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SUPPLY RESPONSE OF TOMATO AND POTATO CROPS IN EGYPT

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Supply Response of Tomato and Potato Crops in Egypt

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Introduction:

This is a preliminary report of a study that attempts to specify the major area determinants of potatoes and tomatoes produced in different seasons in Egypt, through the estimation of relevant supply response functions for potatoes and tomatoes.

The area of vegetable crops in Egypt has been steadily increasing from about 500 thousand feddans in 1960 to over one million feddans in 1980, an increase of more than 200 % during this period.

In Egypt vegetables are produced in three seasons, winter, summer, and Nili seasons. In the period 1975-1979, the summer crop represented about half of the total area of vegetables, and each of the winter and Nili seasons represented one fourth of the total area. While the average annual total area of vegetables in this period (excluding the onion area) is estimated at about 934 thousand feddans, the average annual summer crop area is estimated at about 456 thousand feddans (49 %), the Nili crop area at 254 thousand feddans (27 %), and the winter season area at about 223 thousand feddans (24 %).

The Delta is the major producing region for vegetables with about 69 percent of the average annual area of vegetables in the period 1975-1978, followed by middle Egypt representing about 24 percent of the area, and Upper Egypt representing 7 percent only.

While 41 percent of the vegetables area in the Delta is allocated for summer crop, 33 percent to the Nili crop, and 26 percent for the winter crop, in Upper Egypt about 44 percent of the area is allocated for the winter crop, followed by summer and Nili crops. The relative importance of each season in the production of vegetable crops in each region depends on several factors; 1. the climatic conditions conducive to the production of each, 2. soil fertility, 3. type of rotation and agricultural systems practiced, and 4. population intensity, demand conditions and consumption patterns.

The Behira Governorate is considered the major producer of vegetable crops with an average annual area of about 140 thousand feddans in the period 1975-1978, representing 19 percent of total area in Egypt, followed by Giza (14 percent), Sharkia (11 percent), Kaliobia (9 percent), Menofia (7 percent), Fayoum (5 percent), Kafr El Sheik (4 percent), Menia (3 percent), Qena (2 percent), and Assiut (2 percent). While different vegetables are being produced in Egypt, only ten major crops constitute 82 percent of annual average area during the period. These 10 crops are tomatoes (33 percent of the area), potatoes (14 percent), water melons (13 percent), squash (6 percent), cucumber (4 percent), cabbage (3.8 percent), eggplant (3 percent), green peas (2 percent), dried peas (1.8 percent), and melons (1.7 percent).

The reasons for the rising trend in the area of vegetables could be summarized as follows: 1. population increase, 2. relative profitability of vegetable crops especially in the neighborhood of large cities, 3. improved diets, 4. increased demand for processing and canning of vegetables, 5. increasing foreign demand for Egyptian vegetables, and 6. nonexistence of government controls affecting farm gate price levels or deliveries.

The average annual value of vegetable exports in the years 1970, 1974, and 1978 amounts to L.E. 56.67 million, or 9.6 percent of average annual total value of agricultural exports in the same years.

Because of the nonexistence of government controls affecting cultivated area, type of rotation followed, or farm gate prices of vegetables, it is expected that such situations will stimulate vegetable supply response. In fact, the increasing area of vegetables in the last twenty or thirty years was made available at the expense of government controlled commodities like cotton.

The aim of this study is to estimate area supply response functions for tomatoes and potatoes at the national level.

Potato Production in Egypt

Potatoes have been produced in Egypt for more than one hundred years, however, their production has increased lately in response to increased foreign demand for Egyptian potatoes. It is believed that yields per feddan are high compared to the world average.

There are three seasons for producing potatoes. The summer crop is cultivated in December and January and is grown mainly in the northern Delta area. Imported seeds from Europe are used in this season, and it takes 3 to 4 months to reach harvest stage depending on the variety produced. The crop appears in April and May in local markets. The bulk of this crop is consumed in the local markets, however, some of the early crop is exported. The yield per feddan is high compared to other seasons.

The second or Nili crop is cultivated from July in the northern regions to September in other parts of the Delta and Middle Egypt. The crop appears from December to February. The seeds used are taken from the summer season crop. The bulk of the product is mainly consumed in the local market and part of the late crop is exported.

The third or winter crop is cultivated in October or November and is harvested in February and March. The production is confined to northern parts of the Delta, and the bulk of the product is exported.

The Nili crop covers the largest area, followed by summer crop and the winter crop.

Tomato production in Egypt

Favorable climatic conditions encourage production of tomatoes in Egypt all the year round in four seasons. The winter crop is cultivated in nurseries during July and August and transplanted in September and October. The early summer crop is cultivated in the nursery in November and December and transplanted in January and February and transplanted in March and April. The Nili crop is cultivated in the nursery in May and June and transplanted in July and August.

The Objective of the Study

This study aims at estimating area supply response functions for potatoes and tomatoes in different seasons at the national level in order to identify factors affecting farmers response with regard to area allocated to these two major vegetable crops in Egypt.

Methodology

In many cases the words "supply" and "response" are used synonymously. And while there is a host of existing literature about the economists' point of view with regard to the conceptual distinction between the two terms, suffice it here to mention that for the purpose of this study the term "supply" describes an exact relation, and the term "response" describes a general or mongrel relation. Moreover, the term "supply function" or "supply relation" indicates a definite relation between quantity supplied of a commodity and its prices, ceterus paribus; keeping all other factors and state of technology constant. On the other hand, the term "response function" or "response relation" describes the relation between quantities of a commodity offered in the market and its prices taking into consideration the effect of other changing factors, assumed constant in the first concept (like scale of operation, state of technology, degree of liquidity, credit availability, and market information). In other words, "response relation" refers to the relation between quantities offered by producers and prices without keeping all other factors constant.

Since the aim of this study is to shed light on the farmers' area response for some vegetable crops as functions of prices of these products as well as other factors affecting farmers' response, the relevant procedure is to find estimates for these crops' supply response functions. In this study, linear area response functions were estimated for potato and tomato crops with area cultivated as the dependent variable and several explanatory variables including price of the commodity, area of the same crop, relation between prices of the commodity and prices of other related commodities, and the time trend.

The model specified in the following section was estimated for the two major vegetable crops in Egypt, potato and tomato. Time series data for area, prices, productivity, and some other variables covering the period 1966-1979 were collected at the national level from the MOA statistics.

All estimations were done using an OLS stepwise regression procedure. This procedure selects from a set of explanatory variables those that have the highest significance and also contribute to the explanation of the dependent variable. Hence, the reported variables are only those that have achieved some level of significance. The estimation procedure followed here was to insert in the regression program all of the theoretically appropriate variables and then let the program report only the significant ones, with the results being reported by product.

<u>Results of estimated functions for potato crops</u>

1. Summer crop

$Y = f(X_1, X_2, \ldots, X_n)$ where

Y = cultivated area, feddan

X_1 = farmgate price of summer potatoes_{t-1}

X_2 = cultivated area of summer potatoes_{t-1}

X_3 = yield/feddan, tons_{t-1}

X_4 = (net returns of summer potatoes/net returns of summer potatoes)

X_5 = value of potato exports $(\text{Million L.E.})_{t-1}$

X_6 = quantity of potato exports

X_7 = value of potato exports_{t-2}

X_8 = quantity of potato exports_{t-2}

X_9 = $(\text{price of s. potatoes/price of s. tomatoes})_{t-1}$

X_{10} = $(\text{price of s. potatoes/price of s. squash})_{t-1}$

X_{11} = $(\text{price of s. potatoes/price of eggplant})_{t-1}$

X_{12} = $(\text{price of s. potatoes/price of cucumber})_{t-1}$

X_{13} = (price of s. potatoes/price of green cowpea)$_{t-1}$

X_{14} = (price of s. potatoes/price of dried cowpea)$_{t-1}$

X_{15} = price of Nili potatoes$_{t-1}$

X_{16} = price of exports, tons (L.E.)$_{t-1}$

X_{17} = time trend

The stepwise regression analysis resulted in the following estimated functional relationships:

$$Y = 11895.54 + \underset{(3.139)}{298.73}\, X_1 + \underset{(3.147)}{141.73}\, X_{16} + \underset{(3.514)}{1668.47}\, X_{17}$$

$R^2 = 0.97$ $\qquad$ $F = 138.46$

The value of the coefficient of determination indicates that about 97 % of the change of cultivated area is explained by the independent variables included. The F value indicates the significance of the model to express functional relationships. The regression coefficients were all significantly different from zero at 0.05 level of significance. The empirical results indicate the positive relationship between the cultivated area of summer potatoes and the price of summer potatoes in the previous year, the price of exports, and the time trend.

The elasticity coefficients appearing in table one indicate that an increase of X_1 by 10 percent is associated with an increase in cultivated area of summer potatoes by 2.6 percent, an increase of X_{16} by 10 percent would induce an increase of about 1.8 percent of the area, which indicates a weak response of farmers to both the farm price and export price.

2. The Nili crop

The model used to estimate the supply response relation is expressed as follows:

$Y = f(X_1, X_2, \ldots, X_n)$ where

Y = cultivated area, feddan

X_1 = farmgate price for Nili potatoes$_{t-1}$

X_2 = cultivated area of Nili potatoes$_{t-1}$

X_3 = yield/feddan, tons$_{t-1}$

X_4 = farmgate price of s. potatoes in the same year$_t$

X_5 = (price of Nili potatoes/price of Nili tomatoes)$_{t-1}$

X_6 = (price of Nili potatoes/price of Nili squash)$_{t-1}$

X_7 = (price of Nili potatoes/price of green kidney beans)$_{t-1}$

X_8 = (price of Nili potatoes/price of dried kidney beans)$_{t-1}$

X_9 = (price of Nili potatoes/price of green peas)$_{t-1}$

X_{10} = (price of Nili potatoes/price of dried peas)$_{t-1}$

X_{11} = (price of Nili potatoes/price of spinach)$_{t-1}$

X_{12} = (price of exports, tons (L.E.)$_{t-1}$

X_{13} = Time trend

The estimated function was as follows:

$$\begin{aligned} Y = 7064.09 &+ \underset{(1.013)}{154.47\,X_4} + \underset{(3.850)}{133936.44\,X_8} - \underset{(-3.092)}{29038.53\,X_9} \\ &+ \underset{(4.507)}{3694.21\,X_{13}} \end{aligned}$$

$R^2 = 0.94$ $\qquad$ $F = 34.40$

In this case, the value of the coefficient of determination indicates that the explanatory variables included explain about 94 percent of the total variance of the cultivated area of Nili potatoes. The value of F indicates the significance of the model in expressing the relationship between the dependent variable and the independent variables. The empirical results of this analysis indicate that independent variables (X_4, X_8, and X_{13}) are positively associated with the cultivated area of Nili potatoes, and, at the same time, there is a negative relation between X_9 and the cultivated area. The positive signs are in agreement with the economic logic where on an a priori basis it is expected that the area of Nili potatoes would increase whenever a) the prices of summer potatoes or b) the ratio of Nili potato prices to dried kidney bean prices increase. However, the negative signs, representing an inverse relation between the ratio of Nili potato prices to green pea prices and the area of Nili potatoes, is not in agreement with economic logic.

The value of coefficients of elasticity for independent variables X_4, X_8 (Table one) indicate that an increase of 10 percent of each variable is associated with an increase in the area of Nili potatoes by 1.3 percent and 6.1 percent respectively. At the same time an increase of 10 percent of variable X_9 is associated with 4.3 percent decrease in the area.

Results of estimated functions for tomato crops

1. Winter crop

$Y = f\ (X_1, X_2, \ldots, X_n)$

Y = cultivated area, feddan

X_1= farmgate price of winter tomatoes, tons $(\text{L.E.})_{t-1}$

X_2= cultivated area of winter crop feddan_{t-1}

X_3= yield/feddan tons_{t-1}

X_4= price of exports, tons $(L.E.)_{t-1}$

X_5= farmgate price of Nili tomatoes$_{t-1}$

X_6= time trend

Using the stepwise analysis regression technique, the following regression equation was derived:

$$Y = 75944.93 + 89.37\ X_1 - 57.56\ X_4 + 4351.57\ X_6 - 254.21\ X_5$$
$$(0.681) \quad (-0.656) \quad (2.887) \quad (-1.68)$$

$R^2 = 0.90$ $\qquad\qquad$ $F = 21.39$

The value of the coefficient of determination indicates that about 90 percent of the changes in winter season tomato area is explained by the independent variables included. The F value indicates that the regression model is significant. According to the empirical results, a unit change in the farmgate price of winter tomatoes is associated with a change of 89.0 feddans and that a change of a unit of time (one year) is associated with an increase of about 4.352 feddans of winter tomatoes. However, the results indicate that there is a negative association between each of the export prices of tomato and the price of the Nili tomatoes lagged one year.

2. Summer crop

$Y = f(X_1, X_2, \ldots, X_n)$ where

Y = cultivated area, feddan

X_1= farmgate price of summer tomatoes, tons, L.E.$_{t-1}$

X_2= cultivated area of summer tomatoes, feddan$_{t-1}$

X_3= yield/feddan, tons $_{t-1}$

X_4= price of exports, L.E. tons$_{t-1}$

X_5= net returns of summer tomatoes/net returns of summer potatoes$_{t-1}$

X_6= farmgate price of winter tomatoes in the same year$_t$

X_7= (price of summer tomatoes/price of summer potatoes) L.E. $tons_{t-1}$

X_8= (price of summer tomatoes/price of summer squash) L.E. $tons_{t-1}$

X_9= (price of summer tomatoes/price of summer eggplant) L.E. $tons_{t-1}$

X_{10}= (price of summer tomatoes/price of summer cucumber) L.E. $tons_{t-1}$

X_{11}= (price of summer tomatoes/price of summer green cowpea) L.E. $tons_{t-1}$

X_{12}= (price of summer tomatoes/price of summer dried cowpea) L.E. $tons_{t-1}$

X_{13}= time trend

The estimation of the regression equation was as follows:

$$Y = 78657.7 - 411.98 X_4 + 32828.60 X_7 - 12521.90 X_9 + 10035.4 X_{13} - 26370.0 X_8$$

(-2.110) (-7.212) (2.704) (-1.616) (5.820)

$R^2 = 0.98$ $F = 3.57$

The value of the coefficient of determination indicates that the independent variables included explain 98 percent of changes in the dependent variable.

The empirical results indicate that an increase of one unit in the ratio of the price of summer tomatoes to the price of summer potatoes is associated, significantly at an 0.05 level of significance, with an increase of about 32829 feddans of summer tomatoes. Also, the results indicate that a one unit of time (one year) is associated with an increase of about 10035 feddan of summer tomatoes.

The coefficient of elasticity indicates that an increase of 10 percent in X_7 is associated with an increase of 4 percent in the area. Also an increase of 10 percent in X_4, X_8, and X_9 will be associated with decreases of the area of 6 percent, 4 percent, and 2 percent respectively.

3. Nili crop

$Y = f(X_1, X_2, \ldots, X_n)$, where

Y = cultivated area, feddan

X_1 = farmgate price of Nili tomatoes, tons, L.E.$_{t-1}$

X_2 = cultivated area of Nili tomatoes, feddan$_{t-1}$

X_3 = yield/feddan, tons $_{t-1}$

X_4 = price of exports, tons L.E.$_{t-1}$

X_5 = (net return of Nili tomatoes/net return of Nili potatoes)$_{t-1}$

X_6 = price of summer tomatoes in the same year, tons, L.E.

X_7 = (price of Nili tomatoes/price of Nili potatoes) tons L.E.$_{t-1}$

X_8 = (price of Nili tomatoes/price of green Nili kidney beans) tons$_{t-1}$

X_9 = (price of Nili tomatoes/price of dried Nili kidney beans) tons$_{t-1}$

X_{10} = (price of Nili tomatoes/price of green Nili peas) tons$_{t-1}$

X_{11} = (price of Nili tomatoes/price of dried Nili peas) tons$_{t-1}$

X_{12} = (price of Nili tomatoes/price of Nili spinach) tons$_{t-1}$

X_{13} = (price of Nili tomatoes/price of Nili squash)tons$_{t-1}$

X_{14} = time trend

The following regression equation was derived.

$$Y = 2080.5 \underset{(-2.020)}{-347.20\, X_1} + \underset{(5.430)}{0.75\, X_2} \underset{(2.640)}{-69453.7\, X_9} + \underset{(2.840)}{31666.42\, X_{10}}$$

$$+ \underset{(3.380)}{20785.6\, X_{13}}$$

$R^2 = 0.94$ $F = 4.08$

The value of the coefficient of determination indicates that about 94 percent of the change in the dependent variable (area of Nili tomatoes) is explained by the independent variables.

The empirical results indicate that there is a positive and significant relationship between the area of Nili tomatoes and each of the variables: cultivated area of Nili tomato lagged one year, ratio of prices of Nili tomatoes to prices of green peas, and the time trend. At the same time, there is a negative relationship between each of the variables a) farm gate price of Nili tomatoes lagged one year and b) ratio of prices of Nili tomatoes to prices of dried kidney beans lagged one year.

The coefficient of elasticity indicates that a 10 percent change in each of the cultivated area of Nili tomatoes lagged one year, and the price ratio of Nili tomatoes and green peas would be associated with an increase in the Nili tomato area by 7 percent and 4 percent respectively.

Conclusions

1. The results of the regression analysis indicate that the area of summer potatoes was positively associated with the price of summer potatoes, the price of exports all lagging one year, and the time trend. In the case of Nili potatoes it was found that its area positively associated with the price of summer potatoes, the ratio of Nili potato prices to dried kidney bean prices all lagged one year, and time trend. It associated negatively with the ratio of Nili potato prices to green pea prices lagged one year.

2. The empirical results of the regression analysis indicate that the area of winter tomatoes was positively associated with the farm gate price of winter tomato lagged one year and time trend, but negatively associated with the export prices of tomatoes and the prices of Nili tomatoes lagged one year. In the case of summer tomatoes its area was associated positively with the ratio of price of summer tomatoes to price of summer potatoes lagged one year and time trend, but associated negatively with prices of exports, the ratio of prices of summer tomatoes

to price of squash, and the ratio of the price of summer tomatoes to price of eggplant. In the case of Nili tomatoes it was found that its area associated positively with the area of Nili tomatoes, the ratio of Nili tomato prices to green pea prices all lagged one year, and the time trend. On the other hand the area of Nili tomatoes associated negatively with farmgate price of Nili tomatoes and the ratio of Nili tomato prices to dried kidney beans all lagged one year.

3. Elasticities of all crops included with respect to individual variables indicate that area response is inelastic with respect to any single independent variable.

4. Applications of the results obtained in such a study could be used to achieve two goals.

   a. to predict area of both potatoes and tomatoes, and

   b. to suggest price and non-price manipulations needed to meet certain area goals of potatoes and tomatoes.

In a subsequent phase of this study, an attempt is currently being made to study the effects of the deviations of actual vs. planned areas of government controlled tradional crops where area allotments are common, like cotton and rice, on the area of vegetables.

Table 1. Potato and Tomato area elasticities

Potatoes				Tomatoes					
Summer season		Nili season		Winter season		Summer season		Nili season	
Variable	elasticity	variable	elasticity	variable	elasticity	variable	elasticity	variable	elasticity
X_1	0.257	X_4	0.129	X_1	0.054	X_4	-0.584	X_1	-0.174
X_{16}	0.184	X_8	0.610	X_4	-0.070	X_7	0.391	X_2	0.735
		X_9	-0.428	X_5	-0.116	X_8	-0.419	X_9	-0.232
						X_9	-0.245	X_{10}	0.338
								X_{13}	0.310