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استخدام نظم المعلومات الجغرافية والاستشعار عن بعد لاختيار التركيب المحصولي الأمثل في الأراضي الجديدة بمحافظة الفيوم

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بيانات البحث

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الكلمات المفتاحية

التركيب المحصولي، الأراضي الجديدة، نظم المعلومات الجغرافية، الاستشعار عن بُعد.

المستخلص

تهدف خطط التنمية في مصر اساسا إلى زيادة مساحة الرقعة الزراعية من أجل تعويض الفاقد من الأراضي الزراعية التي تم فقدها سواء بالتدهور أو التعدي عليها وذلك للعمل على سد الفجوة بين إنتاج الغذاء واستهلاكه، وتتمثل مشكلة البحث في عدم الاستغلال الأمثل للأراضي الجديدة في محافظة الفيوم وفق خطة استراتيجية تتضمن وضع التركيب المحصولى المعظم لصافى العائد والمستخدم لأقل كمية من المياة. ويهدف البحث إلى تحليل الاوضاع في الاراضي الجديدة من حيث تحديد المساحات المستصلحة حديثا في الأراضي الجديدة في محافظة الفيوم وتحديد المحاصيل الملائمة للاستزراع ودراسة المتاح من الموارد بهدف وضع خطة تنموية تضمن تركيب محصولي أمثل يعظم صافى العائد ويستخدم أقل كمية من المياة وقد استخدم في الدراسة تقنية الاستشعار عن بعد ونظم المعلومات الجغرافية في الحصول على مرئيات فضائية، تم تحليلها للوصول إلى خرائط (GIS) المساحية للغطاء الأرضي. وقد تم استنتاج خريطة (GIS) المساحية في (2021) كمصدر بيانات مساحات الغطاء الأرضي، وقد تم أيضا استنتاج خريطة مساحية (GIS) بمساحات الأراضي الزراعية الجديدة موضع الدراسة ومساحات الأراضي الزراعية القديمة، كما تم استنتاج خريطة (GIS) كنموذج يبين أنسب المحاصيل الزراعية الملائمة للاستزراع في الأراضي الجديدة.

ومن أهم النتائج التى توصلت إليها الدراسة مايلى:

1- توصلت الدراسة إلى التحديد الدقيق لمساحة الأراضي الجديدة القابلة للاستزراع من خلال خرائط (GIS) المساحية باستخدام تكنولوجيا نظم المعلومات الجغرافية والاستشعار عن بعد، والتى تبلغ حوالى 29.16 ألف فدان.

2- تم الحصول على خرائط (GIS) أنسب المحاصيل الملائمة للاستزراع في الأراضي الجديدة في محافظة الفيوم في العروات الشتوية و الصيفية والنيلية باستخدام تكنولوجيا المعلومات الجغرافية والاستشعار عن بعد، حيث تمثلت فى ثلاثة محاصيل فى العروة الشتوية وهى (القمح، البنجر، البرسيم الشتوى) ، أربعة محاصيل فى العروة الصيفية وهى (الطماطم، البطاطس، القطن، عباد الشمس)، وثلاثة محاصيل فى العروة النيلية وهى (الذرة الشامية، والذرة الرفيعة، والبصل).

3- توصلت الدراسة إلى نموذج التركيب المحصولي الأمثل المعظم لصافى العائد والمستخدم لأقل كمية من المياة في ضوء قيود الموارد المتاحة، وذلك من خلال استخدام برمجة الأهداف، حيث بلغ صافى العائد فى النموذج المقترح حوالى 331.269 مليون جنيه خلال العروات الثلاثة، كما بلغت كمية المياة المستخدمة أيضا حوالى 124.897 مليون متر مكعب من إجمالى الكميات المتاحة من الموارد المائية والتى تبلغ حوالى 166.21 مليون مر مكعب.

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Using the geographica information systems and remote sensing to select the optimal cropping pattern in the new lands in Fayoum Government.

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ABSTRACT

The development plans in Egypt mainly aim at increasing the area of the agricultural area in order to compensate for the loss of agricultural land that has been lost, in order to work to bridge the gap between food production. A strategy involving the placement of cropping structure that maximizes net yield and uses the least amount of water. The research aims to analyze the situation in the new lands in terms of identifying the newly reclaimed areas in the new lands in Fayoum Governorate, identifying the crops suitable for cultivation, and studying the available resources in order to develop a development plan that guarantees an optimal crop composition that maximizes the net yield and uses the least amount of water. In the study, sensing technology was used. Remote and geographic information systems in obtaining satellite visuals, which were analyzed to reach spatial (GIS) maps of the land cover. A cadastral (GIS) map was derived in (2021) as a data source for the land cover areas, and a cadastral map (GIS) was also derived with the areas of the new agricultural lands under study and the areas of the old agricultural lands. The (GIS) map was also derived as a model that shows the most suitable agricultural crops suitable for cultivation in new lands.

Among the most important findings of the study are the following:

1- The study reached an accurate determination of the area of new cultivable lands through cadastral (GIS) maps using geographic information systems and remote sensing technology, which amounts to about 29.16 thousand feddans.

2- Maps (GIS) of the most suitable crops suitable for cultivation in the new lands in Fayoum Governorate were obtained in the winter, summer and Nile seasons, using geographic information technology and remote sensing, as they were represented in three crops in the winter season, which are (wheat, beet, and winter clover). There are four crops in the summer season (tomatoes, potatoes, cotton, and sunflowers), and three crops in the Nile season (maize, sorghum, and onions).

-3 The study reached a model of optimum cropping composition that maximizes net yield and uses the least amount of water in the light of the available resource constraints, through the use of programming goals. Also, about 124.897 million cubic meters of the total available quantities of water resources, amount to about 166.21 million cubic meters.

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Introduction:

Horizontal expansion is one of the objectives of the successive agricultural development strategies in Egypt, for achieving food security, addressing the imbalance in the agricultural trade balance, and providing job opportunities and compensating for the loss of old agricultural lands. The expansion of the cultivation of new lands is the optimal exploitation of the unit area of land while maximizing the return from its exploitation with the highest return and the lowest manifold requirements. Net yield and civil water requirements in light of the available resource constraints. Various countries have realized since the end of the last century, specifically in the sixties, the importance of modern technologies for area sciences and remote sensing, which in its general sense is to collect information about an element by means of a sensor located at a very far distance from this element. These techniques have been used in many areas, the most important of which is determining the areas of land cover and determining the crops suitable for cultivation. The data has been reported using geographic information systems and remote sensing through geographic maps (GIS) maps, through which this data can be used in an appropriate statistical program in order to reach the most suitable cropping System yielding and civil water requirements, using the method of linear goals programming, which can contribute In providing information in order to assist decision-makers or the legislator in setting agricultural development strategies in line with future requirements, as remote sensing techniques are tools that save time and effort, as well as obtaining accurate, important and rapid information.

Research problem:

The problem of the research is the lack of optimal exploitation of the new lands in the Fayoum Governorate without a strategic plan which must include development of the most appropriate cropping System, net yield and civil water requirements A new land area of about 29.16 thousand feddans have been reclaimed in Fayoum desert, where this area is exploited away from taking into account Resources available without a strategic development plan to promote new agricultural lands in Fayoum Governorate.

Research Aims:

Study aims at : -Analyzing the conditions in the new lands in terms of

-defining the newly reclaimed areas in the new lands in Fayoum Governorate.

- identifying the crops suitable for cultivation, and studying the available resources with the aim of developing a development plan that includes cropping System that matches most of the net yield per unit area and civil water requirements, according to a sound scientific study.

First: Description of the study area:

Fayoum Governorate is located in the heart of Egypt in the southwest, at a distance of 100 km between latitudes 29.6 and 29.35 north and longitudes 30.23 and 31.5 east, with a maximum breadth of 70 km and a circumference of 250 km. The area of Fayoum governorate is about (6068) km 2 in the Nile River through Bahr Yusuf, which enters it through the Lahoun opening, which made it part of its river system, which became a floodplain of sediments suitable for cultivation of various crops. Fayoum governorate is bordered to the northeast by Giza governorate, and Fayoum city is about 90 km away from Cairo, and it is bordered to the

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east and south by Beni Suef governorate at a distance of 45 km, and it is bordered to the north, west and southwest by desert lands.

Second: Study results and discussion:

The research results focus on three main axes:

The first axis: the use of geographic information systems and remote sensing in determining the areas of land cover and new lands.

1- **The use of geographic information systems and remote sensing in calculating the land cover areas in Fayoum Governorate.**

Figure (1) refers to the land cover map, as the map included the land cover areas in Fayoum Governorate in terms of desert lands, agricultural lands, urban areas, and water bodies, as it shows the distribution of each of these land covers over the area of Fayoum Governorate, which is estimated at about (6068) square kilometers. We note that the areas on the map are estimated in km².

Table No. (1) shows the land cover areas in square kilometers and in feddans, as we note that the desert land area is (3531) square kilometers, which is equivalent to (872.5) thousand feddans, with a rate of (61%) of the total area in Fayoum Governorate, While we find that the area of agricultural lands in Fayoum Governorate is (1636) square kilometers, which is equivalent to (404.3) thousand feddans, which is (28%) of the total area in Fayoum Governorate, i.e. in the second place after desert lands, while we find that the area of water bodies is (329) square kilometers, which is equivalent to (81.3) thousand feddans, which constitutes 6% of the total area, and thus to the area of agricultural land in the arrangement, while we find the area of urban areas is (296) square kilometers, equivalent to (73.1) thousand feddans 5% of the total area in Fayoum Governorate.

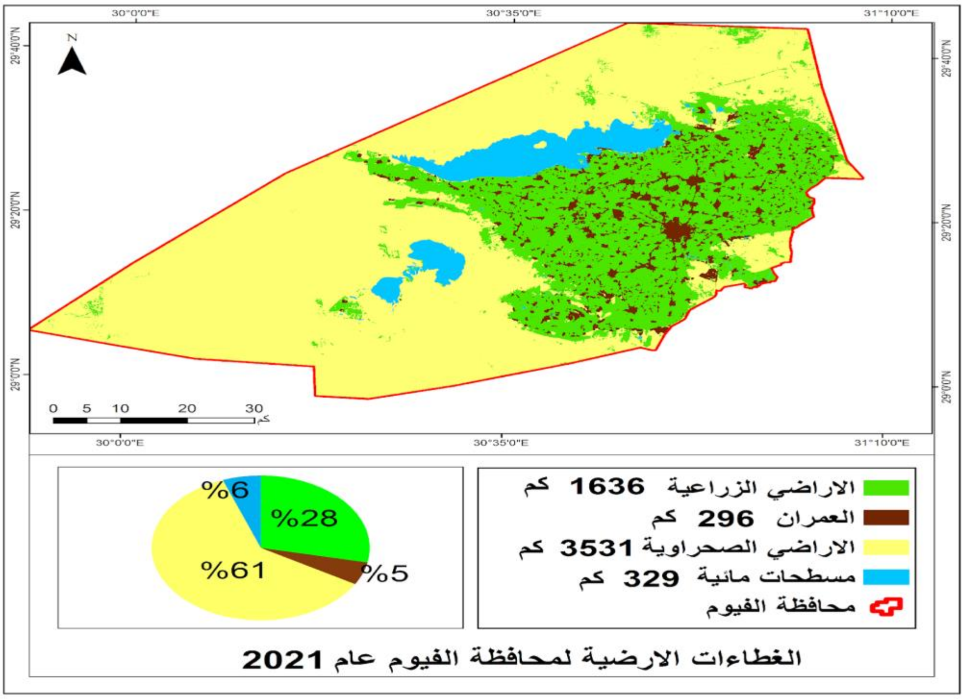

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Figure (1): Map (GIS) of the land cover in Fayoum Governorate for the year (2021).

Source: US Geological Survey (USGS) (https://www.usgs.gov)

Table (1): Shows the land cover areas in Fayoum Governorate for the year (2021)

% of the total area	area in feddans (*)	area in km²	Ground cover type
61 %	872.5	3531	desert lands
28 %	404.3	1636	agricultural lands
6 %	81.3	329	Bodies of Water
5 %	73.1	296	urban areas
100 %	**410**	**6068**	Total

Source: Collected and calculated from the data of the land cover area (GIS) map in Fayoum Governorate for the year (2021).
1 km² = 247.1054 feddans

2- **The use of geographic information systems and remote sensing to determine the areas of old and new agricultural lands in Fayoum Governorate.**

Figure (2) refers to the GIS map of the area of new and old agricultural land in Fayoum Governorate, and its distribution over the area of the governorate. It is (1518) square kilometers and the total cultivated area is (1636) square kilometers. Table (2) indicates the areas of agricultural lands shown in Map No. (2) and converted to feddans, as we note from the table that the area of new agricultural lands is (118) square kilometers. Square, which is equivalent to (29.16) feddans, while the area of old agricultural land is (1518) square kilometers, which is equivalent to (375.1) thousand feddans. The total cultivated area is (1636) square kilometers, equivalent to approximately (404.26) thousand feddans.

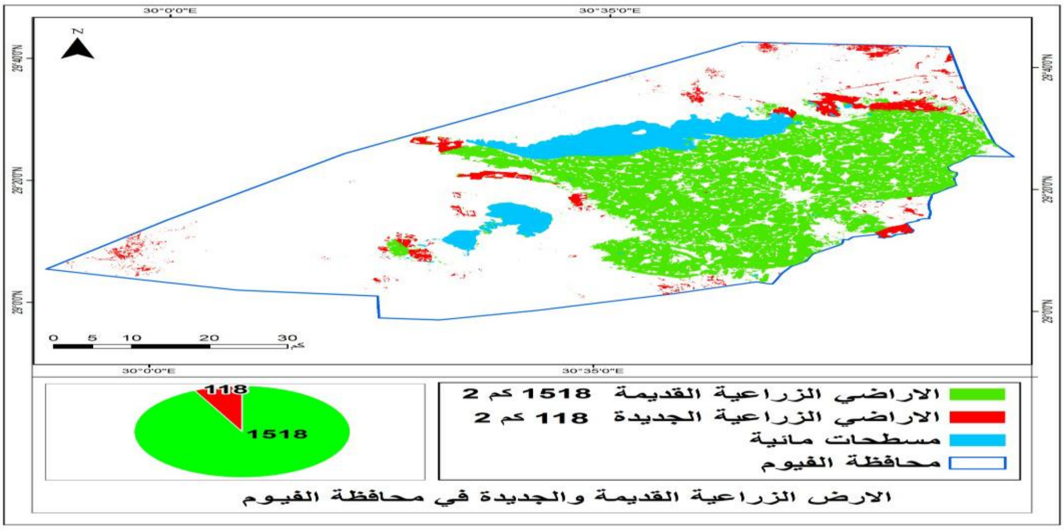

Figure (2): GIS map of the area of the old and new lands in km²
Source: US Geological Survey (USGS)

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Table (2): The area of new and old agricultural land

% of the total cultivated area	area in feddans (*)	area in km^2	Land type
92.7 %	375.11	1518	Old lands
7.3 %	29.16	118	New lands
100 %	404.26	1636	Total

Source: Collected and calculated from (GIS) map data, Figure No. (2) of the study.
1 (*)km^2 = 247.1054 feddans

3- **Study methodology in cadastral maps:**

A- For the land cover map in Figure (1), the satellite visuals were obtained from the USGS website through the (Land Sat 8) satellite, as this satellite includes 11 wavelengths and three wavelengths have been worked on that include true colors. They are channels from 2-4, which are blue, green and red. The monitored classification was carried out on the satellite visual by taking different samples for each of the phenomena to calculate the value within the satellite visual. The samples were taken and applied to all wavelengths, then the data was converted into cadastral phenomena to calculate the area of each cover within a region. the study.
B- For the map of the old and new land area, Figure (2).. through applying the Green Cover Index (NDVI) in the different years between 2010 and 2021, and through that the areas were converted through the Calculate Geometry function and the calculation of the agricultural land area and through The old land areas were deduced through the land cover change model, and it depends on the change of values within the satellite image, and by relying on the CON function, the areas are calculated, and through the values and years of satellite imaging, the areas were deduced using the calculations inside the (Raster Calculator) function. Old and new areas.

The second axis: the use of geographic information systems and remote sensing in determining the most suitable crops suitable for cultivation in the new lands in Fayoum Governorate.

Reliance was made on the data of the (Sentinel 3) satellite of the European area Agency (ESA) due to the high accuracy of these visuals, which is equal to 10 m 2 per cell. Through the spectral fingerprint, the most suitable crops were chosen according to the health status of the crop as well as the expected production, taking into account other factors. Such as climatic factors, soil type and condition, as well as the crops grown in the old lands as a model for predicting the condition of those crops in the new lands. This method was applied in the three lugs of summer, winter and Nile.

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1- **Winter season crops suitable for cultivation in winter season in the new lands in Fayoum governorate:**

Figure (3) refers to a map of crops suitable for cultivation in the new lands in the winter season, where it turns out that the crops suitable for cultivation in the new lands in the winter season are wheat, beets, and winter clover.

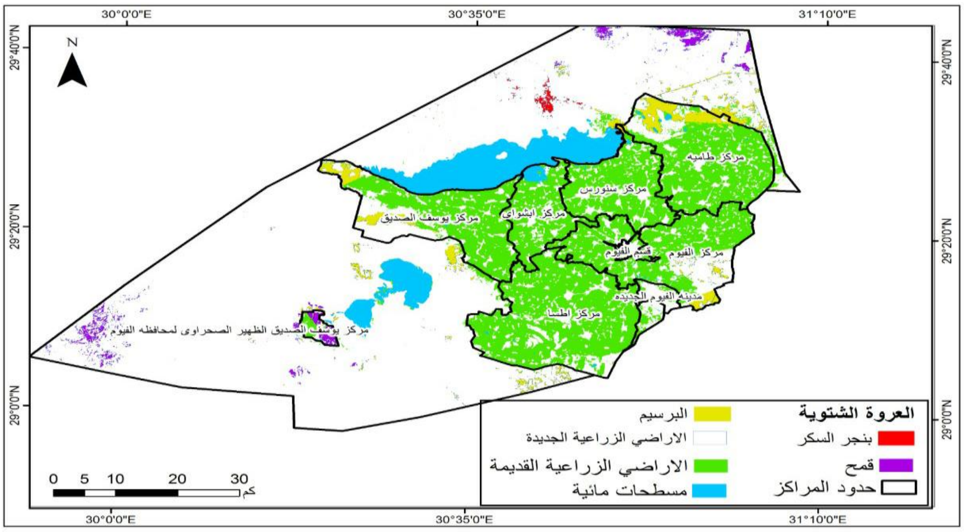

Figure (3): Map of winter season crops suitable for cultivation in the winter season in the new lands in Fayoum Governorate.

Source: European Space Agency (ESA, Sentinel 3). (http://www.esa.int)

2- **Summer stalk crops suitable for cultivation in the new lands in Fayoum governorate.**

Figure (4) refers to a map of crops suitable for cultivation in the new lands in the summer season, where it turns out that the crops suitable for cultivation in the new lands in the summer season are potatoes, tomatoes, cotton, and sunflowers.

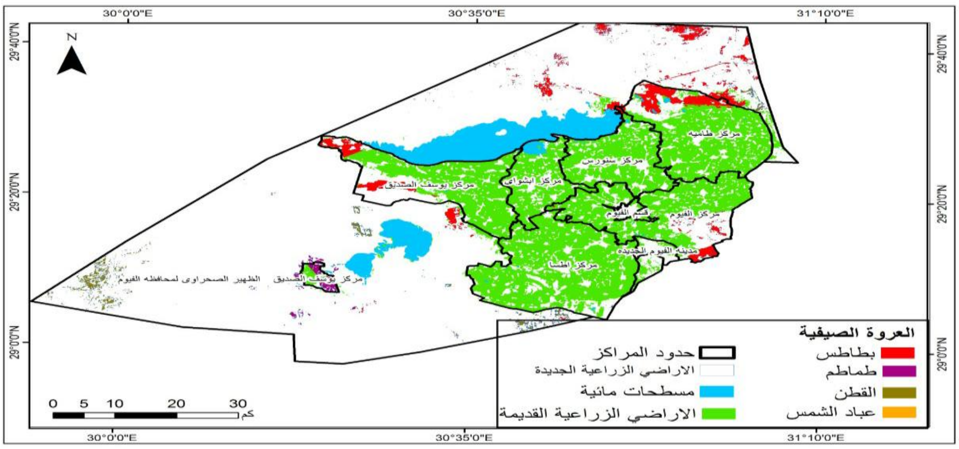

Figure (4): Map (GIS) of the distribution of suitable crops in the new lands during the summer season

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Source: European Space Agency (ESA, Sentinel 3). (http://www.esa.int)

3- **Crops of the Nile loop suitable for cultivation in the new lands in Fayoum governorate:**

Figure (5) refers to a map of the crops suitable for cultivation in the new lands in the winter loop, as it turns out that the crops suitable for cultivation in the new lands in the Nile loop are maize, sorghum, and onions.

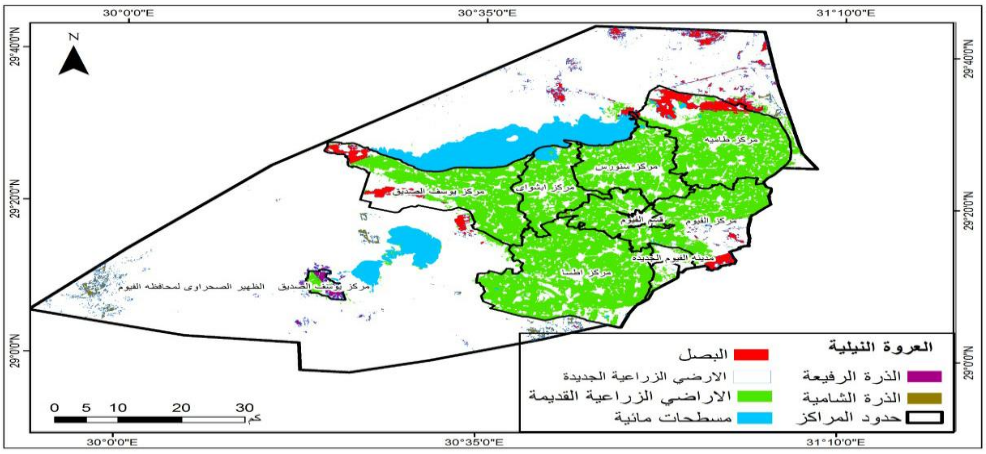

Figure (5): Map (GIS) of the distribution of suitable crops in the new lands in the Nile loop

Source: European Space Agency (ESA, Sentinel 3). (http://www.esa.int)

Table (5) refers to the crops suitable for cultivation in the new lands in Fayoum governorate in each of the winter season, the summer season, and the Nile season, where it is clear from the table that the suitable winter season crops are (wheat, beets, and winter clover), while we find that the summer season crops The suitable crops for cultivation in the new lands are (potatoes, tomatoes, cotton, and sunflowers). We also note that the Nile loop crops suitable for cultivation in the new lands are (maize, sorghum, and onions).

Table (3): Winter season crops suitable for cultivation in the winter season in the new lands in Fayoum Governorate;

Crops of the Nile lug	Summer crops	Winter crops
sorghum	potato	Wheat
maize	tomatoes	beets
onions	cotton	winter clover
	sunflower	

Source: Crops suitable for farming in the new lands in Fayoum governorate were collected and calculated through GIS map data, from the data of Figure (1, 2, 3).

The third axis: the use of programming objectives in maximizing the expected return and minimizing water requirements in the new lands in Fayoum Governorate.

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First: Studying the available resources and their requirements for each feddan of crops suitable for cultivation in the new lands in Fayoum Governorate.

1- **The area available in the new agricultural lands:**

The study found, through the use of remote sensing technology and geographic information systems, about (29.16) thousand feddans, equivalent to (7.3%) of the total area of agricultural land, and the area of old agricultural land is about (375.1) thousand feddans, equivalent to (92.8%), while The total agricultural land area in Fayoum Governorate is (404.26) thousand feddans.

The percentage of the new agricultural land area can also be deduced as follows:

= 29158.43 ÷ 404264.405 x 100 = approximately 7.3%.

The technical transactions used for all productive resources were based on the data of the annual statistics bulletins of the Ministry of Agriculture and Land Reclamation, economic affairs bulletins, water resources and irrigation bulletins, cost and net return bulletins in the year (2019-2020).

2- **Studying the availability and actual requirements of water resources:**

A- The availability of water resources:

Table No. (4) indicates the amount of irrigation water consumed throughout the year for the total cultivated area for each of the winter, summer and Nile loops, as it is clear from the table that the amount of irrigation water consumed in the winter loop is (880.280) million cubic meters, the amount of irrigation water consumed in the loop Summer is (1357.196) million cubic meters, while consumed in the Nile loop is (39.432) million cubic meters.

Table (4): The quantities of irrigation water consumed during the winter, summer and Nile seasons in Fayoum Governorate

(Water quantity in thousand cubic meters)

Total quantity consumed billion cubic metres	Indigo crops billion cubic metres	summer crops billion cubic metres	The winter lug billion cubic metres	cultivated lands
2.276	0.039	1.357	0.880	The total cultivated area

Source: Statistical Bulletin of Water Resources and Irrigation (2019-2020).

Table No. (4) shows the quantities of water consumed in the field in cultivating the total agricultural lands in Fayoum Governorate. Accordingly, it can be deduced from the available water resources for the cultivated area during the three loops in the new lands, which represents (7.3%) of the total amount of water available for cultivation in the lands in Fayoum Governorate. And so it is:

The available water resources for cultivating new lands in Fayoum governorate are:

0.073 * 2276.908 = (166.21) million cubic meters.

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B- The water standard for each feddan of crops suitable for cultivation in the new lands under different irrigation systems, in cubic meters/feddan.

Table No. (7) indicates the water requirements per feddan of agricultural crops suitable for cultivating new lands in Fayoum Governorate under different irrigation systems, namely flood irrigation, sprinkler irrigation, and drip irrigation.

Table (5): The water standard for crops suitable for cultivation in new lands under different irrigation systems In cubic meters / feddan

Drip irrigation cubic meter/feddan	Sprinkler irrigation cubic meter/feddan	Flood irrigation cubic meter / feddan	code	The crop
–	1945	2431	X1	Wheat
2276	2580	3225	X2	Sugar beet
. . .	2716	3395	X3	winter clover
1924	2180	2725	X4	potatoes
2204	2498	3122	X5	Tomatoes
3991	4523	5654	X6	cotton
2440	2765	3456	X7	sunflower
2729	3093	3866	X8	maize
2653	3007	3759	X9	sorghum
3415	3871	4838	X10	onions

Source: Water standard in the field for crops under different irrigation systems, water distribution and climate in agriculture. (Professor Dr. Samia Al-Marsafawy - February 2019),

3- **Studying the availability of chemical fertilizers and the requirements of an feddan for each of the crops suitable for cultivating new lands in Fayoum Governorate:**

A- The need for each feddan of crops in terms of chemical fertilizers:

Table (6) indicates the actual use of agricultural crops suitable for cultivation in the new lands in Fayoum Governorate of nitrogen, phosphate and potassium fertilizers in the total cultivated area in Fayoum Governorate.

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Table (6): Actual use of organic and chemical fertilizers per feddan of winter, summer and Nile crops in Fayoum Governorate for the year 2019

The Crop	Code	Cultivated area (thousand feddans)	Nitrogen fertilizers		Phosphate Fertilizers		Potash Fertilizers	
			Tons / Feddan	Thousand Tons / Total Area	Tons / Feddan	Thousand Tons / Total Area	Tons / Feddan	Thousand Tons / Total Area
Wheat	X1	200.5	0.1	20.05	0.15	30.08	0.024	4.81
Sugar beet	X2	28.01	0.1	20.05	0.15	30.08	0.024	4.81
winter clover	X3	4.9	0.45	12.6	.0.35	0.16	0.15	4.2
potatoes	X4	100	0.1	0.94	0.2	0.98	0.05	0.245
Tomatoes	X5	10.4	0.116	11.6	0.06	6	0.116	11.6
cotton	X6	8.45	0.112	1.165	0.06	0.62	0.14	1.46
sunflower	X7	2.94	0.1	0.845	0.03	0.25	0.05	0.42
maize	X8	10.95	0.04	0.118	0.03	0.09	0.023	0.068
sorghum	X9	125.63	0.094	1.03	0.029	0.32	0.029	0.32
onions	X10	11.8	0.12	15.08	0.03	3.77	0.023	2.89
Total				65.2		42.8		26.6

Source: The Economic Bulletin of the Ministry of Agriculture and Land Reclamation (2019).

B- The available chemical fertilizers:

It is clear from the indicators of table (6) the actual use of chemical fertilizers, and since the area of new agricultural lands in Fayoum governorate is scheduled to be used (7.3%) of the total available chemical fertilizers, which are already used in the total cultivated area, and accordingly, the available chemical fertilizers can be calculated As follows:

- The available nitrogen fertilizers = 0.073 * 65.2 = 4.76 (thousand tons).
- Available phosphate fertilizers = 0.073 * 42.8 = 3.12 (thousand tons).
- Potassium fertilizers available = 0.073 * 26.6 = 1.94 (thousand tons).

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4- Studying the labor requirements of the new lands and the available ones

It is clear from the 2020 statistics that the labor force in Fayoum Governorate is (1,172,884) and according to data (Central Agency for Public Mobilization and Statistics 2019, Statistical Yearbook, Labor, Economic Activity).

And since (40%) of the labor force works in the agricultural sector, that is, the workers in the agricultural sector = 0.4 * 1,172,884 = 469,153.6 workers (males and females), and this number of the total labor force is supposed to be a worker within the agricultural sector in Fayoum Governorate. Given that the area of the new lands represents 7.3% of the total agricultural area in the governorate, it is assumed that the available labor force (males and females) in the new lands are:

0.073 *** 469,154 = 34,249 workers**

Table No. (7) indicates the labor requirements per feddan for each of the suitable crops in the three lugs of the actual labor force in Fayoum Governorate in the new lands.

Table (7): Labor requirements per feddan of new agricultural land (male and female)

the crop	Code	requirements per feddan of labor day (man) / season
Wheat	X1	43
Sugar beet	X2	63
winter clover	X3	33
potatoes	X4	50
Tomatoes	X5	157
cotton	X6	156
sunflower	X7	175
maize	X8	36
sorghum	X9	47
onions	X10	137

Source: Compiled and calculated from:

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Statistics Department records, unpublished data.
- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, 2020.

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5- **Local consumption is one of the most important types of crops suitable for cultivating new lands in Fayoum Governorate.**

Table (8): Domestic consumption is one of the most important types of crops suitable for cultivating new lands in Fayoum Governorate.

The Crop	code	Productivity feddan	cultivated area in 2020 (thousand feddans)	production in the total area	individual need kg/year	requirements of the total population (thousand tons) of total area	food gap (thousand tons)	Population requirements of new lands in thousand tons 7.3% of the total production	Population requirements of area (thousand feddans)
Wheat	X1	1.774	200.5	556.31	153.3	593.81	(37.5)	43.34	15.62
Sugar beet	X2	18.94	28.01	530.59	112.00	433.83	96.76	38.73	2.05
winter clover	X3	15.74	57.96	766.13	0	57.96	0	55.93	3.55
potatoes(*)	X4	14.45	00	00	26.2	101.5	(101.5)	101.5	7.02
Tomatoes	X5	19.35	13.5	261.4	44	170.44	90.96	12.44	0.851
cotton	X6	1.32	8.45	11.15				0.81	0.62
sunflower	X7	0.738	2.94	2.17	0.3	1.16	1.01	0.07	0.09
maize	X8	2.95	104.37	808.21	89.0	344.74	463.47	25.16	ذ8.53
sorghum	X9	2.12	125.63	267.00	3.4	13.17	253.83	0.96	0.452
onions	X10	13.5	11.15	150.34	18.3	70.88	79.45	5.17	0.38

Source: Collected and calculated through the Annual Bulletin of the Movement of Production and Foreign Trade, Available for Consumption of Agricultural Commodities, (The Central Agency for Public Mobilization and Statistics, Domestic Consumption Bulletin 2019), the amount of production and foreign trade, available for consumption, and the average per capita share of agricultural commodities, Chapter One, Statistics Bulletin Costs and net returns, parts one and two, economic affairs sector, unpublished data.

( ): means deficit in the gap.

(**): means that the crop was not grown in the study area, and prices and returns were guided by the data at the level of the Republic.

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Second: Estimating the net yield for each area of suitable crops in the new lands:
Table No. (9) indicates the total yield, total costs, and net yield per feddan of crops suitable for cultivating new agricultural lands in Fayoum Governorate.

Third: Using the Goal Programming Model to Study the Best Cropping System in the New Lands in Fayoum Governorate:

The study used the goal programming method as one of the most important mathematical models used in the field of economic planning in order to reach the best crop System from using limited water resources, and the purpose of using the goals programming model is to reach the optimal solution, which reduces the total deviations from the desired goals to the lowest possible extent The objective of this model is to reach the most appropriate cropping System in light of maximizing the feddan yield and minimizing water use in the new lands in Fayoum Governorate.

Table (9): Total costs and net yields for each of the winter, summer and Nile lug crops for the new lands in Fayoum Governorate.

The Crop	Code	Total Return pounds / feddan))	Total feddancosts pounds / feddan))	Net Return per feddan pounds / feddan))
Wheat	X1	16146	10754	5392
Sugar beet	X2	13324	10074	3250
winter clover	X3	24448	6768	17680
potatoes	X4	36637	28473	7864
Tomatoes	X5	21891	11198	10693
cotton	X6	26749	17607	9142
sunflower	X7	6893	5319	1071
maize	X8	7794	729	575
sorghum	X9	9778	8891	887
onions	X10	26731	14880	11851

Source: Ministry of Agriculture and Land Reclamation, Economic Cost and Net Return Statistics Bulletin, Economic Affairs Sector (2019-2020).

1- **Characterization of the goals programming model used to determine the best cropping System in the new agricultural lands in Fayoum Governorate.**

G1 Max: Maximize net return (pound(.

G2 Min: Low water resource requirements in cubic meters.
RHS : resources available

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C1: The total cropped area, provided that the cropped area is not less than (40.83) feddans during the three seasons.

C2: Water resources restriction, provided that the amount of water consumed does not exceed (166.210) million cubic meters during the three loops.

C3: Recording the area in the winter season, provided that the cultivated area in the winter season is not less than (20.253) thousand feddans.

C4: Recording the area in the summer season, provided that the cultivated area in the summer season is not less than (2.245) thousand feddans.

C5: Area restriction in the summer loop, provided that the cultivated area in the Nile loop is not less than (17,603) thousand feddans.

C6: Nitrogen fertilizers entry, provided that the amount used does not exceed (4.76) thousand tons during the three periods.

C7: Phosphate fertilizers entry, provided that the amount used does not exceed ((3.12) thousand tons during the three loops.

C8: Registration of potash fertilizers, provided that the amount used does not exceed (1.94) during the three loops

C9: Restriction of local consumption of wheat, provided that the cultivated area does not exceed (15.62) thousand feddans in the winter season.

C10: The local consumption of tomatoes, provided that the cultivated area is not less than (0.851) thousand feddans.

C11: Restriction of local consumption of maize, provided that the cultivated area is not less than (8.53) thousand feddans in the Nile loop.

C12: Recording the local consumption of sorghum, provided that the cultivated area is not less than (0.452) thousand feddans in the Nile loop.

C13: Recording the local consumption of potatoes, provided that the cultivated area is not less than (7.0) thousand feddans in the summer season.

C14: Restriction of local consumption of sunflowers, provided that the cultivated area is not less than (0.115) thousand feddans in the summer season.

C15: Recording the local consumption of the onion crop, provided that the cultivated area is not less than (0.38) thousand feddans in the Nile loop.

C16: Recording the local consumption of the alfalfa crop, provided that the cultivated area is not less than (3.55) thousand feddans in the winter season.

C17: Self-sufficiency in the wheat crop, provided that the cultivated area is not less than (13.54) feddans.

C18: Labor registration, provided that the labor used during the three seasons is not less than (34,248) workers (men).

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Table (10): Description of the data of the programming goals model used to determine the best cropping System in the new agricultural lands in Fayoum Governorate.

The Crop	Whe at	Sugar beet	clover	potatoes	Tomatoes	cotton	sunflower	maize	sorghum	onions	Dire ction	RHS
ableVari	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10		
G1	5392	3250	17680	7846	10693	9142	1071	575	887	11851		
G2	1945	2276	2716	1924	2204	3991	2440	2729	2653	3415		
C1 total cropped	1	1	1	1	1	1	1	1	1	1	=>	40083
C2 Water	1945	2276	2716	1924	2204	3991	2440	2729	2653	3415	=>	1662100
C3 Area in the winter season	1	1	1	0	0	0	0	0	0	0	=>	20235
C4 The area in the summer lug	0	0	0	1	1	1	1	0	0	0	=>	2245
C5 The area in the Nile loop	0	0	0	0	0	0	0	1	1	1	=>	17603
C6 nitrogenous	0.1	0.45	0.1	0.116	0.112	0.1	0.04	0.094	0.12	0.15	=>	4760
C7 phosphate	0.15	0.35	0.2	0.06	0.06	0.03	0.03	0.029	0.03	0.044	=>	3120
C8 potash	0.024	0.15	0.05	0.116	0.14	0.05	0.023	0.029	0.023	0.05	=>	1940
C9 wheat	1	0	0	0	0	0	0	0	0	0	=>	15620
C10 tomato	0	0	0	0	0	0	0	1	0	0	=>	851
C11 maize	0	0	0	0		0	0	0	1	0	=>	8530
C12 consumption	0	0	0	0	0	0	0	0	0	1	=>	452
C13 potato	0	0	0	1	0	0	0	0	0	0	=>	7000
C14 sunflower	0	0	0	0	0	0	1	0	0	0	=>	115
C15 Onion	0	0	0	0	0	0	1	0	0	1	=>	380
C16 consumption	0	0	1	0	0	0	0	0	0	0	=>	3550
C17 self-	1	0	0	0	0	0	0	0	0	0	=<	13540
C18 Employment	43	63	33	86	86	157	125	36	47	74	=>	34248

Source: Collected and calculated from Tables No. (2), (4), (5), (6), (7), (8), (9) in the study.

2- The results of estimating the goals programming model used to determine the best cropping System in the new lands in Fayoum Governorate in the year (2021):

The researcher made several attempts using the various restrictions previously referred to, including restrictions in the form of an upper limit and a minimum limit on all the study crops.

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For the crop, the area is not less than the area required for local consumption by 7.3% of the total available cropped area, as the research reached the proposed model in order to maximize net yield and minimize water requirements, as the results of the estimation of the goal programming model (*), as in Table No. The most important crops that were identified for the cultivation of new lands in Fayoum Governorate were represented by (X1) which is the code that expresses the wheat crop, (X3) which expresses the alfalfa crop, (X5) which expresses the tomato crop, (X6) which expresses the crop Cotton, (X10), which expresses the onion crop, with areas of about (13.54) thousand feddans, (1.126) thousand feddans, (3.189) thousand feddans, (21.838) thousand feddans, (0.38) thousand feddans, respectively.

These areas also made a monetary contribution to the value of the achieved return, amounting to about (73.008) million pounds, from the area proposed to be cultivated for the wheat crop. The proposed cultivation of the tomato crop is about (34.205) million pounds, and the net return from the area proposed to be cultivated for the cotton crop is about (199,645) million pounds, and the net return from the area proposed to be cultivated from the onion crop is about (4.503) million pounds, approximately. With a total value of the total net return, which amounts to about (331.269) million pounds during the three seasons of winter, summer and Nile.

The results also showed that these cropped areas for the previous activities identified from the results of the program analysis showed that there is a decrease in water requirements, which amounted to about (124.898) million cubic meters, compared to the available water, which is about (166.21) million cubic meters, and this provides about (41.312) million cubic meters. million cubic meters of the total amount of available water. That is, the cropping System led to a surplus in the amount of water that could be used to cultivate other areas of the new lands.

Table (11): The proposed cropping System that maximizes net yield and minimizes water requirements

S	The Crop	Code	Proposed area (thousand feddans)	Maximizing the net return in million pounds	Reduction of water requirements in million cubic meters
1	Wheat	X1	13.54	73.008	26.335
2	clover	X3	1,126	19,908	3.058
3	tomatoes	X5	3.199	34.205	7.05
4	cotton	X6	21.838	199.645	87.156
5	onions	X10	0.38	4.503	1.298
Total			40.083	331.269	124.897

Source: Collected and calculated through the results of the programming goals model using (Win QSB) program.

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3- A comparison between the actual cropping System as a percentage of the total cropped area and the proposed cropping System.

Table (12): Comparison between the actual cropping System as a percentage of the total cropped area and the proposed cropping System.

The Crop	code	**Actual cropping System (7.3%) of the total crop area**			**Suggested cropping System**		
		Area (thousand feddans(	Net Return (million pounds)	Water requirements (million cubic meters)	Area (thousand feddans(	Net Return (million pounds)	Water requirements (million cubic meters)
Wheat	X1	14634	78.923	21.88	13.54	73.008	26.335
Sugar beet	X2	2045	6.646	4.65	0	0	0
winter clover	X3	2553	62.82	9.65	1.126	19.908	3.058
potatoes	X4	0	0	0	0	0	0
Tomatoes	X5	1413	15.11	3.11	3.199	34.205	7.05
cotton	X6	617	5.64	2.462	21.838	199.645	87.156
sunflower	X7	215	0.23	0.524	0	0	0
maize	X8	7618	4.38	20.79	0	0	0
sorghum	X9	9171	8.13	24.33	0	0	0
onions	X10	814	0.96	2.78	380	4.503	1.298
Total		40.083	178.839	90.17	40.083	331.269	124.898
(*) Net revenue from the unit used		4462		1.98	8246		2.65

Source: Collected and calculated from Table No. (5, 9, 10).

(*) Net Return from the unit used = Total net Return (pounds) ÷ Number of units used (feddan of unit area or cubic meter of water quantity).

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4- A comparison between the actual cropping System (7.3%) of the total cropping area and the proposed cropping System in light of the available resource constraints

Table (13): Comparison between the actual cropping System (7.3%) and the appropriate cropping System in light of the different constraints of the available resources in the new agricultural lands in Fayoum Governorate.

constraints	**Used in the actual cropping System (7.3%) of the cropped area**	**used in the proposed cropping System**	**Deficit / surplus**
area	**40.083**	**40.083**	**0**
Water Resources	**166.210**	**124.898**	**41.312**
Nitrogenous fertilizers	**4.76**	**4.06**	**694**
Phosphate fertilizers	**3.12**	**3.12**	**0**
potash fertilizers	**1.94**	**1940**	**0**
Self-sufficiency in wheat crop	**13.54**	**13.54**	**0**

Source: Results of goals Programming Analysis Using (Win QSB) Program.

Recommendations:

It is taken into account that work is done to promote the new lands in the Fayoum Governorate, through the study learned from the study of the economic conditions in the new lands in the Fayoum Governorate, through the following:

First: Using geographic information technology and remote sensing technology to serve the field of agricultural development, especially in the new lands, as follows:

1- Drawing up geographical maps of the areas of new cultivable lands and updating them periodically to provide the necessary data for cultivating new lands in Fayoum Governorate.

2- Determining the most appropriate crops suitable for cultivation in the new lands and identifying them on GIS maps and updating them continuously.

3- Monitor desertification and degradation in the new lands and work to reduce desertification processes.

4- Monitoring encroachment on new agricultural lands.

5- Work on establishing and developing units of geographic information systems and remote sensing as a modern technology and linking them to scientific research agencies and agencies affiliated to the Ministry of Agriculture and Land Reclamation and the Ministry of Water Resources and Irrigation.

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Second: Rationalizing water consumption and reducing waste through:

1- Commitment to prescribed water standards.

2- The use of gates at the sections of canals and mesqas.

3- Using work to irrigate the lands for 6 days and a 12-day vacation instead of working for 5 days and a 10-day vacation, planting on terraces in the two blades in the case of maize and cotton.

Third: Raising the efficiency of irrigation water:

1- Activating water policies in Fayoum Governorate to try to exploit the surplus of the water resource, which amounts to about (41.312) million cubic meters, in cultivating new lands.

2- The water supply of the Lahoun Dam should be reduced between January and June to save 0.9 billion cubic meters of excess water, thus reducing the volume of sewage and maintaining a safe water level in Lake Qarun. This will protect the surrounding areas from flooding.

3- New projects must be implemented to transfer wastewater away from Lake Qarun, such as the Al-Qati' and Al-Taghani drainage stations, which are scheduled to be installed by the Ministry of Water Resources and Irrigation, and the two stations can raise wastewater to the Bahr Al-Pashawat channel to maintain the safe water level in Lake Qarun and irrigation of new areas of agricultural land.

4- According to the soil analysis, sprinkler and drip irrigation systems should be applied in the new lands. As these lands have high rates of permeability, and water seeps from them into agricultural lands in the Fayoum axis

5- Improving water quality management through:

A- Using modern irrigation systems (sprinkler and drip)

B- Lining canals and watering cans and purifying them on a regular basis to reduce water loss through leakage.

C- Working on leveling the lands with lasers, controlling the slopes of the lands and the ease of water flow.

6- Studying the proposed solutions to the problems in Lakes Qarun and Wadi Al-Rayyan to increase their area to absorb the largest amount of wastewater and reduce the percentage of salinity.

7-

Fourth: Improving the cropping System:

1- Focusing on growing the crops referred to in the model (wheat, alfalfa, tomatoes, cotton, onions), in order to achieve the highest net return of about (331.269) million pounds, and to achieve the lowest level of water requirements, which amounts to about (124.898) million cubic meters. through the three lugs.

2- Work to achieve self-sufficiency in the wheat crop by cultivating about (13.54) thousand feddans.

3- To achieve the highest net yield and the lowest water requirement, it is necessary to cultivate (13.54) thousand feddans of the wheat crop, (1.126) of the perennial alfalfa crop, (3,199) thousand feddans, (21,838) of the cotton crop, (380) feddans of the onion crop, with Observe each crop in the appropriate lug.

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4- Developing the best varieties of agricultural activities with the highest productivity.

5- Providing outlets for marketing agricultural products internally and externally. Paying attention to infrastructure projects that serve development projects and agricultural investment in new lands.

6- Encouraging farmers to adhere to the development plan and cropping during the three seasons throughout the year. Caring for farmers and providing agricultural guidance and technical support.

7- Expanding the establishment of private associations that guarantee the rights of farmers and provide care for them and their products.

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Appendices:

Table (1): Sources of GIS maps used in the study

s	map type	Number	Source	website
1	GIS Map Land Cover Area (2021)	**1**	US Geological Survey USGS (Land sat 8)	**https://www.usgs.gov**
2	GIS map of old and new land area	**1**	US Geological Survey (USGS (landsat 5 vegetation cover equation NDVI	**https://www.usgs.gov**
3	GIS maps of the most suitable crops in the winter, summer and Nile seasons	**3**	European Space Agency ESA (inel 3Sent)	**http://www.esa.int/**

Source: US Geological Survey (USGS), European Space Agency (ESA).

Table (2): The total cropped area in the new and old lands in Fayoum Governorate in 2021

Old lands (feddans)	New Lands (feddans)	The Total Of Old And New Lands
735134	**34812**	**769946**

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector.

Table 3: Input data in (Win.Q.S.B) program

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Variable	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	Directon	RHS
2	G1	5392	3250	17680	7846	10693	9142	1071	575	887	11851		
3	G2	1945	2276	2716	1924	2204	3991	2440	2729	2653	3415		
4	C1	1	1	1	1	1	1	1	1	1	1	<=	40083
5	C2	1945	2276	2716	1924	2204	3991	2440	2729	2653	3415	<=	166210000
6	C6	0.1	0.45	0.1	0.116	0.112	0.1	0.04	0.094	0.12	0.15	<=	4760
7	C7	0.15	0.35	0.2	0.06	0.06	0.03	0.03	0.029	0.03	0.044	<=	3120
8	C8	0.024	0.15	0.05	0.116	0.14	0.05	0.023	0.029	0.023	0.05	<=	1940
9	C9	1	0	0	0	0	0	0	0	0	0	<=	15620
10	C10	0	0	0	0	0	0	0	1	0	0	<=	851
11	C11	0	0	0	0		0	0	0	1	0	<=	8530
12	C12	0	0	0	0	0	0	0	0	0	1	<=	452
13	C13	0	0	0	1	0	0	0	0	0	0	<=	7000
14	C14	0	0	0	0	0	0	1	0	0	0	<=	115
15	C15	0	0	0	0	0	0	1	0	0	1	<=	380
16	C16	0	0	1	0	0	0	0	0	0	0	<=	3550
17	C17	1	0	0	0	0	0	0	0	0	0	>=	13540

Source: Table No. (11).

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Table (4): The results of estimating the goals programming model used to determine the best cropping System in the new lands in Fayoum Governorate in the year (2021)

	Combined Report for s3					
	20:17:19		Monday	October	10	2022
	Goal	Decision	Solution	Unit Cost or	Total	Reduced
	Level	Variable	Value	Profit c(j)	Contribution	Cost
1	G1	X1	13,540.00	5,392.00	73,007,680.00	0
2	G1	X2	0	3,250.00	0	-22,012.74
3	G1	X3	1,126.04	17,680.00	19,908,366.00	0
4	G1	X4	0	7,846.00	0	-2,835.19
5	G1	X5	3,198.78	10,693.00	34,204,528.00	0
6	G1	X6	21,838.18	9,142.00	199,644,672.00	0
7	G1	X7	0	1,071.00	0	-10,063.58
8	G1	X8	0	575	0	-8,506.44
9	G1	X9	0	887	0	-8,241.71
10	G1	X10	380	11,851.00	4,503,380.00	0
11	G2	X1	13,540.00	1,945.00	26,335,300.00	0
12	G2	X2	0	2,276.00	0	2,420.56
13	G2	X3	1,126.04	2,716.00	3,058,321.50	0
14	G2	X4	0	1,924.00	0	-696.53
15	G2	X5	3,198.78	2,204.00	7,050,106.00	0
16	G2	X6	21,838.18	3,991.00	87,156,192.00	0
17	G2	X7	0	2,440.00	0	-1,548.60
18	G2	X8	0	2,729.00	0	-1,633.97
19	G2	X9	0	2,653.00	0	-1,806.60
20	G2	X10	380	3,415.00	1,297,700.00	0
	G1	Goal	Value	(Max.) =	331,268,640.00	
	G2	Goal	Value	(Min.) =	124,897,616.00	
		Left Hand		Right Hand	Slack	Allowable
	Constraint	Side	Direction	Side	or Surplus	Min. RHS
1	C1	40,083.00	<=	40,083.00	0	26,718.03
2	C2	124,897,616.00	<=	166,210,000.00	41,312,384.00	124,897,616.00
3	C6	4,065.69	<=	4,760.00	694.31	4,065.69
4	C7	3,120.00	<=	3,120.00	0	2,928.57
5	C8	1,940.00	<=	1,940.00	0	1,652.11
6	C9	13,540.00	<=	15,620.00	2,080.00	13,540.00
7	C10	0	<=	851	851	0
8	C11	0	<=	8,530.00	8,530.00	0
9	C12	380	<=	452	72	380
10	C13	0	<=	7,000.00	7,000.00	0
11	C14	0	<=	115	115	0
12	C15	380	<=	380	0	0
13	C16	1,126.04	<=	3,550.00	2,423.96	1,126.04
14	C17	13,540.00	>=	13,540.00	0	10,337.36

Source: Compiled and calculated using (Win.Q.S.B) program.