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Research Article

# The Impact of using Technology Packages on the Economics of Sugar beet Production in Egypt): A Case Study in Fayoum Governorate

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## Abstract

The data indicates a decrease in the self-sufficiency rate of sugar year after year. It is clear that there is a great difficulty in increasing the area of sugar cane, in exchange for an opportunity to increase the area of sugar beet in the lands. Modern reclamation and producers face difficulty in using and applying the technological packages used in the production of sugar beet. The Fayoum governorate is considered one of the most important sugar beet producing governorates. Therefore, an intentional random sample was taken from the sugar beet producers in it from the users of the technology package (laser, cultivation using the Printer machine, and fertilization inside the irrigation hoses). It became clear from the results of the productivity function that the most important factors affecting the production function are evident. The element of the number of automatic working hours in laser leveling has a direct effect, while the two elements of seed and nitrogen fertilization have an opposite effect, that is, rationalizing them and not being wasteful in both leads to an increase in beet production. Automatic and reverse increase by rationalizing seed cultivation and fertilization inside the irrigation hoses, and the preference of the producers who used the bundles was confirmed, as the production reached 24.6 tons of beets per feddan, compared to 20.5 tons for non-users of the bundles, and the net yield per feddan amounted to about 10165 pounds, compared to 4130 pounds for non-users of the bundle. Therefore, the research recommends paying attention to the cultivation of sugar beet using the technological package, expanding its cultivation in new lands, and working to contract with producers in the supply of the crop, and for the factory to receive the production at the date agreed upon with the producer.

**Keywords:** Technology, Packages, Sugar beet, Egypt, laser levelling, Nitrogen



## Introduction

Sugar beet cultivation excels in low-fertile lands and has proven successful in newly reformed lands, outperforming all winter crops that could be grown in these areas. In addition to being a cash crop whose marketing and price are contracted in advance and it does not bear any marketing burdens. This makes it much easier for the Egyptian agricultural policy makers to expand horizontally in its cultivation, especially in northern and central Egypt, in the new lands surrounding the beet sugar factories. In addition to its superiority in that it is the least consuming of water, which is recommended with it the

need to expand the cultivation of the sugar beet crop, It is not true that sugar beet is a competing crop with sugar cane, but rather a complementary crop to it, because sugar beet is grown in the Delta and the New Lands, while sugar cane is not grown in the Delta, but rather in Upper Egypt. Whereas, the cane crop needs 12000 cubic meters per feddan, while the beet crop needs 2572 cubic meters per feddan. Therefore, the expansion of sugar beet cultivation will lead to an increase in the total amount of sugar produced in Egypt, which will benefit the national income. In addition to this, the cultivation of sugar beet in the Delta includes the introduction of a profitable winter crop into the agricultural rotation at a time when agricultural operations are reduced. Sugar beet cultivation also includes the establishment of an industry for extracting sugar from beets, which absorbs labor force, which brings prosperity to the population. The area of sugar beet in Egypt is about 408 thousand feddans, of which 33.3 thousand feddans are cultivated in Fayoum, representing about 8.7%. The production of sugar beet is about 8559 thousand tons, of which about 695 thousand tons are produced in Fayoum, representing about 8.1% of the Republic's production for the average period (2005-2022).

**Research Problem**

The increase in sugar production and supply is not commensurate with the continuous and increasing domestic demand for it, due to the steady population increase. Which requires attention to increase the production of both the sugar cane and sugar beet crops to increase the production of sugar to meet the needs of local consumption of it, as the data indicate a decrease in the self-sufficiency rate of sugar year after year It is clear that there is a great difficulty in increasing the area of sugar cane while there is an opportunity to increase the area of sugar beet in the newly reclaimed lands, and the producers face difficulty in using and applying the technological packages used in the production of sugar beet.

The research aims in general to study the productive and economic efficiency of the resources used in the production of the sugar beet crop, and it also aims in particular to:

1- Identifying the development of the production status of the sugar beet crop at the level of the Republic and Fayoum Governorate

2- Studying the current situation of the sugar beet crop, estimating its production, and how to transfer the supply function using technological packages, and challenging the most important factors affecting its production through the study sample in Fayoum Governorate.

3- A study of economic efficiency indicators for the production of sugar beet crop.

## Methodology

The research relied in its research method on the use of descriptive and quantitative economic analysis through the use of mathematical, statistical and analytical methods and tools. With economic and statistical reasoning.

As for the data, it was obtained from an intentional random sample of 150 producers in Fayoumah Governorate, from Ibshway and Youssef El-Seddik centers, divided into about 100 producers who use laser technology and agriculture using printers and fertilization in irrigation hoses, and about 50 producers who do not use technologies in the cultivation of sugar beet.

## Results

**The development of sugar beet area and production during the period:(2021-2005)**

By studying the general temporal trend of the area cultivated with the sugar beet crop in the Arab Republic of Egypt, it became clear that the significant increase in the area was about 26 thousand feddans, representing about 66.3% of the average area in the Republic,

amounting to about 408 thousand feddans for the average period (2021-2005),The coefficient of determination is about 0.85, which means that 85% of the changes in the beet area are due to the time factor. While the statistically significant annual increase of the area in Fayoum Governorate is about 0.289 thousand feddans, representing about 0.86% of the average area of about 33.3 thousand feddans, and the determination coefficient is about 0.32. As for the production of sugar beet at the level of Egypt, the statistically significant annual increase is about 526 thousand feddans, representing about 526 thousand tons, representing about 6.1% of the average production for the study period. The coefficient of determination is estimated at about 0.80, while the annual increase in sugar beet production in Fayoum is about 26 thousand tons, representing about 1.33% of the average beet production of about 695 thousand tons. The coefficient of determination is about 0.44. The area is due to the acre productivity, as the production is the product of multiplying the acre productivity by the area, which confirms that the acre productivity increases at a rate greater than the area increase, as shown in Table 1.

Table 1. Equations of the general time trend for the area and production of sugar beet in Egypt during the period(2021-2005)

| No. | Variable | Equation | $R^2$ | Annual Changing Rate |
|---|---|---|---|---|
| 1 | The cultivated area of sugar beet in Egypt (thousand acres). | $\hat{Y}i$ =173 + 26 Xi ** (9.4) | 0.85 | 6.3 |
| 2 | The cultivated area of sugar beet in Fayoum (thousand feddans). | $\hat{Y}i$ =30.7 +0.289Xi ** (2.7) | 0.32 | 0.86 |
| 3 | The amount of sugar beet produced in Egypt (thousand tons). | $\hat{Y}i$ = 3853+526Xi * * (7.7) | 0.80 | 6.1 |
| 4 | The amount of sugar beet produced in Egypt (thousand tons). | $\hat{Y}i$ = 661 + 9.3 Xi ** (3.5) | 0.44 | 1.33 |

Since $\hat{Y}i$ indicates the estimated value of the dependent variable and Xi refers to the element of time as an independent variable since i (1, 2, 3, 4 ..... 17.)

** Significant at the level of 1%. * Significant at the level of 5%.

**Source**: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Economics Publications, Miscellaneous Editions.

**Sugar beet production function for users of technology packages and non-users of packages**

To obtain the sugar beet production function, some mathematical models must be used in order to choose from them that are consistent with economic and statistical logic, so the production function was estimated in linear and double logarithmic terms using multiple regression analysis, then using phased regression Stepwise Regression Analysis, through which the most important factors affecting the amount of sugar beet production were reached, as shown in Table 2.

And dummy variables can be used in estimating the production function to indicate whether there is an effect of the technologies or not, and by using the dummy variables (d1), the value (zero) was set at the beginning for the old lands and the value (one) was for the newly reclaimed lands, while the second dummy variable was set In which the technology package (d2) was used, in which the value (zero) was set for the product that was not used for technology, and the value (one) in which the technology package is represented is thus (laser leveling, which reduces the amount of water to level the ground and increase germination, and so on Planting with a printer, which performs planting at equal distances, reduces the use of seeds, rationalizes and preserves the amount of seeds, and also uses the addition of chemical fertilizers in irrigation hoses to maintain the amount of fertilizers without waste and waste in the amount of fertilizer), which we put the value (one) for the producers Users of technologies, and the linear and logarithmic double images were used to show the best images of the productivity function, whose results are

consistent with economic and statistical logic. This has been the introduction of the production amount of sugar beet in tons (y) Dependent change, and each of the number of mechanical working hours, the most important of which is laser leveling (x1), the amount of municipal fertilizer per meter (x2), the amount of seeds per kilogram per feddan (x3), and the amount of phosphate fertilizer by the number Effective units (x4), the amount of nitrogen fertilizer in effective units (x5), the amount of potassium fertilizer in effective units (x6), the value of pesticides in pounds (x7), and the amount of water per square meter ( x8) and dummy variables, using phased gradient regression.

It turned out that the most important factors influencing the production of sugar beet in the study sample in the old and new lands (recently reclaimed) together are the amount of mechanical work per hour, the number of seeds, and the amount of nitrogen fertilizer, as by increasing the element of mechanical work by one unit, it led to an increase in the production of the beet crop by about 0.239. tons, which indicates the direct increase of the laser leveling factor. On the other hand, the function showed in linear form that with a decrease or rationalization of the elements, the number of seeds by one unit increases for the amount produced of beets by about 0.555, 0.025 tons / feddan, which confirms the importance of using technological packages. Significance of the dummy variable of the type of land and the significant of the second dummy variable, which is the impact of the use of technological packages on beet production. The coefficient of determination was 0.91, which means the effect of the previous factors on production. As for the double logarithmic picture, the same elements of the picture were shown to be linear, as by increasing the mechanical work element by 1%, the production of sugar beet increased by about 0.105%, and by decreasing and rationalizing the use of the two elements of seed production and nitrogen fertilizer by about 1%, the production of beets increased by about 0.074%, 0.020%. The coefficient of determination is estimated at about 0.93, and the significance of the imaginary variables of the technological package (d2) was confirmed, which means its positive effect on the production of sugar beet, that is, the agricultural technologies (for the technology package, laser, agriculture using the printer machine, and chemical fertilizers in irrigation hoses) have A positive effect, and the statistical significance of the sham variable of land quality (d1) was not confirmed.

And from the estimation of the production function, it is clear that the element of the number of mechanical working hours in the laser leveling has a direct effect, while the two elements of seed and nitrogen fertilization have an opposite effect, that is, rationalizing them and not being wasteful in both leads to an increase in beet production.

Table 2. Functions of sugar beet production using stepwise gradient regression for the study sample.

| Sports photo | The equation | $R^2$ | F |
|---|---|---|---|
| linear | Y= 23.9+0.239 X1-0.555X3-0.029X5+5.6D2<br>(3.3)** ((-2.4)** -3.5)** (10.2)** | 0.91 | 144.5 |
| Logarithmic | LN Y= 3.17+0.105LNX1-0.074LNX3-0.058LNX5+0.25ID2<br>(4.27)** (-2.2)* (-2.8)** (12.03)** | 0.93 | 181.9 |

Where :

Y: the average produced quantity in tan / feddan) . X1: Automatic work (hours/feddan)

X3: The seed quantity in kilograms X5: the amount of nitrogen fertilizer in active units

** Level of significance at 0.01 * Level of significance at 0.05 - not significant

**Marginal production and productive flexibility of the factors affecting the production of sugar beet**

It is possible through estimating the production functions for users of technologies and non-users of technology (laser, cultivation using the printer machine, fertilization in

irrigation hoses) to obtain the marginal product and the productive flexibility of the elements affecting the production of sugar beet, which is evident from Table No. (3) that the marginal product of the elements Automated work in the case of laser leveling, the amount of seeds, the amount of nitrogen units, which amount to about 0.452, -1.83, -0.089 tons, while it turned out that the productive flexibility of the previous elements, respectively, is about 0.194, -0.184, -0.383, respectively. While in the case of not using technology (laser and printer machine in agriculture and fertilization in irrigation hoses), the results indicated that the marginal product value of the previous elements is about 0.343, -0.391, 0.034, respectively, while the productivity elasticity of the previous elements, respectively, is estimated at 0.105% , -0.056% , 0.241% It is clear from the results that the marginal product and flexibility of package users is greater than that of non-users.

Table 3. Marginal product and production elasticity of the most important elements affecting the production of sugar beet for non-users of technology packages and users of packages in the study sample.

| Productive element | Technology package users | | Non-users of technology packages | |
|---|---|---|---|---|
| | Marginal output | Productive flexibility | Marginal output | Productive flexibility |
| Automated work | 0.452 | 0.194 | 0.343 | 0.105 |
| Seeds | 1.38- | 0.184- | 0.391- | 0.086- |
| Nitrogen fertilizer | 0.089- | 0.383- | 0.034 | 0.241 |

Source: Calculated from the study sample data for sugar beet producers in the year 2022-2023

**The effect of using laser, print and fertilization technology on the transfer of sugar beet production function**

Using multiple regression, where the dependent factor is the production quantity of sugar beet crop, in tons

(Y) As for the independent factors, it is the quantity of the productive element involved in the production process, which confirmed the level of statistical significance for each observation, and it is expressed in the variable (X), then the nominal variable (2d) is entered and it is expressed In the function, the value (zero) is for non-technology users and the value (one) is for users, which is expressed in the function by the variable (2d), after which the variable (X) is multiplied by the imaginary variable (d2) to obtain ( (d2X) In order to obtain the effect of technology on the element for the transmission of the production function of the element, the value in front of (X) is combined with the value in front of (d2x) and the result of the combination is known as the technological effect of the element on the transmission of the production function, which amounts to about 0.0 .335 tons of sugar beet, as in the first equation in table (4), that is, the automated work element, using this technology, leads to the transmission of the sugar beet width function upwards, while it was clear from the rationalization of the seed element using the printer machine, which leads to a reverse direction for the transmission of the width function and the amount of 0.835 tons, while it was found that rationalizing the use of nitrogen fertilizer by fertilizing in irrigation hoses may lead to a negative trend. Q for the display function, reaching about 0.084 tons. For clarification and demonstration, the following form was used

Transmission of the production function in the manner of dummy variables

To identify the source of the difference using dummy variables, the used model can be described as follows:

$Yt=a+b1X+b2D+b3 X D$

Where Yt = the dependent variable

X = the independent variable (the production factor that has a significant effect on crop production).

D = a transitional variable by taking the value (zero) for not using the technologies and the value (the correct one) for the user of the technology

X D = D * X

From this equation, the equation representing the first period can be derived as follows:

Y X 1=a+b1 X

The equation representing the second period can also be derived as follows:

Y x2= (a=b2) + (b1+b3) X or Y x2=a+B X

Table 4. The standard estimate of the effect of using the technology package (laser leveling, printer seeds, and fertilization in irrigation hoses) on the transmission of the production function of the sugar beet crop in the study sample.

| Element | Technology | The equation | $R^2$ | F | الأثر |
|---|---|---|---|---|---|
| Automated work | Laser, seed printing and fertilization | $Y^ = 15.5 + 0.025X_1 – 0.19\ d_1 + 0.124\ d_1X_1$ ( 0.2) -0.07)- ( 1. 3) | 0. 41 | 17.8 | 01 49 |
| The piety | Laser, seeds and fertilization | $Y^ = 14.7 + 0.47X3 + 1.1d_1 + 0.5d_1X_3$ ( 1. 4) ( 0.94) ( 0.3 )- | 0.66 | 48.3 | 0.056 |
| Fertilization | Laser, seeds and fertilization | $Y^ = 15.8 + 0.046\ X_1 + 2.1\ d_2 + 0.049\ d_2X_2$ ( 0.97) (1.3)- ( 0.82) | 0. 64 | 45 | 0.096 |

Source: Calculated from the study sample data for sugar beet producers in the year 2022-2023.

**Measures of productive and economic efficiency**

There are many measures of productive and economic efficiency to infer the extent of the efficiency of the production process in the sample of the study and to measure the profitability of the agricultural activity. Therefore, this study relied on the most important of these measures, which are as follows:

**First: the measure of the efficiency of using the land element (average productivity per acre).**

There is no doubt that the use of technological packages (laser, printer and chemical fertilizer inside the irrigation hoses) is considered one of the important factors for vertical expansion in light of the limited land resources. Changes in the feddan yield are a reflection of many technical, economic and social procedures. Table No. (5) shows the productivity of an acre of sugar beet, as it shows the efficiency of the producers who use the technology package, where the feddan productivity is 24.6 tons, while the productivity per feddan for non-users of the technology package is about 20.5 tons/acre

**Second: The net yield per feddan of sugar beet**

The net yield per unit area depends on the prices of the inputs of the production process, the prices of the final and by-products of the crop, in addition to the average productivity per unit area. It is the result of subtracting the total revenue from the total costs, and this measure is considered one of the comprehensive measures of economic efficiency, as it is useful in knowing the difference in returns and receipts from different crops. About 4132 pounds for non-users of the technology package in the study sample

**Third: The rate of return per feddan over costs for sugar beet**

Rate of return to costs: It is the ratio between the value of production to the cost of production elements used in the production process. It was found from the table that the rate of return on costs for users of technology packages is about 0.67 pounds, while it is about 0.285 for non-users of packages, in the study sample it is about 2.76 pounds.

**Fourth, the unit cost of sugar beet production**

The cost of the unit produced is calculated by dividing the total costs by the average production per feddan of the crop, as this measure is useful in identifying the cost of the

unit produced of the crop. The cost of the unit produced for users of the technology package is about 617 pounds, while it is about 708 pounds for non-users of the package.

Table 5. Efficiency measures for users of technology packages and non-users of sugar beet in Fayoum Governorate.

| Statement | Technology package users | Non-technology package users |
|---|---|---|
| Feddan productivity (ton/feddan). | 24.6 | 20.5 |
| The price of a ton is in pounds | 1030 | 910 |
| Total acre costs | 15173 | 14523 |
| Acre revenue | 25338 | 18655 |
| Net return | 10165 | 4130 |
| Ton cost | 617 | 708 |
| Net return on costs | 0.67 | 0.285 |

Source: Calculated from the data of the study sample of sugar beet producers for the year 2022-2023

## Conclusion

The population increase in Egypt devours the supply of sugar production to increase the continuous and growing domestic demand for it. The data indicates a decrease in the self-sufficiency rate of sugar year after year. It is clear that there is a great difficulty in increasing the area of sugar cane, in exchange for an opportunity to increase the area of sugar beet in the lands. Modern reclamation and producers face difficulty in using and applying the technological packages used in the production of sugar beet. The Fayoum governorate is considered one of the most important sugar beet producing governorates. Therefore, an intentional random sample was taken from the sugar beet producers in it from the users of the technology package (laser, cultivation using the Printer machine, and fertilization inside the irrigation hoses). It became clear from the results of the productivity function that the most important factors affecting the production function are evident. The element of the number of automatic working hours in laser leveling has a direct effect, while the two elements of seed and nitrogen fertilization have an opposite effect, that is, rationalizing them and not being wasteful in both leads to an increase in beet production. Automatic and reverse increase by rationalizing seed cultivation and fertilization inside the irrigation hoses, and the preference of the producers who used the bundles was confirmed, as the production reached 24.6 tons of beets per feddan, compared to 20.5 tons for non-users of the bundles, and the net yield per feddan amounted to about 10165 pounds, compared to 4130 pounds for non-users of the bundle. Therefore, the research recommends paying attention to the cultivation of sugar beet using the technological package, expanding its cultivation in new lands, and working to contract with producers in the supply of the crop, and for the factory to receive the production at the date agreed upon with the producer, as it became clear that the delay in receiving the crop leads to a decrease in sugar in beets, in addition to fungal growth and crop damage

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