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اقتصاديات انتاج أهم النباتات الطبية والعطرية في مصر

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المستخلص

فى مصر يتوفر مناخ مناسب لزراعة النباتات الطبية والعطرية، إلا أنها تزرع بمساحات غير كافية من تلك النباتات التي تعتبر الذهب الأخضر الذي يمكن ان يحقق للبلاد مكاسب كبيرة. وتحتاج زراعة تلك النباتات الى رعاية وعناية خاصة تزيد من التكلفة الإنتاجية وتؤثر على الربحية الفدانية مما تؤدى الى تذبذب اتجاهات الزراع نحو زراعة تلك الزروع، وحدوث تقلبات في المساحة المنزرعة من تلك الزروع. واستهدف البحث دراسة اقتصاديات انتاج أهم زروع النباتات الطبية والعطرية، ومدى الاختلاف بين التكاليف والايراد وصافي الايراد الفدانى والكفاءة الاقتصادية لتلك الزروع. اعتمد البحث على استخدم أسلوب التحليل الإحصائي الوصفي والاستدلالي لتحقيق أهداف البحث. تم اختيار زروع الشيح البابونج والكراوية والكركدية والريحان والعتر والبردقوش واليانسون، وتمثل تلك الزروع نحو 66.46% من متوسط مساحة النباتات الطبية والعطرية خلال الفترة2017-2021 والمقدرة بنحو 99.577 ألف فدان.

تبين وجود زيادة معنوية في المساحة المزروعة من النباتات الطبية والطبية والعطرية موضع الدراسة، فيما عدا نباتي الشيح البابونج والبردقوش، وكانت اعلاها في الكراوية والكركدية بزيادة بلغت 572، 446 فدان على الترتيب. كما تبين وجود زيادة معنوية في التكاليف الإنتاجية الفدانية للزروع موضع الدراسة، بلغت اعلاها لليانسون بنحو 1135 جنية، البردقوش 1096 جنية. كذلك كانت الزيادة في صافي العائد الفدانى لتلك الزروع معنوية، فيما عدا الشيح البابونج والكركدية..

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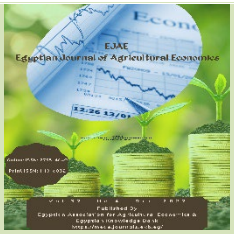

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The economics of the production of the most important medicinal and aromatic plants in Egypt

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ABSTRACT

The cultivation of medicinal and aromatic plants requires special care that increases the production cost and affects the profitability of feddans, which leads to fluctuating trends among farmers regarding these crops and fluctuations in their cultivated area.

The research aimed to study the economics of the production of the most important medicinal and aromatic plants, and the extent of the difference between costs, revenue, net revenue per feddan, and the economic efficiency of these crops.

Wormwood crops of chamomile, caraway, hibiscus, green basil, geranium, marjoram, and anise were selected.It was found that there was a significant increase in the cultivated area of medicinal and aromatic plants under study, except for wormwood, chamomile, and marjoram, and the highest was in caraway and hibiscus, with an increase of 572 and 446 feddans, respectively.

Using some efficiency measures to compare the study crops. It was found that the attar crop ranked first among the study crops in terms of the return of the Egyptian pound with an average of about EGP 8.4, followed by basil with an average of about EGP 5.1. It is followed by hibiscus with an average of about EGP 4.4, followed by marjoram with an average of about EGP 3.8, followed by star anise with an average of about EGP 2.6, followed by caraway with an average of about EGP 1.8, and chamomile wormwood ranks last with an average of about EGP 1.2.

As for the unit cost of the cultivation price, it was 89%, 48%, 48%, 48%, 28%, 27%, 15%, 12%, wormwood, chamomile, caraway, star anise, hibiscus, marjoram, basil, and attar, respectively.

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Introduction

The group of medicinal and aromatic plants is one of the oldest plants known to history and used by man throughout the ages for various purposes; some were used as food and others were used as medicine or perfumes, and it appeared from ancient times their importance and their multiple uses in the pharmaceutical industries and daily uses such as spices, essential oils, ornamental purposes, and other uses.

Egypt is one of the countries with a suitable environment for the cultivation and production of these crops, as it is cultivated in many areas inside and outside the valley and the desert, and it is characterized by the availability of light and thermal range suitable for the cultivation of these plants, as well as the types of land that suit the production of medicinal and aromatic plants with different ground needs.

Despite the availability of the appropriate climate in Egypt for the cultivation of these plants, they are grown in insufficient areas to produce large quantities, which can bring the country great gains as they are multi-industries with direct and indirect uses, due to their need for attention from the fields of research and development and sufficient investment to expand their cultivation for development and modern accompaniment to various agricultural operations and transactions, starting from the stages of its integrated production, marketing, and export system.

Study problem:

Despite the economic and industrial importance of medicinal and aromatic plants, the multiplicity of their types, their high economic return, and the availability of environmental and climatic conditions, they still constitute a small percentage in the crop area of Egyptian agriculture, ranging between 0.39% and 0.79% during the period 2003-2021.

It is noted that the cultivation of these plants needs special care that increases the production cost and affects the profitability of feddans, which leads to fluctuations in farmers' attitudes towards the cultivation as well as fluctuations in their cultivated area.

Research Objective:

The research mainly aims to study the economics of the production of the most important medicinal and aromatic plants, and the following sub-objectives are addressed: study the productive and economic indicators of the most important of these crops; study the most important criteria for the economic efficiency of those crops; study the extent of the difference between costs, revenue, net revenue feddans, and their economic efficiency.

Research method and data sources:

The research depends on the use of the method of descriptive and inferential statistical analysis to achieve the objectives of the research, through the use of some mathematical and statistical methods such as arithmetic averages, percentages, and analysis of general trend equations.

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Analysis of variance and the least significant difference test are also used to study the difference between the costs and net acre return of the cultivation of medicinal and aromatic plants under study. The research depends on published and unpublished data issued by the Agricultural Economics Bulletin, the Central Administration for Agricultural Economics, the Ministry of Agriculture, and Land Reclamation, in addition to some references and previous studies that serve the nature of the research.

First: The relative importance of the area of medicinal and aromatic plants from the total crop area in Egypt

The study of the indicators in Table (1) shows that the relative importance of the area of medicinal and aromatic plants in the total crop area during the study period ranged between a minimum of about 0.39% in 2013 and a maximum of about 0.79% in 2019, with an annual average of about 0.53% during the period 2003-2021.

By calculating the equation of the linear time trend, it is clear from Table (2) that the relative importance of the area of medicinal and aromatic plants in the total crop area increases annually during the study period 2003-2021 by about 0.013 feddans, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.465, which means that time reflects 47% of the variables affecting the relative importance of the area of medicinal and aromatic plants in the total crop area, and the statistical significance of the mathematical image used was proven.

Table (1) Evolution of crop area and area of medicinal and aromatic plants per feddan in Egypt as an average for the period 2003-20212021

years	% of total medicinal and aromatic plants of crop area
2003	0.42
2004	0.49
2005	0.46
2006	0.42
2007	0.52
2008	0.46
2009	0.56
2010	0.55
2011	0.47
2012	0.45
2013	0.39
2014	0.45
2015	0.48
2016	0.51
2017	0.61
2018	0.66
2019	0.79
2020	0.62
2021	0.67
Average	0.53
minimum	0.39
maximum	0.79

Source: Collected and computed from data from the Ministry of Agriculture and Land Reclamation, the Central Administration for Agricultural Economics, Agricultural Economics Bulletin, miscellaneous

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Table (2) Equations of the general time trend of crop area and area of medicinal and aromatic plants per feddan in Egypt 2003-2021

Variable	F	R2	Estimated equation
The relative importance of the area of medicinal and aromatic plants of the total crop area (feddans)	14.759	0.465	Y= 0.399+0.013 Xi (10.701) **(3.842) **

(Y) where: Estimated value % of total medicinal and aromatic plants from crop area
Xi = Time variable where (1,2,3,....... 21)
value in parentheses indicates calculated (T).
(R2) Coefficient of determination
(F) indicates the significance of the regression coefficient
(*) indicates the significance of the regression coefficient at the level of 0.05
(**) indicates the significance of the regression coefficient at the level of 0.01
Source: Collected and calculated from Table 1 data

Second: The relative importance of the area of the most important medicinal and aromatic crops in Egypt

Medicinal and aromatic plants are divided into three main sections, namely medicinal plants, aromatic plants, and aromatic grains.

Medicinal plants: Table (3) shows that the average area of medicinal plants during the period 2017-2021 reached to about 55.26 thousand feddans, and they constitute the largest share of medicinal and aromatic plant groups, representing about 50% of them.
The crop of chamomile wormwood, caraway, and hibiscus comes at the forefront of medicinal plants in terms of cultivated area, as the cultivated area for each of them during the study period was about 14.51 thousand feddans, 13.337 thousand feddans, 8.3 thousand feddans, representing about 14.57%, 13.39%, and 8.33%, respectively, of the average area of the group of medicinal and aromatic plants and aromatic grains in Egypt during the study period.
Aromatic grains: As for the group of aromatic grains, which comes in second place from the group of medicinal and aromatic plants, the average total area of these plants was about 24.619 thousand feddans during the study period, representing about 24.721% of the total area of medicinal and aromatic plants. Marjoram and anise crops are the most important crops planted with aromatic grains, as the area reached about 5963 and 7,041 feddans, representing 7.07% and 5.99% of the average area of the group of medicinal and aromatic plants and aromatic grains in Egypt during the study period. Table (3)

Aromatic plants: Table (3) shows that the average area of aromatic plants during the period 2017-2021 reached to about 19.69 thousand feddans and constitutes the lowest share of the group of medicinal and aromatic plants, representing about 20% of them.
The green basil crop and geranium are at the forefront of aromatic plants in terms of cultivated area, as the cultivated area for each of them during the study period was about 11.984 and 5.651 feddans, representing about 5.675%, and 12.03% of the average area of the group of medicinal and aromatic plants and aromatic grains in Egypt during the study period.
According to the above, the research will be concerned with the crops of chamomile wormwood, caraway, and hibiscus for medicinal plant group, green basil and geranium for the aromatic plant group, and marjoram and star anise for the aromatic grain group.

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Table (3): The Relative Importance of the Cultivated Area in Feddan of the Most Important Medicinal and Aromatic Plants and Aromatic Grains in Egypt during the Period 2017-2021

Crop / years	2017	2018	2019	2020	2021	total	Average	%
Chamomile wormwood	15071	15920	16568	11812	13186	72557	14511.4	14.57
Caraway	14653	19254	12691	9275	10813	66686	13337.2	13.39
Hibiscus	13668	11118	12420	13556	1933	41499	8299.8	8.33
Parsley	1862	2325	1589	1593	13842	21211	2424.2	2.43
Thyme	869	763	1442	2130	2505	7709	1553.8	1.56
Dry chili	1510	1287	1167	676	737	5377	1075.4	1.080
Green mint	4435	4880	5558	10607	7384	32864	6572.8	0.66
Green chili	912	1264	1369	1553	1541	6639	1327.8	1.33
Henna	958	1884	1736	1939	1094	7611	1522.2	1.53
Dill	1107	628	1053	287	888	3963	792.6	0.80
Green coriander	10	12	132	276	295	725	145	0.15
Sugar corn	0	139	177	197	291	804	160.8	0.16
Maghat	164	82	71	44	36	397	79.4	0.080
Peppermint (green)	34	452	349	549	1348	2732	546.4	0.55
Moonflower (Clandiola)	1195	1087	1757	632	596	5267	1053.4	1.058
Jojoba	927	801	1113	990	795	4626	925.2	0.93
Moringa	110	71	296	297	289	1063	212.2	0.21
Sage	299	153	315	471	292	1530	306	0.31
Bitter orange	16	10	24	39	52	141	28.2	0.028
Guava leaf	22	10	10	10	10	62	12.4	0.012
Cloves	528	625	722	0	7	1882	376.4	0.38
Total medicinal	57855	62758	130836	179033	57994	449046	55262.6	49.548
Basil	8544	9762	13106	13910	14596	59918	11983.6	12.03
Geranium	5144	6133	4396	4586	7997	28256	5651.2	5.675
Lemongrass	1445	638	1073	1050	1239	5445	1089	1.093
Jasmine	631	638	751	749	755	3488	697.6	0.701
Local roses	98	409	298	268	299	1372	274.4	0.28
Total aromatic	15862	17580	19624	20563	24886	186015	19695.8	19.779
Marjoram	6534	8512	7546	7032	5583	35207	7041.4	7.071
Star anise	2816	3244	8494	6619	8644	29817	5963.4	5.99
Fennel	4355	4523	4080	3611	1935	18504	3700.8	3.72
Cumin	2587	3909	4094	3582	3663	17835	3567	3.58
Dry coriander	3967	4068	2793	2451	3259	16538	3307.6	3.32
Nigella Sativa	862	228	220	85	200	1595	1039	1.04
Total grains	21121	24484	33227	23353	23284	119556	24619.2	24.721
Total plants	94838	104822	183687	222949	106164	754617	99577.6	100.00

Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economics, Agricultural Economy Bulletin, miscellaneous issues

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Third: The Trend of the cultivated area of the most important medicinal and aromatic plants in Egypt during the period 2003-2021

1- The trend of the area of chamomile wormwood crop:

Table (4) shows that the area of chamomile wormwood crop during the study period ranged from a minimum of about 1271 feddans in 2018 to a maximum of about 16567 feddans in 2019 with an annual average of about 9259 feddans during the period 2003-2021.

By calculating the equation of the time trend, it is clear from Table (5) that the area of the chamomile wormwood crop increases annually during the study period by about 107.235 thousand feddans, where the statistical significance of this increase was not proven, nor did the statistical significance of the mathematical image used, which means that the area does not change and fluctuate around the average during the study period.

2- The trend of the caraway crop area:

Table (4) shows that the area of the caraway crop during the study period ranged from a minimum of about 2202 feddans in 2006 to a maximum of about 19254 feddans in 2018, with an annual average of about 7050 feddans during the study period.

By calculating the equation of the linear time trend. It is clear from Table (5) that the area of the caraway crop is increasing annually during the study period, which amounted to about 571.989 thousand feddans, and the statistical significance of this increase has been proven.
The coefficient of determination was 0.515, which means that time reflects 52% of the variables affecting the area of the caraway crop, and the statistical significance of the model was proven.

3- The trend of the hibiscus crop area:

Table (4) shows that the area of the hibiscus crop during the study period ranged from a minimum of about 3861 feddans in 2020 to a maximum of about 13910 feddans in 2018 with an annual average of about 7618 feddans during the study period.

By calculating the equation of the linear time trend, it is clear from Table (5) that the area of the hibiscus crop increases annually during the study period 2003-2021 by about 446.163 feddans, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.701, which means that time reflects 70% of the variables affecting the area of the hibiscus crop, and the statistical significance of the mathematical image used was proven.

4- The trend of the basil crop area:

Table (4) shows that the area of the basil crop during the study period ranged from a minimum of about 554 feddans in 2016 to a maximum of about 14,746 feddans in 2004, with an annual average of about 7,563 feddans.

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By calculating the equation of the linear time trend, it is clear from Table (5) that the area of the basil crop increases annually during the study period 2003-2021 by about 402.686 feddans, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.410, which means that time reflects 41% of the variables affecting the area of the basil crop, and the statistical significance of the mathematical image used was proven.

5- The trend of the area of the geranium crop:

Table (4) shows that the area of the geranium crop during the study period ranged from a minimum of about 1549 feddans in 2009 to a maximum of about 9055 feddans in 2021, with an annual average of about 4492 feddans.

By calculating the equation of the linear time trend, it is clear from Table (5) that the area of the attar crop increases annually during the study period by about 195.018 feddans, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.409, which means that time reflects 41% of the variables affecting the area of the attar crop, and the statistical significance of the mathematical image used was proved.

6- The trend of the area of the marjoram crop:

Table (4) shows that the area of the marjoram crop during the study period ranged between a minimum of about 4219 feddans in 2014, and a maximum of about 16182 feddans in 2014 with an annual average of about 71450.21 feddans.

By calculating the equation of the linear time trend, it is clear from Table (5) that the area of the marjoram crop decreases annually during the study period by about -66.844 feddans, and the statistical significance of this decrease has not been proven.

The statistical significance of the mathematical image used was not proven, which means that the area did not change and fluctuate around the average during the study period.

7- The trend of the area of the star aniseed crop:

Table (4) shows that the area of the star anise crop during the study period ranged from a minimum of about 1011 feddans in 2012 to a maximum of about 8544 feddans in 2021, with an annual average of about 3226 feddans.

By calculating the equation of the linear time trend, it is clear from Table (5) that the area of the star anise crop increases annually during the study period by about 247.135 feddans, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.339, which means that time reflects 34% of the variables affecting the area of star anise, and the statistical significance of the model as a whole was proven.

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Table (4) Evolution of the total area (feddans) of medicinal and aromatic crops during the period 2003-2021

Years	Star anise	Marjoram	Geranium	Basil	Hibiscus	Caraway	Chamomile
2003	1613	3806	3328	3891	3861	3732	7621
2004	2159	9167	5548	6290	6290	4546	9813
2005	2216	5292	3314	5434	4725	3564	7935
2006	1864	6413	2600	5413	5304	2202	6042
2007	2786	6574	3855	7929	6016	4367	7321
2008	1619	9309	3194	4778	4778	4468	9304
2009	1941	16182	1549	8033	7983	7371	11502
2010	6151	6693	2919	6383	6353	5138	10184
2011	3566	6519	4904	6906	6731	4063	10038
2012	1011	11771	5319	6536	6536	6384	11549
2013	1091	4871	2583	5700	5700	3705	8763
2014	1583	4219	5006	7986	7986	3514	11099
2015	1570	6352	4880	6809	6576	6379	9136
2016	2408	6084	5795	554	6871	7824	12661
2017	2816	6534	5144	8764	8544	14653	2653
2018	3244	5812	6133	9982	9762	19254	1271
2019	8494	7546	4406	13371	12975	12691	16567
2020	6619	7032	5808	14197	13910	9275	9275
2021	8544	5583	9055	14746	13842	10813	13186
Average	3226	7145	4492	7563	7618	7050	9259
minimum	1011	3806	1549	554	3861	2202	1271
maximum	8544	16182	9055	14746	13910	19254	16567

Source: Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economics, Agricultural Economics Bulletin, miscellaneous issues.

Table (5) Equations of the general time trend of the development of the area of medicinal and aromatic plants (Feddan) during the period from 2003-2021

Crop	F	R2	Time trend equation
chamomile wormwood	0.517	0.030	Y= 8186.596+107.235Xi (4.814) ** (0.719)
caraway	18.028	0.515	Y=1329.737 +571.989 Xi (0.866) (4.246) **
Hibiscus	39.855	0.701	Y=3156.421 +446.163 Xi (3.917) (6.313) **
Basil	11.832	0.410	Y=3536.404 +402.686 Xi (2.649) ** (3.440) **
Geranium	11.784	0.409	Y= 2541.404+195.018Xi (3.923) ** (3.433) **
Marjoram	0.297	0.017	Y= 7813.649+ -66.844-Xi (5.591) ** (-0.545-)
Star anise	8.679	0.339	Y= 754.702+ 247.135Xi (0.789) (2.946) **

Where (Y) = Estimated value of medicinal and aromatic plant area.
Xi = Time variable where (1,2,3,....... 21)
value in parentheses indicates calculated (T).
(R2) Coefficient of determination
(F) indicates the significance of the regression coefficient
(*) indicates the significance of the regression coefficient at the level of 0.05
(**) indicates the significance of the regression coefficient at the level of 0.01
Source: Compiled and calculated from Table 4 data

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Fourth: Production costs of the most important medicinal and aromatic plants in Egypt during the period 2010-2020

By studying the evolution of the feddan production costs of the study crops of medicinal and aromatic plants during the period 2010-2020, the structure of productive costs was considered one of the important axes in making the farm decision on the distribution of limited agricultural resources to various agricultural activities, in addition to being one of the main elements in estimating the net return per feddan.

<u>1- The trend of feddan production costs for chamomile wormwood:</u>

Table (6) shows that the amount of the feddans costs during the study period ranged from a minimum of about EGP 3502 in 2010 to a maximum of about EGP 12267 in 2020, with an annual average of about EGP 6749.

By calculating the equation of the linear time trend, it is clear from Table (7) that the amount of the feddan costs increases annually during the study period by about EGP 881.018, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.922. This means that time reflects 92% of the variables affecting the amount of the feddan costs, and the statistical significance of the mathematical image used has been proven.

<u>2- The trend of the feddan production costs of the caraway plant:</u>

Table (6) shows that the amount of the feddans costs during the study period ranged from a minimum of about EGP 2709 in 2010 to a maximum of about EGP 11898 in 2020, with an annual average of about EGP 6284.

By calculating the equation of the linear time trend, it is clear from Table (7) that the amount of the feddans costs increases annually during the study period by about EGP 972.418.

The coefficient of determination was 0.875. This means that time reflects 88% of the variables affecting the amount of the feddan costs, and the statistical significance of the mathematical picture used has been proven.

<u>3- The trend of the feddan production costs of the hibiscus plant:</u>

Table (6) shows that the amount of the feddans costs during the study period ranged from a minimum of about EGP 2321 in 2010 to a maximum of about EGP 8692 in 2020, with an annual average of about EGP 4542.

By calculating the equation of the linear time trend, it is clear from Table (7) that the amount of the feddan costs increases annually during the study by about EGP 651.855.

The coefficient of determination was 0.883. This means that time reflects 88% of the variables affecting the size of the feddan costs, and the statistical significance of the mathematical image used has been proven.

<u>4- The trend of the feddan production costs of the green basil plant:</u>

Table (6) shows that the amount of the feddans costs during the study period ranged from a minimum of about EGP 2531 in 2011 to a maximum of about EGP 11038 in 2020, with an annual average of about EGP 5753.

By calculating the equation of the linear time trend, it is clear from Table (7) that the amount of the feddans costs increases annually during the study period by about EGP 862.900, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.909, which means that time reflects 91% of the variables affecting the amount of feddan costs, and the statistical significance of the mathematical image used was proven.

5- The trend of the feddan production costs of the geranium plant:

Table (6) shows that the amount of the feddans costs during the study period ranged from a minimum of about EGP 3973 in 2010 to a maximum of about EGP 12057 in 2020, with an annual average of about EGP 6566.

By calculating the equation of the linear time trend, it is clear from Table (7) that the amount of the feddans costs increases annually during the study period by about EGP 800, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.665, which means that time reflects 67% of the variables affecting the size of feddan costs, and the significance of the model as a whole was proven.

6- The trend of feddan production costs for marjoram plant:

Table (6) shows that the amount of the feddans costs during the study period ranged from a minimum of about EGP 3259 in 2011 to a maximum of about EGP 13260 in 2020, with an annual average of about EGP 7582.

By calculating the equation of the linear time trend, it is clear from Table (7) that the amount of the feddans costs increases annually during the study period by about EGP 1096.164, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.891, which means that time reflects 89% of the variables affecting the size of the costs per feddan, and the significance of the model as a whole was proven.

7- The trend of feddan production costs for star anise:

Table (6) shows that the amount of the feddan costs during the study period ranged from a minimum of about EGP 2945 in 2010 to a maximum of about EGP 12269 in 2020, with an annual average of about EGP 6964.

By calculating the equation of the linear time trend, it is clear from Table (7) that the amount of the feddans costs increases annually during the study period by about EGP 1134, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.906, which means that time reflects 91% of the variables affecting the size of feddan costs, and the significance of the model as a whole was proven.

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Table (6) Feddan Production Costs (in EGP) of Study Crops of Medicinal and Aromatic Plants and Aromatic Grains during the Period 2010-2020

plants * years	Star anise	Geranium	Geranium	Basil	Hibiscus	Caraway	chamomile wormwood
2010	2945	3594	3973	2966	2321	2709	3502
2011	3004	3259	4256	2531	2531	2950	3857
2012	3116	3432	4402	3441	2810	2984	4046
2013	3360	6608	4548	3473	2735	3371	4130
2014	3668	3801	5082	3896	2948	3804	4137
2015	5909	6298	6769	4187	3007	5787	6467
2016	9234	8813	4276	5923	5017	8001	7776
2017	9988	10702	4482	7497	5625	9636	8635
2018	11702	12156	10759	8373	6542	6886	9664
2019	11407	11478	11618	9953	7732	11097	9753
2020	12269	13260	12057	11038	8692	11898	12267
Average	6964	7582	6566	5753	4542	6284	6749
minimum	2945	3259	3973	2531	2321	2709	3502
maximum	12269	13260	12057	11038	8692	11898	12267

*No data available prior to this period
Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, the Central Administration for Agricultural Economics, the Agricultural Economy Bulletin, miscellaneous.

Table (7) Equations of the general time trend of the feddan production costs (in Egp) of study crops of medicinal and aromatic plants during the period 2010-2020

plants	F	R2	Time trend equation
chamomile wormwood	107.111	0.922	Y= 1462.018+ 881.018Xi (2.533) * (10.349) **
caraway	62.905	0.875	Y= 449.400+ 972.418Xi (0.540) (7.931) **
Hibiscus	67.897	0.883	Y= 630.692+ 651.855 Xi (1.175) (8.240) **
Basil	89.966	0.909	Y= 575.145+ 862.900Xi (0.932) (9.485) **
Geranium	17.849	0.665	Y= 1765.582+ 800.009Xi (1.375) (4.225) **
Marjoram	73.772	0.891	Y= 1004.927+1096.164 Xi (1.161) (8.589) **
Star anise	87.195	0.906	Y= 155.891+1134.655Xi (0.189) (9.338) **

Where (Y) = Estimated value of the evolution of the feddan production costs of study crops of medicinal and aromatic plants
Xi = Time variable where (2010, 2011, 2012....... 2020)
value in parentheses indicates calculated (T).
(R2) Coefficient of determination
(**) indicates the significance of the regression coefficient at the level of 0.01
(*) indicates the significance of the regression coefficient at the level of 0.05
Source: Collected and calculated from Table 6 data

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Fifth: Net feddan return for the most important medicinal and aromatic plants in Egypt during the period 2003-2021

1- Net feddan yield of chamomile wormwood:

Table (10) indicates that the net yield of wormwood during the study period ranged from a minimum of about EGP 887 per feddan in 2018 to a maximum of about EGP 6913 in 2019, with an annual average of about EGP 1074.

By calculating the equation of the linear time trend, it is clear from Table (11) that the net return increases annually during the study period by about EGP 398 per feddan, and the statistical significance of this increase was not proven, nor did the significance of the model prove. This means that the net feddan yield of wormwood fluctuates around the average.

2- Net feddan yield of caraway:

Table (10) indicates that the net yield of the caraway plant during the study period ranged from a minimum of aboutEGP -7626 in 2020 to a maximum of about EGP 19284 in 2018, with an annual average of about EGP 5089.

By calculating the equation of the linear time trend, it is clear from Table (11) that the net return increases annually during the study period by about EGP 1279.755, as the statistical significance of this increase was not proven.

The coefficient of determination was 0.263, and the statistical significance of any of the mathematical images used was not proven.

3- Net feddan yield of hibiscus:

Table (10) indicates that the net yield of the hibiscus plant during the study period ranged from a minimum of about EGP 2531 in 2015 to a maximum of about EGP 22606 in 2015, with an annual average of about EGP 11232.

By calculating the linear time trend equation, it is clear from Table (11) that the net return decreases annually during the study period by about EGP -567 , as the statistical significance of this decrease has not been proven and the significance of the model as a whole has not been proven.

4- Net feddan yield of green basil:

Table (10) indicates that the net yield of the basil plant during the study period ranged from a minimum of about EGP 2482 in 2020 to a maximum of about EGP 32756 in 2015, with an annual average of about EGP 14911.

By calculating the linear time trend equation, it is clear from Table (11) that the net return decreases annually during the study period by about EGP 23354, and the statistical significance of this decrease has been proven. The determination coefficient is 0.570, which means that time reflects 57% of the variables affecting the net return, and the statistical significance of the mathematical image used has been proven.

5- Net feddan yield of geranium:

Table (10) indicates that the net yield of the plant during the study period ranged from a minimum of about EGP 33759 in 2010 to a maximum of about EGP 78401 in 2017, with an annual average of about EGP 48148.

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By calculating the equation of the linear time trend, it is clear from Table (11) that the net return increases annually during the study period by about EGP 3194.145, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.441, which means that time reflects 44% of the variables affecting the net return, and the statistical significance of the mathematical image used was proven.

6- Net fiddan yield of marjoram:

Table (10) indicates that the net yield of the marjoram plants during the study period ranged from a minimum of about EGP 4851 in 2015 to a maximum of about EGP 53877 in 2018 with an annual average of about EGP 23392.

By calculating the equation of the linear time trend, it is clear from Table (11) that the net return increases annually during the study period by about EGP 4281.982, and the statistical significance of this increase has been proven.

The coefficient of determination was 0.574, which means that time reflects 57% of the variables affecting the net return and the significance of the model as a whole was proven.

7- Net yield feddan of star anise:

Table (10) indicates that the net yield of the star anise plant during the study period ranged between a minimum of about EGP -1762 in 2019 and a maximum of about EGP 14219 in 2020, with an annual average of about EGP 7833.

By calculating the equation of the linear time trend, it is clear from Table (11) that the net return increases annually during the study period by about EGP 5572, as the statistical significance of this increase has not been proven nor the significance of the model as a whole.

Table (10) Evolution of the net return in EGP for medicinal and aromatic crops and aromatic grains during the period 2010-2020

* years	Star anise	Marjoram	Geranium	Basil	Hibiscus	caraway	chamomile wormwood
2010	6700	7650	33759	22948	11546	1562	1105
2011	6938	15265	35733	17801	12865	2034	1105
2012	6133	7018	37206	22948	11546	2926	705
2013	5034	5805	35640	21069	17428	1692	566
2014	6903	6191	34311	22577	2531	1691	658
2015	7127	4851	43906	32756	22606	-463	-704
2016	11036	43472	57780	7955	19325	-2292	1479
2017	12639	42472	78401	5822	4160	17988	720
2018	11200	53877	74281	5358	3894	19284	-887
2019	-1762	34409	50198	2775	8708	19186	6913
2020	14219	36300	48415	2482	8939	-7627	153
Average	7833	23392	48148	14954	11232	5089	1074
minimum	-1762	4851	33759	2482	2531	-7627	-887
maximum	14219	53877	78401	32756	22606	19284	6913

*No data available prior to this period

Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, the Central Administration for Agricultural Economics, the Agricultural Economy Bulletin, miscellaneous.

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Table (11) Equations of the general time trend of the development of the net return of medicinal and aromatic crops and aromatic grains during the period from 2010-2020

plants	F	R2	Time trend equation
chamomile wormwood	2.066	0.187	Y= 150.345+398.336Xi (0.080) (1.438)
caraway	3.218	0.263	Y= -1645.527-+1279.755Xi (-0.340) (1.794)
Hibiscus	0.812	0.083	Y= 14633.145+ -566.918 Xi (3.429) ** (-0.901-)
Basil	11.923	0.570	Y= 29032.091+ -2353.591- Xi (6.280) ** (-3.453-) **
Geranium	7.114	0.441	Y= 28983.309+3194.145Xi (3.568) ** (2.667) *
Marjoram	12.113	0.574	Y= -2300.073-+ 4281.982Xi (-0.276-) (3.480) **
Star anise	1.129	0.111	Y= 403.547+5572.335Xi (2.163) * (1.063)

Where (Y) = Estimated value of the net yield of medicinal and aromatic plants and aromatic grains.
Xi= Time variable where (2010, 2011, 2012....... 2020)
value in parentheses indicates calculated (T).
(R2) Coefficient of determination
(**) indicates the significance of the regression coefficient at the level of 0.01
(*) indicates the significance of the regression coefficient at the level of 0.05
Source: Collected and calculated from Table 8 data

Sixth: Trends in time and qualitative changes for the most important types of medicinal and aromatic plants

<u>First: Trends in time and qualitative changes in the feddan production costs of cultivation of medicinal and aromatic plants</u>

The results of the variance analysis indicate the average production costs of planting medicinal and aromatic plants during the period 2017-2020 Table No. (12) The statistical significance of the differences in production costs in relation to time, as well as the cost of production for the cultivation of medicinal and aromatic plants under study, which means that there are differences between the production costs of planting medicinal and aromatic plants among themselves as well as during the years of study.

Table (12): Analysis of variance for average feddan production costs of medicinal and aromatic plants during the period 2017-2020

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	104559323.7a	9	11617702.6	F	.000
Intercept	2743606841.3	1	2743606841.2	6.798	.000
Between year	47840695.0	3	15946898.3	1605.4	.001
Between plants	56718628.7	6	9453104.8	9.3	.002
Error	30762187.0	18	1709010.4		
Total	2878928352.0	28			
Corrected Total	135321510.7	27			

a. R Squared = .773 (Adjusted R Squared = .659)
Calculated from the data in Table (6)

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From Table (13) of the average production costs according to time, it is clear that there are significant differences between 2020, as well as 2018 and 2017, and the years 2019 and 2017 differ, while there is no difference between the rest of the years of study, which means that there is an increase in production costs

Table (13): Results of applying the variance analysis between average costs and average years during the period 2017-2020

years	2017	2018	2019
2018	1359.6		
2019	2353.3*	993.7	
2020	3559.4*	2199.9*	1206.1

Using the L.S.D test and Table (14) to determine the significance of the differences between the feddan production costs of the study crops, it is clear that there are significant differences between the study crops between hibiscus, caraway, wormwood and basil, and a difference between caraway, wormwood, basil, marjoram and star anise is what means that there are differences between the production costs of the crops under study during the study period, which reflects the fluctuation of the cultivated areas of those crops according to the material capabilities and marketing capabilities of farmers.

Table (14): Results of applying the L.S.D test between the differences between different averages. Average production costs for the years during the period 2017-2020

plants	chamomile	caraway	Hibiscus	Basil	Geranium	Marjoram
caraway	200.5					
Hibiscus	2932.0*	2731.5*				
Basil	864.5	664.0	2067.5*			
Geranium	350.8	150.3	2581.3*	513.8		
Marjoram	1819.3	2019.8*	4751.3*	2683.8*	2170.0*	
Star anise	1261.8	1462.3	4193.8*	2126.3*	1612.5	557.5

From the above, it is clear that there are significant differences during the study years for the feddan costs of the study crops of medicinal and aromatic plants as a result of the continuous rise in production costs, as the study period is after 2016, in which the exchange rate was liberalized, which led to this increase in costs.

<u>Second: trends in time and qualitative changes in the net feddan yield of medicinal and aromatic plant cultivation.</u>

Based on the results of the analysis of the variance of the net feddan return for medicinal and aromatic plant crops during the period 2017-2020 Table No. (15), the statistical significance of the differences in the net feddan return for time was not proven, while the statistical significance was proven between the net feddan return of the crops of the study sample, which means that there are differences between the net feddan return of medicinal and aromatic plant crops among themselves, and there are no differences between the net return during the study years.

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Table (15): Analysis of variance for the average net feddan yield of medicinal and aromatic plants during the period 2017-2020

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12102916784.244[a]	9	1344768531.583	24.360	**.000**
Intercept	10968635197.957	1	10968635197.957	198.693	**.000**
Between year	209775053.787	3	69925017.929	1.267	**.321**
Between plants	11792095980.799	6	1965349330.133	35.602	**.000**
Error	828058840.796	15	55203922.720		
Total	25600414059.000	25			
Corrected Total	12930975625.040	24			

a. R Squared = .936 (Adjusted R Squared = .898)

Calculated from the data in Table (10)

From Table (16) and using the L.S.D test to determine the significance of the differences between the net feddan yield between the study crops, it is clear that there are significant differences between the study crops between marjoram, wormwood, caraway, basil, star anise, and hibiscus and between wormwood, star anise, marjoram, caraway, and perfume, and between caraway and tar, which means that there are differences between the net yield of the crops under study during the study period, which reflects the fluctuation of the cultivated areas of those crops according to the farmers' attitudes towards their cultivation.

Table (16): Results of the application of the L.S.D test to test the significance of the differences between the average productivity of the net return for the years during the period (2017-2020)

plants	chamomile	caraway	Hibiscus	Basil	Geranium	Marjoram
caraway	16224.000*					
Hibiscus	3829.9167	12394.083*				
Basil	1513.9167	14710.0833	2316.0			
Geranium	60228.417*	44004.417*	56398.5*	58714.50*		
Marjoram	39169.167*	22945.167*	35339.3*	37655.25*	21059.25*	
Star anise	10090.66	6133.33	6260.75	8576.7500	50137.75*	29078.00*

As for the differences between the feddan production costs and the net feddan return of the crops under study, the statistical significance of the differences between these crops has been proven, which reflects the differences in the needs of those crops from production requirements and care during their cultivation and harvesting.

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Seventh: Economic efficiency of the most important crops of medicinal and aromatic plants

1- Feddan production costs:

The results of the analysis of variance of feddan production costs between the crops of the study showed statistically significant differences, and the results of Table (17) indicate that the marjoram crop ranked first among the study crops in terms of production costs with an average of about EGP 7582, followed by star anise with an average of about EGP 6964, followed by chamomile with an average of about EGP 6749, followed by Al-Ater with an average of about EGP 6566, followed by caraway with an average of about EGP 6284, followed by basil with an average of about EGP 6284, followed by basil with an average of about EGP 6964. 5753, and the hibiscus crop comes in last place with an average of about EGP 4542.

2- Net feddan yield:

It is clear from Table (17) that the ater crop has ranked first among the study crops in terms of net feddan yield with an average of about EGP 48148 during the study period, followed by marjoram with an average of about EGP 23392, followed by basil with an average of about EGP 14911, followed by hibiscus with an average of about EGP 11232, followed by star anise with an average of about EGP 7833, followed by caraway with an average of about EGP 5089, and comes in last place chamomile with an average of about EGP 1074 .

3- Egyptian pound yield:

By estimating the yield of the Egyptian pound for the study crops, it was found that the geranium crop ranked first among the study crops in terms of the yield of the Egyptian pound with an average of about EGP 8.4, followed by basil with an average of about EGP 5.1, followed by hibiscus with an average of about EGP 4.4, followed by marjoram with an average of about EGP 3.8, followed by star anise with an average of about EGP 2.6, followed by caraway with an average of about EGP 1.8, and chamomile wormwood comes in last place with an average of about EGP 1.2.

4- Farm price:

By estimating the agricultural price of the study crops, it was found that the star anise crop ranked first among the study crops in terms of the yield of the Egyptian pound with an average of about EGP 18573 per ton, followed by hibiscus with an average of about EGP 16229 per ton, followed by caraway with an average of about EGP 14370 per ton, followed by chamomile with an average of about EGP 7879 per ton, followed by marjoram with an average of about EGP 6468 per ton, followed by Al-Ater with an average of about EGP 984 per ton, and basil comes in last place With an average of about EGP 984 per ton.

5- The cost of the unit produced:

By studying and reviewing the cost of the unit producing the crops of the study, it was found that the star anise crop is the highest with an average of about EGP 8246 per ton, followed by chamomile with an average of about EGP 7050 per ton, then the caraway crop with an average of about EGP 6851 per ton, followed by hibiscus with an average of about EGP 4517 per ton, followed by marjoram with an average of about EGP 1767 per ton, followed by Al-Attar with an average of about EGP 120 per ton, and the basil crop was the lowest with an average of about EGP 99 per ton.

6- Unit cost of farm price:

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By studying and reviewing the unit cost of the farm price of the study crops, it was found that the crop of chamomile wormwood is the highest, reaching about 89%, followed by caraway, which reached about 48%, followed by star anise, which reached about 44%, followed by hibiscus by about 28%, followed by marjoram by about 27%, followed by basil by about 15%, and the yield of geranium was the least, reaching about 12%.

Table (17): The most important criteria for the economic efficiency of the most important crops of medicinal and aromatic plants during the period 2010-2020

The crop	Star anise	Geometric	Geranium	Basil	Hibiscus	caraway	chamomile
Production costs (EGP)	6964	7582	6566	5753	4542	6284	6749
Net return per acre (EGP)	7833	23392	48148	14911	11232	5089	1074
Pound yield	2.4	3.8	8.4	5.1	4.4	1.8	1.2
Price from the farm (EGP/ton)	18573	6468	984	648	16229	14370	7879
The cost of the unit produced in pounds	8246	1767	120	99	4517	6851	7050
Unit cost of farm price (%)	44	27	12	15	28	48	89

Calculated from the data in Table (10) ،(8) ،(6)

Recommendations:

1- Expanding the cultivation of medicinal and aromatic plants with a high yield as an alternative to less yielding crops.
2- Study foreign markets to identify their quantitative and qualitative needs of these plants.
3- Study the behavior of the local consumer to identify their quantitative and qualitative needs of these plants.
4- Intensify research in the field of cultivation of medicinal and aromatic plants and land reclamation in the Western Sahara, as most medicinal and aromatic species are found in such lands.

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