15 *Egypt. J. Agron.* **Vol. 42**, No. 2, pp. 197-207 (2020)

Egyptian Journal of Agronomy
http://agro.journals.ekb.eg/

The Role of Greenhouses in Filling Trade Gap of Tomato Crop in Saudi Arabia

Hafsa Ali Morci[1, 2], Nagat Ahmed Elmulthum[1, 3]#, Maha Lutfi Hadid[1, 4]
[1]Agribusiness and Consumer Sciences Department, College of Agriculture and Food Science, King Faisal University, Hufof, Saudi Arabia; [2]Agricultural Economics Department, College of Agriculture, Ain Shams University, Cairo, Egypt; [3]College of Agricultural Sciences, Gezira University, Wad Medani, Sudan; [4]College of Agriculture, Damascus University, Damascus, Syria.

USING, time series data, this research aimed at studying the role of greenhouses planted with tomatoes in reducing the import trade gap in Saudi Arabia by forecasting the impact of the change in the area of greenhouses of tomatoes on imports and total production in the Kingdom of Saudi Arabia. The study adopted Piecewise Linear Regression, ordinary least square and simultaneous multi-equation models, using Seemingly Unrelated Regression model. The results of the study indicated that the area and production of tomatoes in greenhouses showed a decreasing trend during the study period. As a result, there was an import trade gap for tomato crops estimated at 171.1 thousand tons on average for the study period, which represents about 42.2% of the average total tomato production. The most important determinants of the production of tomatoes in greenhouses include the area of greenhouses planted with tomatoes, one year lagged tomato price, and the value of medium-term loans allocated to greenhouses production. The study showed that the effect of temperature change on tomato production is more significant than carbon dioxide emissions. The study estimated forecasted reduction in the Kingdom's imports of tomatoes by 98% if the area of greenhouses is doubled. Hence, to reduce trade deficit of tomatoes and convert the deficit into a trade surplus, the study recommended horizontal expansion in greenhouses planted with tomatoes.

Keywords: Forecasting, Piecewise Linear Regression, Saudi Arabia, Simultaneous equations models, Tomato.

Introduction

Saudi Arabia suffers from a noticeable rise in temperature and severe water scarcity. These factors, in turn, affect agricultural production. The kingdom imports most food commodities (cereals, red meat, vegetables and fruits) in an attempt to achieve food security in its domestic market. Saudi Arabia was the 20th largest importer of agricultural products between 2000 and 2016, while the name of the Kingdom was absent among the main exporters of agricultural products for the same period of time (Agriculture Organization of the United Nations, 2004). With climate change, increasing population and rising food prices, it is expected that there will be negative impacts on the food security situation. It was therefore necessary to develop strategies and policies to address these variables, including water distribution plans, land use patterns, food trade, post-harvest treatments, food prices and safety. There are many land and water saving techniques to increase the productivity per unit area and the efficiency of the water used for irrigation, among them hydroponics, protected agriculture and others (Arab Organization for Agricultural Development, 2017).

#Corresponding author email: nelmultham@kfu.edu.sa
Received 5/4/ 2020; Accepted 19/8/ 2020
DOI: 10.21608/agro.2020.27271.1211

Protected agriculture is one of modern technologies for agricultural production in terms of the usage of scientific procedures and technological equipment that safeguard the availability of climatic conditions appropriate for off season crop growth (Mahmood, 2017). Globally greenhouse vegetables production could help in meeting demand for healthy diet by bridging the gap between supply and demand for vegetables. (Dias et al., 2017). Greenhouse environment can be controlled and modified to accommodate the growth of different types of plants. A group of climatic variables, including radiation, temperature, humidity and carbon dioxide concentration, affecting development and plant growth, characterizes the greenhouse environment (Romantchik et al., 2017). Horticultural greenhouses production has expanded greatly in several countries over the last two decades. Protected farming offers an excellent opportunity to yield high quality products and assured consistent supply in large quantities. The principal objective of protective cultivation is to acquire the natural required environment for different crops to achieve optimal productivity by enhancing yields, improving quality, extending harvesting period and expanding production area (Benli, 2013).

In Saudi Arabia, the results of many researches indicated that Climate change, represented by rising temperature and decreasing sources and quality of water, has a significant negative impact on agriculture productivity and drinking water supply in Saudi Arabia. Therefore, greenhouse technology is the sustainable resolution in Saudi Arabia (Alkolibi, 2002; Chowdhury et al., 2013; DeNicola et al., 2015; Chowdhury et al., 2016). In general, the Protected Agriculture presents a sustainable resolution for food production in hot and arid environments (Ghani et al., 2019). The tomato crop is an important agricultural commodity for the consumer as it contains fats, proteins and carbohydrates as well as vitamins and organic acids. As well as containing the necessary elements of the body, especially calcium, magnesium and potassium. It is also of medical importance and many industrial uses such as making paste sauce, juice and others (Jassam, 2017).

Based on Fias et al. (2018) a significant increase in the area and production of vegetables according to greenhouse technology in Saudi Arabia was realized during the period 2010-2013 especially for tomato and cucumber. The hydroponic technique in the greenhouse resulted in a yield increase from 5 tons to 200 tons for each planted acre. Alrwis (2008) results indicated a significant difference between the average of area, production and productivity of protected and open field cultivation of tomato crop in Saudi Arabia. The annual increase was estimated at 17.8% and 16.4% in cultivated area and production, respectively for protected compared to open field cultivation. Accordingly, the research recommended technical training on greenhouses production for workers to enhance production and take advantage of marketing opportunities to increase sales and profits and provide loans for the expansion of greenhouses in various production areas in the Kingdom of Saudi Arabia.

Vegetables grown in greenhouses varied in Saudi Arabia, however, tomato crop ranked first in terms of area and production, followed by cucumber crop. The average percentage of area and production of tomatoes during the period 2009-2018 accounted for 42.4%, 43.7%, respectively of the total area and production of vegetables cultivated in greenhouses. Despite the importance of the use of greenhouse technology for vegetable production in the Kingdom of Saudi Arabia, the use of this technology is declining. According to data's Saudi General Authority for Statistics the total area of vegetables in greenhouses decreased from 9672 hectares in 2009 to only 3265 hectares in 2018. The total vegetable production in greenhouses decreased from 778.82 thousand tons in 2009 to only 260.01 thousand tons in 2018. Thus, the tomato crop also decreased its area and production in greenhouses from 4204 hectares, 351.6 thousand tons, respectively in 2009 to about 1253 hectares, 101.7 thousand tons, respectively in 2018. At the same time, the amount and value of tomato imports in the Kingdom increased to about 193.7 thousand tons, $ 148.9 million, respectively in 2018. While the amount and value of exports of tomatoes in the Kingdom estimated at only 16.3 thousand tons, 5.4 million dollars, respectively for the same year. This represents a trade deficit (import trade gap) for the tomato crop. Thus, the focus of the study lies in the answer to the question on whether the re-expansion of the area of tomatoes in greenhouses bridges this trade gap. The research aims to study the role of greenhouses planted with tomatoes in reducing the import trade gap of tomatoes in Saudi Arabia, by forecasting the impact of the change in the area of greenhouses of tomatoes on the total tomato production and the total imports of tomato in the Kingdom of Saudi Arabia under suggested different scenarios.

Methods

Data

The research was based on time series data published electronically in Food and Agriculture Organization database and in Saudi government institutions including the General Authority for Statistics and the Agricultural Development Fund during the period 2009-2018. It worth noting that protected agriculture started in Saudi Arabia more than fifty years ago (Greenhouses Evidence, 2006). Where, the first license to establish greenhouses project was issued in the Kingdom in 1968. However, the study period 2009-2018, was constrained by the lack of separated data on production and area of greenhouses from total cultivated area before 2009.

Source	Variable
http://www.fao.org/faostat/en/#data/TP	* (Saudi total imports of tomato in 000 tons)
https://www.stats.gov.sa/en/46	(Saudi total production of tomato (open field and greenhouse production)in 000 tons)
http://www.fao.org/faostat/en/#data/TP	(Import price of tomato $/ton)
https://www.stats.gov.sa/en/46	(Size of population in Saudi Arabia (million))
Gross domestic product in constant 2010 prices (billion Saudi Riyals) https://www.stats.gov.sa/en/46	(Gross domestic product in constant 2010 prices (billion Saudi Riyals))
dummy variable (period 2009-2013=1, (period 2014-2018=0)	(Dummy variable)
https://www.stats.gov.sa/en/46	*(Greenhouse tomato production in 000 tons)
http://www.fao.org/faostat/en/#data/PP	(Lagged farm gate tomato price SR/ton)
https://www.stats.gov.sa/en/46	(Area of greenhouse tomato production (hectare))
https://adf.gov.sa/ar/FundLibrary/YearlyReport/Pages/default.aspx	(The value of medium-term loans provided by the Agricultural Development Fund for the greenhouse area (billion Saudi Riyals)
https://www.stats.gov.sa/en/46	(Area of greenhouses planted with crops other than tomatoes (hectare)
http://www.fao.org/faostat/en/#data/GT	CO_2 (emissions from the agricultural sector as an indicator of global warming (kilo tons)
http://www.fao.org/faostat/en/#data/ET	(The amount of temperature change for the meteorological year as an indicator of climate change (Celsius)

The model

The study adopted Piecewise Linear Regression using dummy variable and ordinary least square method for estimation of general trend for some of the research variables. The research adopted the method of simultaneous multi-equation models to study the mutual effect between model variables and avoid econometrics problems (Henneberry & Khan, 2000). The simultaneous equation model is suitable for analyzing the impact of the area of greenhouses of tomatoes on the total imports of tomatoes, greenhouse tomato production and total production of tomato (open field and greenhouse). The model consists of the following two behavioral equations:

$$IMPQ_i = f\left(TPRO_{i,} IMPP_{i,} POP_{i,} GDP_{i,} D_{i,}\right) \quad \dots(1)$$

$$GHP_i = f\left(PP_{i-1,} GHA_{i,} MRL_{i,} D_{i,} OGHA_{i,} CO2_{i,} TEM_{i,}\right) \quad \dots(2)$$

The identification of the simultaneous equation model in accordance with the requirement of rank condition is an important step for appropriate results which must be achieved in each equation separately (Nugroho, 2017). It clear from the simultaneous equation model that all the equations are over identified, where, the omitted variables are more than the number of endogenous variables minus one. However, due to the implicit relationship within the model, studying the impact of the area of greenhouses of tomatoes on the Kingdom›s total imports of tomatoes through its impact on the total production of tomatoes in the Kingdom, seemingly Unrelated Regression Method (SUR) was adopted in estimating the simultaneous model using EVIEWS statistical package. Different policy scenarios were considered for the prediction of the effect of the change in the area of greenhouses of tomatoes on the total imports of tomatoes through the impact on the total production of tomatoes in the Kingdom of Saudi Arabia.

Following AL Karawi & Al Badri (2018), the predictability of the estimated simultaneous model was tested using the following parameters:

1- Comparison between actual and estimated values for every endogenous variable in the simultaneous model, where, the smaller the gap the better predictability of the model. According to Pant & Starbuck (1990), this method is not sufficient for testing predictability for the modest relationship with the accuracy of prediction.

2- Estimation of the coefficient of inequality Theil'μ-statistic (Theil, 1966) using the following equation:

$$\mu = \sqrt{1/N\sum_{t=1}^{N}(\hat{Y}_t - Y_t)^2} \Bigg/ \sqrt{1/N\sum_{t=1}^{N}(\hat{Y}_t)^2} + \sqrt{1/N\sum_{t=1}^{N}(Y_t)^2} \quad \dots(3)$$

Where, μ denotes Theil statistic, N denotes the number of observations, Y_t and $\hat{Y}_t$ denote actual and estimated values of the endogenous variable, respectively. The lower the value of Theil statistic, approaching zero, the more efficient the predictability of model.

Results and Discussions

The relative importance of greenhouse tomato area and production in Saudi Arabia during the period 2009-2018

The area of greenhouses planted with tomatoes amounted to about 4204 ha in 2009, representing 27.8% of the total area of tomatoes in the Kingdom and fluctuated slightly until it reached about 3947 ha in 2013 (Table 1). A sharp decline in area by a rate of decrease of 70.9% was observed in 2014 compared to 2013 amounting to 1149 in 2014, representing only 9.8% of total tomato area in the Kingdom of Saudi Arabia. The decline in area has not improved significantly reaching about 68.3% in 2018.The drop in the area of greenhouses planted with tomatoes was reflected in their production, where the contribution of greenhouse tomato production in the Kingdom reached about 64.8% in 2013 and then decreased to 34.3% in 2014 to reach 32.6% in 2018. In an attempt to find out the reasons for the reduction of tomato area, some experts and specialists from Ministry of Agriculture, and related departments at the college of agriculture and food sciences at King Faisal University were interviewed. Based on specialists' arguments reduction of area is attributed to some factors including, high maintenance cost, water sanity related problems, and shortage of agricultural and extension services.

TABLE 1. Total and greenhouse production and area of tomato in the kingdom of Saudi Arabia, 2009-2018 (area in 000ha, production in 000tons).

Year	Total		Greenhouse			
	Area	Production	Area	%	Production	%
2009	15127	542.6	4204	27.8	351.6	64.8
2010	15374	492.4	3848	25.0	300.4	61.0
2011	16422	520.0	3842	23.4	305.8	58.8
2012	17210	459.1	4027	23.4	323.0	70.3
2013	19652	544.5	3947	20.1	320.2	58.8
2014	11683	280.3	1149	9.8	96.1	34.3
2015	12992	288.6	1176	9.1	91.8	31.8
2016	13153	305.2	1204	9.2	97.7	32.0
2017	13317	306.4	1233	9.3	99.3	32.4
2018	13428	312.3	1253	9.3	101.7	32.6

Source: Statistical Yearbook, General Authority for Statistics, Saudi Arabia, different versions.

It is clear from the above results that there is a clear difference in the area and production of tomato grown in greenhouses between the period (2009-3013) and the period (2014-2018). A sharp decline in the area and production of tomato planted in greenhouses, was observed in 2013. A dummy variable was used to reflect the effect of the difference between the two periods when estimating the time trend equation for greenhouse area and production of tomato, using Piecewise Linear Regression, where the fifth year represents the Knot Value, using the following equation:

$$Y_i = \alpha + \beta_1 X_i + \beta_2 (X_i - X^*) D_i + e_i \quad ..(4)$$

Where: Y_i greenhouse tomato production/area, X_i time in years, X* fifth year equal 5, D_i Dummy Variable (=1 if $X_i \geq 5$, 0 if $X_i \leq 5$), e_i disturbance term, α, β_1, β_2 model coefficients.

Estimating Equation 3, for greenhouse tomato production and area, applying ordinary least squares method using Eviews Statistical package and data in Table 1, the following results of time trend models were obtained.

A- *Greenhouse tomato area*

$$Y_i = 5247.5 - 464.6X_i + 103.7(X_i - 5)D_i$$

(3.9)* (-2.6)* (0.29)-

= 0.76 F = 11.1* N = 10$\bar{R}^2$

where,

$Y_i = 4729 - 360.9X_i$ if D_i = 1 (in 2009-2013)

$Y_i = 5247.5 - 464.6X_i$ if D_i = 0 (in 2014-2018)

From the above results, time trend model for greenhouse tomato area is significant at 5% level. Seventy six percent of the variability in area is due to the time. Results indicated backward trend in area during the study period, however, the period (2009-2013 is characterized by insignificant decrease of 360.9 hectares, compared to period 2014-2018) which showed significant decrease of 464.6 hectares. Hence, based on the above results there is not only a sharp decline in the area of tomatoes grown in greenhouses in the second period, but also that the annual decrease in the area in the second period exceeds that of the first period by 103.7 hectares

B- *Greenhouse Tomato production*

$$Y_i = 419.5 - 37.04X_i + 7.08(X_i - 5)D_i$$

(4.0)* (-2.7)* (0.25)-

= 0.77 F = 11.2* N = 10$\bar{R}^2$

where,

$Y_i = 384.1 - 29.96X_i$ if D_i = 1 (in 2009-2013)

$Y_i = 419.5 - 37.04X_i$ if D_i = 0 (in 2014-2018)

The above results, time trend model for greenhouse tomato production proved significance at 5% level. Seventy seven percent of the variability in tomato production is explained by time variable. Results indicated decreasing trend in production during the study period, however, the period (2009-2013) is characterized by insignificant reduction of 29.9 thousand tons, compared to period 2014-2018) which indicated significant decrease of 37 thousand tons. Hence, based on the above results the drop in production of tomatoes grown in greenhouses in the subsequent period exceeded that of the first period by 7 thousand tons.

Trade gap of tomato crop in Saudi Arabia

Table 2 shows that the quantity and value of tomato imports in Saudi Arabia far exceeded the quantity and value of tomato exports during the study period, 2009-2018. The average quantity and value of tomato imports in the Kingdom during the study period was 181.7 thousand tons, 89.7 million dollars, respectively, while the average amount and value of the Kingdom's exports of tomatoes during the same period amounted to 10.7 thousand tons, 3.5 million dollars, respectively. The above results proved a trade deficit or an import trade gap for the tomato crop in the Kingdom of Saudi Arabia estimated at 171.1 thousand tons on average for the period under consideration, representing around 42.2% of the average production of tomatoes (open field and protected) in the Kingdom of about 405.2 thousand tons for the same period.

As a result, the role of greenhouses in tomato production in the Kingdom of Saudi Arabia has declined sharply and open field production has not compensated the decline in production, resulting in trade gap during the study period. Hence, a logical question arises. Will further investment in greenhouses planted with tomatoes in the Kingdom of Saudi Arabia emphasizing horizontal expansion will reduce the trade deficit of tomatoes and eventually turn it into surplus. The next part of the research is concerned with answering this question by constructing and estimating a model that illustrates the relationship between study variables and then predicting them under different scenarios emphasizing horizontal agricultural expansion for tomatoes grown in greenhouses.

Estimation of the simultaneous model

Estimating Equations 1 and 2 applying seemingly unrelated regression method (SUR), excluding statistically insignificant variables and variables that proved economically not logical. The best results are shown in Table 3.

The results in Table 3 indicated the statistical significance of the independent variables included in the estimated model at 5% level. First order autocorrelation between successive values of the disturbance term was excluded for all estimated equations as indicated by Durbin-Watson statistics (Dayoub, 2015) (Table 4).

Table 3 depicts results of estimating Equation 1. From the table seventy-three percent of the variation in of the variation in the quantity of tomato imports in Saudi Arabia is due to the explanatory variables included in the equation. The amount of tomato imports is inversely related to total tomato production and import price while positively related to population size, and gross domestic product. This is consistent with economic logic, where, with the increase of total tomato production (open and protected) in Saudi Arabia by about 1000 tons, the amount of imports of tomatoes decreases by about 407 tons. The amount of imports of tomatoes decreases by about 45 tons in the case of an increase in the import price of tomatoes by about $ 1/ton. Results indicated that, increasing the population by about 1 million people will increase tomato imports by 9.5 thousand tons. However, there is a statistically significant difference for imports of tomato between 2009-2013 and 2014-2018, where, amount of imports in the first period exceeds the second period by around 63.8 thousand tons.

TABLE 2. Trade gap of tomato crop in the kingdom of Saudi Arabia, 2009-2018 (quantity in 000tons, value in $million).

Year	Imports		Exports		Trade gap	
	Quantity	Value	Quantity	Value	Quantity	Value
2009	190.5	62.0	4.2	1.8	-186.3	-60.2
2010	207.6	81.6	5.7	1.9	-201.9	-79.7
2011	190.4	61.8	15.4	4.3	-175.0	-57.5
2012	205.6	71.0	5.7	2.0	-199.8	-69.0
2013	135.5	59.0	6.6	2.2	-128.9	-56.8
2014	167.4	74.8	5.9	1.9	-161.5	-72.9
2015	183.0	93.3	15.9	5.6	-167.1	-87.7
2016	160.3	113.6	15.9	5.1	-144.4	-108.5
2017	184.1	130.7	15.0	5.0	-169.0	-125.7
2018	193.1	148.9	16.3	5.4	-176.8	-143.5
Average	181.7	89.7	10.7	3.5	-171.1	-86.1

Source: Electronic database of the Food and Agriculture Organization (FAO).

TABLE 3. Results of the estimated simultaneous model.

Equation No.	Explanatory variables	Coefficients	t-Stati.	Probability	$\bar{R}^2$	D.W
(1)	α	607.9	*5.53	0.0006		
	$TPRO_i$	-0.407	-*3.2	0.012	0.73	1.74
	$IMPP_i$	-0.045	-*2.28	0.052		
	POP_i	9.511	*2.87	0.021		
	GDP_i	0.0001	*2.46	0.039		
	D_i	63.83	*2.18	0.051		
(2)	α	158.39	*2.77	0.024		
	PP_{i-1}	0.0058	*2.93	0.049	0.98	1.84
	$GHA_{i,}$	0.0803	*37.72	0.0000		
	$MRL_{i,}$	0.0469	*2.27	0.050		
	$CO2_{i,}$	-0.0002	-2.16	0.062		
	TEMi	-10.322	-*5.24	0.0008		

* Indicate to statistical significance at 5% level.

Source: Author's calculation.

TABLE 4. Autocorrelation test for each equation in the simultaneous model.

Equation number	$IMPQ_i$ (1)	GHP_i (2)
DW	1.74	1.84
K	5	5
dL	0.150	0.150
dU	2.690	2.690
Hypothesis of DW test	H_0: non autocorrelation in residual H_1: positive first-order autocorrelation	
Result	(4 – DW) > dL Assent H_0	

DW: The observed value of the Durbin-Watson test statistic.

K: The number of coefficients excluding the intercept.

dL: The tabulated lower bound at the 5% level of significance, N=10.

dU: The tabulated upper bound at the 5% level of significance, N=10.

Source: Author's calculation based on the results in Table 3.

From the results of the second equation in Table 3 it is clear that about 98% of the variation in the production of greenhouses from tomatoes in Saudi Arabia is due to the independent variables included in the equation. It turns out that the most significant effect on tomato production in greenhouses is due to area of greenhouses planted with tomatoes, where the increase in area of greenhouses planted with tomatoes by about 1 hectare increases the production of tomatoes in greenhouses by about 80.3 tons. While an increase in the farm price of tomatoes above the previous year price by about 1000 riyals/ton resulted in an increase of the production of tomatoes in greenhouses by 5.8 tons. The importance of credit facilitation is evidenced by an increase in greenhouses tomato production by 46.9 tons in response to an increase in the value of medium-term loans provided by the Agricultural Development Fund for greenhouses agriculture production by about 1 million riyals. While climate factors negatively affect the production of greenhouse tomatoes, where the production of greenhouse tomatoes will drop by 0.2 and 10322 tons in response to an increase of CO_2 emissions from the agricultural sector by about one kiloton and the temperature by one degree Celsius, respectively. These results indicated that change in temperature has more impact that is significant on greenhouses tomato production compared to carbon dioxide emissions.

Forecasting

It is worth mentioning that before using the simultaneous equation model to predict the endogenous variables, its predictability should be tested as follows:

A- Next Figs. 1 and 2 show that the gap between actual and estimated values for each endogenous variable in the simultaneous model is very small, that reflecting high predictability.

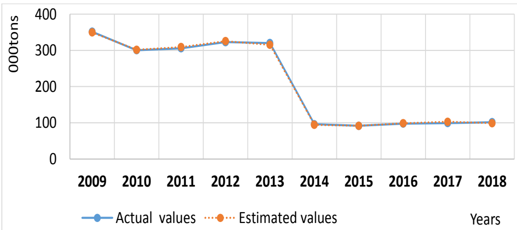

Fig. 1. Actual and estimated values of tomato greenhouse production.

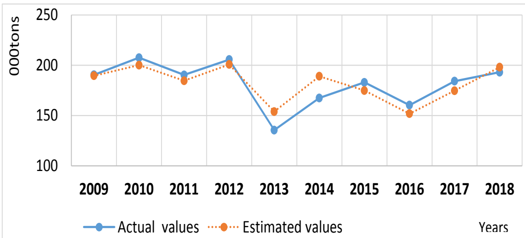

Fig. 2. Actual and estimated values of tomato imports quantity.

B- According to the calculated value of the Theil'-statistic, which was about 0.0296 and 0.0055 for the first and second equations respectively, it turns out that it is less than one and approaches zero for each equation, reflecting the high predictability of the model.

After confirming the predictability of the model, it can be used to forecast future values of endogenous variables. Due to the difference in the area and production of tomato produced in greenhouses in Saudi Arabia between the periods (2009-2013) (2014-2018) where the area decreased in the second period by about 330% compared to the first period, the study proposed four different scenarios for forecasting as follows:

First Scenario: It is assumed that the area of the greenhouses planted with tomatoes in the second period (2014-2018) is stable at the lowest value during this period, which amounted to about 1149 hectares in 2014.

Second scenario: It is assumed that the decrease in the area of greenhouses planted with tomatoes during the second period (2014-2018) will continue and halve to about 575 hectares.

Third scenario: The area of greenhouses planted with tomatoes is supposed to improve as it was in the first period (2009-2013) reaching the maximum area during the period, which amounted to about 4027 hectares in 2012.

Fourth scenario: It is assumed that the area of greenhouses planted with tomatoes will continue to improve as in the first period (2009-2013) and doubled (100%) to about 8054 hectares.

Table 5 shows forecasting results of the impact of changing the area of greenhouses planted with tomatoes according to proposed scenarios on the production of greenhouses, total production in the Kingdom and imports of tomatoes using the estimated simultaneous equations model.

It is clear that in the case of the first scenario, the reduction of greenhouses tomato area by 56% from the average area during the period 2009-2018, would result in a decrease in the average tomato production in greenhouses to about 93.1 thousand tons, compared to the actual average of 208.8 thousand tons. In addition to, a decrease in the total tomato production in the Kingdom by about 29%, leading to an increase in the Kingdom's imports of tomatoes by about 26%. However, in the case of the second scenario, specifically, the decrease in the area of greenhouses planted with tomatoes by 78% from the actual average during the study period resulted, in reduction in the average production of tomatoes in greenhouses by about 77%. Further, the total production of tomatoes in the Kingdom decreased by about 40%, leading to an increase in the Kingdom's imports of tomatoes by 36%. It is clear from the above that if the current area and production of greenhouses from tomatoes are maintained, the quantity of imports will increase. A similar result is expected in case of reduction in area of greenhouses planted with tomato.

TABLE 5. Results of forecasting scenarios using the estimated simultaneous model.

Variables		Forecasting scenarios			
		First	Second	Third	Fourth
Greenhouses area	average of actual value	2588	2588	2588	2588
	Predicted value	1149	575	4027	8054
	Change rate %	-56	-78	56	211
Greenhouses production	average of actual value	208.76	208.76	208.76	208.76
	Predicted value	93.14	47.03	324.34	647.84
	Change rate %	-55	-77	55	210
Total production	average of actual value	405.15	405.15	405.15	405.15
	Predicted value	289.52	243.41	520.72	844.23
	Change rate %	-29	-40	29	108
Total imports	average of actual value	181.7	181.7	181.7	181.7
	Predicted value	228.83	247.61	134.67	2.91
	Change rate %	26	36	-26	-98

Source: Author's calculation based on the results in Table 3..

Regarding the third scenario, horizontal development in greenhouses planted with tomatoes of about 56% of the actual average during the study period, the average production of tomatoes produced in greenhouses increased to about 324.3 thousand tons compared to the actual average of 208.8 thousand tons, an increase of about 55%. Thus, the total tomato production in the Kingdom increased to about 520.7 thousand tons compared to the actual average of about 405.2 thousand tons, an increase of about 29%, which reduces the Kingdom's imports of tomatoes to 134.7 thousand tons compared to the actual average of 181.7 thousand tons, an estimated 26% decrease.

In the case of the continued horizontal expansion of greenhouses planted with tomatoes as assumed by the fourth scenario, suggesting an increase of about 211% of the actual average during the study period. Results indicated an increase in the average production of tomatoes produced in greenhouses to about 647.8 thousand tons compared to the actual average of 208.8 thousand tons, an increase of about 210%. Consequently, the total tomato production in the Kingdom increased to about 844.2 thousand tons compared to the actual average of 405.2 thousand tons, an increase of about 108%, reducing the Kingdom's imports of tomatoes to 2.9 thousand tons compared to the actual average of 181.7 thousand tons, a reduction rate of about 98%. It is clear from this that the horizontal expansion of greenhouses planted with tomatoes not only has a role in reducing the amount of tomato imports and reducing the trade deficit of tomatoes, but also turning that deficit into a trade surplus. the surplus produce together with the waste during harvest could contribute to food industries through adding value by tomato processing

Conclusion and Policy Recommendations

Area of greenhouses planted with tomatoes showed a significant positive effect on production. More than doubling the area diminishes the Kingdom's imports of tomatoes by about 98%. Medium-term loans provided by the Agricultural Development Fund greatly increases production. Lagged farm gate price of tomatoes played a significant role in increasing production. Based on results, the research recommends horizontal expansion in greenhouses planted with tomatoes to bridge consumption gap and turn the commercial deficit of tomatoes into surplus. Moreover, the research recommends facilitation and increased levels of credit for the purpose of greenhouses production. Aiming at rational production decisions, further studies on tomato price analysis, tomato marketing, processing, and forecasting are recommended.

Acknowledgement: Authors acknowledged the financial support provided by Deanship of scientific research at King Faisal University (research number 186283).

References

Agriculture Organization of the United Nations (2004) Commodities & Trade Division. The state of agricultural commodity markets. Food & Agriculture Organization. Retrieved on May 09, 2018 from http://www.fao.org/documents/card/en/c/I9542EN

AL Karawi, H.A., Al Badri, B.H. (2018) An economic study for Iraq's rice imports for the period (1990-2015) and prediction for the period (2016–2023). *Iraqi Journal of Agricultural Sciences*, **49**(1), 43-49.

Alkolibi, M.F. (2002) Possible effects of global warming on agriculture and water resources in Saudi Arabia: Impacts and responses. *Climatic Change*, **54**(1-2), 225-245.

Alrwis, K.N. (2008) The economic dimension of greenhouses tomato production in Saudi Arabia. *Alexandria Science Exchange Journal*, **29**(4), 308-314.

Arab Organization for Agricultural Development. (2017) Arab Food Security Annual Report No 29 (in Arabic). Retrieved on April 29, 2018 from http://www.aoad.org/Arab_food_Security_Report_2017.pdf

Benli, H. (2013) A Performance comparison between a horizontal source and a vertical source heat pump systems for a greenhouse heating in the mild climate Elaziğ Turkey. *Applied Thermal Engineering*, **50**(1), 197-206.

Chowdhury, SH., Al-Zahrani, M. (2013) Implications of climate change on water resources in Saudi Arabia. *Arabian Journal for Science and Engineering*, **38**(8), 1959-1971.

Chowdhury, SH., Al-Zahrani, M., Abbas, A. (2016) Implications of climate change on crop water requirements in arid region: An example of Al-Jouf, Saudi Arabia. *Journal of King Saud University - Engineering Sciences*, **28**(1), 21-31.

Dayoub, M. (2015) Econometric analysis of the cost functions of sugar beet cultivation in Idleb Province, Syria. *Jordan Journal of Agricultural Sciences*, **11**(1), 295-306.

DeNicola, E., Aburizaiza, S.O., Siddique, A., Khwaja, H., Carpenter, O.D. (2015) Climate change and water scarcity: The case of Saudi Arabia. *Annals of Global Health*, **81**(3), 342-353.

Dias, G.M., Ayer, N.W., Khosla, S., Van Acker, R., Young, S.B., Whitney, S., Hendricks, P. (2017) Life cycle perspectives on the sustainability of ontario greenhouse Tomato Production: Benchmarking and improvement opportunities. *Journal of Cleaner Production*, **140**(2), 831-839.

Fias, S., Noor, M.A., Aldosari, F.A. (2018) Achieving food security in the Kingdom of Saudi Arabia through innovation: Potential Role of Agricultural Extension. *Journal of the Saudi Society of Agricultural Science*s, **17**(4), 365-375.

Ghani, S., Bakochristou, F., ElBialy, E.M.A.A., Gamaledin, S.M.A., Rashwan, M.M., Abdelhalim, A.M., Ismail, M.S. (2019) Design challenges of agricultural greenhouses in hot and arid environments. *Engineering in Agriculture, Environment and Food*, **12**(1), 48-70.

Greenhouses Evidence (2006) Public Relations and Agricultural Information Department. Ministry of Agriculture. Saudi Arabia (in Arabic). Retrieved on March 02, 2018 from http://agri-science-reference.blogspot.com/2015/06/blog-post_9.html

Henneberry, S.R., Khan, M.E. (2000) An analysis of the linkage between agricultural exports and economic growth in Pakistan. *Journal of International Food & Agribusiness Marketing*, **10**(4), 13-29.

Jassam, Q.T. (2017) Economic study to measure the efficiency and items of marketing margins of tomato crop year 2015 Al-Taji District. *The Iraqi Journal of Agricultural Sciences*, **48**(3), 791-796.

Karawi, H.A., Al–Badri, B.H. (2018) An economic study for Iraq's rice imports for the period (1990-2015) and prediction for the period (2016-2023). *Iraqi Journal of Agricultural Sciences*, **49**(1), 43-49.

Mahmood, Z.H. (2018) Measurement economic and marketing efficiency for cucumber growing in green houses Shatrah at Dhiqar Province Iraq during Planting season 2017. *Iraqi Journal of Agricultural Sciences*, **49**(5), 775-785.

Nugroho, P.E. (2017) Government expenditure, agricultural productivity, and poverty reduction in Indonesia: A simultaneous equations approach. *Journal of the Graduate School of Asia-Pacific Studies*, **34**(9), 9-54.

Pant, P.N., Starbuck, W.H. (1990) Innocents in the forest: Forecasting and research methods. *Journal of Management*, **16**, 433-460.

Romantchik, E., Ríos, E., Sánchez, E., López, I., Sánchez, J.R. (2017) Determination of energy to be supplied by photovoltaic systems for Fan-Pad systems in cooling process of greenhouses. *Applied Thermal Engineering*, **114**(5), 1161-1168.

Theil, H. (1966) Applied Economic Forecasting. Chicago, Rand McNally.