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Geographical Information System (GIS) for Managing the Production and Cultivated Areas of Orange in Egypt

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***Abstract*:** The geographic information system is a computer-based system that allows studying natural and man-made phenomena with an explicit bearing in space. Geographic information systems (GIS) provide a powerful tool to organize and analyze spatial data. This study used a geographic information system to analyze orange production in Egypt.
The current research paper focuses on economic aspects and discusses the ability of controlling, monitoring, and managing of orange production through collecting the graphic data and attribute data all together in a low cost GIS system in order to assist and support the producers to choose the most appropriate conditions to maximize yield of orange production. In other words, the data can be classified into: spatial or positional data necessary to define where the graphic or cartographic features occur and non-spatial or attribute data that record what the cartographic features represent. This happened through the integration between available computer software's at any engineering office. This software's are AUTOCAD, EXCEL, and ARC-VIEW. Any version of the previously mentioned software's can be used in the low cost GIS system. Nowadays, these old software's are available with low cost price.
So, the GIS system was built using the orange governorate production data. Then, analysis of the integrated data was made. The obtained results show that, the suggested GIS system can efficiently control, monitor, and manage the orange production in Egypt more easier by supplying the needed data, with its analysis, in a very short time, in real world. Also, it can be concluded that, Behera is the biggest producer of orange, accounting for 36.6% , the second region is Ismailia accounting for 9 % of Egypt orange total production. Also, the comparison between the area and orange production show that, the best region are behara, suez, Ismailia, North Sina, Menia,and Sohag.

***Keywords*:** GIS, GIS Integrated System, Geographical information system, Data processing, Data Analysis, Orange Production in Egypt, Orange Consumption, Orange in Egypt, Orange Cultivated Areas, Cultivated Areas map.

1. Introduction

Our planet is facing many challenges in the 21st century. Widespread growth of populations and economies around the globe are increasing the pressure on natural resources, our environment, and societies. The impacts of a global economy and other socio-economic developments create challenges in many aspects of our lives as societies and individuals. The need for sound and sustainable management of natural resources, socioeconomic justice, and viable, socially & culturally acceptable economic opportunities for individuals and societies is indispensable.

Nowadays, the development in the computer science has gained paramount achievements. These achievements appear clearly in all fields of computer science, which can be easily visible in both hardware and software modern technologies. All other sciences had benefited from advances, making use of rapid mathematical treatment, fast data acquisition, large data storage and logical decision making.

Geographic information system (GIS) technology is used throughout the agricultural industry to manage resources, increase yields, reduce input costs, predict outcomes, improve business practices, and more. The capability of GIS to visualize agricultural environments and workflows has proved to be very beneficial to those involved in farming. The powerful analytical capabilities of the technology is used to examine farm conditions and measure and monitor the effects of farm management practices including crop yield estimates, soil amendment analyses, and erosion identification and remediation. GIS can also be used to reduce farm input costs such as fertilizer, fuel, seed, labor, and transportation. In addition, farm managers use GIS to submit government program applications, simplifying what used to be time-consuming multistep processes.

A GIS is a computerized database for coding storing and retrieving information tied to a geographic coordinate system or a set of places. The primary function of the GIS is the combination and evaluation of different map overlays for the purpose of providing new composite information. Additional functions of GIS include the digital storage of map data, the production of maps and graphic displays and the reporting of statistical summaries. GIS has three important components computer hardware, application software and a proper organizational context.

Consequently, the traditional control, monitoring, and management tools and techniques became no longer sufficient with the increase in projects complexities and progress of computer sciences, some advanced tools and techniques such as models, geographic information system (GIS), and expert systems began to take place [1]. So, computers and information systems are constantly changing the organizations manage their work. Knowing that, the geographic information system is a computer-based system that allows studying natural and man-made phenomena with an explicit bearing in space [2]. Knowing that the orange production need on-line tool that has the ability to monitor their current cases; control the volume of production; manages the agriculture areas needs; and also give the decision-maker the up-to-date data in simple and accurate form.

In this context, the study investigates how remote sensing and geographic information system (GIS) technology can be used with a physiological crop model to examine spatial variability in orange yield. Remote sensing provided a means of classifying land cover and for identifying agricultural regions in Egypt, Examination of the spatial patterns of simulated yield can improve production estimates and highlight high and low production areas. While data acquisition for remote sensing, GIS, and physiological models can be costly, these tools allow analysis that is impossible through other means and that provides insight into the interacting variables influencing yield.

Hence, the main objectives of the current research paper are the prediction of an orange capacity of a land unit to support a specific land use for a long period of time and the practical ability of controlling, monitoring, and management of orange production through building of a low cost GIS system. In this system, the graphic data and attribute data all combined together. This is aimed to replace the traditional control, monitor and management tools, which depends on the experiences of persons.

2. Geographic Information System (GIS)

In geography, many innovations in the application of information technologies began in the late 1950s, 1960s and early 1970s. Methods of sophisticated mathematical and statistical modeling were developed and the first remote sensing data became available. Researchers began also to envision the development of geographic information systems. The mid-1970s to early 1990s was a period of contagion. The first commercially available software for GIS became available in the late 1970s and spurred many experiments, as did the development of the first microcomputers in the early 1980s. This was an exciting time in which the development of powerful software coupled with the availability of inexpensive computers permitted many researchers to test new ideas and applications for the first time. In the early 1990s, or perhaps just a bit earlier, many innovations entered the coordination phase even as other experimentation continued at a fast pace.

GIS have emerged as very powerful technologies because they allow geographers to integrate their data and methods in ways that support traditional forms of geographical analysis, such as map overlay analysis as well as new types of analysis and modeling that are beyond the capability of manual methods. With GIS it is possible to map, model, query, and analyze large quantities of data all held together within a single database.

The importance of GIS as an integrating technology is also evident in its pedigree. The development of GIS has relied on innovations made in many different disciplines: Geography, Cartography, Photogrammetry, Remote Sensing, Surveying, Geodesy, Civil Engineering, Statistics, Computer Science, Operations Research, Artificial Intelligence, Demography, and many other branches of the social sciences, natural sciences, and engineering have all contributed.

The Geographic Information System (GIS) enables to collect graphical data (spatial data) and attribute data (like: records, tables, images, documents, etc) all together in one computer system (on-line system). In the previous section the geographic phenomena is identified as the study objects of the field of GIS. GIS supports such study because it represents phenomena digitally in a computer. GIS also allows visualizing these representations in various ways, figure [1].

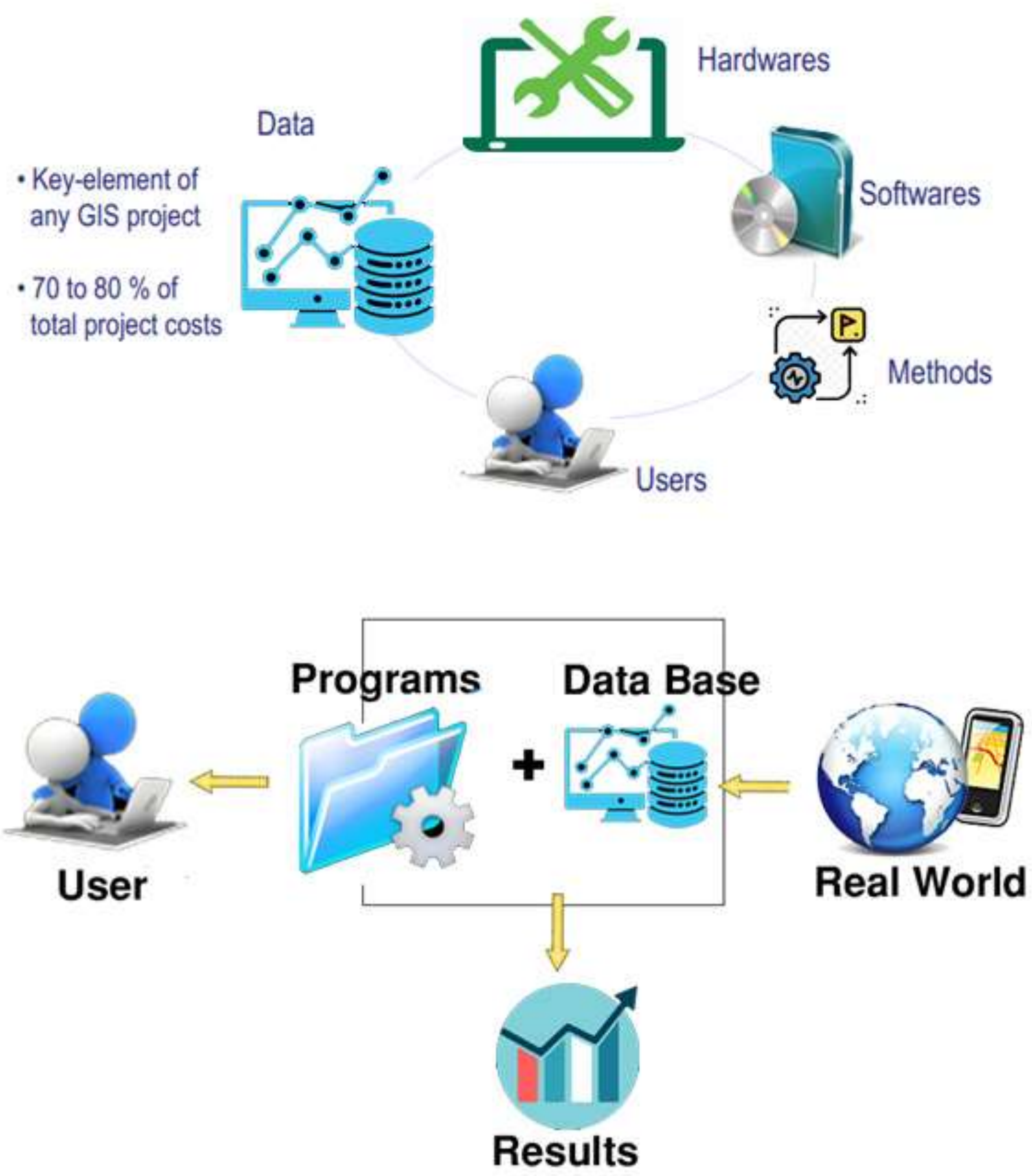


Fig. 1: Concept of Geographic Information System.

In GIS operations, the spatial data should be obtained at first, and stored in the computer memory in bits and bytes, as faithfully as possible. Geographic data are commonly classified as having two major components: the phenomenon being reported such as physical dimension or class and the spatial location of such phenomenon. In other words, the data can be classify into: spatial or positional data necessary to define where the graphic or cartographic features occur and non-spatial or attribute data that record what the cartographic features represent [3]. So, the spatial data is the data pertaining to the location aspect of geographical features together with their spatial dimensions. They are approximated by point, line, and area extent. Attributes are the description, measurement and classification of the geographic features. Attributes are presumed to be identical to the whole geographic feature. A geographic feature could have many attributes depending on the degree of significance. General speaking, attributes has descriptive, quantitative, qualitative and thematic aspects. Hence, the geographic information system is a data integration tool that allows collecting spatial and non-spatial data together in one system and process them to get the required results [4], figure (2).

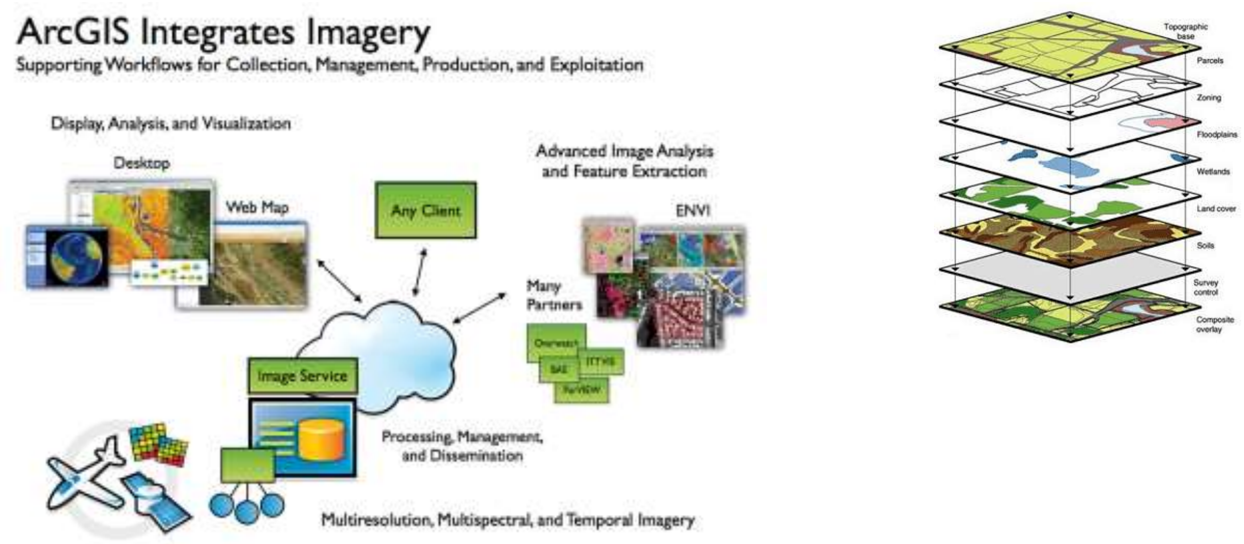


Fig. 2: Geographic Information System as a data integration Tool.

Any geographic information system may be split into five functional groups [5]:

1. Data input and verification.
2. Data storage and database management.
3. Data output and presentation.
4. Data transformation.
5. Interaction with the user.

3. Orange Production

3.1. International Orange Production

3.1.1. Global

orange production for 2013/14 is estimated to rise 2 percent from the previous year to 50.7 million metric tons as larger production in Brazil and China more than offset the decline in the United States. Fresh consumption is estimated to expand whereas fruit for processing and exports remain relatively flat. Table 1 shows oranges, Fresh: Production, Supply and Distribution in Selected Countries [6].

3.1.2. United States

production is estimated to fall 16 percent to 6.3 million tons due primarily to severe drop page in Florida, where 95 percent of the oranges are used for processing juice.

Exports are estimated to drop over 20 percent on reduced sales to Canada and South Korea.

3.1.3. Brazil’s

production is forecast to grow 6 percent to 17.3 million tons based on higher yields and favorable weather. Two thirds of production is used for processing with nearly all the rest for fresh consumption.

3.1.4. EU

production is estimated up 3 percent to 6.1 million tons on account of favorable weather. Imports are flat with South Africa and Egypt the largest suppliers. Fresh consumption is down as more oranges are expected to be processed.

3.1.5. South Africa’s

production is forecast to expand 3 percent to 1.6 million tons as a result of increased area and favorable weather. Exports are forecast at a record 1.2 million tons accounting for over 25 percent of global trade with the EU and Russia the largest markets.

3.1.6. Morocco’s

production is estimated to jump more than 25 percent to a record 1.0 million tons, following a drought-impacted crop. Along with favorable weather, area increased with the government citrus policy that includes support payments for new plantations, subsidies for irrigation equipment, and crop insurance for growers. Exports remain flat since 85 percent of the oranges are used for fresh consumption. Figure (1) shows the global citrus production for the 2009 to 2013.

Table 1: Oranges, Fresh: Production, Supply and Distribution in Selected Countries (1,000 Metric Tons).

Production	**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Jan 2013/14**	**July 2013/14**
Brazil	15,830	22,603	20,482	16,361	17,750	17,340
China	6,500	5,900	6,900	7,000	7,600	7,600
United States	7,478	8,078	8,166	7,502	6,707	6,291
European Union	6,244	6,198	6,023	5,888	6,600	6,075
Mexico	4,051	4,080	3,666	4,000	3,900	3,900
Egypt	2,401	2,430	2,350	2,450	2,570	2,570
Turkey	1,690	1,710	1,650	1,600	1,700	1,700
South Africa	1,459	1,428	1,466	1,560	1,500	1,600
Morocco	823	904	850	784	1,000	1,000
Argentina	770	850	565	550	550	700
Vietnam	694	730	530	675	675	675
Australia	380	300	390	435	465	465
Costa Rica	370	325	370	325	315	315
Guatemala	132	150	150	150	150	150
Israel	148	100	116	73	100	100
Other	181	188	186	191	191	191
Total	49,151	55,974	53,860	49,544	51,773	50,672
Fresh Dom. Consumption						
China	6,220	5,727	6,349	6,405	6,795	6,780
Brazil	5,788	4,827	5,488	7,255	5,421	5,501
European Union	5,717	5,324	5,536	5,379	5,871	5,261
Mexico	3,167	3,156	2,852	2,647	2,895	2,895
Egypt	1,503	1,350	1,365	1,365	1,435	1,435
United States	1,360	1,411	1,526	1,540	1,312	1,374
Turkey	1,409	1,315	1,224	1,290	1,320	1,320
Morocco	627	689	652	642	740	845
Vietnam	750	765	584	713	715	735
Russia	476	572	494	510	549	449
Argentina	530	560	376	360	365	410
Saudi Arabia	302	312	348	324	350	350
Iraq	172	222	287	264	315	270
Australia	202	150	165	210	224	224
Saudi Arabia	302	312	348	324	350	350
Iraq	172	222	287	264	315	270
Australia	202	150	165	210	224	224
Other	1,593	1,645	1,676	1,698	1,769	1,605
Total	29,037	28,853	30,885	28,971	30,366	29,951
For Processing						
Brazil	10,975	17,095	13,220	10,935	12,241	11,547
United States	5,554	6,019	6,064	5,423	4,895	4,552
European Union	1,214	1,356	1,056	1,069	1,299	1,374
Mexico	880	930	830	1,350	1,000	1,000
South Africa	280	348	249	283	160	300
Argentina	84	166	104	113	115	240
Costa Rica	235	210	275	220	220	220
Australia	105	100	128	110	119	119
Turkey	100	100	100	95	100	100
Other	129	145	183	171	230	200
Total	19,758	26,649	22,729	20,369	21,159	20,432

3.2. Egyptian Orange:

Egypt is likely to retain its position as the world's sixth largest orange producer and the second biggest exporter in 2012, 2013/2014. Post forecasts orange production at roughly 2.5 MMT with exports at 1.1 MMT, up 10 percent compared to the previous season. This increase in production and exports is attributed to the increase in total area harvested and the number of fruit bearing trees, total fruit bearing trees at 8.9 million are up by almost 450 thousand trees compared to the previous season. Fresh domestic consumption is likely to increase less than 1 percent or 10 TMT at approximately 1.375 MMT [**6**].

3.2.1. Egypt Orange Area Planted

Post forecasts Egypt's MY2013/2014 total area planted to increase slightly by 1.6 percent or 2,100 ha at roughly 133,236 ha versus 131,136 ha for MY 2012/13. In the last two years citrus exports in general and oranges shipments in particular have increased and are expected to climb this marketing year.

Post forecasts Egypt's MY2013/2014 total area harvested to increase by 2,000 ha to 115,000 ha versus 113,000 ha this past marketing year. The total number of fruit bearing trees is forecasted to increase by 200 thousand trees to 9.1 million trees compared to MY 2012/13[**6**].

The MY2012/13 season saw an increase in total area harvested and total number of fruit bearing trees due to better growing weather conditions, and this is expected to continue during MY2013/2014. Table 2 shows the cultivated areas and the orange production during five years in the Egyptian Governorate. Also, figure (3) shows the ratio of production to the cultivated proportion.

Table 2: The cultivated areas and the orange production during five years in the Egyptian Governorate.

	2008		**2009**		**2010**		**2011**		**2012**	
Governorate	F. Area	F. Area	F. Area	Production (ton)	F. Area	Production (ton)	F. Area	Production (ton)	F. Area	Production (ton)
Cairo	281	249	249	739	752	197	194	739	194	736
Alexandria	624	625	625	6056	640	5889	653	6056	661	6270
Port Said		-	-	15	-	-	3	15	3	15
Suez	112	291	291	13315	292	1703	2115	13315	2307	14006
Damietta	17	16	16	181	23	147	31	181	31	217
Dakahlia	3789	3822	3822	42009	3887	41275	3917	42009	3963	51512
Sharkia	28230	29877	29877	248596	29722	242052	30647	248596	35600	296205
Qalyoubia	31250	31907	31907	310452	33443	313720	33328	310452	32786	301121
Kafr-El Sheikh	3377	3625	3625	52672	3829	52694	3877	52672	3366	35628
Gharbia	9397	9437	9437	90243	9582	90731	9805	90243	10224	95201
Menoufia	21747	23455	23455	234776	24181	202210	25567	234776	25741	222767
Behera		44955	44955	522098	46674	489168	49735	522098	50421	538851
Ismailia	10160	10799	10799	268171	12751	189820	14.254	268171	22532	318435
Giza	4555	98	98	30027	238	1327	4401	30027	4370	33239
Beni Suef	3208	3191	3191	27463	3255	26915	3241	27463	3180	25975
Fayoum	608	608	608	3833	613	3700	646	3833	646	4374
Menia	1071	1010	1010	6161	1001	5714	1017	6161	994	6172
Assuit	5807	5752	5752	40791	5217	46637	4641	40791	5190	49514
Suhag	1275	1183	1183	7944	1142	9086	1071	7944	1091	9122
Qena	533	516	516	1378	213	1393	211	1378	216	1366
Aswan	157	153	153	1310	147	1258	146	1310	157	1343
Luxor	141	134	134	3211	438	3936	379	3211	367	2986
New Valley	1111	1115	1115	3983	1120	4011				
Matruh	44	38	38	729	73	286	1179	3983	1475	4843
North Sinai	1179	1312	1312	8083	1251	8166	173	729	192	815
South Sinai	14	20	20	79	25	68	1242	8083	31	8256
Noubaria	47988	56003	56003	653405	56929	629251	30	79	1273	85
Total	214572	2785397	244108.25	2577720	237438	2371354	230191	2337262	176675	1729218

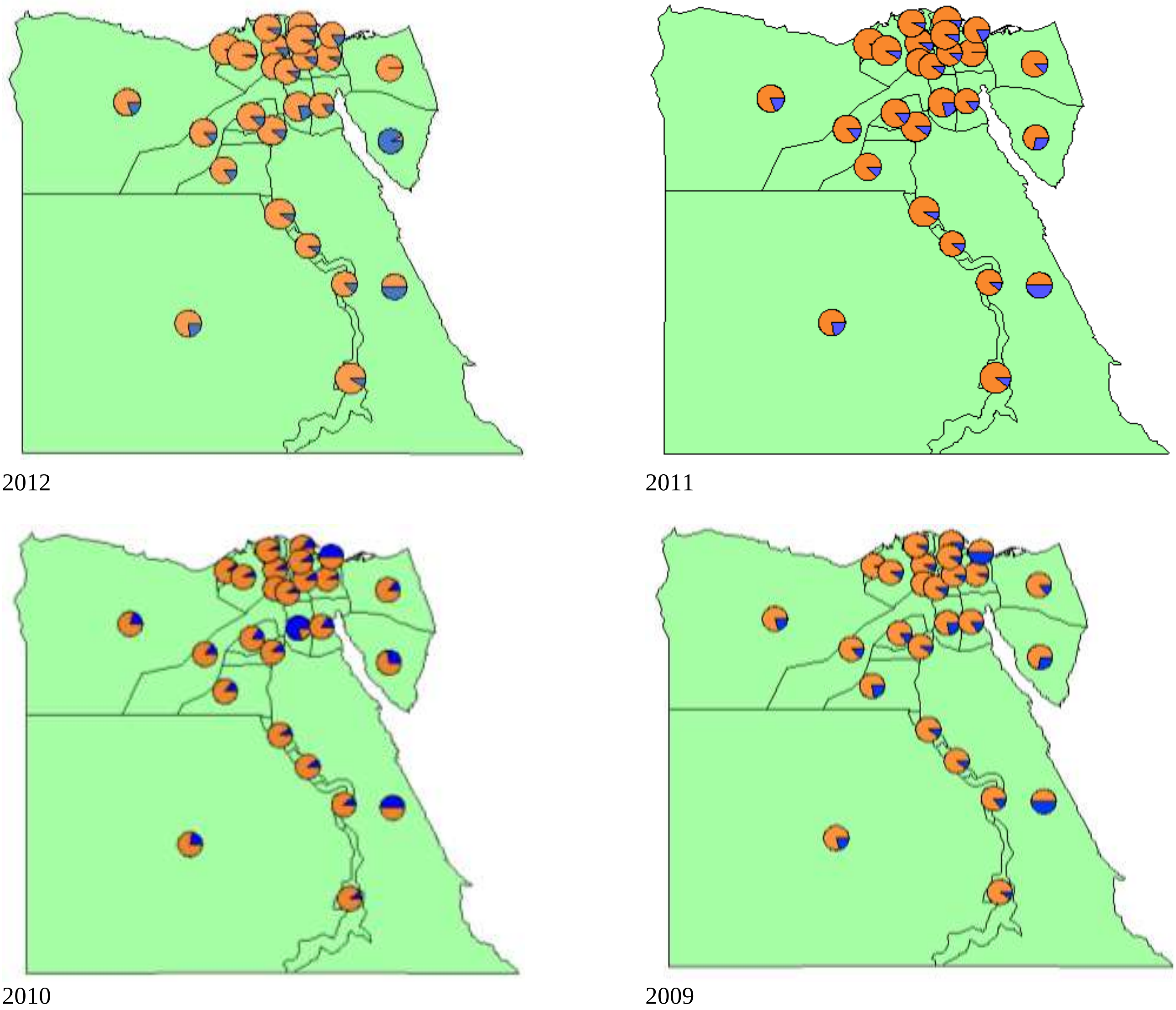


Fig. 3: Ratio of production to the cultivated proportion.

3.2.2. Orange Consumption in Egypt

Post forecasts fresh domestic consumption in MY2013/2014 to increase by less than 1 percent at approximately 1.375 MMT. Roughly 63 percent of the orange crop is consumed fresh, while 3.6 percent is consumed as juice. We estimate per capita orange consumption at roughly 33 kilograms per annum. Orange is one of the favorite fruits for Egyptian consumers during the winter season.

The orange market in Egypt is frequently subject to price fluctuations. Orange prices can change as many as three times per day. Prices also differ per geographical area so that prices in the neighborhoods of the working poor areas are very low versus prices in high end residential areas. Lower prices are usually found at the large wholesale markets outside of Cairo (such as El-Obour Wholesale Market and 6th of October Wholesale Market), as the wholesale markets sell in bulk at wholesale prices. In 2013, as a result of the economic and political situation, prices of some products including fruits and vegetables have increased. In the last week of November 2013, one kilogram of navel orange was sold at 1.75-7.00 E.L/ kg, while the regular price was 12.5-4.00 E.L/ kg, see table (3) [7], [8]and figure (4). This prompted the government in an attempt to control prices to announce indicative prices for some food products every week. The Ministry of Supply and Internal Trade continues to encourage traders to abide by these prices. However, traders deal in market-determined prices which remain above the indicative prices. This does not affect orange consumption as consumers still find oranges less expensive than other fruits.

Table 3: The Local price of orange at 2012 and 2013.

	Local Retail prices for Oranges			Local wholesale prices for Oranges		
	2013 Last week of November	**2012**		**2013 Last week of November**	**2012**	
	EGP. Piaster/Kg	EGP. Piaster/kg	**Equivalent in $US**	**Price in EG**	**Price in EG**	**Equivalent in $US**
Navel Orange	175-700	125-400	21-67 cents/kg	1.50 EGP. Piaster/Kg	85EGP. Piaster/kg	21-67 cents/kg
Local Orange	200-350	100-600	17 cents - 1 dollar/kg	150 EGP. Piaster/kilo	85 EGP. Piaster/kg – LE 1.40/kg	17 cents - 1 dollar/kg
Sweet Orange	200-350	125-350	21-58 cents/kg	2.00 LE /Kg	LE 2/kg	21-58 cents/kg
Valencia Orange	200-350	200-350	33 – 58 cents/kg	3.00 LE /Kg	LE 2/kg	33 – 58 cents/kg
Source: Ministry of Finance 100 EGP piaster = 14.5 U.S. cents $US 1 = Egyptian Pound (LE) 6.10						

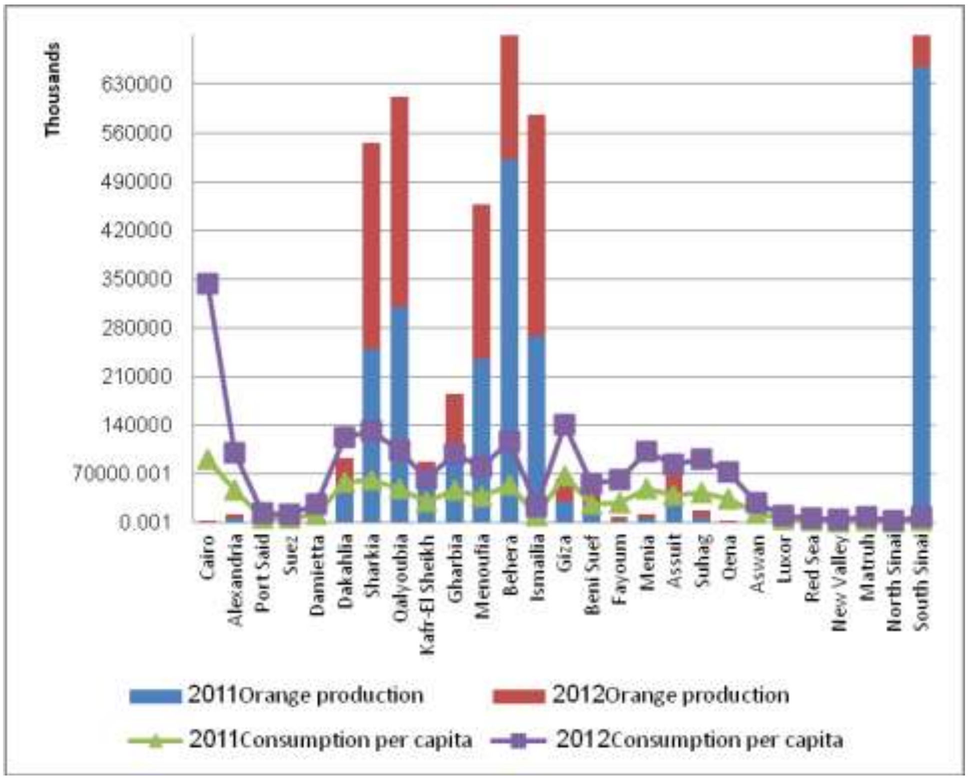


Fig. 4: The Orange Production with respect to the Egyptian Governorates.

4. Methodology of Investigation

The application of GIS modeling in the current research paper is performed for the orange production in Egypt. Many algorithm steps have been performed to obtain the low cost geographic information system. These algorithm steps can be summarized as follows:

- Obtain the digital map of the Egyptian Governorate using the AutoCAD program facilities [9].
- Prepare the obtained digital map in the form that each separate entity (governorate border) surrounded with a closed polygon that its elevation has the value of the entity number. (governorate number).
- Collect the attribute data (orange production data).
- Write the attribute data on a Microsoft Excel worksheet then save them in a DBASE IV format [10].
- Insert the AutoCAD file in ArcView program and convert it to ship file (ArcView file) **[**11].

- Add new column in the ship file attribute table and name it as ID (entity identification) and copy the column of elevations in it.
- Link the attribute table of the ship file (using ID column) with the DBASE IV (using the governorate number).
- For updating the graphical data or the attribute data, edit the ship file directly for any updateable data.
- For inserting new attribute data, add new columns in the attribute table of the ship file for any new data.
- Analyze, monitor, and management of the orange production through the prepared low cost geographic information system on the ArcView program facilities.

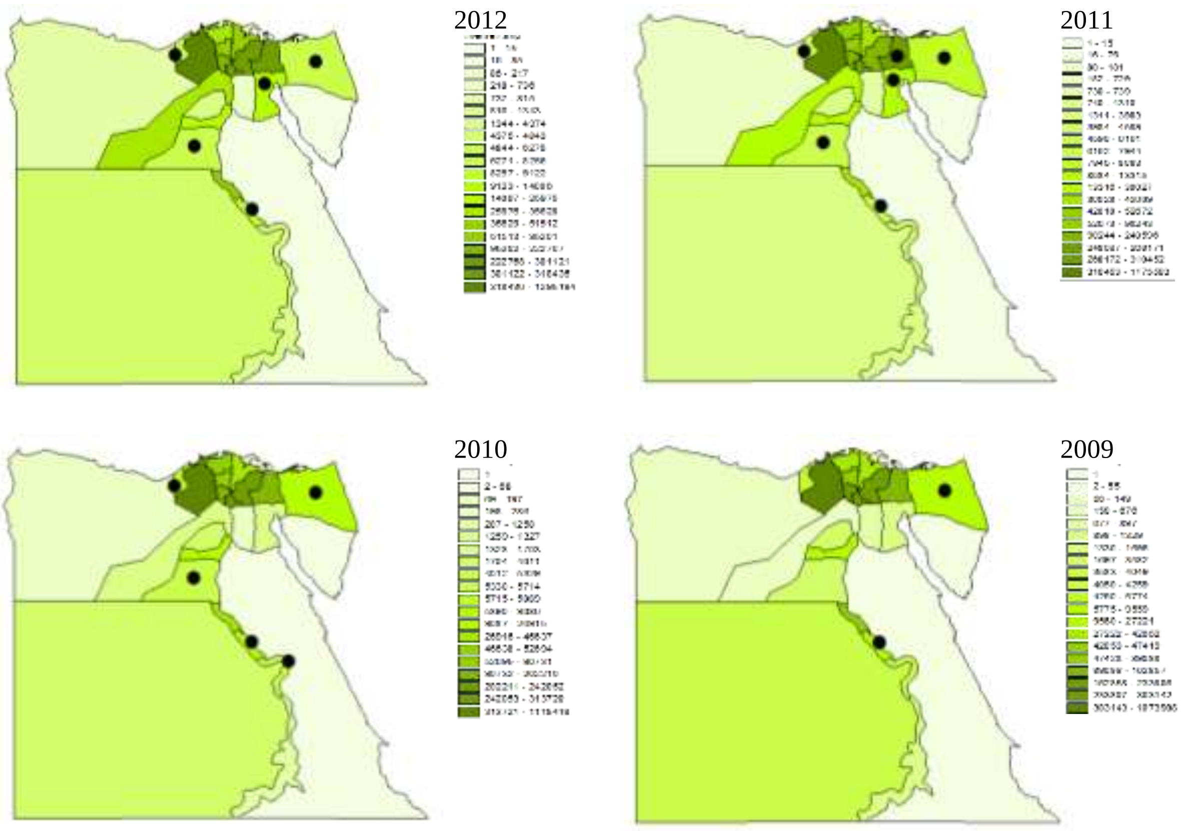
Each one of the previously mentioned items has its share in the total quality of the obtained geographic information system. In this context, a stage of data checks and verifications must be performed in parallel with each step of the previously mentioned steps.

The previously mentioned data on area and production of different orange growing Governorates of Egypt for 5 years were collected from the Ministry of Agriculture, Egypt

For more explicitly and data analysis, the data processed through a GIS system, as mentioned before. In other words, the processing and analysis of the collected data of the cultivated areas as well as the production of orange through the Egyptian governorate will be through a GIS maps show the data configuration in a simple way.

5. Data Processing and Analysis

First, the GIS system was build using the orange governorate production data. Figure (5) shows the classification of the production of orange with each respective governorate. The analysis of Figure (5) mentioned that Behera is the biggest producer of orange, accounting for 36.6% , the second region is Ismailia accounting for 9 % of Egypt orange total production. Other leading orange production include Qalyoubia, Sharkia and Monifia . Also, figure (5) shows the Egypt region production, Otherwise the behara, suez, North Sina, Menia and Sohag are the best orange production are more than 6000 ton in less than 3000 fadan in 2012. In 2011, The comparison between the area and orange production, the figure show the best region are behara, suez, Ismailia, North Sina, Menia,and Sohag. In 2010, the best region are behara, North Sina, Menia and Sohag and Qena. In 2009, North Sina and Sohag are the best orange production which have more than 6000 ton in less than 3000 fadan.



Egypt government orange production

- Orange production is over 6000 Ton and area is less 3000 KM

Fig. 5: Egypt Production over the governement from 2008 to 2012 and the best regions in orange production.

Figure (6) shows that the orange production in 2012 as a percentage of the production of each production in other years (2011, 2010, 2009 and 2008). For example, for the Giza orange production in 2012 are about 1.15 of the same region in 2011, 25.1 in 2010, 49.1 in 2009 and 0.95 in 2008.

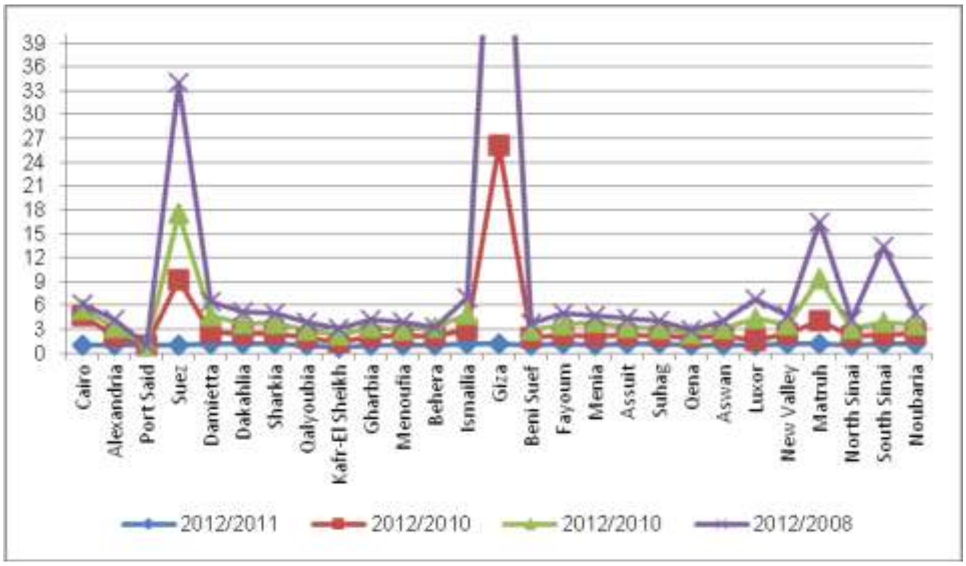


Fig. 6: Comparative of Orange Production over the Egypt Governorate between 2008- 2012.

6. Conclusion

GIS application in agriculture has been playing an increasingly important role in crop production throughout the world by helping farmers in increasing production, reducing costs, and managing their land resources more efficiently. GIS application in agriculture such as agricultural mapping plays a vital role in monitoring and management of soil and irrigation of any given farm land. GIS agriculture and agricultural mapping act as an essential tools for management of agricultural sector by acquiring and implementing the accurate information into a mapping environment. GIS application in agriculture also helps in management and control of agricultural resources. GIS agriculture technology helps in improvement of the present systems of acquiring and generating GIS agriculture and resources data.

In the current research paper, the suggested GIS system is a low cost system that allows the user to have its need easily. The obtained results indicate that the geographic information system can efficiently control, monitor, and manage the orange production in Egypt more easier by supplying the needed data, with its analysis, in a very short time, in real world. Also, the results showed the power of the GIS system in supporting decision-makers. So, it can be concluded that, Behera is the biggest producer of orange, accounting for 36.6% , the second region is Ismailia accounting for 9 % of Egypt orange total production. Aso, the comparison between the area and orange production show that, the best region are behara, suez, Ismailia, North Sina, Menia,and Sohag.

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