicinal plant producers, where the

studied farmers' sample assured that by 80% and 70%, respectively (where established societies have no effective role for farmers).

**3- Suggested Solutions for the Studied Caraway Crop Farmers' Sample:** The study showed that, the most important solutions for these farmers were supplying them with loans from the agricultural banks, saving production inputs which must be of reasonable prices, when the studied farmers' sample assured that by 55%, 70% and 90%, respectively.

**4- Suggested Solutions for the Studied Anise Crop Farmers' Sample:** It was seen from the study that, the most important solutions for such farmers were supplying them by selected clean seeds, loan from agricultural banks, production inputs with reasonable prices, trained – specialized agricultural guides and finally, establishing medicinal and aromatic plant production and marketing societies. The farmers' sample assured such result by 75%, 70%, 100%, 95% and 80%, respectively.

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