Agricultural Economic

Economic analysis of climate-smart Agriculture in Egypt

Abd El Mowla, K. E.[1] and H.H. Abd El Aziz[2]

[1]*Central lab. Of Organic Agriculture, Agricultural Research Center, P.O. Box 12619, Giza, Egypt.*

[2] *Agricultural Economics Research Institute, Agricultural Research Center, Giza, Egypt*

Abstract

E gypt faces many challenges in achieving food security. Climate change is one of the obstacles facing agricultural production in achieving self-sufficiency in strategic crops. Agricultural sector emissions amounted to about 2.57 million tons of carbon, representing1.25% of the total emissions for different sectors in 2017/2018. This may negatively affect the productivity of major crops in Egypt, This leads to a decrease in farmer incomes this leads to a decrease in farmers 'income, which is reflected on the extent of the contribution of the agricultural sector to Gross Domestic Product (GDP). This research aims to estimate the impacts of increasing the production of crops, livestock and aquatics production on achieve the food security, in the same time decreasing the emissions of greenhouses gasses in Egypt" Also mitigating climate change without having a negative impact on the environmental, The average supply of protein of animal origin recorded the highest contribution rate (0.970)% from total variance, followed by the average protein supply reached (0.948)% from total variance, The energy supply of grains, roots and tubers recorded the lowest percentage **(**-0.137)% from total variance, also, there is a strong correlation between the average supply of protein of animal origin and the main component (food availability), The study recommends the use of modern agricultural methods, , by supporting small farmers to the application of climate-smart farming systems in Egypt, and provide the necessary funding To continue research in the field of agricultural production. Providing farmers with various extension services, increase organic agriculture area, and providing full support to organic farms, which help increase Egyptian exports of agricultural products.

Key words: *Climate-Smart Agriculture in Egypt, Economic Analysis, increases agricultural productivity, more resilient to Climate changes, Reduce GHGs' emissions.*

Introduction

Climate-smart agriculture (CSA) defined as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces GHGs (mitigation) where possible, and enhances achievement of national food security and development goals" (FAO 2016a). The main objective of Climate-smart agriculture is to achieve food security by increasing productivity, adaptability and mitigating harmful emissions.

As a result, food systems should become more efficient and flexible, on every scale from farm to consumer. Therefore, they must become more efficient in the use of resources, using the optimum combination of production elements (land, work, capital, and management) that achieve the highest returns, the lowest costs and the most able to cope with climate change.

Thus, the smart agriculture climate achieves the goals of sustainable agricultural development economic, social and environmental through increased agricultural productivity and agricultural income, and adapts to climate change, and reduces global warming gases emissions.

A number of strategies can be adopted to achieve the objectives of climate smart agriculture. For example, the use of renewable energy in agriculture such as wind energy, solar panels, pyrolysis units, and solar powered water pumps are very crucial for smart food systems (Amin et al 2015). Resource conserving technologies (RCTs) like zero tillage[1] , also the emergence of newly developed varieties that withstand heat, drought and salinity is also a better strategy for CSA. Therefore, crops that suit climate change must be grown in more suitable areas. Availability of information on weather forecasts and the use of early warning systems in growing different crops will be very useful to reduce losses from climate change. Information and Communication Technology (ICT) can efficiently assist officials and researchers in developing plans and programs for use in emergency situations, like using Agricultural Expert System to see the potential risks of climate change to future crop productivity.

In the context of the foregoing, the agricultural sector in Egypt faces many challenges in achieving food security. Given Egypt's geographical location, Egypt can produce a varied range of vegetation grains, fruits, vegetables, Medical, Aromatic and cutting flower plants, due to the moderate climate all round year. Agricultural and irrigation emissions amounted to about 2.57 million tons of carbon, representing 1.25% of the total emissions for different sectors in 2017/2018. This may negatively affect the productivity of major crops in Egypt (CAPMAS. 2019). The largest emitters in agriculture are: Enteric fermentation 40%, Manure left on pasture 16%, Chemical fertilizers 13%, rice farms 10%, Manure management 7%, and Burning of agriculture wastes 5%. Therefore be Livestock contributed nearly two-thirds of the total emissions (FAO. 2018).

In the other hand, Egypt categorized by the World Bank as a lower income country, with a total GDP of US 250 billion dollars and a population of more than 98 million people in 2018. The population is expected to reach 112 million people in 2025.The agriculture sector contributed about 10.8 percent of the GDP in 2018 (W.Bank 2018).

Research problem:

The agricultural sector in Egypt faces a major challenge in providing food, as Egypt is facing a decrease in the productivity of the main crops by 2040, due to climate change and fragmentation to a decrease in the yield of wheat by 12%, vegetables by 28%, corn by 47%, and rice by 26 % (IFAD, 2019); This leads to a decrease in farm incomes and a decline in the percentage of the agricultural sector contribution to the GDP.

Research Objectives:

This research aims to estimate the impacts of increasing the production of crops, livestock and aquatics production on achieve the food security, in the same time decreasing the emissions of greenhouses gasses in Egypt. As well as, studying the effect of some economic variables related to the agricultural sector on emissions Carbon dioxide in Egypt.

Research Methodology and Data Sources:

This research will rely on the analytical method in terms of both qualitative and quantitative, like: The Simple Correlation and The Analysis of Variance. Some econometrics methods such as: The Seemingly Unrelated Regression Equations (SURE) model, Principle Component Analysis (PCA), will use to achieve the research objectives. The SPSS program was used in this research.

The research will based on secondary data published by FAO, the World Bank, the Central Bank of Egypt, the Central Agency for Public Mobilization and Statistics (CAPMAS), the Economic

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[1] **Concept of zero-tillage**. Zero-tillage are tillage systems in which soil disturbance is reduced to sowing operations and traffic only and where weed control must be achieved by chemical means. Zero-tillage has been demonstrated to be of practical value in maize production on sloping, structurally unstable soil, in double cropping systems with cereal and forage crops, and in pasture renovation. It maintains crop residues on the soil surface and protects the ground against wind and water erosion. https://doi.org/10.1016/S0065-2113(08)60779-8

Affairs Sector in the Ministry of Agriculture, and Climate Analysis indicators Tools (CAIT)[2] during the period from 1999 to 2017 for Egypt; as well as some of references, scientific journals, researches and academic theses related to the subject of this research core.

Theoretical framework:

Climate change is any significant long-term change in the rate of weather occurring to a particular area. Rate and status Weather can include temperature, rainfall, and wind conditions. It is performed Long run climate changes, have enormous impacts on ecosystems Natural.

Since more than 5,000 years ago, Egypt was famous for its temperate climate and fertile soil and abundant source of water from the Nile River. Cultivated area 9.1 million feddan (cultivated land area for permanent & temporary agricultural crops without repeating of crops varieties where cultivated in more than once throughout the year), cropped area 16.4 million feddan of cultivated land area of each field and vegetables crops in the three lugs & fruit gardens are grown in 2016/2017(CAPMAS). The agricultural system depends primarily on irrigation from the Nile, in addition to a very small percentage, which comes from groundwater; the Egyptian government is working to expand land reclamation in the Eastern and Western Desert and the New Valley with the aim of providing food (Ramadi et al., 2013).

As the agricultural activities stand a source of greenhouse gasses emission and responsible for about 14 percent of global greenhouse gasses emission (Żukowska *et al.*, 2016), contributing a significant amount of emissions in Egypt. GHG emissions from agriculture sector consist mainly from other gases non-CO_2 like (Methane and Nitrous oxide), produced by crop and livestock production. it can be said that agricultural sector including crops, livestock, and aquatics sectors do not use enough climate friendly practices and technologies in Egypt.

Agriculture emissions total reached in Egypt 31 Mt CO_2e in 2016 (Enteric Fermentation 9.6Mt, Manure Management 8.8 Mt, Rice Cultivation 6.3Mt, Synthetic Fertilizers 4.0 Mt, Manure applied to Soils1.5 Mt, Manure left on Pasture 430 kt, Crop Residues230 kt, Burning Crop residues 160 kt), It represents about 11.07% of the total emissions reached about 280 Mt CO_2e (CAIT 2016).

Good agricultural practices that help mitigate the effects of climate change: Good practices can contribute to sustainable crop production. Examples include sustainable crop intensification (SCPI) reduces the adverse impact on the agricultural environment, contributes to lowering costs of agricultural operations, and achieving High return to farmers, and promotes biodiversity.
SCPI can be achieved through good agricultural practices that include: maintaining soil fertility, by increasing its content of nutrients needed for crop production, crop rotation system, using good seeds, high-yielding varieties, and using Integrated Pest Management (IPM), as well as Modern irrigation systems in agriculture.

SCPI aims to produce more crops in the same production unit while avoiding the harmful effects on the agricultural environment, preserving natural resources, and biological diversity. This system helps small farmers to obtain a high return per unit area.

Climate-smart Livestock: The smart management system for the livestock sector can be used by using expert systems programs in managing poultry and livestock farms that contribute to the reduction of greenhouse gas emissions, as 40% of emissions produce from enteric fermentation, also reduces the percentage of losses in animal feed, and increases Feed conversion Ratio (FCR) decrease Production costs and increase profits for farm.

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[1] CAIT Climate Watch is an online platform designed to empower policymakers, researchers, media and other stakeholders with the climate data, visualizations and resources they need to gather insights on national and global progress on climate change

The livestock sector can also contribute to providing animal protein, achieving food security and providing job opportunities for small farmers, and the use of unconventional feeds in animal feeding provides large areas planted with feed crops used in the cultivation of other crops.

Fisheries and aquaculture in Egypt occupy areas of more than 13 million acres, equivalent to about 150% of the agricultural land, and these sources vary according to their nature. Fish farming is the main source for providing cheap, high-quality animal protein, which represents 80% of fish production in Egypt, and contributes to food security.

The direction of the government in the next years is to expand the establishment of new fish farms in the Suez Canal and next to the various lakes, apply technology in managing fish farms, and use water recycling systems to benefit from them in agriculture, which is reflected in reducing production costs and raising the efficiency of fish farms.

Climate-Smart Agriculture systems transitioning by providing the appropriate infrastructure to apply technology in farm management and developing feed factories, to avoid losses and meet the needs of the expansion plan in livestock and aquaculture.

RESULTS AND DISCUSSION:

Two main objectives of the concept of climate-smart agriculture have been considered: achieving food security by increasing agricultural productivity of different sectors and reducing greenhouse gas emissions by adapting agricultural activities to be climate-friendly. For greenhouse gas emissions in agriculture, carbon dioxide, methane and nitrous oxide are the most important. According to the research's objectives, which attempts to find the role of agricultural sectors in achieving food security and this of the challenges are the emission of greenhouse gases, the production of crops, livestock and aquatic organisms were independed variables during the period (1999-2017).

Table1 shows that some of descriptive statistics of the variables under study. The standard deviation of food availability indicators is is about 11.8 for Average value of food production, while it is about 3.3 for Average protein supply, for the standard deviation of Greenhouse gasses indicators is about 41.2 for Carbon dioxide, while it is about 1.8 for Nitrous oxide. For the explanatory variables the standard deviation of Livestock production is about 20.3 while it is about 3.4 for Aquatics production. Differences in temperature and precipitation rate affect crop production, livestock production as well as agricultural income (FAO, 2017a), the mean of Precipitation and temperature annual has been shown to be around 2.48mm, 24.12∘C, respectively.

For the variable of food availability and greenhouse gas emissions, which are dependent variables, a total variance analysis was used to clarify the relationship between dependent and independent variables. It was found through the results of the analysis of the total variance of the indicators; Table 2 shows the contribution of each variable with different percentages of the total variance. The variable Share of dietary energy supply derived from cereals crops, roots and tubers recorded the highest contribution rate 0.966 % from total variance, while the variable Average value of food production recorded the lowest contribution rate of 0.475% from total variance. Therefore, the first component is expected to be considered the most important variable responsible for food availability.

Table 1. Descriptive statistics of the variables used in during the period (1999-2017).

Variables	Mean	S.D.	Min	Max
Dependent variables: Food availability indicators:				
Average dietary energy supply adequacy (percent) (3-year average)	149.1	3.4	144.0	155.0
Average value of food production (constant 2004-2006 I$/cap) (3-year average)	238.4	11.8	216.0	257.0
Share of dietary energy supply derived from cereals, roots and tubers (kcal/cap/day) (3-year average)	64.8	0.8	62.0	66.0
Average protein supply (g/cap/day) (3-year average)	60.5	3.3	56.0	65.0
Average supply of protein of animal origin(g/cap/day) (3-year average)	23.2	4.3	18.0	30.0
Greenhouse gasses indicators:				
Carbon dioxide (mt-co_2)	157.8	41.2	97.0	217.3
Methane (mt-co_2e)	41.4	18.0	2.3	76.3
Nitrous oxide (mt-co_2e)	16.2	1.8	13.6	19.1
Explanatory variables:				
Crops production (mt)	102.3	14.0	76.1	124.6
Livestock production (mt)	107.1	20.3	77.5	129.8
Aquatics production (mt)	11.5	3.4	7.6	18.2
Other variables:				
Precipitation (mm)	2.48	0.620	1.57	3.79
Temperature (°C)	23.12	0.678	21.04	24.73

Source: Collected and calculated from: the Egyptian data on the websites of: Food and Agriculture Organization (FAO) and (CAIT) during the period (1999-2017).

Table 2. Contribution of each variant in total variance for food availability

Variable number	Variables	Contribution Ratio
1	Share of dietary energy supply derived from cereals, roots and tubers (kcal/cap/day) (3-year average)	0.966
2	Average value of food production (constant 2004-2006 I$/cap) (3-year average)	0.475
3	Average dietary energy supply adequacy (percent) (3-year average)	0.875
4	Average protein supply (g/cap/day) (3-year average)	0.915
5	Average supply of protein of animal origin(g/cap/day) (3-year average)	0.949

Source: Collected and calculated from: the Egyptian data on the websites of: Food and Agriculture Organization (FAO) and (CAIT) during the period (1999-2017).

Table 3 shows the contribution of each variable with different percentages of the total variance. The variable Carbon dioxide recorded the highest contribution rate 0.843% from total variance, while the variable Methane recorded the lowest contribution rate of 0.494% from total variance. Therefore, the first component is expected to be considered the most important variable responsible for greenhouses gasses.

Table 3. Contribution of each variant in total variance for greenhouses gasses

Variable number	Variables	Contribution Ratio
1	Carbon dioxide (mt-co$_2$)	0.843
2	Methane (mt-co$_2$e)	0.494
3	Nitrous oxide (mt-co$_2$e)	0.764

Source: Collected and calculated from: the Egyptian data on the websites of: Food and Agriculture Organization (FAO) and (CAIT) during the period (1999-2017).

Table 4 shows the Principle Component Analysis (PCA), shows the contribution of each variable with different percentages of total variation. The average supply of protein of animal origin (gr / cap / day) recorded the highest contribution rate (0.970)%, followed by the average protein supply (gr / cap / day)reached (0.948)%, The share of dietary energy supply derived from cereals, roots and tubers recorded the lowest contribution rate (-0.137)%, also, there is a strong correlation between the average supply of protein of animal origin and the main component (food availability), which shows that the principle component for the variable 5 in the table contributed the highest percentage of total variance of about 63.3% (Eigenvalue = 3.2[3]), the principle component is the most representative of the evidence, 63.3% of the data and thus it represents the dependent variable representing the group of variables related to food security.

Table 4. The correlation between the main component and the food availability.

Variables	Component 1
Average dietary energy supply adequacy (percent) (3-year average)	0.933
Average value of food production (constant 2004-2006 I$/cap) (3-year average)	0.661
Share of dietary energy supply derived from cereals, roots and tubers (kcal/cap/day) (3-year average)	- 0.137
Average protein supply (g/cap/day) (3-year average)	0.948
Average supply of protein of animal origin(g/cap/day) (3-year average)	0.970

Source: Collected and calculated from: the Egyptian data on the websites of: Food and Agriculture Organization (FAO) and (CAIT) during the period (1999-2017).

Table 5 shows the Principle Component Analysis (PCA), shows the contribution of each variable with different percentages of total variation. The Carbon dioxide recorded the highest contribution rate (0.913) %, followed by the Nitrous oxide reached (0.874) %, The Methane recorded the lowest contribution rate (0.703) %, also, there is a strong correlation between the Carbon dioxide and the main component (greenhouse gasses)

Also, Table 5 shows the principle component (1) contributed the highest percentage of total variance of about 70% (Eigenvalue = 2.1), which is the most representative of the evidence, 70% of the data and thus the represents the dependent variable representing the group of variables related to greenhouse gasses.

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[3] if the eigenvalue ≥ 1.the principle component represents the data better

Table 5. the correlation between the main component and the greenhouse gasses.

Variables	Component 1
Carbon dioxide (mt-co_2)	0.913
Methane (mt-co_2e)	0.703
Nitrous oxide (mt-co_2e)	0.874

Source: Collected and calculated from: the Egyptian data on the websites of: Food and Agriculture Organization (FAO) and (CAIT) during the period (1999-2017).

Due to the impact of investment by economic sectors on one another and on common factors among them, at the same time, there are technical ties and linkages between different economic sectors. The existence of such relationships means that the growth of a particular sector requires a minimum level of growth in a number of other sectors. In light of this, the phenomenon of investment cannot be seen individually in each sector but rather should be studied and analyzed in a way that takes into account the intertwining and interdependence of the economic sectors with each other. Therefore, the correct treatment of this phenomenon requires its formulation in the form of a nested set of functions, (SURE) in estimating and analyzing the parameters of the proposed functions by merging the time series data of the economic sectors (Zellner A., 1962).

The system of functions to be estimated using the SURE model will take the following form:

$Y_1 = B_0 \pm B_1X_1 \pm B_2X_2 \pm B_3X_3 + E_1$ (1)

$Y_2 = a_0 \pm a_1X_1 \pm a_2X_2 \pm a_3X_3 + E_2$ (2)

Where: Y_1 food availability, Y_2 gases are the dependent variables. X_1 Crops production, X_2 livestock production, X_3 Aquatics production are the explanatory variables.

Through the statistical results of the model to the independent variables in both models are positive (+). According to the first equation for food availability, livestock production is not significant statistically, while Crops production and Aquatics production is statistically significant. The value of the coefficient of determination indicates that 95% of the changes in food availability are due to the independent factors of Crops production, Livestock production and Aquatics production and 5% due to other unknown factors.

As for the second equation for emissions from the agricultural sector, the results indicate that the plant and water production sector is not significant statistically, while the Livestock production sector is statistically significant. This indicates the importance of the Livestock production sector in the availability of food, but it is responsible for 40% of the emissions from greenhouse gases.

The value of the coefficient of determination indicates that 87% of the changes in greenhouse gas emissions are due to the independent factors namely (Crops production, Livestock production and Aquatics production and 13% due to other unknown factors.

Table 6. The statistical results of seemingly unrelated regression of climate-smart agriculture.

Variables	Food availability		Greenhouse gasses		
	Coef.	P > z	Coef.	P > z	
Crops production	0.0279979	0.014	0.0092984	0.640	
Livestock production	0.0085223	0.203	0.031021	0.008	
Aquatics production	0.1319223	0.000	0.0587235	0.320	Number of obs = 19
Constant	-5.296756	0.000	-4.94911	0.000	
R- squared	0.95		0.87		
Chi2	429.64		127.44		
Prob.	0.000		0.000		

Source: Collected and calculated from: the Egyptian data on the websites of: Food and Agriculture Organization (FAO) and (CAIT) during the period (1999-2017), by using program (SPSS).

Effect of Economic Variables on Emissions Carbon dioxide:

To illustrate the effect of some economic variables on the emissions of carbon dioxide, through the work of the Co-integration analysis, after verifying the first condition that assumes the integration of time series of the same degree, we do a Co-integration test using the Johansen test, assuming zero hypothesis that there is no Co-integration, and alternative hypothesis is that there is Co-integration between the variables.

According to the results of the analysis, the results showed that there are at least three integrated vectors, thus rejecting zero hypothesis and accepting the alternative hypothesis in the presence of Co-integration between the variables. Where the value of trace statistic is greater than the critical value at the 5% significance level for three vectors, if we accept the alternative hypothesis, there is Co-integration between model variables, thus we perform a regression test.

The study conducted by (Ang, J. 2007) in order to test the dynamic relationship between CO_2 emissions, GDP and energy consumption, the study found a strong direct correlation between CO_2 emissions and GDP and to measure the long-term effect of GDP on CO_2 emissions it takes the quadratic formula.

Accordingly, the functional relationship between carbon dioxide emissions, both gross domestic product, foreign direct investment and energy consumption can be described as follows:

CO_2 = f (GDP, GDP2, ENG, FDI)

Table 7 shows the regression by Co-integrating Regression Method which is close to Ordinary Least Squares Method (OLS) but the correction is in both the independent variables and the dependent variable where the second order bias for the least squares capabilities is removed according to the following model.

$$CO_{2t} = \beta_o + \beta_1 GDP_t + \beta_2 FDI_t + \beta_3 ENG_t - \beta_4 GDP^2_t$$

Where: CO_2 emissions (t) is the dependent variables. Gross Domestic Product (GDP) (US $ million), Foreign Direct Investment (FDI) (US $ million) Energy Consumption (ENG) (KW), Gross Domestic Product square $(GDP)^2$, are the explanatory variables

Table 7. Effect of Economic Variables on Emissions Carbon dioxide in Egypt during the period (1999-2017)

Variables	Coef.	t- Statistics	Prob.
Gross Domestic Product (GDP)	0.586717	3.788379	0.0010
Foreign Direct Investment (FDI)	1.236809	2.051614	0.0518
Energy Consumption (ENG)	0.993647	6.426255	0.0000
Gross Domestic Product square (GDP)^2	-1.77E-06	-5.901852	0.0000
Constant	27130.87	4.547983	0.0001
R- squared	0.9652		
Adjusted R-Squared	0.9591		

Source: Collected and calculated from: the Egyptian data on the websites of: The World Bank Data during the period (1999-2017).

Describes the results of regression analysis All independent model variables are statistically significant at 5% level. The signals are in line with economic logic, as carbon emissions are rising by increasing Gross Domestic Product (GDP) and Foreign Direct Investment (FDI) as well as by increasing Energy Consumption ENG, while the negative relationship between GDP in its quadratic form this a logically in economics. This is evidenced by the existence of the Environmental Kuznets Curve (EKC) in the Egyptian economy; Kuznets curve has its theoretical and practical implications as it suggests that when a country is economically growing, an increasing trend in emissions is observed but as the journey of growth goes on, emissions and pollution start decreasing, making the environment better off eventually (Grossman and Krueger, 1995). The rise in GDP could therefore reduce CO_2 emissions. When increases economic growth and the level of living, there is a trend to adopt methods that reduce CO_2 emissions.

Agriculture Sector Variables:

There are many variables that affect CO_2 emissions; Table 8 shows the relationship between the environmental variable (CO_2) and the economic variables of the agricultural sector in the logarithm form.

Selecting the regression model in order to obtain consistent and efficient capabilities and it was the logarithmic formula that gave the best results, as the value of F was about 104.11 at the level of significance 1%.

$$LnY= \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5$$

Where: Y: CO_2 emissions (t), X1: cultivated area million feddan, X2: Agricultural production (metric tons), X3: Agricultural imports (US $ million), X4: Agricultural exports (US $ million), X5: Added Value to agriculture.

According to the results of the analysis, the results showed that there are at least four integrated vectors, thus rejecting zero hypothesis and accepting the alternative hypothesis in the presence of Co-integration between the variables. Where the value of trace statistic is greater than the critical value at the 5% significance level for three vectors, if we accept the alternative hypothesis, there is Co-integration between model variables, thus we perform a regression test.

Table 8. The Effects of Agriculture Sector Variables on Emissions Carbon dioxide in Egypt during the period (1999-2017).

Variables	Coef	t- Statistics	Prob.
Cultivated area (million feddan)	1.033	2.692	.013
Agricultural production (mt)	0.198	5.231	.000
Agricultural imports (US $ million)	-0.035	-.0856	.401
Agricultural exports (US $ million)	0.143	2.435	.023
Added value to agriculture	-0.014	-.0197	.846
Constant	6.553	11.460	.000
R- squared	0.958		
Adjusted R-Squared	0.948		
F	104.119		.000

Source: Collected and calculated from: the Egyptian data on the websites of: The World Bank Data and Food and Agriculture Organization (FAO) during the period (1999-2017).

The model showed a significant correlation between the cultivated area (X_1) and CO_2 emissions. Increasing the cultivated area entails an increase in the use of irrigation machines. If negative, it means that farmers are adopting primitive methods of farming that do not rely on the use of machinery. The relationship between the increase of agricultural production (X_2) and CO_2 emission, positive and statistically significant and is closely related to the first variable, increase production is by agricultural processes, using more machinery, means of transport, and modern technology in agricultural.

The relationship between imports of agricultural inputs (X_3) and CO_2 emissions is inverse relationship, but not statistically significant, because dependence on imports reduces agricultural operations and agriculture-based industries, for example, packaging and plastic factories if they were produced locally. Also, the relationship between the increase of Agricultural exports (X_4) and CO_2 emissions positive relationship and statistically significant.

While the relationship between added value to agriculture (X_5) and CO_2 emissions, inverse relationship but not statistically significant between added value of agriculture and CO_2 emissions. Increasing added value of agriculture by improving production methods or shifting to organic production reduces CO_2 emissions and may be statistically insignificant in view of the low organic production to total agricultural production in Egypt.

Conclusion

The study recommends the use of modern agricultural methods, and the adoption of sustainable system crop production, livestock production and Aquatics production, which are appropriate to climate change, reduce emissions of greenhouse gases, and increase agricultural production, by supporting small farmers to the application of climate-smart farming systems in Egypt, and provide the necessary funding To continue research in the field of agricultural production. Providing farmers with various extension services, increase organic agriculture area, and providing full support to organic farms, which help increase Egyptian exports of agricultural products.

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التحليل الاقتصادى للزراعة الذكية مناخيًا فى مصر

خالد السيد عبدالمولى[1]، حسام حسنى عبدالعزيز[2]

١– المعمل المركزى للزراعة العضوية– مركز البحوث الزراعية– جيزة– مصر.

٢– معهد بحوث الاقتصاد الزراعى – مركز البحوث الزراعية– جيزة– مصر.

الملخص

يشكل تغير المناخ تحديًا كبيرًا للنظم الزراعية فى مصر؛ وتواجه الزراعة الذكية هذه التحديات من خلال تحقيق زيادة الإنتاج، وزيادة دخل المزارع، وتقليل الانبعاثات من الغازات الدفيئة؛ حيث بلغت كمية الانبعاثات لقطاع الزراعة والرى نحو ٢,٥٧ مليون طن كربون تمثل ١,٢٥ % من إجمالى الانبعاثات للقطاعات المختلفة فى عام ٢٠١٧/٢٠١٨. والتى أثرت سلبًا على إنتاجية المحاصيل الرئيسية فى مصر.

وتمثلت مشكلة البحث فى تناقص إنتاجية بعض المحاصيل الرئيسية؛ فبحلول عام ٢٠٤٠ من المتوقع أن ينخفض محصول القمح ١٢ %، والخضروات ٢٨%، والذرة ٤٧%، والأرز ما بين ٢٦% و٤٧% بسبب التغيرات المناخية والتفتت الحيازى.

وقد هدف البحث إلى تقدير آثار زيادة الإنتاج النباتي والحيواني والسمكي علي تحقيق الأمن الغذائي، وفي الوقت نفسه تقليل انبعاثات الغازات الدفيئة في مصر. وكذلك دراسة تأثير بعض المتغيرات الاقتصادية المتعلقة بالقطاع الزراعي على انبعاثات ثاني أكسيد الكربون في مصر. من خلال دراسة مؤشرات توافر الغذاء، وانبعاثات الغازات المسببة للاحتباس الحرارى خلال الفترة ١٩٩٩–٢٠١٧. وقد تبين أن الطاقة الغذائية المستمدة من محاصيل الحبوب والدرنات والجذور قد ساهمت بنحو ٠,٩٧ من التباين الكلى لتوافر الغذاء، ووجد ايضًا ارتباط قوى بين توافر الغذاء ومتوسط المعروض من البروتين الحيوانى قدر بنحو ٠,٩٧. فى حين ساهمت انبعاثات غاز ثانى اكسيد الكربون بنحو ٠,٨٤ من التباين الكلى لإجمالى الغازات.

وتبين من العلاقة العكسية بين الناتج المحلى والانبعاثات من غاز ثانى أكسيد الكربون انخفاض الانبعاثات بزيادة الناتج، وذلك باتباع الاساليب الحديثة فى الانتاج. أيضًا تبين أن التحول للزراعة العضوية يقلل من انبعاثات غازات الاحتباس الحرارى.

وتوصى الدراسة باتباع الأساليب الحديثة فى الإنتاج الزراعى؛ والتى تسهم فى التخفيف من انبعاثات غازات الاحتباس الحرارى وزيادة الإنتاجية خاصة فى الحيازات الصغيرة والتى تتأثر بدرجة كبيرة بالتغيرات المناخية عن طريق تجميع هذه الحيازات فى تعاونيات تستطيع من خلالها تطبيق الأساليب التكنولوجية فى الإنتاج الزراعى وتزويد المزارعين بخدمات الارشاد المختلفة، واتباع نظام الانتاج الزراعي المستدام.