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The impact of price changes on sugar beet crop in Egypt

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Abstract: The research aimed to identify the impact of price changes on sugar beet crop in Egypt, by identifying the role of farm price in changing the value of production and thus farmers' income from sugar beet crop in Egypt, using the triple discrete effect, estimating the supply response function for sugar beet crop in Egypt using different models, estimating the targeted area for sugar beet cultivation in light of price changes according to the supply response models under study, estimating the guaranteed price for sugar beet crop in Egypt, and predicting the area planted with sugar beet crop in light of the Akaike criterion according to the models under study. To achieve its objectives, the research relied on using index numbers to measure the triple discrete effect using the change partitioning method, and supply response functions according to the models of Mark Nerlove, Fisher, Solow, Jorgenson, Kudhy, and modified Mark Nerlove, and using the Akaike criterion for prediction. The research results showed that the separate effect of the change in the cultivated area only, without the effect of the other elements, led to an increase in the total production value by about 168.75 million pounds. It also showed that the separate effect of the change in productivity per feddan only, without the effect of the other elements, led to an increase in the total production value by about 0.44 million pounds. It also showed that the separate effect of the change in the farm price only, without the effect of the other elements, led to an increase in the total production value by about 295.89 million pounds. The supply response function for sugar beet crop in Egypt was estimated during the period (2005-2022), using the models of Nerlove, Fisher, Solow, Jorgenson, Kudhy and modified Nerlove. The results of the statistical estimation of the supply response models showed that all the aforementioned estimated models were significant at a significance level of 0.01 according to the calculated (F) value. By estimating the supply response function for sugar beet crop using the Nerlove model, it was found that an increase in the farm price by 1% leads to an increase in the cultivated area by 0.43%, 0.87% respectively. The modified Nerlove model was also used, where other variables related to the crop were added to the basic Nerlove model and analyzed statistically, where the significance of the farm price and the cost of production per feddan for sugar beet crop in the previous year was proven, as well as the price risk for sugar beet crop, which represents the standard deviation of the farm price for sugar beet crop for the previous three years, where It was found that an increase in the farm price of sugar beet in the previous year by one pound leads to a response from farmers to increase the cultivated area of the crop by 1580 feddans, while a decrease in both the cost of production of an feddan of sugar beet in the previous year by one pound, and the price risk of sugar beet by 1%, leads to a response from farmers to increase the cultivated area of the crop by 40 and 1680 feddans, respectively. By estimating the targeted area for sugar beet cultivation in light of price changes, it was found that there was a decrease in the actual cultivated area compared to its targeted counterpart according to the Solow, Jorgenson, Kudhy, and modified Mark Nerlove models, where the decrease amounted to about 22, 6, 29, and 354 thousand feddans, respectively. By estimating the guaranteed price of the sugar beet crop in Egypt for the average period (2005-2022), it was found that the guaranteed price estimated using the product of multiplying the cost of living index for the base year 2005 by the actual price for previous years was estimated at about 431 pounds per ton, which is 21 pounds more than the actual price of about 410 pounds per ton. Accordingly, determining the farm price using this method is the optimal method, as the estimated price is greater than the actual price, which allows for a profitable net return for the farmer, encouraging him to increase production. The area planted with sugar beet was predicted in light of the Akaike criterion according to the models under study, as the model with the lowest value of the Akaike criterion is considered the best model because it reduces the difference between the estimated model data and the actual model data. This criterion was used because it is more suitable for the study data, as it excludes or neglects any effect due to the time-lag or time-shifted periods, as it was found that the Solow model is the best model for prediction according to the Akaike criterion, which amounted to about 10.70, as it is expected that the area planted with sugar beet in Egypt will increase from about 696 thousand feddans in 2023 to about 888 thousand feddans in 2030 with an average area of about 792 thousand feddans and an increase rate of about 27.69% over 2023.
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Keywords: Triple discrete effect, supply response models, target area, guarantee price, Akaike forecasting criterion.

Introduction:

Sugar is of strategic importance through its pivotal role and its fundamental and direct impact on human life, as it is one of the most important food commodities in the food basket of the peoples of the world, as it provides the body with the energy needed to carry out various human activities, and sugar is consumed either in its known form as final consumption or within some foods, drinks, sweets and other food industries, and sugar cane and sugar beet crops are considered sugar crops that are considered the main source of sugar industry in most countries of the world (Hussein and Hamid, 2021).

Sugar beet is considered one of the important crops for sugar production in Egypt, as the state has adopted interest in this crop, as the agricultural policy seeks to achieve self-sufficiency in sugar by expanding the area planted with the crop and working to increase its production, which leads to increasing its contribution to sugar production due to its relatively low water requirements compared to the sugar cane crop, which has high water requirements, in light of the limited water element (El-Sayed, 2023).

The waste from sugar factories that manufacture sugar from sugar beet crops can also be used to make concentrated feed. Its green mass is also used to feed farm animals. It can also be grown in saline, calcareous and newly reclaimed lands, as its cultivation leads to providing many job opportunities through its production and manufacturing processes (Hussein, 2023).

The sugar beet crop is affected by a set of economic policies, perhaps the most prominent of which is the agricultural pricing policy, which plays an effective role in increasing production and thus raising the level of farmers' income (Melouk, 2007).

Research problem:

The research problem lies in the inability of local sugar production to meet local consumption, as local sugar production has reached about 2.84 million tons, while local consumption has reached about 3.27 million tons, and thus the sugar food gap is estimated at about 430 thousand tons of sugar, representing about 15.14% of local sugar production for the average period (2020-2022), as the state imports this quantity from abroad, which represents a burden on the state's trade balance, especially in light of the difficulty of providing foreign currencies.

Although the sugar industry in Egypt depends on two main crops, sugar cane and sugar beet, statistics indicate a significant development in the contribution of sugar beet to the sugar industry, as its contribution reached about 68.9% of sugar production in Egypt for the average period (2020-2022). This is due to the fact that sugar beet consumes less water than sugar cane, as the water consumption per feddan of sugar beet was estimated at about 2943 m3, while the water consumption per feddan of sugar cane was estimated at about 9755 m3 for the average period (2020-2022). In addition, sugar beet cultivation is good in new and newly reclaimed lands (Central Agency for Public Mobilization and Statistics).

Since sugar production from sugar beet depends on the quantity supplied to sugar factories, which mainly depends on the area planted with the crop, which is affected by price fluctuations in the price of the crop and the prices of competing crops, the state uses price incentives to encourage farmers to grow sugar beet, which requires identifying the impact of these price changes on the sugar beet crop in Egypt.

Research objective:

The research aims to identify the impact of price changes on sugar beet crop in Egypt, through studying the following sub-objectives:

1- Identifying the development of some productive and economic indicators of sugar beet crop in Egypt.
2- Identifying the role of farm price in changing the value of production and thus farmers' income from sugar beet crop in Egypt using the triple discrete effect.
3- Estimating the supply response function for sugar beet crop in Egypt using different models.
4- Estimating the targeted area to be planted with sugar beet crop in light of price changes according to the supply response models under study.
5- Estimating the guaranteed price of sugar beet crop in Egypt.
6- Predicting the area planted with sugar beet crop in light of the Akaike criterion according to the models under study.

Research method and data sources:

The research relied on descriptive and quantitative analyses to achieve its objectives to analyze data related to the research topic by using some mathematical and statistical methods such as arithmetic averages, percentages, and regression analysis method to estimate the general time trend, and using index numbers to measure the separate triple effect using the change partitioning method, and supply response functions according to the models of Mark Nerlove, Fisher, Solow, Jorgenson, Kudhy, and modified Mark Nerlov, and using the Akaike criterion for prediction.

The research used secondary statistical data for the period (2005-2023) available from the Economic Affairs Sector of the Ministry of Agriculture and Land Reclamation, in addition to scientific references related to the research topic.

Search results:

Before identifying the impact of price changes on the sugar beet crop in Egypt, we must first identify the production and economic indicators of the sugar beet crop in Egypt, which helps to give an accurate view of the development of indicators related to the crop, and sheds light on the changes that occurred during the study period. Below we will identify the development of these indicators:

First: The development of some production and economic indicators of sugar beet crops in Egypt during the period (2005 - 2022):

A- Development of some production indicators of sugar beet crop in Egypt:

1- Development of the cultivated area:

By studying the development of the cultivated area of sugar beet crop in Egypt during the period (2005-2022), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 167 thousand feddans in 2005, and a maximum of about 683 thousand feddans in 2021, i.e. an increase rate of about 308.98% over the minimum, and about 119.17% over the average cultivated area of sugar beet crop in Egypt, which is estimated at about 433 thousand feddans.

Table (1): Development of some production and economic indicators of sugar beet crop in Egypt during the period (2005-2022).

Year	Productivity indicators			Economic indicators			
	Cultivated area (thousand feddans)	Feddan productivity (tons)	Total production (thousand tons)	Farm price (pounds per ton)	Cost of production per feddan (pounds)	Total revenue per feddan (pounds)	Net yield per feddan (pounds)
2005	167	20.54	3430	157	1857	3222	1365
2006	186	20.99	3905	172	1856	3611	1755
2007	248	22.01	5458	164	1886	3608	1722
2008	258	19.90	5133	224	1959	4448	2489
2009	265	20.13	5334	246	2368	4946	2578
2010	386	20.31	7840	341	2697	6927	4230
2011	362	20.68	7486	293	3003	6054	3051
2012	424	21.52	9126	345	3457	7421	3964
2013	460	21.83	10044	399	4092	8720	4628
2014	504	21.92	11046	427	4393	9352	4959
2015	555	21.59	11983	419	4869	9039	4170
2016	560	20.01	11206	457	5316	9154	3838
2017	523	20.77	10861	417	6853	8663	1810
2018	493	21.05	10377	579	7394	12191	4797
2019	605	20.24	12247	693	8613	14027	5414
2020	518	19.85	10284	663	9517	13158	3641
2021	683	20.78	14195	670	10261	13924	3663
2022	598	20.96	12535	720	11321	15095	3774
minimum	167	19.85	3430	157	1856	3222	1365
maximum	683	22.01	14195	720	11321	15095	5414
Average	433	20.84	9027	410	5095	8531	3436

Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, Cost and Net Return Statistics Bulletin, various issues.

By estimating the equation of the general time trend of the cultivated area of sugar beet crop in Egypt, it is clear from Table (2) that there is a statistically significant annual increase of about 27.40 thousand feddans, representing about 6.33% of the annual average of about 433 thousand feddans. The coefficient of determination (R^2), estimated at about 0.89, indicates that about 89% of the changes occurring in the cultivated area of sugar beet crop in Egypt are due to the influence of factors reflected by the time element.

2- Development of average productivity per feddan:

By studying the development of the average productivity per feddan of sugar beet crop in Egypt during the period (2005-2022), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 19.85 tons per feddan in 2020, and a maximum of about 22.01 tons per feddan in 2007, i.e. an increase rate of about 10.88% over the minimum, and about 10.36% over the general average of the average productivity per feddan of sugar beet crop in Egypt, which is estimated at about 20.84 tons per feddan.

By estimating the equation of the general time trend of the average productivity of the feddan of sugar beet crop in Egypt, it is clear from Table (2) that the average productivity of the feddan of sugar beet crop in Egypt has decreased by an annual amount that has not been proven statistically significant.

3- Total production development:

By studying the development of total sugar beet production in Egypt during the period (2005-2022), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 3430 thousand tons in 2005, and a maximum of about 14195 thousand tons in 2021, i.e. an increase rate of about 313.85% over the minimum, and about 119.25% over the average total sugar beet production in Egypt, which is estimated at about 9027 thousand tons.

By estimating the equation of the general time trend of the total production of sugar beet crop in Egypt, it is clear from Table (2) that there is a statistically significant annual increase of about 562.26 thousand tons, representing about 6.23% of the annual average of about 9027 thousand tons. The coefficient of determination (R^2), estimated at about 0.86, indicates that about 86% of the changes occurring in the total production of sugar beet crop in Egypt are due to the influence of factors reflected by the time element.

Table (2): The general time trend of some production and economic indicators of sugar beet crop in Egypt during the period (2005-2022).

Y	Cultivated area (thousand feddans	Feddan productivity (tons)	Total production (thousand tons)	Farm price (pounds per ton)	Cost of production per feddan (pounds)	Total revenue per feddan (pounds)	Net yield per feddan (pounds)
C	172.79	20.95	3685.71	84.00	-294.97	1821.33	2116.29
B	27.40	- 0.01	562.26	34.35	567.38	706.29	138.92
t	11.56**	-0.37	10.01**	16.71**	13.99**	17.28**	3.02**
R^2	0.89	0.01	0.86	0.95	0.92	0.95	0.36
F	133.62**	0.14	100.16**	279.39**	195.85**	298.54**	9.09**
Average	433	20.84	9027	410	5095	8531	3436
Rate of change(%)	6.33	-	6.23	8.37	11.14	8.28	4.04

Where: Y = refers to the estimated value of the phenomenon, C = constant of the equation.
B = time coefficient, where time = 1, 2, 3, ..., 18. t = significance of the regression coefficient.
R^2 = coefficient of determination, F = significance of the model. **Significant at a significance level of 0.01.
Source: Collected and calculated from data in Table (1).

B - Development of some economic indicators of sugar beet crop in Egypt:

1- Development of the farm price:

By studying the development of the farm price per ton of sugar beet crop in Egypt during the period (2005-2022), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 157 pounds per ton in 2005, and a maximum of about 720 pounds per ton in 2022, i.e. an increase rate of about 358.60% over the minimum, and about 137.32% over the average farm price of sugar beet crop in Egypt, which is estimated at about 410 pounds per ton.

By estimating the time trend equation for the farm price per ton of sugar beet crop in Egypt, it is clear from Table (2) that there is a statistically significant annual increase of about 34.35 pounds per ton, representing about 8.37% of the annual average of about 410 pounds per ton. The coefficient of determination (R^2), estimated at about 0.95, indicates that about 95% of the changes occurring in the farm price per ton of sugar beet crop in Egypt are due to the influence of factors reflected by the time element.

2- Development of the costs of production per feddan:

By studying the development of the costs of producing an feddan of sugar beet in Egypt during the period (2005-2022), it was shown from the data in Table (1) that it increased during the study period, and was between a minimum of about 1856 pounds per feddan in 2006, and a maximum of about 11321 pounds per feddan in 2022, i.e. an increase rate of about 509.97% over the minimum, and about 185.77% over the average costs of producing an feddan of sugar beet in Egypt, which is estimated at about 5095 pounds per feddan.

By estimating the equation of the general time trend of the costs of producing an feddan of sugar beet in Egypt, it is clear from Table (2) that there is a statistically significant annual increase of about 567.38 pounds per feddan, representing about 11.14% of the annual average of about 5095 pounds per feddan. The coefficient of determination (R^2), estimated at about 0.92, indicates that about 92% of the changes occurring in the costs of producing an feddan of sugar beet in Egypt are due to the effect of factors reflected by the time element.

3- Development of total revenue per feddan:

By studying the development of the total revenue per feddan of sugar beet crop in Egypt during the period (2005-2022), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 3222 pounds per feddan in 2005, and a maximum of about 15095 pounds per feddan in 2022, i.e. an increase rate of about 368.50% over the minimum, and about 139.17% over the average total revenue per feddan of sugar beet crop in Egypt, which is estimated at about 8531 pounds per feddan.

By estimating the equation of the general time trend of the total revenue per feddan of sugar beet crop in Egypt, it is clear from Table (2) that there is a statistically significant annual increase of about 706.29 pounds per feddan, representing about 8.28% of the annual average of about 8531 pounds per feddan. The coefficient of determination (R^2), estimated at about 0.95, indicates that about 95% of the changes occurring in the total revenue per feddan of sugar beet crop in Egypt are due to the effect of factors reflected by the time element.

4- Development of net yield per feddan:

By studying the development of the net yield per feddan of sugar beet crop in Egypt during the period (2005-2022), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 1365 pounds per feddan in 2005, and a maximum of about 5414 pounds per feddan in 2019, i.e. an increase rate of about 296.63% over the minimum, and about 117.84% over the average net yield per feddan of sugar beet crop in Egypt, which is estimated at about 3436 pounds per feddan.

By estimating the general time trend equation of the net yield per feddan of sugar beet crop in Egypt, it is clear from Table (2) that there is a statistically significant annual increase of about 138.92 pounds per feddan, representing about 4.04% of the annual average of about 3436 pounds per feddan. The coefficient of determination (R^2), estimated at about 0.36, indicates that about 36% of the changes occurring in the net yield per feddan of sugar beet crop in Egypt are due to the effect of factors reflected by the time element.

Second: The role of the farm price in changing the value of production and thus farmers' income from sugar beet crops in Egypt using the triple separate effect:

This section deals with the quantitative measurement of the impact of the change in the components of the total production value on the total production value of sugar beet crop in Egypt using the triple separate effect, as the total production value is the result of the impact of each of the cultivated area, productivity per feddan, and farm price. To determine the extent of the contribution of each of these variables to the production value, the study used the change segmentation method, by using partial index numbers as an analytical tool in the quantitative measurement of the impact of the change in the components of the total production value on the total production value. It is preferable to use partial index numbers because they give the amount of change in the phenomenon as a result of the change in its components with specific values. The use of index numbers is linked to two basic conditions: the first is that all the elements that make up the total production value can be measured quantitatively, and the second is that there is a multiplication relationship between the components of this value. This method is used by calculating the index numbers in the comparison year, which is every year following each year of the study for the base year, which is every year preceding the comparison years, then the average of these years is calculated. Table (3) shows the equations of the partial index numbers to measure the relationship between the components of the total production value using the triple discrete effect.

Table (3): Equations of partial index numbers to measure the relationship between the components of the total production value using the separate triple effect.

variable	Discrete effect equations
Area	$I_A = (A_1M_0P_0 - A_0M_0P_0)$
Feddan productivity	$I_M = (A_0M_1P_0 - A_0M_0P_0)$
Farm price	$I_P = (A_0M_0P_1 - A_0M_0P_0)$

Total production value	$I_R = I_A + I_M + I_P$
cascading effect equations	
Area	$SI_A = (A_1M_1P_1 – A_0M_1P_1)$
Feddan productivity	$SI_M = (A_0M_1P_1 – A_0M_0P_1)$
Farm price	$SI_P = (A_0M_0P_1 – A_0M_0P_0)$
Total production value	$SI_R = I_A + I_M + I_P$
joint effect equations	
Area and productivity per feddan	$I_{AM} = ((A_1M_1P_1 – A_0M_1P_1) - (A_1M_0P_1 – A_0M_0P_1))$
Area and farm price	$I_{AP} = ((A_1M_0P_1 – A_0M_0P_1) - (A_1M_0P_0 – A_0M_0P_0))$
Feddan productivity and farm price	$I_{MP} = ((A_0M_1P_1 – A_0M_0P_1) - (A_0M_1P_0 – A_0M_0P_0))$

Where: (A0), (A1) refer to the cultivated area of the crop in the base and comparison years respectively, (M0), (M1) refer to the average production per feddan of the crop in the base and comparison years respectively, (P0), (P1) refer to the unit price of the crop production in the base and comparison years respectively.
Source: Fayyad, Sherif Mohamed Samir. (2006). The impact of economic reform policies on the export value of the most important Egyptian vegetable exports, Contemporary Egypt Magazine, Egyptian Society for Political Economy, Statistics and Legislation, Egypt, Volume (97), Issue (483), July: pp. 491-522.

By studying the effect of the change in the components of the total production value on the total production value of sugar beet crop in Egypt for the average period (2005-2022), it is clear from Table (4) that the separate effect of the change in the cultivated area only without the effect of the rest of the other components, led to an increase in the total production value by about 168.75 million pounds, while measuring the effect of the change in the cultivated area with the presence of the joint effect between the components, led to an increase in the total production value by about 206.55 million pounds. It was also shown that the separate effect of the change in productivity per feddan only without the effect of the rest of the other components, led to an increase in the total production value by about 0.44 million pounds, while measuring the effect of the change in productivity per feddan with the presence of the joint effect between the components, led to a decrease in the total production value by about 3.26 million pounds, because the percentage of decrease in the joint effect between the components affected by a greater percentage than the percentage of increase in productivity per feddan in some years, which led to a negative result on the production value. It was also shown from the same table that the separate effect of the change in the farm price only, without the effect of the other elements, led to an increase in the total production value by about 295.89 million pounds, which is the same effect in the case of the joint effect between the elements, as it was shown from the same previous table also that the joint effect between the cultivated area and the productivity of the feddan led to an increase in the total production value by about 3.57 million pounds, and it was also shown that the joint effect between the cultivated area and the farm price led to an increase in the total production value by about 34.23 million pounds, while it was shown that the joint effect between the productivity of the feddan and the farm price led to a decrease in the total production value by about 3.70 million pounds, due to the fluctuation of the productivity of the feddan during the study period, so that the decrease was significantly influential in some years and by a greater percentage than the increase in the farm price, which led to a negative result on the production value, and the validity of the results was verified through the sequential effect, which is equal to the sum of both the separate effect and the joint effect of the elements that make up the total production value of the sugar beet crop in Egypt for the average period (2005-2022).

Table (4): Quantitative analysis of the components of the total production value of sugar beet crop in Egypt for the average period (2005-2022).

variable	Separate impact (million pounds)	Cascading effect (million pounds)	variable	Combined Impact (million pounds)
Cultivated area	168.75	206.55	Cultivated area and productivity per feddan	3.57
Feddan productivity	0.44	-3.26	Cultivated area and farm price	34.23
Farm price	295.89	295.89	Feddan productivity and farm price	-3.70
Total	465.08	499.18	Total	34.10
Verify results		separate effect+ combined effect= cascading effect		
		465.08 + 34.10 = 499.18		

The sequential effect means the effect of a change in the element with the presence of a common effect between the elements.
Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, various issues.

Third: Estimating the supply response function for sugar beet crop in Egypt using different models.

Before estimating the supply response function, it is necessary to distinguish between the supply function and the supply response function. It is common to use the terms supply and supply response as synonyms when discussing the meaning of supply without distinguishing between them, as the supply function expresses a static relationship between the quantity of the crop and its price, assuming that other factors affecting the quantity supplied are constant, while the supply response function expresses a dynamic relationship between the quantity of the crop and its price, assuming that the factors affecting the quantity supplied change (Bahloul and Younes, 2022).

Thus, the supply response curve includes both the change on the same curve and the shift of that entire curve, which confirms that the supply response function is not reflexive, meaning that the factors that lead to the expansion of the supply curve, i.e. an increase in supply, are not the same factors that lead to its contraction, i.e. a decrease in supply (Ibrahim et al., 2022).

The function is not reflexive if there is a trend with rising prices and another trend with falling prices. In the case of rising prices, the quantity supplied of the commodity increases as a result of attracting resources from less profitable agricultural projects and adopting new technological methods. However, in the case of falling prices, the quantity supplied of the commodity decreases, but at a lower rate than in the stage of price increase, because if the farmer adopts a certain technological level, he rarely abandons it, because according to economic theory, the costs of the production unit decrease once modern technological methods are used (Abdel Hady and Soliman, 2014).

The quantity supplied in a certain period of time depends on the price that prevailed in the previous period of time, meaning that there is a type of lag time, and including this lag in the economic model makes the scope of the analysis closer to reality (Abdel Rahman and Qamar, 2013).

There are a number of reasons for including lag in economic models. These reasons may be psychological reasons, technological reasons, or institutional reasons. As for psychological reasons, human behavior in making decisions depends on customs and traditions on the one hand, and expectations and hopes on the other hand. While customs and traditions make the value of the past variable a determinant of the value of the current variable, expectations and hopes determine the value of the future variable. As for technical reasons, they can be explained by the fact that producing a commodity takes a period of time during which some variables related to production may change, such as input prices and wages. Also, the supply of agricultural products often depends on the prices of the previous period. As for institutional reasons, they are related to legislation and laws, such as inheritance laws and the subsequent fragmentation of possession that affects, after a period of time, farmers' decisions regarding the allocation of cultivated area (El-Showeikh et al., 2015).

The producers' response to reducing or increasing the cultivated area depends on their price expectations. Expected prices depend not only on the prices of the previous year, but on a series of previous years. In addition, they also depend on the yield of the crop and the yield of competing crops on the same agricultural area in the same cultivated season. They also depend on the costs of producing the crop and the costs of producing competing crops, as well as their prices. These factors directly affect producers' decisions to reduce or increase the cultivated area of the crop or competing crops, which is reflected in the quantity of crop production (Badr et al., 2021).

The models used are dynamic models, i.e. they contain slow time periods, because these models have the ability to obtain the Adjusted Coefficient, which indicates the extent of farmers' ability to adjust the cultivated areas based on the variables that affect the crop supply response. Table (5) shows the different formulas for supply response models.

Table (5): Different formulas for display response models

Model Name	The model
Mark Nerlove	$Y_t = C+B_1X_{(t-1)}+B_2Y_{(t-1)}$
Fisher	$y_t = C+BX_{[(t-1)+(t-2)+(t-3)]/3}$
Solo	$y_t = C+B_1X_{(t-1)}+B_2Y_{(t-1)}+B_3Y_{(t-2)}$
Jorgenson	$Y_t = C+B_1X_{(t-1)}+B_2X_{(t-2)}+B_3X_{(t-3)}+B_4Y_{(t-1)}+B_5Y_{(t-2)}$
Kudhy	$Y_t = C+B_1W_{(t-1)}+B_2Y_{(t-1)}$
Mark Nerlove Modified	$y_t=C+B_1x_{(t-1)}+ B_2G_{(t-1)}+ B_3PR_{(t-1)}$
short term flexibility	$ES= B_a*[XM_{(t-1)}/YM_t]$

Long-term flexibility	$EL= [B_a / (1-B_a)]*[XM_{(t-1)}/YM_t]$
Annual response factor	$MS= 1- B_a$
Full response time	ML= 1 / MS

Where Yt = cultivated area in the study year, Y(t-1) = cultivated area with a one-year delay, Y(t-2) = cultivated area with a two-year delay, X(t-1) = farm price with a one-year delay, X(t-2) = farm price with a two-year delay, X(t-3) = farm price with a three-year delay, X[(t-1)+(t-2)+(t-3)]/3 = average cultivated area with a one-year, two-year and three-year delay, W(t-1) = net return per feddan with a one-year delay, G(t-1) = production costs per feddan with a one-year delay, PR = price risk, which represents the standard deviation of the farm price for the previous three years, ES = short-run elasticity, EL = long-run elasticity, Ba = regression coefficient of cultivated area with a one-year delay, XM(t-1) = average farm price with a one-year delay, YMt = average area Planted in the study year, MS = annual response factor ML = full response period.

Source:

1- Sharabin, Ehab Moreed. (2014). An economic study of the response of the supply function of oil crops in Egypt, Assiut Journal of Agricultural Sciences, Faculty of Agriculture, Assiut University, Volume (45), Issue (5): pp. 153-183.
2- El-Sebaei, Momtaz Nagy Mohamed. (2015). An econometric study of the supply response of the most important grain crops in Egypt, Alexandria Journal of Agricultural Research, Faculty of Agriculture, Alexandria University, Volume (60), Issue (2): pp. 353-372.

The supply response function for sugar beet crop in Egypt was estimated during the period (2005-2022), using the models of Nerlove, Fisher, Solow, Jorgenson, Kudhy and modified Nerlove. The results of the statistical estimation of the supply response models recorded in Table (6) showed that all the aforementioned estimated models were significant at a significance level of 0.01 according to the calculated (F) value. By estimating the supply response function for sugar beet crop using the Nerlove model, it was found that the elasticity of supply response in the short and long term reached about 0.43, 0.87 respectively. This shows that an increase in the farm price by 1% leads to an increase in the cultivated area by 0.43%, 0.87% respectively. The annual response coefficient also reached about 0.50, and thus the full response period reached about 2.00 years starting from the year following planting.

Table (6): Results of estimating supply response models for sugar beet crops in Egypt during the period (2005-2022).

variable	Mark Nerlove	Fisher	Solo	Jorgenson	Kudhy	Mark Nerlove Modified
C	95.90	149.54	87.25	89.74	67.69	108.11
$X_{(t-1)}$	0.35	-	0.23	0.23	-	1.58
t	(1.72)	-	(1.47)	(0.95)	-	(4.63)**
$X_{(t-2)}$	-	-	-	-0.05	-	-
t	-	-	-	(-0.16)	-	-
$X_{(t-3)}$	-	-	-	0.07	-	-
t	-	-	-	(0.29)	-	-
$_{3/}X_{(t-1,2,3)}$	-	0.82	-	-	-	-
t	-	(9.59)**	-	-	-	-
$Y_{(t-1)}$	0.50	-	0.01	-0.01	0.74	-
t	(2.21)*	-	(0.04)	(-0.05)	(5.04)**	-
$Y_{(t-2)}$	-	-	0.68	0.68	-	-
t	-	-	(3.49)**	(2.97)**	-	-
$W_{(t-1)}$	-	-	-	-	0.02	-
t	-	-	-	-	(0.28)	-
$G_{(t-1)}$	-	-	-	-	-	-0.04
t	-	-	-	-	-	(-2.21)*
PR	-	-	-	-	-	-1.68
t	-	-	-	-	-	(-2.71)*
F-value	47.13**	91.97**	85.82**	30.47**	41.90**	36.05**
R^2-adj.	0.84	0.84	0.91	0.90	0.83	0.86
Jarque-Bera	0.52	1.09	1.13	1.06	3.56	1.60

Breusch-Godfrey	0.02	0.06	0.63	0.67	0.00	0.09
White	0.02	0.16	0.37	-	0.69	-
ES	0.43	-	0.01	-0.01	0.64	-
EL	0.87	-	0.01	-0.01	2.47	-
MS	0.50	-	0.99	1.01	0.26	-
ML	2.00	-	1.01	0.99	3.85	-

Where Yt = area planted with sugar beet in thousand feddans in the study year, $Y_{(t-1)}$ = area planted with sugar beet in thousand feddans with a one-year delay, $Y_{(t-2)}$ = area planted with sugar beet in thousand feddans with a two-year delay, $X_{(t-1)}$ = farm price of sugar beet in pounds with a one-year delay, $X_{(t-2)}$ = farm price of sugar beet in pounds with a two-year delay, $X_{(t-3)}$ = farm price of sugar beet in pounds with a three-year delay, $X_{(t-1,2,3)/3} = X_{[(t-1)+(t-2)+(t-3)]/3}$ = average farm price of sugar beet in pounds with a one-year, two-year and three-year delay, $W_{(t-1)}$ = net return per feddan of sugar beet in pounds with a one-year delay, $G_{(t-1)}$ = production costs per feddan Sugar beet yield in pounds with one year lag, PR = price risk which represents the standard deviation of the farm price of sugar beet crop for the previous three years, Ba = regression coefficient of the cultivated area with one year lag, ES = short-run elasticity, EL = long-run elasticity, MS = annual response coefficient, ML = full response period, **Significant at a significance level of 0.01, *Significant at a significance level of 0.05.

Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, Cost and Net Return Statistics Bulletin, various issues.

As for the Fisher model, it is clear from the same previous table that an increase of one pound in the farm price of sugar beet crop with an average delay of one, two, and three years leads to farmers responding by increasing the cultivated area of the crop by 820 feddans, assuming that other factors remain constant at a certain level.

As for the Solow model, it is clear from the same previous table that the elasticity of supply response in the short run is the same as in the long run and reached about 0.01, which shows that an increase in the farm price by 1% leads to an increase in the cultivated area by 0.01%, and the annual response coefficient reached about 0.99, and thus the full response period reached about 1.01 years starting from the year following planting.

As for the Jorgenson model, it is clear from the same previous table that the elasticity of supply response in the short run is the same as in the long run and reached about -0.01, which shows that an increase in the farm price by 1% leads to a decrease in the cultivated area by 0.01%, and the annual response coefficient reached about 1.01, and thus the full response period reached about 0.99 years starting from the year following planting.

As for the Kudhy model, it is clear from the same previous table that the elasticity of supply response in the short and long term reached about 0.64 and 2.47 respectively. This shows that an increase in the farm price by 1% leads to an increase in the cultivated area by 0.64% and 2.47% respectively. The annual response coefficient also reached about 0.26, and thus the full response period reached about 3.85 years starting from the year following planting.

The modified Nerlove model was also used, where other variables related to the crop were added to the basic Nerlove model and analyzed statistically, where the significance of the farm price and the cost of production per feddan of sugar beet crop in the previous year, and the price risk of sugar beet crop, which represents the standard deviation of the farm price of sugar beet crop for the previous three years, were proven. The same previous table shows the results of the modified Nerlove model, where it was shown that increasing the farm price of sugar beet crop in the previous year by one pound, leads to the farmers' response to increase the cultivated area of the crop by 1580 feddans, while decreasing both the cost of production per feddan of sugar beet crop in the previous year by one pound, and the price risk of sugar beet crop by 1%, leads to the farmers' response to increase the cultivated area of the crop by 40, 1680 feddans, respectively.

Estimating the targeted area for sugar beet cultivation in light of price changes according to the supply response models under study:

The data in Table (7) show the actual and targeted cultivated area and the difference between them according to the supply response models for the sugar beet crop in Egypt for the total period (2005-2022), as it was shown that there was an increase in the actual cultivated area, which amounted to about 7795 thousand feddans compared to its targeted counterpart according to the Mark Nerlove and Fisher models, as the increase amounted to about 28, 5 thousand feddans respectively, while it was shown that there was a decrease in the actual cultivated area compared to its targeted counterpart according to the Solow, Jorgenson, Kudhy and modified Mark Nerlove models, as the decrease amounted to about 22, 6, 29, 354 thousand feddans respectively.

Table (7): Actual and targeted cultivated area and the difference between them in thousand feddans according to supply response models for sugar beet crops in Egypt for the total period (2005 - 2022).

The model	Total targeted area	Total Actual Area - Total Target Area
Mark Nerlove	7768	28
Fisher	7790	5
Solo	7817	-22
Jorgenson	7801	-6
Kudhy	7824	-29
Mark Nerlove Modified	8149	-354

The total actual cultivated area amounted to about 7,795 thousand feddans.
Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, various issues.

Estimation of the guaranteed price of sugar beet crop in Egypt:

Sugar beet production depends on the contract farming system between producers and sugar companies, as the state, represented by the Ministry of Agriculture and Land Reclamation, attaches great importance to contract farming as one of the tools that it relies on to develop and grow the agricultural sector in Egypt. Contract farming is defined as agricultural production that is marketed based on a contract between the producer and the buyer, whereby the producer is obligated to supply according to the quantities, varieties, quality, price and other conditions included in the contract. Therefore, the objectives of contract farming are to increase the income levels of farmers, especially small farmers, by achieving a fair price for the producer and the consumer and working to reduce marketing margins. It also aims to provide an opportunity to increase the quantity supplied to the factory from the sugar beet crop, thus achieving a tangible degree of stability and sustainability for sugar production while achieving higher rates of production and marketing efficiency for the sugar beet crop in Egypt (El-Shater, 2021).

Intervention in determining farm prices is considered one of the most effective agricultural policy tools, as prices are the basic and determining factor in directing resources between different areas of production. In the sugar beet crop, it requires state intervention to determine the price of the crop, which is called the guarantee price, which is a price that encourages farmers to contract to grow the crop (Esmail et al., 2017).

Proposed methods for estimating the guarantee price for sugar beet crop in Egypt:

In this section, we will discuss the proposed methods for estimating the guaranteed price of the sugar beet crop in Egypt in order to calculate the value that will be added as net profit for the farmer. The following are these methods:

First warranty price:

The price per ton is calculated using the following law: (costs of production per feddan, including rent, plus the rent per feddan as profit for the farmer) divided by the average productivity per feddan (Ibrahim, 2023).

As shown in Table (8), the estimated guaranteed price for the sugar beet crop using this method for the average period (2005-2022) was estimated at about 346 pounds per ton, which is less than the actual price of about 410 pounds per ton by 64 pounds. Accordingly, determining the farm price using this method is not the optimal method, as the estimated price is less than the actual price.

Table (8): The actual price, the guaranteed price, and the difference between them for the sugar beet crop in Egypt during the period (2005-2022).

Year	Actual price in pounds per ton (1)	First guarantee price in pounds per ton (2)	(2) – (1)	Second guarantee price in pounds per ton (3)	(3) – (1)	Third guarantee price in pounds per ton (4)	(4) – (1)
2005	157	128	-29	136	-21	157	0
2006	172	125	-47	133	-39	166	-6
2007	164	120	-44	129	-35	188	24
2008	224	146	-78	148	-76	238	14
2009	246	174	-72	176	-70	264	18
2010	341	193	-148	199	-142	285	-56
2011	293	212	-81	218	-75	313	20

2012	345	241	-104	241	-104	336	-9
2013	399	267	-132	281	-118	361	-38
2014	427	285	-142	301	-126	393	-34
2015	419	312	-107	338	-81	416	-3
2016	457	428	-29	399	-58	448	-9
2017	417	490	73	495	78	507	90
2018	579	509	-70	527	-52	566	-13
2019	693	589	-104	638	-55	677	-16
2020	663	647	-16	719	56	762	99
2021	670	655	-15	741	71	803	133
2022	720	704	-16	810	90	875	155
Mean	410	346	-64	368	-42	431	21

Where: (1) The actual price is the farm price, (2) The first guarantee price = (costs of production per feddan including rent + rent per feddan as profit for the farmer) ÷ average productivity per feddan, (3) The second guarantee price = (costs of production per feddan including rent + 50% of the cost of production per feddan including rent) ÷ average productivity per feddan, (4) The third guarantee price = the product of multiplying the cost of living index for the base year 2005 by the actual price for previous years.

Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, various issues.

Second warranty price:

The price per ton is calculated using the following law: (costs of production per feddan, including rent, plus 50% of the costs of production per feddan, including rent) divided by the average productivity per feddan (Abdul Aziz and Harby, 2022).

As shown in Table (8), the estimated guaranteed price for the sugar beet crop using this method for the average period (2005-2022) was estimated at about 368 pounds per ton, which is 42 pounds less than the actual price of about 410 pounds per ton. Accordingly, determining the farm price using this method is not the optimal method, as the estimated price is less than the actual price, but it is better than the first method.

Third warranty price:

The price per ton is calculated using the following law: multiplying the cost of living index for the base year 2005 by the actual price for previous years (Esmail et al., 2017).

As shown in Table No. (8), the estimated guaranteed price for the sugar beet crop using this method for the average period (2005-2022) was estimated at about 431 pounds per ton, which is 21 pounds more than the actual price of about 410 pounds per ton. Accordingly, determining the farm price using this method is the optimal method, as the estimated price is greater than the actual price, as this method is considered the best way to determine the farm price, which allows for a profitable net return for the farmer, encouraging him to increase production.

Forecasting the area planted with sugar beet crop in light of the Akaike criterion according to the models under study:

Based on the properties of the appropriate model and the criteria of autocorrelation, the scientist Akaike proposed a criterion named after him to identify the best model, as the model that has the lowest value of the Akaike criterion is considered the best model because it reduces the difference between the estimated model data and the actual model data. This criterion was used because it is more suitable for the study data, because it excludes or neglects any effect due to the time-lag or time-slowed periods, as it is preferable in statistical applications to use autoregressive models for time series with finite ranks because they give realistic results when we perform the prediction process, as determining a rank lower or higher than the actual rank will lead to inaccuracy in estimating the model coefficients, as knowing the best model is one of the most important stages of statistical analysis, and therefore we used the Akaike criterion shown in Table (9) (Abdel Ahad, 2011).

Table (9): Akaike criterion used to select the best prediction model.

AIC = nLn (σ2 ε) + 2k
Where: AIC = Akaike criterion, Ln = natural logarithm, K = number of parameters in the model, σ2 ε = amount of variance for the error, n = number of observations

Source: Abdel Ahad, Manahil Daniel. (2011). Forecasting sugar sales in Mosul factory using Akaike criterion, Journal of Education and Science, College of Education for Pure Sciences, University of Mosul, Iraq, Volume (24), Issue (1): pp. 114-122.

In order to predict the area planted with sugar beet in Egypt during the period (2023-2030), the Akaike criterion was used to choose the best prediction model from among the models under study. From the data shown in Table (10), it was found that the Solo model is the best prediction model according to the Akaike criterion, which amounted to about 10.70, as it is expected that the area planted with sugar beet in Egypt will increase from about 696 thousand feddans in 2023 to about 888 thousand feddans in 2030 with an average area of about 792 thousand feddans and an increase rate of about 27.69% over 2023, followed in order by the models of Jorgenson, modified Mark Nerlove, Fisher, Mark Nerlove, and Kudhy according to the Akaike criterion, which amounted to about 10.91, 11.14, 11.18, 11.21, 11.31. The area planted with sugar beet in Egypt is expected to increase from about 695, 722, 683, 682, 675 thousand feddans in 2023 to about 887, 921, 867, 867, 852 thousand feddans in 2030, with an average area of about 791, 822, 775, 774, 763 thousand feddans, with an increase rate of about 27.71%, 27.51%, 26.97%, 27.07%, 26.22% over 2023, in the same order.

Table (10): Forecasting the area planted with sugar beet crop in Egypt in thousand feddans in light of the Akaike criterion according to the models under study during the period (2023-2030).

Year	Forecasting the planted area according to the Mark Nerlove model	Forecasting the cultivated area according to the Fisher model	Forecasting the cultivated area according to the Solo model	Forecasting the cultivated area according to the Jorgenson model	Forecasting the cultivated area according to the Kudhy model	Forecasting the planted area according to the modified Mark Nerlove model
Akaike standard	11.21	11.18	10.70	10.91	11.31	11.14
2023	682	683	696	695	675	722
2024	708	709	723	722	700	751
2025	735	735	751	750	725	779
2026	761	761	778	777	751	808
2027	788	788	806	804	776	836
2028	814	814	833	832	801	864
2029	840	840	861	859	827	893
2030	867	867	888	887	852	921
Average	774	775	792	791	763	822
Increase rate (%)	27.07	26.97	27.69	27.71	26.22	27.51

Source: Collected and calculated from data from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, various issues.

Conclusion:

Sugar beet is considered one of the important crops for sugar production in Egypt, as the state has adopted interest in this crop, as the agricultural policy seeks to achieve self-sufficiency in sugar by expanding the area planted with the crop and working to increase its production, which leads to increasing its contribution to sugar production due to its relatively low water requirements compared to the sugar cane crop, which has high water requirements, in light of the limited water element.

Sugar beet crop is affected by a set of economic policies, perhaps the most prominent of which is the agricultural pricing policy, which plays an effective role in increasing production and thus raising the level of farmers' income.

The research problem lies in the inability of local sugar production to meet local consumption, as local sugar production has reached about 2.84 million tons, while local consumption has reached about 3.27 million tons, and thus the sugar food gap is estimated at about 430 thousand tons of sugar, representing about 15.14% of local sugar production for the average period (2020-2022), as the state imports this quantity from abroad, which represents a burden on the state's trade balance, especially in light of the difficulty of providing foreign currencies.

Since sugar production from sugar beet crop depends on the quantity supplied from the crop to sugar producing factories, which depends mainly on the area planted with the crop, which is affected by price fluctuations in the price of the crop and the prices of competing crops, the state therefore uses price incentives to encourage farmers to grow sugar beet crop, which requires identifying the impact of these price changes on the sugar beet crop in Egypt.

The research aims to identify the impact of price changes on sugar beet crop in Egypt, by identifying the role of farm price in changing the value of production and thus farmers' income from sugar beet crop in Egypt, using the triple discrete effect, estimating the supply response function for sugar beet crop in Egypt using different models, estimating the targeted area for sugar beet cultivation in light of price changes according to the supply response models under study, estimating the guaranteed price for sugar beet crop in Egypt, and predicting the area planted with sugar beet crop in light of the Akaike criterion according to the models under study.

The research relied on descriptive and quantitative analyses to achieve its objectives to analyze data related to the research topic by using some mathematical and statistical methods such as arithmetic averages, percentages, and regression analysis to estimate the general time trend, and using index numbers to measure the separate triple effect using the change partitioning method, and supply response functions according to the models of Mark Nerlove, Fisher, Solo, Jorgenson, Kudhy, and modified Mark Nerlove, and using the Akaike criterion for Forecasting.

The research results showed that the cultivated area, total production, farm price, production costs per feddan, total revenue per feddan, and net return per feddan of sugar beet crop in Egypt during the period (2005-2023) had a statistically significant annual increase estimated at about 27.40 thousand feddans, 562.26 thousand tons, 34.35 pounds per ton, 567.38, 706.29, 138.92 pounds, equivalent to about 6.33%, 6.23%, 8.37%, 11.14%, 8.28%, 4.04% of the annual average estimated at about 433 thousand feddans, 9027 thousand tons, 410 pounds per ton, 5095, 8531, 3436 pounds respectively, while the significant decrease in productivity per feddan was not proven.

By identifying the role of the farm price in changing the value of production and thus the income of farmers from the sugar beet crop in Egypt using the triple separate effect, it was found that the separate effect of the change in the cultivated area only without the effect of the rest of the other elements, led to an increase in the value of the total production by about 168.75 million pounds. It was also found that the separate effect of the change in productivity per feddan only without the effect of the rest of the other elements, led to an increase in the value of the total production by about 0.44 million pounds. It was also found that the separate effect of the change in the farm price only without the effect of the rest of the other elements, led to an increase in the value of the total production by about 295.89 million pounds.

The supply response function for sugar beet crop in Egypt was estimated during the period (2005-2022), using the models of Nerlove, Fisher, Solo, Jorgenson, Kudhy and modified Nerlove. The results of the statistical estimation of the supply response models showed that all the aforementioned estimated models were significant at a significance level of 0.01 according to the calculated (F) value. By estimating the supply response function for sugar beet crop using the Nerlove model, it was found that an increase in the farm price by 1% leads to an increase in the cultivated area by 0.43%, 0.87% respectively. The modified Nerlove model was also used, where other variables related to the crop were added to the basic Nerlove model and analyzed statistically, where the significance of the farm price and the cost of production per acre for sugar beet crop in the previous year was proven, as well as the price risk for sugar beet crop, which represents the standard deviation of the farm price for sugar beet crop for the previous three years, where It was found that an increase in the farm price of sugar beet in the previous year by one pound leads to a response from farmers to increase the cultivated area of the crop by 1580 feddans, while a decrease in both the cost of production of an feddan of sugar beet in the previous year by one pound, and the price risk of sugar beet by 1%, leads to a response from farmers to increase the cultivated area of the crop by 40 and 1680 feddans, respectively.

By estimating the targeted area for sugar beet cultivation in light of price changes, it was found that there was a decrease in the actual cultivated area compared to its targeted counterpart according to the Solow, Jorgenson, Kudhy, and modified Mark Nerlove models, where the decrease amounted to about 22, 6, 29, and 354 thousand feddans, respectively.

By estimating the guaranteed price of the sugar beet crop in Egypt for the average period (2005-2022), it was found that the guaranteed price estimated using the product of multiplying the cost of living index for the base year 2005 by the actual price for previous years was estimated at about 431 pounds per ton, which is 21 pounds more than the actual price of about 410 pounds per ton. Accordingly, determining the farm price using this method is the optimal method, as the estimated price is greater than the actual price. This method is considered the best way to determine the farm price, which allows for a profitable net return for the farmer, encouraging him to increase production.

The area planted with sugar beet was predicted in light of the Akaike criterion according to the models under study, as the model with the lowest value of the Akaike criterion is considered the best model because it reduces the difference between the estimated model data and the actual model data. This criterion was used because it is more suitable for the study data, as it excludes or neglects any effect due to the time-lag or time-shifted periods, as it was found that the Solow model is the best model for prediction according to the Akaike criterion, which amounted to about 10.70, as it is expected that the area planted with sugar beet in Egypt will increase from about 696 thousand feddans in 2023 to about 888 thousand feddans in 2030 with an average area of about 792 thousand feddans and an increase rate of about 27.69% over 2023.

In light of the results reached, the research recommends the following:

1- Activating the role of agricultural guidance in encouraging farmers to grow sugar beet, as it can be grown in saline, calcareous and newly reclaimed lands.
2- The necessity of paying attention to raising the farm price of sugar beet crop, which encourages farmers to increase the cultivated area.
3- Providing control over the prices of production requirements to ensure that production costs do not rise and thus farmers refrain from growing the crop.
4- Guidance by the estimated guarantee price using the product of multiplying the current year's cost of living index by the actual price of the previous year, as determining the farm price using this method is the optimal method, which allows for a profitable net return for the farmer, encouraging him to increase production.

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