The Role of Scientific Research and Government Expenditure in Achieving Sustainable Development in The Agriculture

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ABSTRACT

The research aimed mainly at studying and analyzing indicators of scientific research, as well as government expenditure directed to the agricultural sector, as well as studying the interrelationship between added value and each of the indicators of scientific research and innovation, and government expenditure on the agricultural sector. The research used the Autoregressive Distributed Lag Approach (ARDL). p, q)], as well as testing the extent to which there is a causal or mutual relationship between these variables using the Pairwise Granger Causality Tests. The results showed an improvement in the index of sustainable development and innovation, and Egypt's ranking in the field of international publishing during the period (2000-2021) as a result of Egypt's interest in R&D and expansion of projects that depend on modern technology and stimulating patents. The results also showed an increase in expenditure on R&D, an increase in expenditure on education, as well as the added value of agriculture during the study period. Finally, the results showed that there is a positive and statistically significant effect of the value of expenditure on R&D, the increase in scientific articles published in the agricultural field, the number of researchers per million people, government expenditure on agriculture, the number of graduates of agricultural faculties, and Egypt's ranking in international publishing on the added value of the agricultural sector in the long and short run, which confirms the direct relationship of these variables in raising the economic efficiency of production factors.

Keywords: Added value – (ARDL) Model - Causal relationship - Innovation - International publishing.

INTRODUCTION

Achieving the goals of agricultural development is closely linked to the country's interest in directing investments as well as spending directed to the agricultural sector, where agricultural spending is one of the direct and effective tools to enable the economic growth of the sector, and then increase the added value of the agricultural sector, which is the result of the returns of land, labor and capital directly invested in productive activity in addition to the interest in raising the efficiency of the human element through the development of scientific research and development, which in turn leads to achieving optimal utilization of agricultural resources, as scientific research is considered one of the most important means of achieving comprehensive and sustainable development, and it is a major pillar of the progress and prosperity of countries, as it is primarily responsible for achieving development and progress in all economic and social fields and activities, and due to the contribution of the agricultural sector to increasing the national product as one of the leading sectors for economic development, and the employment of a large percentage of employment, the matter requires the necessity of advancing agricultural development so that maximum productive efficiency can be achieved from the use of available agricultural resources, especially the educated agricultural labor "agricultural graduates" (El-Rasoul et al., 2018) on the base that it is the cornerstone in the development of agricultural production, as well as the role of scientific research in raising the efficiency of utilization of land and water resources, in addition to raising the productivity of many agricultural crops.

The sustainable development strategy "Egypt Vision 2030" (SIS, 2022) adopts the concept of sustainable development as a general framework that aims to improve the quality of life at the present time without prejudice to the rights of future generations to a better life, and then the concept of development adopted by the strategy is based on 8 basic axes, the fourth axis among these axes presented in knowledge, innovation and scientific research, which is based on or concerned with investing in people and building their creative capabilities, stimulating innovation and spreading its culture and supporting scientific research, strengthening links between education, scientific research and development.

The development of productivity and agricultural production, in both its plant and animal branches, to meet the challenges facing the agricultural sector represented by climate change, the Covid-19 crisis and the Russian-Ukrainian war, as well as improving the food security situation, is largely linked to technical modernization, which in turn depends on scientific research and basic and applied agricultural research of all different kinds (Elsaied, 2021), as well as interest in increasing investments directed to this sector.

Justifications and research problem

Despite the importance played by scientific research, as well as spending and investment in the agricultural sector as an important resource for providing the

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necessary infrastructure for conducting economic development for the sector, as well as the importance of scientific research in achieving economic efficiency in the use of resources, and maximizing unit productivity from them, Egypt is still not making progress compared to developed countries, whether in spending on scientific research, as it does not exceed 1% of the gross domestic product, in addition to the decrease in spending on the agricultural sector compared to other economic sectors. Hence the problem of the study lies in the following questions:

1- Are the indicators of scientific research in Egypt still low?

2- Has Egypt achieved positive indicators in scientific research, as well as in spending directed to the agricultural sector?

3- Is there a correlation between the added value of the agricultural sector and each of the indicators of scientific research and government spending directed to the agricultural sector?

Objectives

The research mainly aimed at studying and analyzing the concepts and indicators of scientific research and innovation, as well as government spending directed to the agricultural sector and its role in achieving sustainable development in the agricultural sector, through a set of sub-objectives that are: defining scientific research and innovation and its indicators, studying the most important indicators of the agricultural sector, as well as studying the interrelationship between added value and each of the indicators of scientific research and innovation, and government spending on the agricultural sector.

Measurement procedures and Data

Research Method:

The research used both the methods of descriptive statistics and the quantitative analysis of the economic variables under study. The Bounds Testing Approach to Co-integration was used to analyze the interrelationship between added value and each of scientific research and innovation indicators, and government spending on the agricultural sector through using the Autoregressive Distributed Lag Approach [ARDL(p,q)], as well as examine whether there is a causal or mutual relationship between these variables using Pairwise Granger Causality Tests.

The variables of the model of the impact of spending on R&D and government spending on the added value agricultural sector in Egypt were determined based on several reference studies as follows:

$$V_{addt}\uparrow = \mathcal{F}\Big(V_{add(t-P)}\uparrow, EXP_{RD(t-q1)}\uparrow, AG_{DOC(t-q2)}\uparrow, R_{Derm(t-q3)}\uparrow, Labr_{agri(t-q4)}\uparrow, INV_{agri(t-q5)}\uparrow, EXP_{AG(t-q6)}\uparrow, EXP_{edu(t-q7)}\uparrow, EXP_{hedu(t-q8)}\uparrow, AG_{colg(t-q9)}\uparrow, R_{pblsh(t-q10)}\uparrow, R_{sdnt(t-q11)}\uparrow\Big)$$

V_{addt}	: Agriculture, value added (current million US$)	EXP_{AGt}	: Government Expenditure on agriculture (US$)
EXP_{RDt}	: R&D expenditure (current million US$)	EXP_{edut}	: Public Expenditure on Education (US$ Million**)**
AG_{DOCt}	:Documents in Agricultural and Biological Sciences	EXP_{UGedut}	: Public Expenditure on Undergraduate Education
R_{Dermt}	: Researchers in R&D (per million people)	$\ln AG_{faclt}$	: Total graduates of the faculties of Agriculture
$Labr_{Agri}$	**:** Agricultural Labor	R_{pblsht}	: Ranking of Egypt in the field of international publishing
INV_{agrit}	:Executed agricultural investments (US$ million)	R_{sdnt}	: Patents for Resident

a methodology was used to combine the AR and DL models, or Autoregressive Distributed Lag Approach [ARDL(p,q)], proposed by Pesaran and Shin through the use of the Bounds Testing Approach to Cointegration (Pesaran & Shin, 1995; Pesaran et al., 2001; Shrestha and Bhatta, 2018) in order to estimate the long- and short-run elasticity, and based on the aforementioned study variables, the ARDL model (p, q1, q2,….qn) can be estimated according to the following formulas:

$$\Delta V_{addt} = \beta_0 + \pi_1 V_{addt-1} + \pi_2 EXP_{RDt-1} + \pi_3 AG_{DOCt-1} + \pi_4 R_{Dermt-1} + \pi_5 EXP_{AGt-1} + \pi_6 AG_{colgt-1} + \pi_7 R_{pblsht-1} + \pi_8 R_{sdnt-1} + \sum_{i=1}^{p} \gamma_i \Delta V_{addt-i} + \sum_{i=1}^{q1} \delta_1 \Delta EXP_{RDt-i} + \sum_{i=1}^{q2} \delta_2 \Delta AG_{DOCt-i} + \sum_{i=1}^{q3} \delta_3 \Delta R_{Dermt-i} + \sum_{i=1}^{q4} \delta_4 \Delta EXP_{AGt-i} + \sum_{i=1}^{q5} \delta_5 \Delta AG_{colgt-i} + \sum_{i=1}^{q6} \delta_6 \Delta R_{pblsht-i} + \sum_{i=1}^{q7} \delta_6 \Delta R_{sdnt-i} + \varepsilon_t$$

Where β_0 expresses the intersection parameter, ε the random error, iπ the long-run coefficients, γi, δj the short-run coefficients, and the long-run effect of a variable EXP_{RDt-1}, for example, is $[-\pi_2/\pi_1]$, and the short-run effect of EXP_{RDt-1} is the first difference coefficient δ_1, ARDL-UECM models were also estimated: according to the following formulas:

$$\Delta \ln V_{addt} = \beta_0 + \delta_1 \Delta \ln EXP_{RDt} + \delta_2 \Delta lnAG_{DOCt} + \delta_3 \Delta lnR_{Dermt} + \delta_4 \Delta lnEXP_{AGt} + \delta_5 \Delta lnAG_{colgt} + \delta_6 \Delta \ln R_{pblsht} + \delta_7 \Delta \ln R_{sdnt} + \psi ECT_{t-1}$$

$$ECT_{t-1} = lnV_{addt-1} - \alpha - \beta_1 lnEXP_{RDt-1} - \beta_2 lnAG_{DOCt-1} - \beta_3 lnR_{Dermt-1} - \beta_4 lnEXP_{AGt-1} - \beta_5 lnAG_{colgt-1} - \beta_6 \ln R_{pblsht-1} - \beta_7 \ln R_{sdnt-1}$$

where ECT $_{t-1}$ is the error correction limit, and ψ is the correction speed.

Data:

The research depends on secondary statistical data published and issued by many agencies on the websites of the International Information Network (Internet) as: The World Bank (2022), International Monetary Fund (IMF), the World Intellectual Property Organization (WIPO) (2022a,b,c), the Central Agency for Public Mobilization and Statistics(CAPMAS), the Ministry of Planning (MoP), Simago Authority (SCImago), the United Nations Sustainable Development Group, Also articles, theses, work paper and scientific books have been used. Annual data over the period 2000-2022 was used to analyzing the interrelationship between added value and each of the indicators of scientific research and innovation, and government spending on the agricultural sector.

Empirical results:

Egypt sustainable development index

The Sustainable Development Report is consider the only official report of the United Nations that tracks global progress on the 2030 Agenda for Sustainable Development. It is a global assessment of countries' progress towards achieving the Sustainable Development Goals, and is complementary to the official SDG indicators and the Voluntary National Reviews.

Figure (1) shows the value of the sustainable development index for Egypt over the period (2000-2022), as it reached 63.71 in 2000 then, followed a general upward trend until it reached 68.66 in 2022, especially after Egypt's Vision 2030 in February 2016 was issued (ECSS, 2022).

Innovation index, patents, globally indexed research

Indicators of innovation

The Innovation Index is a key measurement tool for business managers, policy makers and those interested in the innovation. The Innovation Index includes two sub-indicators "Innovation Input Index and Innovation Output Index", in which innovation factors are subject to continuous evaluation.

Cornell University, the European Institute of Business Administration (INSEAD) and the World Intellectual Property Organization (WIPO, 2022a), one of the specialized agencies of the United Nations, participate in the Global Innovation Index report, and it has been published annually since 2007.

Figure (2) shows the innovation index for Egypt in the period (2007-2022), when Egypt's rank globally was 74 in 2007, but in the period (2012-2018) Egypt's ranking lagged by several places, but it began to improve in recent years as a result of Egypt's interest in research and development and expansion of projects that depend on modern technology and stimulating patents and other factors that resulted from intellectual property and scientific development.

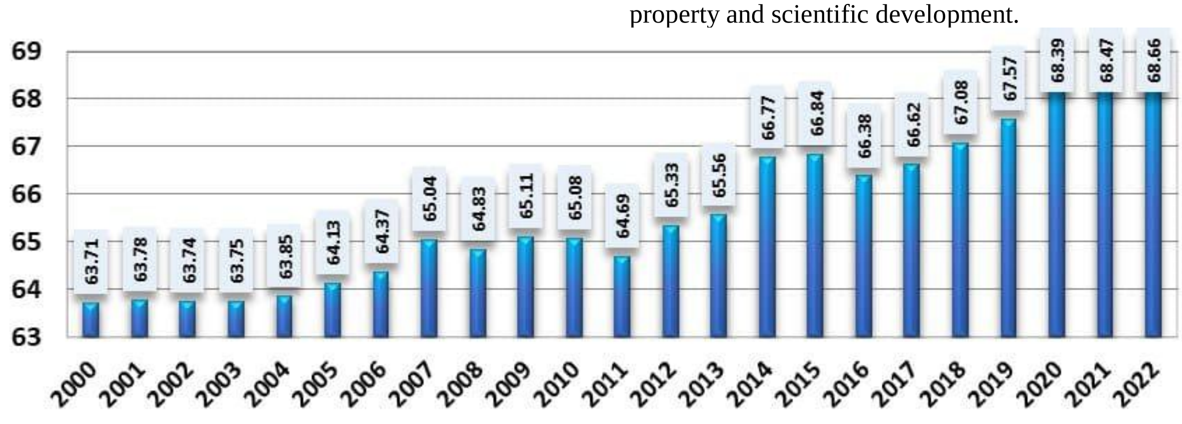

Figure. 1.Egypt's sustainable development index during the period (2000-2022)

Source (data collected): https://dashboards.sdgindex.org/downloads.

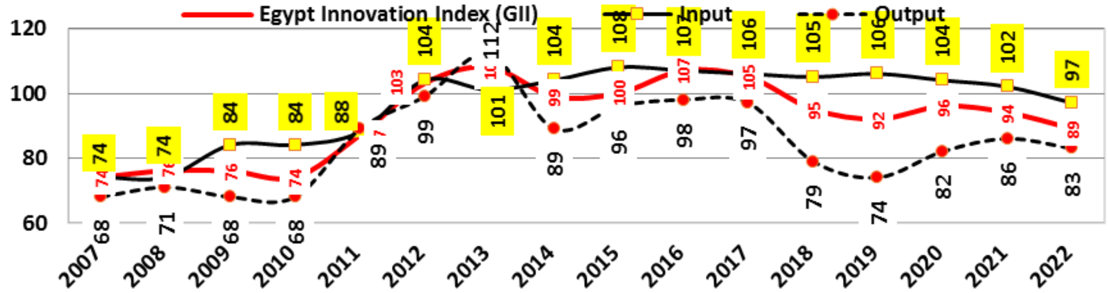

Figure. 2. Innovation Index for Egypt and its two main pillars during the period (2007-2022)

Source (data collected): https://www.wipo.int/portal/en/index.html.

Figure 2 also shows the innovation input index, which is based on five basic pillars that show the elements of the economy that enable innovative activities, represented in -institutions, human capital and research, infrastructure, market development, business development (WIPO, 2022c), where innovation inputs ranging between a minimum of 74 in 2007 and a maximum of 118 in 2015.

The values of the innovation output index ranged between a minimum of 63 in 2007 to a maximum of 112 in 2012. It should be noted that the innovation output index is based on two main pillars (knowledge and technological outputs and creative outputs).

Patents

Figure (3) shows that the total patent applications over the period (2000-2021) averages to 1911 applications, fluctuating between a minimum of 694 in 2004, and a maximum of 2279 in 2017, these applications are divided into applications submitted by Residents averages to 670 applications, fluctuating between a minimum of 382 applications in 2004, and a maximum of 1027 applications in 2019, and other applications submitted by non-residents averages to 1241 applications, fluctuating between a minimum of 312 applications in 2004, and a maximum of 1649 applications in 2008. The increase in patent applications indicates the availability of favorable conditions for scientific research and development, which reflects positively on the innovation index for Egypt, as well as contributes to achieving economic growth and thus achieving sustainable development.

Figure (3) also shows that the patent applications for residents per $ 100 billion of GDP averages to 79 applications / $100 billion over the period (2000-2021), fluctuating between a minimum of 60 applications / $100 billion in. 2009, and a maximum of 111 in 2002.

While the average of patents for residents per million inhabitants during the studied period was 8 patents per million inhabitants, it ranges between a minimum of 5 patents per million inhabitants in 2004, and a maximum of 11 patents per million inhabitants in 2017. It is clear that there has been a noticeable increase in recent years in the number of patents, which confirms the country interest in the field of R&D (Figure 3).

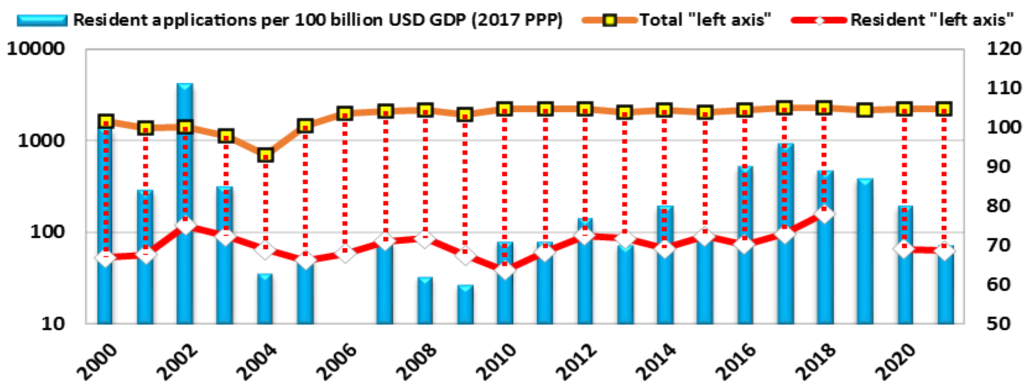

Figure. 3. Total patent applications, (residents) applications, patent applications / $100 billion of GDP over the period (2000-2021)

Source (data collected): https://www.wipo.int/portal/en/index.html.

The total international publication of Egypt in globally indexed journals in all fields and the agricultural field

According to the global statistics database of the SCImago Corporation "is a research group affiliated to the Supreme Council for Scientific Research (CSIC) at the University of Granada in Madrid - Spain, and is concerned with analyzing, representing and retrieving information through visual technologies" (SJR, 2022), Figure 4 shows the researches published in all fields over the period (2000-2021), where it averages to 13,215 research, it ranged between a minimum of 3,308 research in 2000, and a maximum of 38,651 research in 2021.

Figure (4) also shows the researches published in the agricultural and biological sciences, which averaged to 1296 documents, representing 9.8% of total number of researches published in all fields, it ranged between a minimum of 292 research in 2002, and a maximum of 4493 research in 2021.

Scientific and technical journal articles

Figure 4 presents the researches published in scientific and technical journals over the period (2000-2018). According to the statistics of the World Bank, it averaged to 6566 articles, and it ranged between a minimum of 2705 articles in 2000, and a maximum of 13327 articles in 2018.

Ranking Egypt in the field of international publishing

Figure (5) shows Egypt's ranking in the field of international publishing, as it is clear that Egypt ranked 39 in the world in 2000, then Egypt's globally ranking decreased up to 43 in 2008, then it gradually improved until it globally ranking to 26 in 2021.

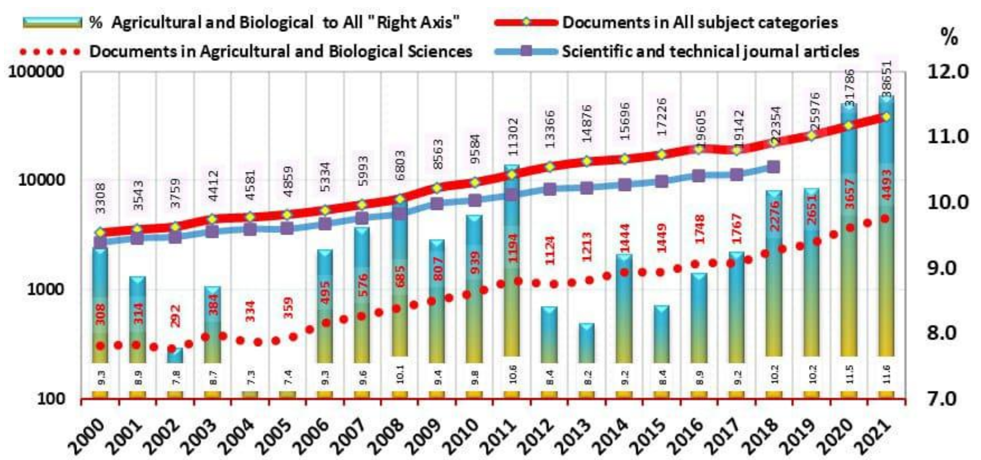

Figure .4. Number of research papers published in all fields, especially the field of agricultural and biological sciences During the period (2000-2021)

Source (data collected):

- https://www.scimagojr.com/countryrank.php?area=1100&region=Africa&year.
- https://data.worldbank.org/indicator/IP.JRN.ARTC.SC?locations=EG.

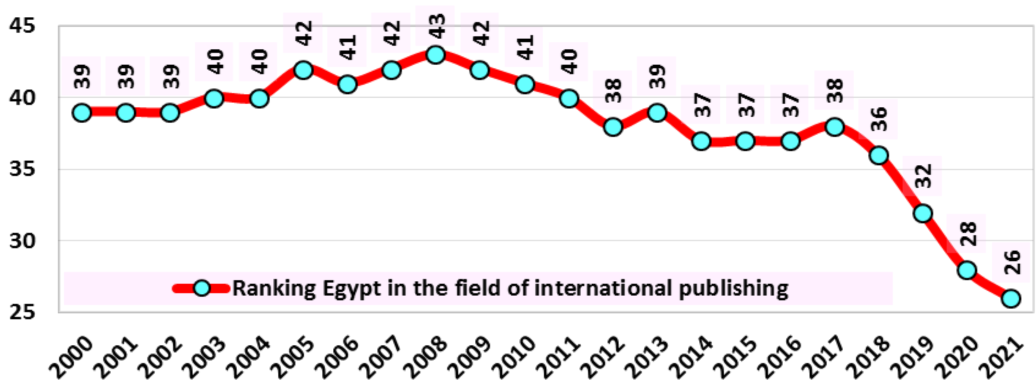

Figure 5. Ranking of Egypt in the field of international publishing over the period (2000-2021)

Source (data collected): https://www.scimagojr.com/countryrank.php.

The Indicators of Expenditure on Education, R&D, and the Most Important Indicators of The Egyptian Agricultural Sector Closely related to Education and Scientific Research.

Government expenditure on Education, and R&D.

- **R&D expenditure (% of GDP)**

Table (1) presents the percentage of spending on R&D (% of GDP), It can be noted that the average recording 0.5% over the period (2000-2021), and it ranged between a minimum of 0.19% in 2000, and a maximum of 1.0 % in 2021, it proven Statistically significant increasing of 0.04% representing 7.8% of the period's average (table 2).

- **R&D expenditure (US$ Billion)**

Egypt paid attention to R&D, this explains the increase in R&D allocations which increased from $0.18 billion in 2002 as a minimum to $4.04 billion in 2021 as a maximum during the period (2000-2021) shown in Table 1, it proven Statistically significant increasing amounted to $0.16 billion, representing 12.5% of the period's average (Table 2).

- **Researchers in R&D (per Million people)**

Table (1) shows researchers in R&D over the period (2000-2021), it averaged to 550 researchers per million people, ranging between a minimum of 311 researchers/ million people in 2000, and a maximum of 856 researchers/ million people in 2021. it proven Statistically significant increasing amounting to 24.5 researcher/ million people, representing 4.5% of the period's average (table 2).

- **Public Expenditure on Education (US$ Million)**

Table (1) presents public expenditure on education over the period (2000-2021), it averaged to $7.15 billion, fluctuating between a minimum of $3.61 billion in 2004, and a maximum of $11.85 billion in 2014, i it proven Statistically significant increasing amounting to $0.27 billion representing 3.8% of the period's average (table 2).

- **Public Expenditure on Undergraduate Education (US$ Million)**

Table (1) shows public expenditure on Undergraduate education over the period (2000-2021), it averaged to $1.8 billion, fluctuating between a minimum of $1.13 billion in 2006, and a maximum of $2.78 billion in 2014, it proven Statistically significant increasing amounting to $0.26 billion representing 14.6% of the period's average (table 2).

Table. 1. indicators of education, R&D and indicators of the Egyptian agricultural sector During the Period 2000-2021

Indicators	Aver.	Mini. Value		Max. Value	
		Value	Year	Value	Year
Research and development expenditure (% of GDP)	**0.5**	0.19	2000	1.0	2021
Research and development expenditure (US$ Billion)	**1.3**	0.18	2002	4.04	2021
Researchers in R&D (per million people)	**550**	311	2000	856	2021
Public Expenditure on Education	**7150**	3611	2004	11850	2014
Public expenditure on Undergraduate Education	**1803**	1134	2006	2786	2014
Total Degrees (Higher scientific Degrees)	**73732**	25844	2000	119759	2018
Total graduates of the Faculties of Agriculture	**6530**	3318	2014	12955	2019
Agriculture value added per hectare of agricultural land (constant 2015 US$)	**9827**	8395	2004	12630	2021
Value added for Agriculture (constant 2015 US$ billion)	**36.1**	27.9	2000	50.4	2021
Value added for Agriculture (% GDP)	**12.9**	11	2019	15.5	2000
Agriculture value added per worker (constant 2015 US$)	**5141**	4029	2007	7680	2019
Value added for Agriculture (current US$ billion)	**25.9**	11	2004	45	2021
Government expenditure on agriculture (US$ million)	**1171**	780	2017	2024	2001
Executed agricultural investments	**0.77**	0.43	2007	1.86	2019

Source (data collected and calculated):

- https://www.albankaldawli.org
- http://www.resakss.org
- https://www.capmas.gov.eg
- https://www.wipo.int
- https://mped.gov.eg

Table 2. Simple Regression Equations for indicators of education, R&D And indicators of the Egyptian agricultural sector over the period (2000-2021)

Indicators	Equation	R^2	F_{test}	Change rate (%)
Research and development expenditure (% of GDP)	$\hat{Y}_i = 0.49 + 0.04 X_i$ $(1.68)^{ns}$ $(17.46)^{**}$	0.94	304.85^{**}	7.8
Research and development expenditure (US$ Billion)	$\hat{Y}_i = -0.57 + 0.16 X_i$ $(-2.89)^{**}$ $(10.80)^{**}$	0.85	116.65^{**}	12.5
Researchers in R&D (per million people)	$\hat{Y}_i = 267.42 + 24.5 X_i$ $(10.28)^{**}$ $(12.39)^{**}$	0.88	153.50^{**}	4.5
Public Expenditure on Education (US$ Million)	$\hat{Y}_i = 4019.2 + 272.26 X_i$ (4.91)** (4.37)**	0.49	19.12^{**}	3.8
***Public expenditure on Undergraduate Education* (US$ Million)**	$\hat{Y}_i = -368.31 + 263.6 X_i$ $(-0.22)^{ns}$ (2.03)*	0.17	4.14^{**}	14.6
Total Degrees (higher education degrees)	$\hat{Y}_i = 12534.46 + 5321.5 X_i$ $(1.31)^{ns}$ (7.33)**	0.73	53.77^{**}	7.2
Total graduates of the Faculties of Agriculture	$\hat{Y}_i = 2230.2 + 373.9 X_i$ (2.43)* (5.34) **	0.59	28.55^{**}	5.7
Agriculture value added per hectare of agricultural land (constant 2015 US$)	$\hat{Y}_i = 7883.73 + 168.94 X_i$ (28.86)** (8.12)**	0.77	65.98^{**}	1.7
Value added for Agriculture (constant 2015 US$ billion)	$\hat{Y}_i = 25.49 + 0.92 X_i$ (23.91)** (11.34)**	0.86	128.61^{**}	2.6
Value added for Agriculture(%GDP)	$\hat{Y}_i = 15.39 - 0.22 X_i$ (49.57)** (-9.20)**	0.81	84.70^{**}	-1.7
Agriculture value added per worker (constant 2015 US$)	$\hat{Y}_i = 3589.34 + 134.96 X_i$ (13.32)** (6.58)**	0.68	43.27^{**}	2.6
Value added for Agriculture (current US$ billion)	$\hat{Y}_i = 8.756 + 1.49 X_i$ (4.11)** (9.18)**	0.81	84.33^{**}	5.8
Government expenditure on agriculture (US$ million)	$\hat{Y}_i = 1308.5 - 11.9 X_i$ (8.38)** $(-1.01)^{ns}$	0.81	1.01^{ns}	-1.0
Executed agricultural investments (current US$ billion)	$\hat{Y}_i = 0.20 + 0.049 X_i$ $(1.09)^{ns}$ (3.43)**	0.37	11.76^{**}	6.4

Notes: ** and *: significance at 1% and 10% levels, respectively, ns: not significant.
Source (data collected and calculated):
- https://www.albankaldawli.org
- http://www.resakss.org
- https://www.capmas.gov.eg
- https://www.wipo.int

- **Total Degrees (Higher scientific Degrees)**

Table (1) presents the holders of scientific postgraduate degrees over the period (2000-2021), it averaged to 73.7 thousand, Divided into (56, 12.04, and 56.69 thousand) for each diploma, master's, and doctorate respectively, representing 76.0%, 16.3%, and 7.7% respectively, ranged between a minimum of 25.84 thousand holders of a higher degree in 2000, and a maximum of 119.76 thousand in 2018, it proven Statistically significant increasing amounting to 5.3 thousand, representing 7.2% of the period's average (table 2).

- **Total graduates of the faculties of agriculture**

The number of graduates of the faculties of agriculture over the period (2000-2021) averaged to 6.53 thousand, fluctuated between a minimum of 3.32 thousand in 2014, and a maximum of 12.95 thousand in 2019 shown in Table 1, it proven Statistically significant increasing amounting to 0.37 thousand, representing 5.7% of the period's average (table 2).

Indicators of the Egyptian agricultural sector

- **Agriculture value added per hectare of agricultural land (constant 2015 US$)**

Table (1) shows the value added per hectare of agricultural land, it averaged to $ 9.83 thousand, it ranged between a minimum of $ 8.4 thousand in 2004, and a maximum of $ 12.6 thousand in 2021 over the period (2000-2021), it proven Statistically significant increasing amounting to $ 0.169 thousand, representing 1.7% of the period's average (table 2).

- **Value added for agricultural (constant 2015 US$)**

Value added for agricultural is averaged to $ 36.1 billion over the period (2000-2021), it ranged between a minimum of $ 27.9 billion in 2000, and a maximum of $ 50.4 billion in 2021 shown in Table (1), it proven Statistically significant increasing amounting to $ 0.92 billion, representing 2.6% of the period's average (table 2).

- **Value added for agricultural (% of GDP)**

Table (1) presents the value added for agricultural as a percentage of GDP, it averaged to 12.9% over the period (2000-2021), it ranged between a minimum of 11% in 2019, and a maximum of 15.5% in 2000, it proven Statistically significant increasing amounting to 0.22%, representing 1.7% of the period's average (table 2).

- **Agriculture value added per worker (constant 2015 US$)**

Table (1) shows the value added per worker, it averaged to $ 5.14 thousand, it ranged between a minimum of $ 4.03 thousand in 2007, and a maximum of $ 7.68 thousand in 2019 over the period (2000-2021), it proven Statistically significant increasing amounting to $ 0.14 thousand, representing 2.6% of the period's average (table 2).

- **Value added for agricultural**

Table (1) presents the value added for agricultural, it averaged to $ 25.9 billion over the period (2000-2021), it ranged between a minimum of $ 11 billion in 2004, and a maximum of $ 45 billion in 2021, it proven Statistically significant increasing amounting to $ 1.49 billion, representing 5.8% of the period's average (table 2).

- **Government expenditure on Agriculture**

Government expenditure on Agriculture is averaged to $ 1171 million over the period (2000-2021), it ranged between a minimum of $ 780 million in 2017, and a maximum of $ 2024 million in 2001 shown in Table (1), however the results did not proven statistically significant change (table 2).

- **Executed agricultural investments**

Table (1) shows the executed agricultural investments, it averaged to $ 0.77 billion over the period (2000-2021), it ranged between a minimum of $ 0.43 billion in 2007, and a maximum of $ 1.86 billion in 2019, it proven Statistically significant increasing amounting to $ 0.04 billion, representing 6.4% of the period's average (table 2).

Analysis of the impact of spending on R&D and government spending on the added value of the agricultural sector

The Augmented Dickey-Fuller Test (ADF) was tested to determine the degree of co-integration of the studied variables. Table (3) shows the stability of many of the study variables after obtaining their initial differences, meaning that the variables under study (R_{pblsht}, R_{sdnt}, AG_{DOCt}, EXP_{UGedut}, EXP_{edut}, INV_{agrit}, $Labr_{agrit}$, AG_{DOCt}, EXP_{RDt}, V_{addt}) are not stable in the level, but they are stable in the first differential, i.e. integrated of the order of one [I (1)]. Thus, one of the solutions of the instability of the series is to take the difference, while it reveals that each of is stable, but (EXP_{AGt} ‘R_{Dermt}) performing a regression of the variables in the form of differences leads to the loss of the long-run characteristics, as the co-integration between the unstable variables prevents the increase in the error of the long run relationship, this means that the time series data may be unstable if they are taken separately, but they are stable as a group (Attala and Ali, 2016).

According to the unit root test, the model that can be applied (Shrestha and Chowdhury, 2005) to the variables under study is chosen. If all the variables are stable in the level, the OLS, VAR method is used, but if all the variables are no stable in the level, the VECM method, or the causality test, is used. But if some of the variables are stable in the level and the other when taking the difference, ARDL models are used.

Table. 3. Unit root test for R&D expenditure, and government spending on value added of agriculture using the Augmented Dickey–Fuller test

Variable		Without intercept		With intercept (η_μ)		With intercept and trend ($\eta_{\mu T}$)		case of integration
		Test statistic	AIC	Test statistic	AIC	Test statistic	AIC	
V_{addt}	**Level**	(1.454)	19.5	(-0.109)	19.6	**(-2.98)**	**19.3**	**Not stable**
	Difference	(-2.99)***	19.5	(-3.26)**	19.5	**(-3.24)**	**19.6**	**stable** I(1)
EXP_{RDt}	**Level**	(2.90)	14.46	(1.42)	14.5	**(-2.74)**	**14.2**	**Not stable**
	Difference	(-2.13)**	14.5	(-2.64)	14.5	**(-2.98)**	**14.51**	**stable** I(1)
AG_{DOCt}	**Level**	(1.005)	13.14	(1.49)	13.17	**(3.58)**	**13.15**	**Not stable**
	Difference	(3.23)	13.09	(2.34)	13.2	**(1.003)**	**13.26**	**Not stable** I(1)
R_{Dermt}	**Level**	(1.37)	11.49	(-0.64)	11.53	**(-3.28)***	**11.17**	**stable** I(0)
	Difference	(-5.32)***	11.59	(-6.13)***	11.47	**(-6.027)*****	**11.56**	**stable** I(1)
$Labr_{agrit}$	**Level**	(1.508)	0.60	(-0.86)	0.63	**(-1.24)**	**0.681**	**Not stable**
	Difference	(-3.63)***	0.697	(-4.136)***	0.65	**(-4.13)****	**0.72**	**stable** I(1)
INV_{agrit}	**Level**	(2.901)	28.3	(1.422)	28.4	**(-2.74)**	**28.04**	**Not stable**
	Difference	(-2.132)**	28.3	(-2.64)	28.3	**(-2.98)**	**28.3**	**stable** I(1)
EXP_{AGt}	**Level**	(-1.22)	14.3	(-2.808)*	14.13	**(-2.605)**	**14.2**	**stable** I(0)
	Difference	(-4.18)***	14.4	(-4.14)***	14.5	**(-4.30)****	**14.55**	**stable** I(1)
EXP_{edut}	**Level**	(0.3117)	17.1	(-1.135)	17.1	**(-1.45)**	**17.18**	**Not stable**
	Difference	(-3.37)***	17.11	(-3.37)**	17.19	**(-3.28)***	**17.3**	**stable** I(1)
EXP_{hedut}	**Level**	(-0.005)	14.12	(-2.338)	13.98	**(-2.888)**	**13.9**	**Not stable**
	Difference	(-3.52)***	14.01	(-3.44)**	14.11	**(-3.337)***	**14.2**	**stable** I(1)
AG_{colgt}	**Level**	(1.291)	17.19	(0.049)	17.27	**(-1.27)**	**17.19**	**Not stable**
	Difference	(-4.15)***	17.3	(-4.47)***	17.3	**(-3.80)****	**17.39**	**stable** I(1)
R_{pblsht}	**Level**	(-1.55)	3.89	(2.057)	3.75	**(0.171)**	**3.60**	**Not stable**
	Difference	(-2.49)**	3.818	(-2.76)*	3.84	**(-4.006)****	**3.63**	**stable** I(1)
R_{sdnt}	**Level**	(0.563)	11.9	(-0.779)	11.9	**(-2.38)**	**11.8**	**Not stable**
	Difference	(-4.73)***	11.93	(-4.916)***	11.96	**(-4.701)*****	**12.06**	**stable** I(1)

Notes: ***, ** and * denote significance at 1%, 5% and 10% levels, respectively.
Source: Authors' results were obtained using the EViews9.5 econometrics package.

The most statistically significant formula, consistent with the economics logic and with different lagged periods of the value added of the agricultural sector was reached in context of the aforementioned explanatory variables after several attempts. The formula of the ARDL(p,q) model has been reached through the lowest value of the informatics criteria AIC,SC,HQ, and according to the bounds test, the F distribution is non-normative, so the two critical values are used (Pesaran et al., 2001), and the results presented in Table (4) showed that the studied variables (R_{sdnt}‘ R_{pblsht}‘EXP_{RDt}‘AG_{DOCt}‘R_{Dermt}‘EXP_{AGt}‘AG_{colgt}‘

V_{addt}) are integrated at all familiar levels of significance, where the value of F-statistic is 20.9, which is greater than the maximum values of the corresponding critical limits "The maximum value of the critical limit at a significant level of 1% is 4.63", and therefore the null hypothesis is rejected that there is no co-integration between the studied variables, and this means that there is a long-run equilibrium relationship among the variables in the model used, as shown by the results of the estimation in Table (4), the following:

- There is a statistically positive and significant effect of the value of spending on R&D on the added value of the agricultural sector in the short and long run, which confirms the direct relationship of spending on R&D in raising the economic efficiency of production factors (human labor, land), which is reflected in a positive impact on the increase in value added of the agricultural sector, the coefficients of elasticity amounting (0.51) and (0.49) at the levels of the short and long run respectively, this means that an increase in spending on R&D by 1% will lead to an increase in the added value of the agricultural sector by about 0.51% in the short run, and 0.49% in the long run, which means an improvement in added value in the short and long run.

- There is a statistically positive and significant effect of increasing in scientific articles published in the agricultural field on the added value of the agricultural sector in the short and long run, which means that the more articles (research) published internationally in the agricultural field, the more it will have a positive impact on the sector and thus increase the added value of the sector, the results of the model confirm this, as the short and long run elasticity were (0.75), (0.75) respectively.
- There is a positive effect in the short and long run of the number of researchers per million people on the added value of the agricultural sector, and the elasticity coefficients amounting (0.117), (0.25) at the short and long run, respectively.

Table 4. Cointegration estimation for R&D expenditure, and government spending on added value of agriculture by using the bound test approach over the period (2000-2021)

Model	ARDL(1, 1, 1, 1, 0, 0, 1, 1) Dependent Var.; lnV_{addt}			ARDL Bounds Test Dependent Var.; ΔlnV_{addt}			ARDL Cointegrating And Long Run Form Dependent Var.; lnV_{addt}			Elasticities
Dynamic reg.	**Coef.**	**t-stat.**	**p value**	**Coef.**	**t-stat.**	**p value**	**Coef.**	**t-stat.**	**p value**	-
$lnEXP_{RDt}$	0.512	11.846	0.000	-	-	-	**0.485**	**15.047**	0.000	-
$lnAG_{DOCt}$	0.750	13.060	0.000	-	-	-	**0.837**	**13.034**	0.000	-
lnR_{Dermt}	0.117	2.022	0.090	-	-	-	**0.356**	**5.343**	0.002	-
$lnEXP_{AGt}$	0.120	3.103	0.021	-	-	-	**0.088**	**2.799**	0.031	-
$lnAG_{colgt}$	0.101	3.228	0.018	-	-	-	**0.074**	**2.819**	0.030	-
lnR_{pblsht}	1.337	5.206	0.002	-	-	-	**0.603**	**5.925**	0.001	-
lnR_{sdnt}	0.323	5.762	0.001	-	-	-	**(0.011)**	**(0.222)**	0.832	-
lnV_{addt-1}	(0.372)	(2.726)	0.034	(1.772)	(9.141)	0.000	-	-	-	**Long Run**
$lnEXP_{RDt-1}$	0.154	2.120	0.078	0.870	8.898	0.000	-	-	-	0.491
$lnAG_{DOCt-1}$	0.398	5.035	0.002	1.331	7.373	0.000	-	-	-	0.751
$lnR_{Dermt-1}$	0.371	6.276	0.001	0.446	4.333	0.005	-	-	-	0.252
$lnEXP_{AGt-1}$	-	-	-	0.192	2.417	0.052	-	-	-	0.108
$lnAG_{colgt-1}$	-	-	-	0.095	1.697	0.141	-	-	-	0.053
$lnR_{pblsht-1}$	(0.509)	(2.135)	0.077	1.223	3.724	0.010	-	-	-	0.690
lnR_{sdnt-1}	(0.338)	(8.074)	0.000	0.015	0.189	0.857	-	-	-	0.009
constant	(4.178)	(3.705)	0.010	(4.289)	(2.149)	0.075	**(3.046)**	**(3.161)**	0.020	**Short-Run**
$\Delta lnEXP_{RDt-1}$	-	-	-	0.568	9.008	0.000	**0.512**	**11.846**	0.000	0.512
$\Delta lnAG_{DOCt}$	-	-	-	0.795	9.128	0.000	**0.750**	**13.060**	0.000	0.750
ΔlnR_{Dermt}	-	-	-	0.011	0.144	0.891	**0.117**	**2.022**	0.090	0.117
$\Delta lnEXP_{AGt}$	-	-	-	-	-	-	**0.120**	**3.103**	0.021	0.120
$\Delta lnAG_{colgt}$	-	-	-	-	-	-	**0.101**	**3.228**	0.018	0.101
ΔlnR_{pblsht}	-	-	-	1.201	3.863	0.008	**1.337**	**5.206**	0.002	1.337
ΔlnR_{sdnt}	-	-	-	0.260	3.015	0.024	**0.323**	**5.762**	0.001	0.323
$trend_t$	-0.182	-10.725	0.000	(0.208)	(8.713)	0.000	**(0.133)**	**(17.648)**	0.000	-
$\Delta trend_t$	-	-	-	-	-	-	**(0.182)**	**(10.725)**	0.000	-
ETCt-1	-	-	-	-	-	-	**(1.372)**	**(10.060)**	0.000	-

	ARDL	ARDL Bounds Test
, $\bar{R}^2 R^2$	0.99, 0.99	0.99 0.97
$F_{statistic}$	1012 [0.000]	53.7 [0.00]
Akaike criter.	(5.114)	(4.564)
Schwarz criter.	(4.368)	(3.818)
Hannan-Q criter.	(4.952)	(4.402)
DW_{stat}	2.767	3.029

F-Bounds test =20.9 *
* **Denotes rejection the null at 10% level of significance.**
- **Bound Testing Critical Values**:
10 %; 2.38 [I(0)], 3.45 [I(1)]
5 %; 2.69 [I(0)], 3.83 [I(1)]
1 %; 3.31 [I(0)], 4.63 [I(1)]

Where:

lnV_{addt} : Agriculture, value added (current million US$)
$lnEXP_{RDt}$: R&D expenditure (current million US$)
$lnAG_{DOCt}$:Documents in Agricultural and Biological Sciences
lnR_{Dermt} : Researchers in R&D (per million people)
ECT_{t-1} : error correction:
$lnEXP_{AGt}$: Government spending on agriculture (US$)
$lnAG_{faclt}$: Total graduates of the faculties of Agriculture
lnR_{pblsht} : Ranking of Egypt in the field of international publishing
lnR_{sdnt} : Resident Patents:

Notes: ***, ** and * denote significance at 1%, 5% and 10% levels, respectively.
Source: Authors' results were obtained using the EViews9.5 econometrics package and Gretl.

- There is a statistically positive and significant effect of government spending on agriculture on the added value of the agricultural sector in the short and long run by 1% will lead to an increase in the added value of the agricultural sector by 0.12% in the short run, and by 0.11% in the long run, which positively affects the added value of the agricultural sector in the long run if the current situation continues as it is.
- There is a positive effect of the number of the agricultural faculties graduates on the added value of the agricultural sector in the short and long run, as the coefficients of elasticity amounting (0.10), (0.053) at the short and the long run respectively, but the statistical significance of these two effects was not proven.
- There is a statistically positive and significant effect of Egypt's ranking in international publishing on the added value of the agricultural sector in the short and long run, which indicates that the greater the interest in developing scientific research as well as international publishing, the more it will have a positive impact on the development of the agricultural sector and increase its added value.
- The results reveal that the coefficient of error correction is negative statistically significant sign, this means that the added value of the agricultural sector and the factors influencing it that are included in the model have a cointegration when the added value is a dependent variable, which supports this effect in the short and long- run moving models**.**

The causal relationship between the added value of the agricultural sector and spending on R&D, government spending and the most important factors related to them in Egypt:

The causal or mutual relationship between the added value of the agricultural sector and the factors affecting it, which were included in the model, was tested using Pairwise Granger Causality Tests, which are shown in Table (5), which includes statistically significant results and consistent with economic logic. The most important results were the following:

- The results reveal that spending on R&D improves the added value of the agricultural sector.
- There is also a mutual relationship between publishing in international scientific journals in the field of agriculture and the added value of the agricultural sector.
- It was also found that there is a one-way causal relationship of the added value of the agricultural sector and the patents variable.
- The causal results also confirmed that there is a one-way causal relationship from the government spending on the agricultural sector to each of the added value of the agricultural sector, spending on R&D, and Egypt's ranking in international publishing.
- It has been found that there is a complementary relationship between each of the variables of spending on R&D and the variable of patents for residents, and it was also found that there is a one-way causal relationship from the variable number of articles in the field of agriculture published in international journals to each of the expenditures on research and development, the number of researchers per million inhabitants, and patents for residents.
- On the other hand, the number of articles in the field of agriculture published in international journals variable affects spending on scientific research, just as the variable of patents for residents affects Egypt's ranking in international publishing.

From the foregoing, it becomes clear that it is very difficult to study spending on R&D and government spending on the added value of the agricultural sector, separately, or that one affects without the other, because it involves many interrelated and complex relationships among them.

Table 5. Pairwise Granger Causality Tests between the added value of the agricultural sector and both spends on R&D, and government spending in Egypt during the period (2000-2021)

Variable	F-Statistic	Prob.	Direction
$EXP_{RDt} \Rightarrow V_{addt}$	3.694	0.050	$EXP_{RDt} \longrightarrow V_{addt} \longrightarrow EXP_{RDt-1}$ $\searrow \qquad \swarrow$ V_{addt-1}
$V_{addt} \Rightarrow EXP_{RDt-1}$	17.599	0.000	
$EXP_{RDt} \Rightarrow V_{addt-1}$	22.725	0.000	
$EXP_{RDt-1} \Rightarrow V_{addt-1}$	3.830	0.047	
$AG_{DOCt} \Rightarrow V_{addt}$	3.775	0.047	$AG_{DOCt} \rightleftharpoons V_{addt}$ $\downarrow\uparrow \qquad \downarrow\uparrow$ $V_{addt-1} \rightleftharpoons AG_{DOCt-1}$
$V_{addt} \Rightarrow AG_{DOCt}$	3.743	0.048	
$AG_{DOCt-1} \Rightarrow V_{addt}$	3.589	0.055	
$V_{addt} \Rightarrow AG_{DOCt-1}$	4.197	0.037	
$AG_{DOCt} \Rightarrow V_{addt-1}$	5.851	0.014	
$V_{addt-1} \Rightarrow AG_{DOCt}$	3.417	0.062	
$AG_{DOCt-1} \Rightarrow V_{addt-1}$	4.661	0.028	
$V_{addt-1} \Rightarrow AG_{DOCt-1}$	3.356	0.065	
$V_{addt} \Rightarrow R_{sdnt}$	2.915	0.085	$V_{addt}, V_{addt-1} \longrightarrow R_{sdnt}, R_{sdnt-1}$
$V_{addt} \Rightarrow R_{sdnt-1}$	3.026	0.081	
$V_{addt-1} \Rightarrow R_{sdnt}$	3.602	0.055	
$V_{addt-1} \Rightarrow R_{sdnt-1}$	2.999	0.082	
$EXP_{AGt} \Rightarrow V_{addt}$	6.461	0.010	$EXP_{AGt} \longrightarrow V_{addt}, V_{addt-1}, EXP_{RDt}, EXP_{RDt-1}, R_{pblsht}, R_{pblsht-1}$
$EXP_{AGt} \Rightarrow V_{addt-1}$	4.295	0.035	
$EXP_{AGt} \Rightarrow EXP_{RDt}$	5.552	0.016	
$EXP_{AGt} \Rightarrow EXP_{RDt-1}$	3.233	0.070	
$EXP_{AGt} \Rightarrow R_{pblsht}$	3.518	0.056	
$EXP_{AGt} \Rightarrow R_{pblsht-1}$	6.328	0.011	
$EXP_{RDt} \Rightarrow R_{pblsht-1}$	5.038	0.023	$EXP_{RDt} \rightarrow R_{pblsht-1}$
$R_{pblsht} \Rightarrow EXP_{RDt-1}$	3.556	0.056	$R_{pblsht} \rightarrow EXP_{RDt-1}$
$EXP_{RDt} \Rightarrow R_{sdnt}$	3.379	0.061	$EXP_{RDt} \rightarrow R_{sdnt}$ $\downarrow \qquad \uparrow$ $R_{sdnt-1} \leftarrow EXP_{RDt-1}$
$EXP_{RDt} \Rightarrow R_{sdnt-1}$	5.382	0.019	
$EXP_{RDt-1} \Rightarrow R_{sdnt}$	13.392	0.001	
$EXP_{RDt-1} \Rightarrow R_{sdnt-1}$	3.432	0.061	
$AG_{DOCt} \Rightarrow EXP_{RDt-1}$	3.977	0.043	AG_{DOCt} $\downarrow$ $AG_{DOCt-1} \longrightarrow \{EXP_{RDt-1}, R_{Dermt}, R_{sdnt}, R_{sdnt-1}\}$ $R_{sdnt} \longrightarrow R_{pblsht}$; $R_{sdnt-1} \nearrow R_{pblsht}$ $\downarrow$ AG_{colgt}
$AG_{DOCt-1} \Rightarrow EXP_{RDt-1}$	3.111	0.076	
$AG_{DOCt-1} \Rightarrow R_{Dermt}$	3.282	0.068	
$AG_{DOCt-1} \Rightarrow R_{sdnt}$	8.394	0.004	
$AG_{DOCt-1} \Rightarrow R_{sdnt-1}$	2.765	0.097	
$R_{sdnt-1} \Rightarrow AG_{colgt}$	3.797	0.048	
$R_{sdnt} \Rightarrow R_{pblsht}$	3.653	0.051	
$R_{sdnt-1} \Rightarrow R_{pblsht}$	3.446	0.061	

Notes: $\Rightarrow$ denote “does not Granger Cause”.
Source: Authors’ results were obtained using the EViews9.5 econometrics package.

According the previous results, the research offers the following **recommendations**:

- Devoting high attention to expenditure on research and development in general and particularly in the agricultural sector, as the results of the research confirmed that there is a causal relationship between expenditure on R&D and improving the added value of the agricultural sector.
- Researchers in the agricultural sector must be encouraged and supported to publish in international scientific journals in the field of agriculture, as the results of the research confirmed that this has a

positive impact on improving and increasing the added value of the agricultural sector.

- Devoting high attention to directing government expenditure and encouraging investment in the agricultural sector, because of its positive impact on increasing the added value of agriculture, as confirmed by the research results.
- The results of the research confirmed that it is very difficult to study expenditure on R&D and government expenditure on the added value of the agricultural sector, separately, or that one affects without the other, because it involves many interrelated and complex relationships among them.

REFERENCES

Attala, M.A., M.H.G. Ali. 2016. 'An Econometric Study of long-term equilibrium relationships for some strategic crops in Egypt'. *Egyptian Association of Agric. Economics, Egyptian J.l Agric. Economic*. **26**(1): 75-98.

ECSS 'Egyptian Center for Strategic Studies'. 2022. *Egypt in Sustainable Development Report 2022*. Available at: https://ecss.com.eg/20523.

El-Rasoul, A.A A.K. Aon and E.Y.Youssef. 2018. 'Agricultural Education and its Impacts on the Agricultural Economic Growth in Egypt'. *J. Agric. Economic. and Social Sci.*, Mansoura Univ. **8**(12): 221-225.

Elsaied, E.S. 2021. 'The importance of scientific research and technology in agricultural development'. *J. Uni. Performance Development (JUPD)*, Mansoura University, **16**(1): 3-16.

Pesaran, M.H. and Y. Shin. 1995. An autoregressive distributed lag modeling approach to co integration analysis. *Department of Applied Economics*, university of Cambridge, n/a(n/a), 1-34. Available at: https://www.researchgate.net/publication/4800254.

Pesaran, M.H., Y. Shin and R.J. Smith. 2001. Bounds testing approaches to the analysis of level relationships. *J. Applied Econometrics*, **16**(3):289–326.

SDG 'Sustainable Development Goals'. 2022.*Sustainable Development Report* Available at: https://dashboards.sdgindex.org/downloads.

Shrestha, M.B. and G.R. Bhatta. 2018. Selecting appropriate methodological framework for time series data analysis. *The J.Finance and Data Sci.***4**(2): 71-89.

Shrestha, M.B., K. Chowdhury. 2005. ARDL modelling approach to testing the financial liberalization hypothesis. *Department of Economics, University of Wollongong, WP* 05-15(n/a): 1–30. Available at: https://ro.uow.edu.au/commwkpapers/121.

SIS 'Egypt State Information Service Your Gateway toEgypt'. 2022. Available at: https://www.sis.gov.eg/Story/235782/?lang=ar.

SJR 'SCImago Journal and Country Rank'. 2022. *SCImago Institutions Rankings* Available at: https://www.scimagojr.com/aboutus.php.

WIPO 'World Intellectual Property Organization'. 2022a. Available at: https://www.wipo.int/pressroom/ar/articles/2015/article_0010.html.

WIPO 'World Intellectual Property Organization'. 2022b. Available at: https://www.wipo.int/patents/en/patent-analytics.html.

WIPO 'World Intellectual Property Organization'. 2022c. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_2000_2022/eg.pdf.

World Bank. 2022. Available at: https://data.worldbank.org/indicator/IP.JRN.ARTC.SC?locations=EG.

الملخص العربي

دور البحث العلمى والإنفاق الحكومى فى تحقيق التنمية المستدامة بالزراعة

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استهدف البحث بصفة رئيسية دراسة وتحليل مؤشرات البحث العلمى، وكذا الإنفاق الحكومى الموجهة للقطاع الزراعى، وكذا دراسة العلاقة التشابكية بين القيمة المضافة وكل من مؤشرات البحث العلمى والابتكار، والإنفاق الحكومى على قطاع الزراعة. واستخدم البحث منهج اختبار الحدود للتكامل المشترك The Bounds Testing Approach to Co integration، لتحليل العلاقة التشابكية بين القيمة المضافة وكل من مؤشرات البحث العلمى والابتكار، والإنفاق الحكومى على قطاع الزراعة، وذلك باستخدام نماذج الانحدار الذاتي لفترات الإبطاء الموزعة The Autoregressive Distributed Lag Approach [ARDL(p,q)]، وكذلك اختبار مدي وجود علاقة سببية أو تبادلية بين تلك المتغيرات باستخدام اختبار جرانجر للسببية Pairwise Granger Causality Tests وأوضحت النتائج تحسن مؤشر التنمية المستدامة والابتكار، وترتيب مصر فى مجال النشر الدولى لمصر خلال الفترة (٢٠٠٠–٢٠٢١) نتيجة اتجاه الدولة للاهتمام بالبحوث والتطوير والتوسع فى المشروعات التى تعتمد على التكنولوجيا الحديثة وتحفيز براءات الاختراع. كما أوضحت النتائج زيادة الإنفاق على البحث والتطوير، وزيادة الإنفاق على التعليم وكذلك القيمة المضافة للزراعة خلال فترة الدراسة. وأخيراً أوضحت النتائج وجود أثر موجب ومعنوي إحصائيًا لقيمة الإنفاق على البحث والتطوير، وزيادة المقالات العلمية المنشورة فى المجال الزراعى، وعدد الباحثين لكل مليون نسمة، والإنفاق الحكومى على الزراعة، وعدد خريجوا كليات الزراعة، وترتيب مصر فى النشر الدولى علي القيمة المضافة لقطاع الزراعة في المدي القصير والمدي الطويل، الأمر الذي يؤكد العلاقة المباشرة لتلك المتغيرات فى رفع الكفاءة الإقتصادية لعوامل الإنتاج.

الكلمات المفتاحية: القيمة المضافة – نموذج (ARDL) – العلاقة السببية – الابتكار – النشر الدولى.