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Econometric analytical study of agricultural output determinants

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Abstract: In recent years, Egypt has faced many political and economic changes, which have negative impact on the agricultural sector; decline in the contribution of the agricultural output to GDP had been noticed from about 14% in 2005/2006 to about 11% in 2018/2019. This research therefore aims to measure the causation between agricultural output and the most important determinants using Vector Auto Regression (VAR). The causations between agricultural output and both agricultural investment and agricultural exports was studied after examining all the explanatory factors affecting agricultural output and estimating the significance of these two variables.
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1. Introduction:

The state seeks to raise the growth rates in various sectors to achieve the desired economic and social development. The agricultural sector is considered one of the most important sectors in the national economy and the state shows a great deal of interest to it due to its great role in food security beside decreasing the unemployment rate and provide new jobs. In addition, it has an effective role in providing necessary raw materials for the other sectors. Despite the big role of this sector, the contribution of agricultural output to GDP has gradually declined to about 11.5% in 2019/2020, compared to about 17% in 2000/2001.There is no denying that the agricultural sector has been under many pressures in recent periods, such as encroachment on agricultural land, the fragmentation of holdings, the decline in agricultural exports, as well as the negative effects of climate changes. . This is in addition to the depreciation of the local currency and the high rate of agricultural imports, which caused a deficit in the agricultural trade balance estimated by 8.8 billion pounds in 2019/2020

Research problem:

During the last 10 years, Egypt has suffered many political, economic and environmental changes, which has negatively affected the agricultural sector, despite attempts to revive it by increasing investments and agricultural projects, so these changes prevented the goal of raising the efficiency of the performance of the agricultural sector and therefore the resulting output of agricultural GDP, where the contribution of the agricultural sector in GDP compared to other sectors, fell from about 14% in 2005/2006 to about 11% in 2018/2019.

Research goal:

The research aims mainly to study the relationship between agricultural output and its most important determinants, and to measure the causation between them by achieving the following sub-objectives:

- The development of GDP and agricultural domestic production.
- Study the development of the most important factors affecting agricultural domestic production.
- Estimate the impact of the most important variables specified for agricultural GDP during the period (2005/2006 - 2018/2019).
- Estimate the causal relationship between the most important determinants of agricultural GDP and agricultural output (1995/1996-2018/2019).

Research method and data sources:

The research relied on descriptive and quantitative analysis methods, the use of some statistical methods such as general trend equations, linear decline and gradual decline to estimate factors affecting agricultural output, as well as the application of the standard VAR (Regressive Auto Vector) vector model. As well as analyzing and measuring the causation between the dependent variable, the independent variables in question through Granger causal testing, and the IRFs (Impulse Response Functions) , through which specific factors of agricultural output can be identified, identifying their spread effects, as well as "analysis of VDCs components (Variance Decomposition) and then conduct the necessary tests such as: model stabilization test by conducting a unit root test using the expanded D.Y.Y. Fuller model (ADF), Philip Byron, testing the number of deceleration periods, and the joint integration test, as well as standard problem tests such as: the auto-correlation test for trumpets, and the normal distribution test for trumpets.

The research was based on published and unpublished data issued by the Ministry of Planning, Follow-up and Administrative Reform, the Central Agency for Public Mobilization and Statistics, the Agricultural Bank; economic affairs sector bulletins at the Ministry of Agriculture and Land Reclamation, in addition to economic studies and relevant scientific thesis.

Research results:

1. The development of GDP and agricultural GDP.

The average GDP in real prices was about 1218 billion pounds during the period (2005/2006-2019/2020), and equation (1) table (1) shows that GDP is increasing by a statistically moral annual amount of about 141.5 billion pounds. The annual growth rate was estimated at 11.6%, and the determination factor indicated that 85% of the changes in GDP were due to time-related factors.

Table (1) Equations of the overall development of GDP and economic sectors in real prices (1) during the period (2005/2006- 2019/2020) (Value: billion pounds)

Statement	Slope coefficient (b)	t	R^2	Average	Growth rate (2)
Gross Domestic Product	*141.5	(8.8)	0.85	1218	11.6
Agricultural GDP	***15.2**	**(7.2)**	**0.79**	**146.7**	**10.4**
GDP Commodity Sectors	*63	(8.3)	0.84	586.3	10.7
GDP Productivity Services	*33.5	(8.1)	0.83	270	12.4
GDP Social Services	*45	(10.1)	0.88	362	12.4

(1) Current prices have been converted into real prices using the wholesale price index, considering that the base year (2004/2005=100).

(2) Annual growth rate = $\times 100 \frac{b}{\bar{y}}$ * Indicates morale at statistical probability level 0.01

Source: Ministry of Planning, Follow-up and Administrative Reform, International Information Network, Official Website, Various Years.

By reviewing the value of output for the various national sectors, it is shown that the share of commodity sector is about 49% of GDP, with an average value of about 586 billion pounds, and the equation (2) shows that the GDP of the commodity sector is increasing by a statistically significant annual amount of about 63 billion pounds. With regard to the value of the GDP of the productive and social sector, their average is about 270,362 billion pounds during the research period. The equations (3 , 4) show that the GDP of the productive and social sector is increasing by a statistically significant annual amount of about 33.5 , 45 billion pounds, respectively. The annual growth rate was estimated at 12.4%, 12.43% each, respectively.

The agricultural sector is one of the arms of the commodity sector, contributing about 25% of the income of the commodity sector during the period (2005/2006-2019/2020). Despite the importance of this sector and the high degree of entanglement with other sectors, its contribution is gradually declining, as its participation in GDP declined from about 14% in 2005/2006 to about 11%in 2018/2019. Regarding to the growth of other sectors, the contribution ranged from a minimum of about 73 billion pound in 2005/2006 to a maximum of 318 billion pounds in 2019/2020, with an average of about 147 billion pounds. Equation (4) shows that agricultural output is increasing by a statistically significant annual amount of about 15.2 billion pounds. The annual growth rate was estimated at 10.4%.

2. Studying development of the important factors affecting agricultural GDP:

a. Agricultural investment: Agricultural investment represents about 4.2% of the total investment value during the period (2005/2006-2018/2019), with an average of 8.2 billion pounds. Equation (1) in Table 2 shows that agricultural investment increases by a statistically significant annual amount of about 990 million pounds. The annual growth rate was estimated at 12.1% and a surge in agricultural investment over the last three years was observed due to the increase in the public sector's contribution more than the private sector, with the first contribution ranging from about 39% of total agricultural investment till year 2015, and increased to about 65% during the period (2016-2018), due to the state's interest in infrastructure spending and the processing of agricultural reclamation areas to raise growth and development rates in the rural sector.

b. Agricultural Labor: The agricultural sector includes about 27% of the total supply of Egyptian labor during the research period, where the average number of agricultural workers is estimated at 6.3 million. Equation (2) shows that the number of agricultural workers is increasing by a statistically unethical annual amount. The annual growth rate was estimated at 0.52%.The limited growth rate is due to the recent decline in the number of agricultural workers, due to the adoption of modern agricultural systems, in addition to the migration of workers to the construction sector due to increased wages and the increase in the number of national projects in this sector.

c. Agricultural exports: The average value of agricultural exports was about 95.3 billion pounds during the research period. Equation (3) shows that agricultural exports increase by a statistically significant annual amount of about 7.1 billion pounds. The annual growth rate was estimated at 7.4%. A surge in the value of agricultural exports, represented by horticultural crops, is observed in recent years.

d. Agricultural loans: The average value of agricultural loans was about 5.6 billion pounds, and the value of agricultural loans decreased from about 9.27 billion pounds in 2005/2006 to about 6.59 billion pounds in 2018/2019. Equation (4) shows that agricultural loans are decreasing by a statistically insignificant annual amount.

e. The value of agricultural production: the average value of agricultural production during the period referred to was about 171 billion pounds. The equation (5) indicates that the value of agricultural production increases by a statistical annual significant amount of about 9.8 billion pounds. The annual growth rate is estimated at about 5.8%.

Table (2) Equations of general development of the most important factors affecting agricultural output at real prices during the period (2005/2006- 2018/2019)

M	Statement	Slope coefficient(b)	t	Average	Growth rate	R^2
1	**Agricultural investment** (billion pounds)	0.99 Xi	(2.8)*	8.2	12.1	0.40
2	**Number of agricultural** workers(million)	0.03 Xi	(0.83)	6.3	0.52	0.05
3	**Agricultural exports (million pounds)**	7.1 Xi	(7.1)*	95.3	7.4	0.80
4	**Agricultural loans (million pounds)**	-213.6 Xi	(-1.7)	5614	-4.0	0.19
5	**Value of agricultural production (billion pound)**	9.8.4 Xi	(6.9)*	171	5.8	0.79

* Indicates morale at statistical probability level 0.01

Source: Collected and calculated from the data of:

- The Central Agency for Public Mobilization and Statistics, annual statistical book.
- Ministry of Planning, Follow-up and Administrative Reform, International Information Network, Official Website.
- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Income Bulletin.
- Agricultural Bank (formerly The Main Bank for Development and Agricultural Credit),Credit Sector, Unpublished Data.

3. Estimating the impact of the most important variables specified for agricultural GDP during the period (2005/2006-2018/2019)

To study the specific factors of agricultural GDP during the period (2005/2006-2018/2019), the simple correlation matrix between agricultural GDP was set as a dependent factor and each of the independent variables believed to have an impact on this dependent variable, in order to determine the interpretive variables that are strongly related to each other to exclude them in order to avoid the problem of linear correlation between independent variables. The simple regression equations between the dependent variable and each of the independent variables selected in the first step were then estimated to identify variables with a significant effect on the dependent variable based on the value of R2 determination coefficient, the T test, and the F test. The multiple regression functions were also estimated in their different images between the dependent variable and the independent variables using stepwise, and the forms of functions (linear, half logarithm, double logarithm) were used and the best forms were chosen that were consistent with economic and statistical logic.

The relationship between agricultural GDP has been estimated at billion pounds in real terms (as a dependent variable) (Y), and the most important agricultural economic variables with direct and positive impact, which consisted of: agricultural investment in billion pounds (X1), the number of workers per million workers (X2), agricultural exports in billion pounds (X3), and the value of agricultural production in billion pounds (X4). In addition to the negative impact variables of agricultural loans in billion pounds (X5), a dummy variable that reflects the impact of political and economic changes (X6) and takes value (zero) for the period (2005/2006-2010/2011) and the value (one) for the period (2011/2012-2018/2019).

By examining the relationship between agricultural GDP as a dependent variable and the interpretive factors affecting it, it is shown that the dual logarithmic form is the best mathematical form expressing that relationship and is illustrated by the equation in table (3).

Table (3) Statistical estimation of the most important agricultural output in real prices using the method of gradual decline

Statement	Equation	R^2	R^{-2}	F	D W
Double logarithmic image	$\ln y = 3.1 + 0.24 \ln X_1 + 0.57 \ln X_3$ (3.8) (7.7)	0.95	0.94	103	1.76

Source: Collected and calculated from the data of:

- The Central Agency for Public Mobilization and Statistics, annual statistical book.
- Ministry of Planning, Follow-up and Administrative Reform, International Information Network.

The results indicate that the most important factors affecting agricultural GDP in real terms are: agricultural investment, and agricultural exports. These variables are consistent with statistical economic and significant logic. There is a statistically direct relationship between agricultural output and both agricultural investment and agricultural exports. These variables explain about 95% of the change in the real value of agricultural output. These factors have been shown to be significant at a significant level of 0.05, and the estimated model has been shown to be devoid of the problem of serial auto-correlation between first-class trumpets, based on the calculated value of Durban-Watson of about 1.76. The relative impact of both agricultural investment and agricultural exports was estimated by 2.4%, 5.7%, respectively. This means that with a 10% increase in agricultural investment, agricultural output is increasing by about 2.4% and with a 10% increase in agricultural exports, agricultural output is increasing by about 5.7%.

4. Estimating the standard relationship between agricultural output and the most important determinant:

By identifying the most important variables affecting agricultural GDP, agricultural, investment and agricultural exports, (VAR) Vector Auto Regression was applied during the period (1995/1996-2019/2020), a model that describes the behavior of parameters across the different time gaps of the parameter. It is seen as a potential dynamic model, considering current and past random shocks. The VAR model methodology is similar to the models of real-time equations, i.e. there are many internal variables together, but each internal variable is described in its different values and the slow values of all other internal variables in the model, and there are no external variables in the model. By introducing time, these models will distinguish between short-term response and long-term variable response of the Interpretive Variable Change unit, and because of their reliance on slowing downs, these models require reliance on the optimal standard of testing, and the best test is **Schwarz, Likelihood, AIC.**

The application of the auto-regression-oriented model follows:

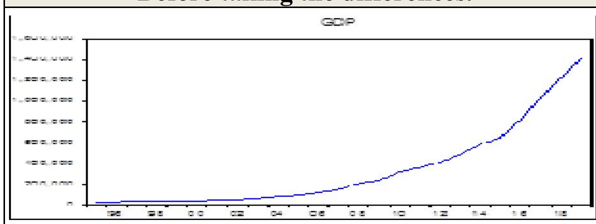
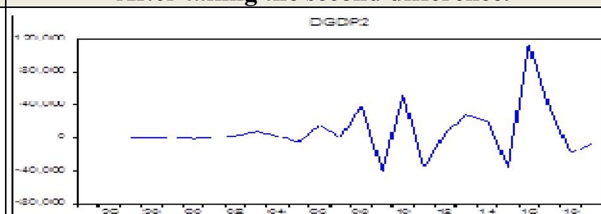
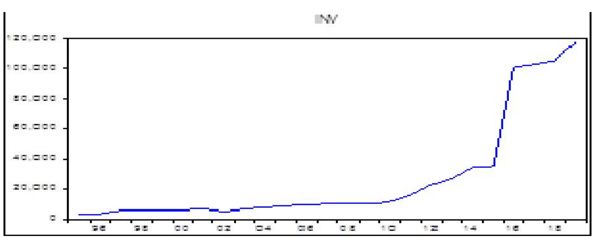
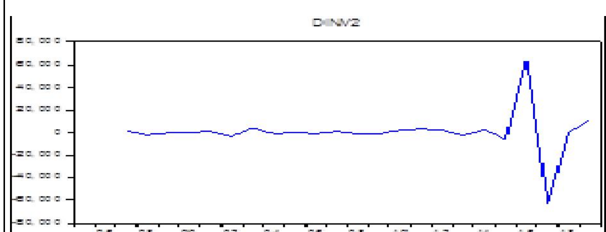
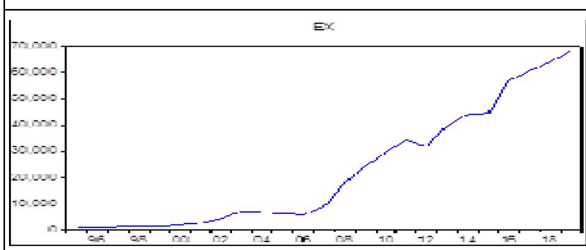
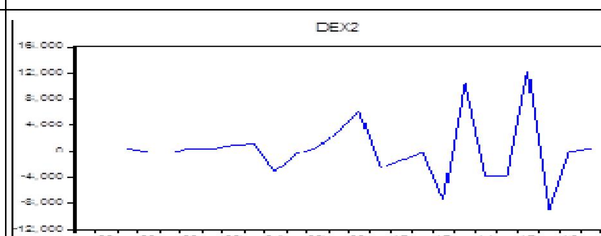
a. Unit Root Test:

In a study carried out by (Nelson and Plosser, 1982) show that most macro-economic variables are not static at the level, the time series is referred to as static when its arithmetic level and variation is constant, i.e. both its medium and variation remain constant over time. Determining the degree of integration of these series to reach sound results and to avoid the phenomenon of false deviation (Spurious Regression), which means that the relationship between economic variables expresses a false relationship, some indications of this from are the high value of R^2, and the high statistical significant of the estimated parameters, with the limitations of a subjective relationship that appears in the depreciation of DW so the stability test is conducted. The most important methods used are the Extended Augmented Dickey–Fuller test (ADF) and Philips Peron test. The ADF test contains three different slope equations; the first contains the fixed limit, the second with the fixed and incremental limit, and the third without a fixed and time-based limit.

The unit root test assumes that the series is unstable if the estimated t < of critical t, here we accept the nihilistic hypothesis H0:B=0, which requires retesting again but after taking the differences, while accepting the alternative hypothesis H1:B<0 which indicates the stability of the series, if the t estimated > of table-critical t value, and when the original series is found static at the level, it is said to be integrated from zero grade (0), but if you require taking differences d(1), or d (2) to make it stable we say it is integrated class I (1), or I (2).

By estimating the unit root of the study variables according to **Augmented Dickey-Fuller, Phillips Peron** ,the results of Table (4) indicated acceptance of the zero hypothesis that all variables in the study are not static at the level, as estimated values are lower than table values at different significant levels, as illustrated by the graph of the variables. To get rid of the non-stillness of the series, the first difference was taken, but the data was unstable, so the second difference was taken, and the root of the unit was eliminated. Therefore, the alternative hypothesis was therefore accepted that the variables were stable second-class I (2) so that the series would be soothed at the second difference.

Form (1) shows the evolution of variables before and after the extended Dickie-Volar test.

Before taking the differences.	**After taking the second difference.**
	
	
	

Source: Results of model estimates using Eviews.

Table (4) Unit Root Test Results (Dickie-FuL. R., P.J. Lips Byrne)

<table>
<tr><th colspan="16">Augmented Dickey - Fuller</th></tr>
<tr><th rowspan="2">Model</th><th colspan="6">Level</th><th colspan="9">2nd difference</th></tr>
<tr><th colspan="2">intercept</th><th colspan="2">trend & intercept</th><th colspan="2">None</th><th colspan="3">intercept</th><th colspan="3">trend & intercept</th><th colspan="3">None</th></tr>
<tr><td rowspan="2">Critical Value</td><td>1%</td><td>5%</td><td>1%</td><td>5%</td><td>1%</td><td>5%</td><td>1%</td><td>5%</td><td>10%</td><td>1%</td><td>5%</td><td>10%</td><td>1%</td><td>5%</td><td>10%</td></tr>
<tr><td>-4</td><td>-3.09</td><td>-4.8</td><td>-3.79</td><td>-2.74</td><td>-1.96</td><td>-4.2</td><td>-3.18</td><td>-2.73</td><td>-5.11</td><td>-3.92</td><td>-3.41</td><td>-2.82</td><td>-1.97</td><td>-1.6</td></tr>
<tr><td>GDP</td><td colspan="2">12.06</td><td colspan="2">3.54</td><td colspan="2">16.83</td><td colspan="3">-6.77</td><td colspan="3">-6.6</td><td colspan="3">-5.94</td></tr>
<tr><td>INV</td><td colspan="2">5.06</td><td colspan="2">4.26</td><td colspan="2">0.54</td><td colspan="3">1.35</td><td colspan="3">-6.06</td><td colspan="3">1.91</td></tr>
<tr><td>EX</td><td colspan="2">2.01</td><td colspan="2">-1.42</td><td colspan="2">4.19</td><td colspan="3">-4.3</td><td colspan="3">-4.22</td><td colspan="3">-4.38</td></tr>
<tr><th colspan="16">Phillips Perron</th></tr>
<tr><td rowspan="2">Model</td><td colspan="6">Level</td><td colspan="9">2nd difference</td></tr>
<tr><td colspan="2">intercept</td><td colspan="2">trend & intercept</td><td colspan="2">None</td><td colspan="3">intercept</td><td colspan="3">trend & intercept</td><td colspan="3">None</td></tr>
<tr><td>GDP</td><td colspan="2">21.86</td><td colspan="2">9.03</td><td colspan="2">29.7</td><td colspan="3">-6.65</td><td colspan="3">-16.78</td><td colspan="3">-5.94</td></tr>
<tr><td>IN</td><td colspan="2">1.56</td><td colspan="2">-0.32</td><td colspan="2">2.75</td><td colspan="3">-19.43</td><td colspan="3">-19.17</td><td colspan="3">-18.22</td></tr>
<tr><td>EX</td><td colspan="2">2.1</td><td colspan="2">-1.37</td><td colspan="2">4.19</td><td colspan="3">-21.7</td><td colspan="3">-22.69</td><td colspan="3">-15.45</td></tr>
</table>

Source: Results of model estimates using Eviews

b. Determining periods of ideal slowing down of the VAR model.

After determining the stability of the series at the second difference, this indicates the possibility of a common integration between the variables. The degree of ideal slowing of the VAR model is determined by several criteria such as Akaike, Schwarz, Hannan-Quinn and the results showed that appropriate slowing periods are approval of the lowest value according to the AIC, HQ, SC, FPE, LR. Therefore, two slow P=2 periods have been set for the rest of the form.

Table (5) Criteria for determining the number of periods of time slowing of variables

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-684.7487	NA	5.61E+24	65.49987	65.64909	65.53226
1	-668.9095	25.64439	2.97E+24	64.84852	65.44539	64.97806
2	-648.5876	**27.09585***	**1.08e+24***	**63.77025***	**64.81477***	**63.99693***

Source : Model results using Eviews

c. Common integration relationship test

This test identifies the existence or nonexistence of common integration between variables, and if it is not achieved, the balanced relationship between variables will remain questionable and suspicious, and to determine the number of inter-variable integration relationships, Johansen and Juselius propose two tests: Test Trace, Eigen value Max. Table (6) results have shown that there is a common integration relationship between the three variables, because the calculated value of the two tests is greater than critical values at a significant level of 0.05. In doing so, we reject zero hypothesis and accept the alternative hypothesis that there is a tendency for the common integration between variables and the existence of an integrated relationship.

Table(6)Results of the joint integration test in accordance with Johansen and Jusellius methodology

Hypothesized	Test Trace				Max Eigenvalue Test			
No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.9568	**73.74**	**29.80**	0.0000	0.957	**47.125**	**21.132**	0.0000
At most 1 *	0.6891	**26.62**	**15.49**	0.0007	0.689	**17.526**	**14.265**	0.0147
At most 2 *	0.4545	**9.09**	**3.84**	0.0026	0.455	**9.091**	**3.841**	0.0026

Source : Model results using Eviews

d. VAR model estimate:

After defining the slowing periods of the variables in the study, and applying the OLS method by estimating each model equations individually, the results of the VAR model are as shown in Table (7) are as follows:

1. Agricultural output equation:

The results of the agricultural output equation indicate that the agricultural output logarithm is explained by 55% in terms of its previous and slow value and the previous values of other variables slowed down for two periods. The significant of the agricultural output parameters for the initial slowdown period has been proved, as well as the significant of agricultural investment parameters for the slowing down period, the significant agricultural exports for the second slowing periods as well as the significant of the fixed limit. The statistical significant of the VAR model has been proven in accordance with the self-information standard of both SC and AIC. Hence, the alternative hypothesis shown that the significant of the agricultural output logarithm is statistically acceptable.

2. Agricultural investment equation:

The results of the agricultural investment equation indicate that the agricultural investment logarithm is explained by 69% in terms of its previous and slow value, and the previous values of other variables which are slow for two periods. The significant of agricultural investment and agricultural output parameters have been demonstrated for the initial slowdown period, and the rest of the model parameters have been shown to be insignificant. The statistical significance of the VAR model has also been proven..

3. Agricultural export equation:

The results of the agricultural export equation indicate that logarithm of agricultural exports are explained by 57% in terms of its previous and slow value, and the previous values of other variables, which are slow for two periods. The significance of agricultural export parameters have been proven for the second slowdown period, and the rest of the model parameters have been shown to be insignificant. The statistical significance of the VAR model has also been proven.

e. VAR model validity test:

After estimating auto-regression VAR, and accepting the agricultural output model as the subject of measurement, we tested the validity of the model by

Table(7) VAR model results for agricultural output, agricultural investment and agricultural exports

Vector Auto-regression Estimates			
	DGDP2	DINV2	DEX2
DGDP2(-1)	-0.64	-0.32	-0.04
	-0.26	-0.13	-0.04
	[-2.46]	[-2.50]	[-1.06]
DGDP2(-2)	0.31	-0.12	-0.08
	-0.29	-0.14	-0.04
	[1.07]	[-0.83]	[-2.03]
DINV2(-1)	1.54	-0.55	-0.09
	-0.58	-0.29	-0.08
	[2.66]	[-1.88]	[-1.11]
DINV2(-2)	1.38	0.05	0.04
	-0.48	-0.24	-0.07
	[2.85]	[0.20]	[0.57]
DEX2(-1)	-1.42	-0.36	-0.48
	-2.01	-1.01	-0.29
	[-0.707]	[-0.36]	[-1.64]
DEX2(-2)	-4.43	-1.33	-0.33
	-1.96	-0.98	-0.28
	[-2.25]	[-1.35]	[-1.15]
C	12387.51	5058.85	1505.23
	-7077.03	-3543.60	-1018.89
	[1.75]	[1.427]	[1.47]

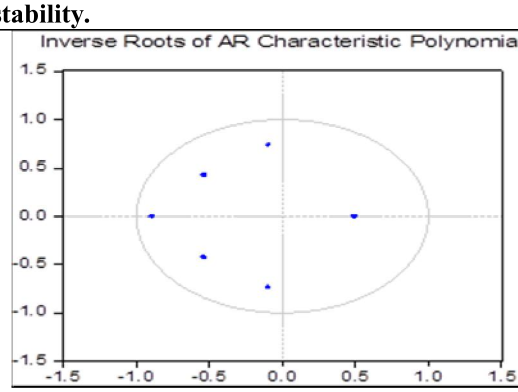
R-squared	0.55	0.69	0.57
Adj. R-squared	0.36	0.56	0.38
F-statistic	2.84	5.22	3.05
Log likelihood **(-648.6)**	-239.79	-225.26	-199.09
Akaike AIC **(63.77)**	23.50	22.12	19.63
Schwarz SC **(64.81)**	23.85	22.47	19.98
Mean dependent	8778.24	632.43	182.90
S.D. dependent	33603.28	20323.49	4932.03
Determinant reside covariance (dof adj.)	4.54E+23		
Determinant reside covariance	1.35E+23		
DGDP2 = -0.637 *DGDP2(-1) + 0.309 *DGDP2(-2) + 1.54 *DINV2(-1) + 1.37 *DINV2(-2) -4.43* DEX2(-1) - 4.43 *DEX2(-2) + 12387.5			
DINV2 = C(8)*DGDP2(-1) + C(9)*DGDP2(-2) + C(10)*DINV2(-1) + C(11)*DINV2(-2) + C(12)*DEX2(-1) + C(13)*DEX2(-2) + C(14)			
DEX2 = C(15)*DGDP2(-1) + C(16)*DGDP2(-2) + C(17)*DINV2(-1) + C(18)*DINV2(-2) + C(19)*DEX2(-1) + C(20)*DEX2(-2) + C(21)			

Source : Results of model estimates using Eviews.

VAR stability test : To ensure the stability of the model, the inverse root test has been done, and this test confirms that the results of the VAR model are stable if there are no roots equal to one, as explained by table (8). The results indicate that all inverse root values are located within the border circle, and this confirms that the model is stable. This means that all terms are smaller than one, which means that the form does not have a problem of error correlation or Hetero scedasticity.

Table(8) Results of VAR Vector Auto Regression model stability.

Roots of Characteristic Polynomial	
Endogenous variables: DGDP2 DEX2 DIN2	
Exogenous variables: C	
Lag specification: 1 2	
Root	Modulus
-0.89	0.892364
-0.094712 - 0.737642i	0.743698
-0.094712 + 0.737642i	0.743698
-0.535569 - 0.427075i	0.685001
-0.535569 + 0.427075i	0.685001
0.49	0.493192
No root lies outside the unit circle.	
VAR satisfies the stability condition.	



Source: Model results using Eviews.

1. **VAR** model residual test for auto-correlation : By using Residual Portmanteau Tests for Auto-correlations, Table(9) indicates that there is no autocorrelation of residuals at the two slowing periods, because the probability value is greater than the indicated level. This means accepting zero hypotheses.

Table(9) VAR Residual Portmanteau Tests for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	12.0	NA*	12.6	NA*	NA*
2	20.6	NA*	22.1	NA*	NA*
3	32.7	0.0002	36.2	0.0000	9
4	46.5	0.0002	53.3	0.0000	18
5	58.6	0.0004	69.1	0.0000	27
6	64.4	0.0025	77.3	0.0001	36
7	70.1	0.0097	85.8	0.0002	45
8	81.5	0.0092	104.2	0.0000	54
9	84.4	0.0370	109.4	0.0003	63
10	86.5	0.1168	113.3	0.0014	72

Source : Model results using Eviews.

2. Test of the natural distribution of VAR model equations: To confirm the natural distribution of the residual series and adopt the zero hypothesis, jarque-Bera test is used, which combines the Skewness and Kurtosis tests. Table (10) shows that Jarque-Bera values for all residuals are lower than the scheduling value, as all their values are greater than 5%, which is confirmed by Prob values, and therefore zero hypothesis is accepted, i.e. all residuals follow normal distribution. According to previous tests of both the model stability test, autocorrelation test and the natural distribution test, we conclude the validity of the estimated VAR Vector Auto-Regression model.

Table(10)Results of var Residuals Normality Tests

VAR Residual Normality Tests				
Component	Skewness	Chi-sq	df	Prob.
1	-0.03	0.00	1.00	0.96
2	1.05	3.82	1.00	0.05
3	0.02	0.00	1.00	0.98
Joint		**3.83**	**3.00**	**0.28**
Component	Kurtosis	Chi-sq	df	Prob.
1	4.79	2.80	1.00	0.09
2	3.80	0.56	1.00	0.45
3	3.84	0.61	1.00	0.43
Joint		**3.97**	**3.00**	**0.27**
Component	Jarque-Bera	df	Prob.	
1	2.80	2.00	0.25	
2	4.38	2.00	0.11	
3	0.61	2.00	0.74	
Joint	**7.79**	**6.00**	**0.25**	

Source: Model results using Eviews.

f. Analysis of the response functions:

It is intended to measure the extent to which internal variables in the model respond to shocks, and this test aims to measure the model ability to explain the sudden change in a variable over the rest of variables.

Agricultural Output Response:

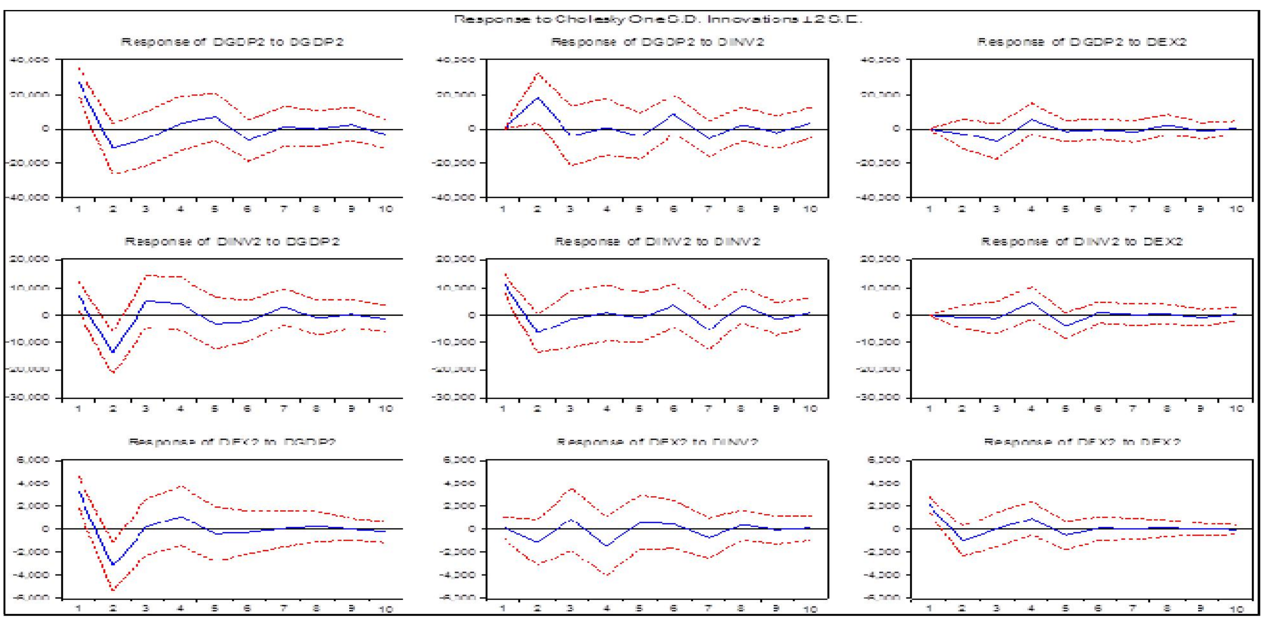
Table (11) shows the estimate of the batch response functions by Cholesky test. In 10 years, data show that a positive shock in the first year has no impact on agricultural investment and exports, while a negative shock to agricultural output in the second year, the amount of its standard deviation (-11.3%). It has an estimated positive significant impact on agricultural investment (17.8%), a significant negative impact on agricultural exports and an estimated response volume of (-3.15%). For the third year, a negative shock to agricultural output (-5.8%) has a significant negative impact on both agricultural investment and agricultural exports by a deviation (-4.2%, -7.3%) respectively. This explains the existence of a conflicting relationship in the short term. In the long run, the relationship between a reverse and a direct relationship is shown.

Figure 2 refers to the functions of responding to agricultural output.

Table (11) Results of estimation of the response functions for Agricultural Output, Agricultural Investment, and Agricultural Exports

Period	Response of DGDP2			Response of DINV2			Response of DEX2		
	DGDP2	DINV2	DEX2	DGDP2	DINV2	DEX2	DGDP2	DINV2	DEX2
1	27.0	0.0	0.0	6.8	11.7	0.0	3.2	0.1	2.1
	-4.2	0.0	0.0	-2.8	-1.8	0.0	-0.7	-0.5	-0.3
2	-11.3	17.8	-3.1	-13.6	-6.4	-0.8	-3.2	-1.2	-1.0
	-7.4	-7.2	-4.3	-3.9	-3.5	-2.2	-1.0	-1.0	-0.6
3	-5.8	-4.2	-7.3	5.1	-1.5	-1.1	0.2	0.9	0.0
	-7.9	-8.6	-5.1	-4.7	-5.1	-2.9	-1.2	-1.3	-0.7
4	3.3	0.9	5.5	4.0	0.9	4.6	1.1	-1.5	1.0
	-7.9	-8.1	-4.5	-4.9	-5.1	-2.9	-1.3	-1.3	-0.7
5	6.8	-4.2	-1.4	-3.0	-1.0	-3.8	-0.4	0.6	-0.5
	-7.0	-6.6	-3.2	-4.6	-4.5	-2.4	-1.2	-1.2	-0.6
6	-6.8	8.5	-0.4	-2.1	3.6	1.0	-0.3	0.4	0.1
	-6.0	-5.7	-3.0	-3.7	-4.0	-1.9	-0.9	-1.0	-0.5
7	1.3	-5.8	-1.6	3.0	-5.2	0.2	0.0	-0.7	0.0
	-5.8	-5.2	-3.2	-3.3	-3.6	-1.9	-0.8	-0.9	-0.5
8	0.0	2.5	2.3	-1.0	3.6	0.4	0.2	0.4	0.1
	-5.2	-4.9	-3.0	-3.2	-3.1	-1.7	-0.7	-0.7	-0.4
9	2.5	-2.2	-1.3	0.4	-1.5	-0.8	0.0	-0.1	0.0
	-4.8	-4.7	-2.4	-2.6	-3.0	-1.5	-0.5	-0.6	-0.3
10	-3.3	3.4	0.5	-1.4	0.9	0.5	-0.2	0.1	-0.1
	-4.2	-4.5	-2.0	-2.4	-2.7	-1.2	-0.5	-0.5	-0.2

Source : Model results using Eviews



Form (2) response functions for both of agricultural output, agricultural investment, and agricultural exports within 10 years
Source: Model results using Eviews.

g. Variance of the prediction error fragmentation Analysis (Sheikhi**, 2011):**

Analysis of the prediction error contrast aims to determine the extent to which it contributes to mathematical error variation, and the prediction error variation for a certain period can be written by indicating the variation of the error of each variable individually, and to know the weight or share ratio of each variation, we divide this variation to the variation of the overall forecast error. The importance of this test is that it demonstrates the impact of any sudden change of shock on each search variable on all other variables.

1. Variance of the error fragmentation Analysis for agricultural output:

Table (12) data indicate an analysis of the fragmentation of the variation of the forecast error of agricultural output, and shows that the standard forecasting error (S.E) reached in the first period about 27%, and then increased to 40% during the end of the period, as the error of agricultural output was explained by the change in the same variable in the first period 100% and decreased gradually to reach 63.4%. By dismantling the variation of the agricultural GDP variable in the short term, most of the variation in the forecast error for the agricultural output variable is due to shocks in the same variable of 100% in the first year. In the second year, agricultural output, agricultural investment and agricultural exports the variance is found to be about 72.4%, 26.8%, and 0.8%, respectively. The contribution rate of agricultural output variation declines in the long term to 63.4% in the tenth year, and the contribution of agricultural investment variation and exports by about 30%, 6.6%. A slight increase is observed in investment variation compared to export variation.

2. Analysis of the fragmentation of error variation for agricultural investment:

The data in the same table indicate that the analysis of the fragmentation of the variation of the forecast error for agricultural investment, show that the standard forecasting line in the first period was about 13.5%, and then increased to reach 24% during the end of the period, and the difference in error for agricultural investment explained by the change in the same variable in the first period towards 74.7%, agricultural output varied by 25.3%., and by dismantling the variation of the agricultural investment variable for the second year, agricultural investment, agricultural output and agricultural exports varied by 56.6%, 34.3%, 0.1%, respectively. The contribution rate of agricultural investment variation declines in the long term to 41.1% in the tenth year, and the contribution of the variation of agricultural output and agricultural exports by about 52%, 6.9%.

3. Analysis of the fragmentation of error variation for agricultural exports:

The data of the same table indicate that the analysis of the fragmentation of the variation of the forecast error for agricultural exports, show that the standard forecast line in the first period was about 3.9%, and then increased to 5.9% during the end of the period, and the error variation of agricultural exports explained by the change in the same variable in the first period about 30.5%, Agricultural output and agricultural investment varied by 69.4%, 0.1%, and by analyzing a variable variation in agricultural exports for the second year, agricultural exports, agricultural output and agricultural investment varied by about 20.2%, 75%, and 4.8%, respectively. The contribution rate of agricultural export variation declines in the long term to reach in the tenth year to 19.5%, and the contribution of the variation of agricultural output and agricultural investment by about 64.6%, 15.8%.

Table (12) Results of variation analysis of forecasting error for agricultural output, agricultural investment, and agricultural exports

Period	Variance Decomposition of DGDP2				Variance Decomposition of DIN2				Variance Decomposition of DEX2			
	S.E.	**DGDP2**	**DIN2**	**DEX2**	**S.E.**	**DGDP2**	**DIN2**	**DEX2**	**S.E.**	**DGDP2**	**DIN2**	**DEX2**
1	27.0	100.0	0.0	0.0	13.5	25.3	74.7	0.0	3.9	69.4	0.1	30.5
2	34.4	72.4	26.8	0.8	20.2	56.6	43.3	0.1	5.3	75.0	4.8	20.2
3	35.9	69.2	26.0	4.9	21.0	58.7	40.9	0.4	5.4	73.1	7.3	19.6
4	36.4	67.8	25.2	7.0	21.9	57.4	37.8	4.9	5.8	67.2	13.0	19.8
5	37.3	67.9	25.3	6.8	22.4	56.3	36.1	7.5	5.8	66.1	13.8	20.1
6	38.9	65.7	28.0	6.3	22.8	55.2	37.3	7.5	5.8	65.8	14.2	20.0
7	39.4	64.2	29.5	6.3	23.6	53.3	39.7	7.0	5.9	64.8	15.5	19.7
8	39.5	63.7	29.7	6.6	23.9	52.2	41.0	6.9	5.9	64.6	15.8	19.6
9	39.7	63.6	29.7	6.7	24.0	51.9	41.1	6.9	5.9	64.6	15.8	19.6
10	40.0	63.4	30.0	6.6	24.0	52.0	41.1	6.9	5.9	64.6	15.8	19.5
Cholesky Ordering: DGDP2 DEX2 DINV2												

Source : Model results using Eviews.

h. Granger Causality Test (Granger (1988)**)**

Granger's model is used in most time series studies and the causal relationship between economic variables called the change in current and past values of a variable that causes change in another variable (C.W.Granger,1988), This test is used to test the null hypothesis that there is no causal relationship between variables. Granger assumes the absence of causal relationships between variables, and each internal research variable has been tested as an external variable.

Table (13) data indicate the results of causal testing, where causal relationships are found to be directed from agricultural output to both agricultural investments at a moral level of 0. 01, agricultural exports at a significant level of 0.1, this means that there is a 99%, 90% probability of changes in agricultural output preceding changes in each of the previously indicated variables respectively. This means accepting the alternative hypothesis and rejecting zero because of the causal relationship between variables. Table (14) also refers to the results of the WALD test of the significant for each other internally slowed variables in the same equation. The significant of agricultural output is shown during the two periods of slowing down.

The data in the same table also indicates that there is a causal relationship between agricultural investment and agricultural output at a significant level of 0.05%, while there is no causal relationship between agricultural exports and both agricultural output and agricultural investment, which means accepting zero hypothesis .

Results:

- GDP growth was estimated at 11.6% during the period (2005/2006-2019/2020), and the growth rate of the productive and service sectors compared to the commodity sector increased, with growth ranging from 12.4%, 12.4%, 10.7%, respectively. The agricultural sector grew by 10.4% for the same period.

Table (13) Causal test results according to Granger Causality

VAR Granger Causality/Block Exogeneity Wald Tests											
Sample: 1995 2019											
Included observations: 21											
Dependent variable: DGDP2				Dependent variable: DINV2				Dependent variable: DEX2			
Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
DINV2	10.48	2.00	0.005	DGDP2	6.29	2.00	0.04	DGDP2	4.36	2.00	0.11
DEX2	5.25	2.00	0.07	DEX2	1.92	2.00	0.38	DINV2	2.75	2.00	0.25
All	12.48	4.00	0.01	All	11.72	4.00	0.02	All	4.92	4.00	0.30

Source : Model results using Eviews.

Table (14) Causality test results according to Granger Causality

VAR Lag Exclusion Wald Tests				
Sample: 1995 2019				
Included observations: 21				
Chi-squared test statistics for lag exclusion:				
Numbers in [ ] are p-values				
	DGDP2	DINV2	DEX2	Joint
Lag 1	12.23222	24.54622	17.40449	110.4879
	[0.006629]	[1.92e-05]	[0.000583]	[0.000000]
Lag 2	9.476283	4.48487	8.671864	57.31487
	[0.023585]	[0.213644]	[0.033987]	[4.40e-09]
df	3	3	3	9

Source : Model results using Eviews.

- Growth rates for the most important determinants of agricultural output, namely agricultural investment, agricultural exports, and the value of agricultural production by about 12.1%, 7.4%, 5.8%. The growth rate of agricultural employment was shown to be stable at 0.52%. It also shows that the growth rate of agricultural loans has declined to about 4%.
- By studying the dual logarithmic relationship between agricultural output and its most important determinants, it shows that both agricultural investment and agricultural exports are compatible with economic logic and statistical moral. There is a statistically significant direct relationship between agricultural output and both agricultural investment and agricultural exports. The value of Derben-Watson was estimated at 1.76. The relative impact of both agricultural investment and agricultural exports was estimated at 2.4%, 5.7%. This means that the 10% increase in agricultural investment and exports is accompanied by an increase in agricultural output of about 2.4%, 5.7%, respectively.
- By identifying the most important variables affecting agricultural GDP, namely agricultural investment and agricultural exports, a self-regression-oriented model (VAR) has been applied by calming the series at the second difference and at two slowing periods.
- By studying the integration relationship, it shows that there is a common integration relationship between the three variables, thereby accepting the alternative hypothesis that there is a tendency for the common integration of variables, and that there is a complementary relationship.
- By estimating the VAR model, the agricultural output equation showed that the GDP of two previous periods and two periods of slowing, and the late values of agricultural investment and agricultural exports have an impact on GDP this year by about 55%. The significance of the agricultural output parameters for the initial slowdown period has been shown, the significance of the agricultural investment parameters of the slowing down and the significance of agricultural exports for the second slowing period has been shown as well as the significance of the fixed limit. The statistical significance of the VAR significance has been shown in accordance with the auto-media standard of both SC, AIC.
- The agricultural investment equation also showed the significance of values for two previous periods and two periods of slowing, and the late values of agricultural output and exports have an impact on agricultural investment in the current year by about 69%. The significance of agricultural investment parameters and agricultural output for the initial slowdown period has been shown, and it shown that there is a insignificance of the rest of the model parameters.
- The equation of agricultural exports shows the significance of previous and late values and two periods of slowing down; the late values of agricultural output and investment show their impact on agricultural exports in the current year by about 57%. The significance of agricultural export parameters for the second slowdown period was shown, as well as the insignificance of the rest of the model parameters. The statistical morale of the VAR model has been shown.
- The validity of the VAR Vector Auto-Regression model has been confirmed by several tests such as VAR model stability test to ensure the stability of the model, the self-association test of VAR model residuals to ensure that there is no self-association between residuals of the time series, the natural distribution test of VAR model for equations residuals to ensure the natural distribution of the series of residuals and the adoption of the zero hypothesis i.e. that all residuals follow the natural distribution.
- By analyzing the response to agricultural output, agricultural investment and agricultural exports, the relationship between the short and long-term response is swinging between an inverse and direct relationship.
- By analyzing the fragmentation of the error variation of agricultural output showed that the standard forecasting error (S.E) in the first period was about 27%, then increased to reach 40% during the end of the period, and the error variation of agricultural output explained by the change in the same variable in the first period 100% and gradually declined to 63.4%. By dismantling the variation of the agricultural GDP variable in the short term, most of the variation in the forecast error for the agricultural output variable is due to shocks in the same variable of 100% in the first year. In the second year, the variance of agricultural output, agricultural investment, and agricultural exports is about 72.4%, 26.8%, and 0.8%, respectively. The contribution rate of agricultural output variation declines in the long term to 63.4% in the tenth year, and the contribution of agricultural investment variation and agricultural exports by

about 30%, 6.6%. A slight increase in investment variation compared to export variations is observed.

- By analyzing the fragmentation of the error variation of agricultural investment showed that the standard forecasting error in the first period was about 13.5%, and then increased to reach 24% during the end of the period, as the error for agricultural investment explained by the change in the same variable in the first period was about 74.7%, and the variation of agricultural output reached 25.3%. By dismantling the variation of the agricultural investment variable for the second year, agricultural investment, agricultural output, and agricultural exports was about 56.6%, 34.3%, and 0.1%, respectively. The contribution rate of agricultural investment variation declined in the long term until it reached 41.1% in the tenth year, and the contribution of the variation of agricultural output and agricultural exports is about 52%, 6.9% respectively.
- By analyzing the fragmentation of the error variation of agricultural exports showed that the standard forecast error in the first period was about 3.9%, and then increased to 5.9% during the end of the period, as the error for agricultural exports explained by the change in the same variable in the first period was about 30.5%, and the variation of agricultural output and agricultural investment reached 69.4%, 0.1%. Analyzing the variation in agricultural export variables for the second year, agricultural exports, agricultural output, and agricultural investment was about 20.2%, 75%, and 4.8%, respectively. The contribution share of agricultural export variation declines in the long term until it reached at the tenth year about 19.5%, and the contribution of the variation of agricultural output and investment by about 64.6%, 15.8%.
- The results of the causal test indicate that there are causal relationships that tend from agricultural output to both agricultural investment at a significant level of 0.01, and agricultural exports at a significant level of 0.1, meaning that there is a probability 99%, 90% of changes in agricultural output preceding changes in each of the previously indicated variables respectively. This means accepting the alternative hypothesis and rejecting zero because of the causal relationship between variables. The results of the WALD test also indicate the significant of each of the other internal variables in the same equation. Where the significant of agricultural output is shown during the two periods of slowing down. It also showed the causal relationship between agricultural investment and agricultural output at a significant level of 0.05%, while there is no causal relationship between agricultural exports and both agricultural output and agricultural investment, which means accepting the zero hypoth.

The study therefore recommends that:

1. Intensifying agricultural investment to achieve the objectives of the desired agricultural development strategy, which seeks to achieve an estimated growth rate of 3.2%, this is by improving the investment climate, by increasing the effectiveness and development of the performance of the Ministry of Investment, Planning, Ministry of Agriculture and Ministry of Scientific Research in the revitalization and development of agricultural investments.
2. Work to increase the volume of agricultural exports of horticultural crops and food products, in addition to expanding the current markets and opening new markets, and improving product quality to ease export restrictions, and here comes the role of Ministry of Commerce represented in the organizations of trade representatives abroad as one of the organizations responsible for the study of foreign markets, as well as the Ministry of Agriculture and Scientific Research.

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