



Economic efficiency of resources used in the production of the most important varieties of rice in Beheira Governorate

Prof. Dr. Ramadan Ahmed Mohamed Hassn¹, Dr. Mervat Rofael Girgis Youssef², Dr. Reda El -Sayed Mohamed Morsi³

¹ Professor of Agricultural Economics, Agricultural Economics Research Institute, Agricultural Research Center – Egypt.

²Senior Researcher, Agricultural Economics Research Institute, Agricultural Research Center, Egypt.

³Senior Researcher, Agricultural Economics Research Institute, Agricultural Research Center, Egypt.

Emails: economic.ramadan72@gmail.com¹, mervat_economic@yahoo.com², redaelsayad802@gmail.com³

Abstract: The results of the analysis of production cost structure, production outputs, and economic indicators for the most important rice varieties of Beheira Governorate during the summer production season 2024, showed that the Super 300 rice variety achieved an increase in productivity per feddan of approximately 0.6 ardebs/feddan compared to the Sakha 108 rice variety and 1.3 ardebs/feddan compared to the Giza177 rice variety, this represents an increase of approximately 5.13% and 11.82%, respectively. The total costs decreased by approximately 10% and 22.4% compared to the two aforementioned varieties. This resulted in an increase in the productivity per feddan for this variety by 6.4% compared to the Sakha 108 rice variety and by approximately 14.4% compared to the Giza 177 rice variety. This was reflected in an increase in the net return for the Super 300 rice variety by 30% and 99% compared to the two aforementioned varieties, respectively, leading to an increase in both relative profitability and revenue to costs percentage. In terms of the rate of return on the invested pound, it is 52.8%, 16.9%, and 42.4% compared to the Sakha 108 rice variety, and 176.7%, 39.6%, and 141% compared to the Giza 177 rice variety. Therefore, the most important rice varieties of Beheira Governorate can be ranked according to their productive and economic efficiency as follows: Super 300 rice comes in first place, followed in second place by Sakha 108 rice, and then Giza177 rice comes in last place.

The results of estimating the production functions for the most important rice varieties of Beheira Governorate showed that there is a direct relationship between the quantity of production of the Super 300 rice variety and the production inputs affecting the production of that variety, the most important of which are the quantity of seeds, the quantity of nitrogen fertilizer and the quantity of pesticides, as they have a positive effect. The results of the estimation showed that the function for the aforementioned variety has an increasing return on scale, and the value of the marginal product of the production inputs is higher than the price of the production inputs. Therefore, the farmer of this variety should increase the quantities used of the aforementioned inputs in the production of the variety until the value of the marginal product of each input is equal to its price in order to increase his profits. On the other hand, there is an inverse relationship between the quantity of production of Super 300 and agricultural labor, which has a negative effect on the productivity of the variety, which indicates a waste in the use of this input. Therefore, farmers of the Super 300 rice variety should reduce the quantities used for this input.

As for the production function of the Sakha 108 variety, it resulted in a direct relationship between the quantity of production and the productive inputs affecting the variety's production, the most important of which are automated labor, the quantity of nitrogen fertilizer, and the quantity of pesticides, as they have a positive effect. The results also showed that the aforementioned function has an increasing return on capacity, and the value of the marginal product of the productive inputs is higher than the price of the productive inputs. Therefore, the Sakha 108 farmer must increase the quantities used of the aforementioned inputs in his production until the value of the marginal product of each input is equal to its price, which results in an increase in his profits. On the other hand, there is an inverse relationship between the quantity of production of the Sakha 108 variety and the quantity of seeds, as it has a negative effect on the variety's productivity, which indicates a waste in the use of this input. Therefore, farmers of this variety must reduce the quantities used of it.

The results of the production function estimation for the Giza 177 variety show an inverse relationship between the quantity of Giza 177 production and automated labor, the quantity of seeds, the quantity of nitrogen fertilizer, and the quantity of phosphate fertilizer, as these have a negative impact on its productivity. This indicates a waste in the use of the aforementioned inputs, and therefore, farmers of the Giza 177 variety should reduce the quantities used of these inputs, as continuing to add units of the inputs used during this stage is illogical.

The results indicated that if the farmer implements the proposals developed in the research, this will contribute to increasing rice production in Beheira Governorate by applying one of the following scenarios:

The first scenario: using the maximum amount of inputs with a positive effect and the minimum amount of inputs with a negative effect on the production function of rice varieties Super 300, Sakha 108 and Giza 177 in Beheira Governorate will lead to an increase in the production quantity of these varieties at the level of Center (Damanhour, Abu Hummus, El-Delengat and Itay El-Baroud) by about 38.57 thousand ardebs, resulting in an increase in the net return for the farmers of the aforementioned varieties by about 64.9 million GEP at the level of the research area, resulting in an increase in the governorate's production quantity of the crop by 2.04%.

The second scenario: Replacing the less productive rice varieties Sakha 108 and Giza 177 with the higher productivity Super 300 in Beheira Governorate will result in an increase in rice production at the level of Center (Damanhour, Abu Hummus, El-Delengat and Itay El-Baroud) by about 32.7 thousand ardebs, resulting in an increase in the net return for the farmers of those varieties by about 52 million pounds. When generalizing the application of the second scenario at the level of Beheira Governorate, when replacing the less productive varieties, Sakha 108 and Giza 177, with the high productivity Super 300 rice variety, will result in an increase in the quantity of rice production in the governorate by 3.4%.

The research recommends the following:

1. The rice varieties cultivated in Beheira Governorate should be redistributed to ensure optimal production inputs utilization in crop production, which results in an increase in the net return for farmers.
2. The Ministry of Agriculture and Land Reclamation and its affiliated research centers should expand their efforts in developing high-productivity rice varieties, in consistent with the search results.
3. The role of the agricultural extension service and research centers Agriculture should be strengthened to persuade farmers to adopt modern production methods by utilizing high-productivity varieties and the optimal allocation of production inputs.

[Ramadan Ahmed Mohamed Hassn, Mervat Rofael Girgis Youssef, Reda El -Sayed Mohamed Mors. **Economic efficiency of resources used in the production of the most important varieties of rice in Beheira Governorate.** *Nat Sci* 2025,23(12):1-14]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). <http://www.sciencepub.net/nature> 01. doi:[10.7537/marsnsj231225.01](https://doi.org/10.7537/marsnsj231225.01)

Keywords: Economic efficiency; productive inputs; rice varieties.

1. Introduction:

It should be noted that Mohammad Ali Pasha was the first to establish rice cultivation in Egypt in 1812, where he began cultivating 4,500 feddans, and the average production at that time reached 600 kg per feddan. Since then, research related to the rice crop has developed, as it actually began in 1917, when the first signs of establishing a research entity concerned with improving varieties, breeds and hybrids suitable for the Egyptian environment appeared, with the aim of enhancing productivity by the end of each agricultural season. The year 1987 witnessed the peak of this boom, when the Rice Research Center was inaugurated at Sakha agricultural research station in Kafr El-Sheikh Governorate, to be research headquarters that combines various specializations and scientific expertise from institutes such as diseases, prevention, insects, and weeds, in order to advance the rice crop as a very important strategic crop.

The new rice varieties have contributed to reducing the amount of water required from 7,000 cubic meters to 5,000 cubic meters per feddan, an achievement that reflects the success in integrating scientific research with practical application. Rice cultivation also has clear environmental benefits, as it

is one of the important reclamation crops used to protect northern lands from the intrusion of seawater salinity. Consequently, these lands have been transformed from marginal lands into fertile agricultural land that can be exploited in cultivating other strategic crops. The Field Crops Research Institute has made great efforts to improve the rice crop and ensure the sustainability of the agricultural land allocated to it. As a result of these research efforts, new strains and varieties with high quality and productivity have been produced, the most prominent of which were the Japanese Giza 177 and the Indian-Japanese Giza 178 varieties, which were pioneers in the field of improving rice cultivation. After that, more than 16 to 17 commercial varieties were developed.

In this context, the Ministry of Agriculture and Land Reclamation in Egypt recently announced the success of the Agricultural Research Center in developing two new varieties of rice, which are characterized by a high productivity exceeding 4.5 tons per feddan, with a great ability to withstand changing environmental conditions. These two varieties were developed within the framework of the center's plan to modernize agricultural varieties, in line with the challenges of climate change and the

needs of farmers. The new rice varieties are characterized by their good resistance to diseases, low water consumption, and high grain quality, making them perfectly suitable for local consumption and enhancing the position of rice as an indispensable strategic crop in Egypt.

Research problem:

The research problem lies in the state's tendency to implement agricultural policies that reduce the area of water-intensive crops, most notably rice. Statistics indicate a decrease in the area of rice in Beheira Governorate from 186,500 feddans during the period (2019-2021) to about 164,200 feddans during the period (2022-2024), a decrease of about 13.6%, estimated at about 22,200 feddans. This resulted in a decrease in rice production in the governorate from 676,000 tons to 612,000 tons during the aforementioned period, a decrease of about 10.5%, estimated at about 64,000 tons. Therefore, it is necessary to reconsider the distribution of the cultivated varieties of rice that consume less water across different production areas. This, in turn, reflects on the efficiency of using the productive and economic resources used in producing this crop and thus maximizing the net farmer's return.

Objective:

Objective was primarily to:

1. Analyze the cost structure and output of the most important rice varieties and estimate their economic indicators in the research sample in Beheira Governorate for the 2024 summer production season.
2. Measure the economic efficiency of the resources used in producing the most important rice varieties of the research sample in Beheira Governorate for the 2024 summer production season.
3. Develop some proposed scenarios to increase the production of the most important rice varieties of the research sample in Beheira Governorate for the 2024 summer production season.

Materials and methods:

The research relied on the quantitative method based on standard, economic and statistical analysis to achieve its objectives, using some statistical methods and mathematical models, which are represented in the analysis of variance to test the extent of the existence of significant differences between the most important varieties of rice crop cultivated in the research area, and estimating different models of production functions for those varieties and comparing those estimated models according to their conformity with economic and statistical logic.

Data sources:

The research relied on two main sources for collecting data: The first source is secondary data published and unpublished published by the Economic Affairs Sector and the Directorate of Agriculture in Beheira Governorate, Statistics Department. The second source is primary data collected through a research sample collected via a questionnaire from each of the centers (Damanhour, Abu Hummus, El-Delengat, Itay El-Baroud), which represent about 17.36%, 16.86%, 14.72%, and 7.82% respectively of the total area of the rice crop of 153.52 thousand feddans during the summer production season of 2024 in Beheira Governorate.

Sample:

The center of Damanhour, Abu Hummus, El-Delengat, and Itay El-Baroud were chosen for this research due to their relative importance in rice cultivation within the Beheira Governorate. By surveying the area of rice varieties cultivated in the center of Damanhour, Abu Hummus, El-Delengat, and Itay El-Baroud, it became clear that the most important cultivated variety is Super 300, as its area of the center of Damanhour and Abu Hummus is estimated at about (6.15, 5.27) thousand feddans, representing about (17.1%, 14.65%) respectively of the area of this variety at the level of the governorate. This is followed by the Sakha 108 variety, whose cultivated area in El-Delengat, and Itay El-Baroud district is estimated at approximately (8.54, 6.36) thousand feddans, representing approximately (19.59%, 14.59%) respectively of the area of this variety at the governorate level. It is followed by Giza 177 in last place, and its cultivated area in the two centers, Damanhour and Abu Hummus under study, is estimated to be about (5.86, 3.5) thousand feddans, representing about (19.77%, 11.81%) of the area of this variety at the level of Beheira Governorate as shown in Table 1.

Table 2 Shows that the number of agricultural credit associations representing the research sample for the most important rice varieties of the selected centers in Beheira Governorate was chosen according to the relative importance of the number of farmers of the most important rice varieties under research. The associations of (Tolombat Bersiq, Abu Youssef) in Abu Hummus Center were selected, representing approximately (5.7%, 5.4%) respectively, of the total number of rice farmers of the Super 300 variety at the center level, and Nediba Association in Damanhour Center represents about 15.5% of the total number of farmers of this variety at the center level, as the number of farmers at the level of the selected associations reached about 1600 farmers, and taking 5% of the number of farmers for that variety, the size of the selected sample reached 80 farmers.

For the Sakha 108 variety, the Zawyet Hamour Association in El-Delengat center was selected, representing about 9.8% of the total number of farmers of the variety, and the (Shisht Al-An'am, Al-Nebira) Association in the Itay El-Baroud center, representing about (6%, 5.8%) respectively, of the total number of

farmers of the Sakha 108 variety at the center level, The number of farmers at the level of the selected associations for the aforementioned variety reached about 1500 farmers, and taking 5% of the number of farmers for that variety, the number of selected observations reached 75 farmers.

Table 1: Total area of the most important rice crop varieties of Beheira Governorate for the summer production season 2024.

| The Center | Area* (feddan) | Rice (feddan) | % | Rice varieties | | | | | |
|----------------|-------------------|------------------|--------------|----------------|--------------|--------------|--------------|------------|---|
| | | | | Super 300 | % | Sakha 108 | % | Giza 177 | % |
| Damanhour | 26650 | 17.36 | 6150 | 17.09 | 6000 | 13.77 | 5860 | 19.77 | |
| Abu Hummus | 25890 | 16.86 | 5271 | 14.65 | 6000 | 13.77 | 3500 | 11.81 | |
| El-Delengat | 22593 | 14.72 | 5048 | 14.03 | 8537 | 19.59 | 1731 | 5.840 | |
| El-Mahmoudia | 14116 | 9.200 | 3000 | 8.340 | 2766 | 6.350 | 3400 | 11.47 | |
| Itay El-Baroud | 12000 | 7.820 | 3000 | 8.340 | 6361 | 14.59 | 1645 | 5.55 | |
| Koum Hamada | 11000 | 7.170 | 3000 | 8.340 | 3050 | 7.000 | 2700 | 9.110 | |
| Kafr El-Dawwar | 11000 | 7.170 | 2010 | 5.590 | 2681 | 6.150 | 2296 | 7.750 | |
| Shubrakhit | 9386 | 6.110 | 3200 | 8.890 | 2952 | 6.770 | 3234 | 10.91 | |
| Hosh Essa | 8675 | 5.650 | 1665 | 4.630 | 1600 | 3.670 | 2000 | 6.750 | |
| El Rahmaniya | 6012 | 3.920 | 2050 | 5.700 | 2300 | 5.280 | 1662 | 5.610 | |
| Janakles | 3088 | 2.010 | 650 | 1.810 | 700 | 1.610 | 950 | 3.210 | |
| Edku | 1607 | 1.050 | 565 | 1.570 | 157 | 0.360 | 292 | 0.990 | |
| Rashid | 775 | 0.500 | 275 | 0.760 | 280 | 0.640 | 220 | 0.740 | |
| Abu El-Matamir | 725 | 0.470 | 100 | 0.280 | 200 | 0.460 | 150 | 0.510 | |
| Total | 153517 | 100.0 | 35984 | 100.0 | 43584 | 100.0 | 29640 | 100 | |

*Area = feddan = 4200 m²

Source: Compiled and calculated from: Ministry of Agriculture and Land Reclamation, the Directorate of Agriculture in Beheira, statistics Department, and unpublished data.

By reviewing the data contained in Table2, the selection was made of the Tolombat Bersiq Association in Abu Hummus Center, representing 7% of the total number of farmers of the Giza 177 rice variety at the center level in Beheira Governorate; The Nediba Association in Damanhour Center represents

19.1% of the total farmers of the aforementioned variety. Therefore, the number of farmers at the level of the represented associations reached about 1460 farmers. Taking 5% of the number of farmers who cultivate the aforementioned variety, the size of the selected sample reached 73 farmers.

Table 2. Number of farmers of the most important rice varieties at the level of agricultural associations representing the research sample in the chosen centers for the summer production season of 2024.

| The Center | the association | Number of rice variety farmers | | | | | |
|--|-----------------|--------------------------------|-------|-----------|-------|----------|-------|
| | | Super 300 | % | Sakha 108 | % | Giza 177 | % |
| El-Delengat | Zawyet Hamour | - | - | 738 | 9.80% | - | - |
| Rice variety farmer at the center | | - | - | 7513 | - | - | - |
| Itay El-Baroud | Shisht Al-An'am | - | - | 387 | 6.00 | - | - |
| | Al-Nebira | - | - | 375 | 5.80 | - | - |
| Rice variety farmer at the center | | - | - | 6469 | - | - | - |
| Abu Hummus | Tolombat Bersiq | 345 | 5.70 | - | - | 270 | 7.00 |
| | Abu Youssef | 326 | 5.40 | - | - | - | - |
| Rice variety farmer at the center | | 6075 | - | - | - | 3854 | - |
| Damanhour | Nediba | 929 | 15.50 | - | - | 1190 | 19.10 |
| Rice variety farmer at the center | | 5980 | - | - | - | 6219 | - |

Source: Ministry of Agriculture and Land Reclamation, Beheira Agriculture Directorate, Agricultural Administration at (El-Delengat, Itay El-Baroud, Abu Hummus, Damanhour), Statistics Department, Unpublished Data.

From the results of Table2, it was found that the total number of farmers in the sample was 228 farmers, which were chosen as follows: 80 observations for the Super 300 rice variety, 75 observations for the Sakha 108 rice variety, and 73 observations for the Giza 177 rice variety. The number of observations was chosen randomly within the boundaries of each agricultural association, and therefore the sample is called a multi-stage random cluster sample.

Results and Discussion:

First: Analysis of the cost structure and outputs of the most important rice varieties and estimation of their economic indicators in the research sample in Beheira Governorate for the summer production season of 2024.

The study objective was to analyze the inputs and outputs of production for the most important rice varieties of the research sample in Beheira Governorate and to compare these cultivated varieties and rank them according to their economic importance. And many economic factors contribute to the production of these varieties under study, including agricultural labor and automated labor, and production

requirements include quantity of seeds, chemical fertilizers and pesticides. The production of rice varieties consists of a main output in the form of grains, and a secondary output in the form of straw used for animal feed.

1. The cost structure productivity for the most important rice varieties of the research sample in Beheira Governorate:

The data in Table 3 show that the average amount of agricultural labor used in the production of Super300, Sakha108, and Giza177 rice varieties was approximately 28, 30, and 33 Laborer/Fed., respectively. The average wages of agricultural labor for these varieties were approximately 5600, 6600, and 7920 EGP/Fed., respectively, representing approximately 18.4%, 19.7%, and 21.3% of the average total costs, respectively. As for the average number of automated hours used in the production of the most important rice varieties, Super 300, Sakha 108, and Giza 177 in Beheira, it was 29, 31, and 34 Hours/Fed., respectively. The average value of these automated hours was approximately 4930, 5580, and 6460 EGP/Fed., respectively, representing approximately 16.2%, 16.7%, and 17.3% of the average total costs, respectively.

Table 3. Average production inputs for the most important rice varieties of the research sample in Beheira Governorate for the summer production season 2024.

| Inputs | Unit | Rice varieties | | | | | |
|---------------------------|--------------|----------------|------------|--------------|------------|--------------|------------|
| | | Super 300 | % | Sakha 108 | % | Giza 177 | % |
| Agricultural labor | Laborer/Fed. | 28 | - | 30 | - | 33 | - |
| Labor cost | EGP/Fed. | 5600 | 18.4 | 6600 | 19.7 | 7920 | 21.3 |
| Labor Automated | Hour/Fed. | 29 | - | 31 | - | 34 | - |
| Labor Automated cost | EGP/Fed. | 4930 | 16.2 | 5580 | 16.7 | 6460 | 17.3 |
| Wage cost | EGP/Fed. | 10530 | 34.6 | 12180 | 36.4 | 14380 | 38.6 |
| Seeds | KG/Fed. | 55 | - | 58 | - | 60 | - |
| Seed cost | EGP/Fed. | 1650 | 5.40 | 1798 | 5.30 | 1980 | 5.30 |
| Nitrogen fertilizer | KG/Fed. | 150 | - | 175 | - | 200 | - |
| Nitrogen fertilizer cost | EGP/Fed. | 1575 | 5.20 | 1838 | 5.50 | 2200 | 5.90 |
| Phosphate fertilizer | KG/Fed. | 200 | - | 250 | - | 300 | - |
| Phosphate fertilizer cost | EGP/Fed. | 1000 | 3.30 | 1375 | 4.10 | 1800 | 4.80 |
| Pesticide units | Liter/Fed. | 7 | - | 8 | - | 9 | - |
| Pesticide cost | EGP/Fed. | 2653 | 8.70 | 3272 | 9.80 | 3852 | 10.4 |
| Cost of production inputs | EGP/Fed. | 6878 | 22.6 | 8283 | 24.7 | 9832 | 26.4 |
| Variable costs | EGP/Fed. | 17408 | 57.2 | 20463 | 61.2 | 24212 | 65.0 |
| Rent cost | EGP/Fed. | 13000 | 42.8 | 13000 | 38.8 | 13000 | 35.0 |
| Total costs | EGP/Fed. | 30408 | 100 | 33463 | 100 | 37212 | 100 |

EGP =Egyptian Pound

Source: collected and calculated from the data of the questionnaire form in the study sample

Table 3 shows that the average quantity of seeds in the research sample used in the production of the rice variety Super 300, Sakha 108, Giza 177 amounted to about 55, 58, 60 KG/Fed. Respectively, while the average cost of the aforementioned varieties amounted to about 1650, 1798, 1980 EGP/Fed., representing about 5.4%, 5.3%, and 5.3%, respectively of the average total costs.

Reviewing the results of the production input analysis in Table3, the average quantity of nitrogen fertilizer (urea 46%) used in the production of the rice crop in Beheira Governorate for the rice varieties Super 300, Sakha 108, and Giza 177 was about 150, 175, and 200 KG/Fed. For the same varieties mentioned above, representing its cost is about 5.2%, 5.5%, and 5.9%, respectively, of the total cost of the crop. The average quantity of phosphate fertilizer (super phosphate calcium 15.5%) used in the production of the rice crop in Beheira Governorate for the rice varieties Super 300, Sakha 108, and Giza 177 was about 200, 250, and 300 KG/Fed. Respectively, representing its cost about 3.3%, 4.1%, and 4.8% respectively, of the total costs.

Finally, the average amount of pesticides used in the production of the most important rice varieties of Beheira Governorate reached about 7 liters/Fed, for the Super300 variety, 8 liters/Fed, for the Sakha108 variety, and 9 liters/Fed, for the Giza177 variety, the cost of pesticides for each variety represents about 8.7%, 9.8%, and 10.4%, respectively, of the total costs of the crop, as shown in Table3.

2. Production outputs of the most important rice varieties of the research sample in Beheira Governorate:

From the results of the analysis of the production outputs of the most important rice varieties of Beheira Governorate, as stated in Table 4, the average productivity per feddan of the rice variety Super 300, Sakha 108, and Giza 177 was approximately 12.3, 11.7, and 11 Ardebs/Fed, respectively, with an estimated value of approximately 58,991, 55,446, and 51,568 EGP/Fed, respectively.

From the previous account of the results of the production output analysis of the most important rice varieties of Beheira, the Super 300 variety achieved the highest productivity and return per feddan and represents the first place in terms of economic importance in rice production, followed by the Sakha 108 variety, which represents the second place, and then the Giza 177 variety, which represents the third and last place.

Table 4. Average production outputs of the most important rice varieties of the research sample in Beheira Governorate for the summer production season 2024.

| Outputs | Unit | Rice varieties | | |
|---------------|--------------|----------------|-----------|----------|
| | | Super 300 | Sakha 108 | Giza 177 |
| Production | Ardebs*/Fed. | 12.3 | 11.7 | 11.0 |
| Total revenue | EGP/Fed. | 58991 | 55446 | 51568 |

*One ardebs = 300 kg

Source: collected and calculated from the data of the questionnaire form in the study sample.

3. Economic indicators of the most important rice varieties of the research sample in Beheira Governorate:

The data in Table 3, 4, 5, indicated an increase in the per feddans productivity of the Super 300 rice variety in Beheira Governorate by approximately 0.6 Ardebs/Fed, compared to the Sakha 108 variety and 1.3 Ardebs/Fed, compared to the Giza 177 variety, this represents an increase of approximately 5.13% and 11.82%, respectively, and a decrease in total costs of approximately 10% and 22.4% compared to the previous two varieties, this resulted in an increase in the return per feddan of this variety by 6.4% compared to Sakha 108 and about 14.4% compared to the Giza 177 variety, this was reflected in an increase in the net return of the Super 300 variety by 30% and 99.1% compared to the aforementioned variety, respectively, resulting in an increase in (relative profitability, revenue-to-cost ratio, and return on invested pound) by (52.8%, 16.9%, 42.4%) compared to Sakha 108, and by (176.7%, 39.6%, 141%) compared to Giza 177.

Table 5. Economic indicators of the most important rice varieties of the research sample in Beheira Governorate for the summer production season 2024.

| Economic indicators | Unit | Rice varieties | | |
|---|----------|----------------|-----------|----------|
| | | Super 300 | Sakha 108 | Giza 177 |
| Net Return ¹ | EGP/Fed. | 28583 | 21983 | 14356 |
| Relative Profitability ² | % | 164.1 | 107.4 | 59.3 |
| Revenue-to-Cost Ratio ³ | EGP | 1.94 | 1.66 | 1.39 |
| Rate of Return on Egg Investment ⁴ | EGP | 0.94 | 0.66 | 0.39 |

1. Net return = Total return – Total costs.

2. Relative profitability = (Net return / Variable costs) x 100.

3. Revenue-to-cost ratio = (Total revenue / Total costs).

4. Rate of return on Egg invested = (Net return / Total costs).

Source: collected and calculated from the data of the questionnaire form in the study sample.

Based on the above, the most important rice varieties of Beheira can be ranked according to their productive and economic efficiency as follows: Super

300 comes in first place, followed in second place by Sakha 108, and then Giza 177 comes in third and last place.

Second: The economic efficiency of the resources used in the production of the most important summer rice varieties in the research sample in Beheira Governorate.

1. Analysis of the variance between factors affecting productivity of the most important rice varieties of the research sample in Beheira Governorate:

By conducting an analysis of the variance test between the most important factor affecting the

productivity of the most important rice varieties of Beheira Governorate to find out if there are any changes that have occurred to the change in each of (the productivity, total revenue, net return, variable costs, total costs) per feddan for the rice variety Super 300, Sakha 108, Giza 177, and it is clear from the data contained in Table6, that there are significant differences at a significance level of 0.01 between these factors that are supposed to affect the production of the most important rice varieties, and therefore it is not acceptable to assume nullity, which calls for addressing the analysis at the level of the cultivated varieties, each separately.

Table 6. Analysis of the variance between factors affecting productivity of the most important rice varieties of the research sample in Beheira Governorate

| Items | Unit | Rice varieties | | | |
|----------------|-------------|----------------|-----------|----------|---------|
| | | Super 300 | Sakha 108 | Giza 177 | F |
| productivity | Ardebs/Fed. | 12.3 | 11.7 | 11.0 | 29.50** |
| Total Revenue | EGP/Fed. | 58991 | 55446 | 51568 | 47.10** |
| Net Return | EGP/Fed. | 28583 | 21983 | 14356 | 14.5** |
| Variable Costs | EGP/Fed. | 17408 | 20463 | 24212 | 2979** |
| Total Costs | EGP/Fed. | 30408 | 33463 | 37212 | 2979** |

**Significant at a probability level of 0.01.

Source: collected and calculated from the data of the questionnaire form in the study sample.

2. The economic efficiency of resources used in producing the most important rice varieties of Beheira Governorate for the 2024 production season.

To achieve the third objective, the research relied on estimating the Cobb-Douglas production function in the double logarithmic form for the most important influencing production elements, which are agricultural labor (X_1), automated labor (X_2), seeds (X_3), nitrogen fertilizer (X_4), t phosphate fertilizer (X_5), and pesticides (X_6), in the production (Y) of the most important rice varieties of Beheira Governorate. The logarithmic model was chosen because it is the most consistent with statistical, econometric, and economic tests based on economic theory and the estimated model for the most important rice varieties faced econometric problems when using the ordinary least square method in the analysis, the most important of which are: the presence of outliers in the data of the research sample, non-homogeneity of variance, Non-normal distribution for residuals, and finally, multicollinearity between the independent variables for all estimated models of rice varieties of Beheira. Therefore, another method of estimation was used to address the measurement problems, Robust Regression.

A. Production functions for a Super 300 rice variety.

$$\ln Y = -2.53 - 0.11 \ln X_1 + 0.49 \ln X_3 + 0.66 \ln X_4 + 0.05 \ln X_6 \rightarrow (1)$$

$$(2.9)** \quad (3.4)** \quad 3.2** \quad 4.4** \quad 2.2*$$

$$\bar{R}^2 = 0.98 \quad F = 450**$$

The results of estimating the production function No.1, for the Super 300 rice variety in Beheira Governorate, based on the value of (t-test) for the production resources (agricultural labor, quantity of seeds, quantity of nitrogen fertilizer, quantity of pesticides), and showed partial significance at the level of 0.01. Based on the value of (f-test) for the model, the total significance of the function was confirmed at the level of 0.01. The adjusted coefficient of determination is estimated \bar{R}^2 at about 0.98, which means that the aforementioned resources are responsible for 98% of the changes that occur in the quantity of Super 300 production, and 2% of the changes are responsible for other factors.

The results of production function estimation No.1 revealed a direct relationship between the production quantity of the Super 300 rice variety in Beheira and each of the production resources: seed quantity, nitrogen fertilizer quantity, and pesticide

quantity, the elasticity coefficients for the aforementioned inputs were estimated at approximately 0.49, 0.66, and 0.05, respectively, this means that a 10% change in the quantity of production resources used in producing the variety can lead to an increase in the production of Super 300 rice by approximately 4.9%, 6.6%, and 0.5%, respectively, this reflects the fact that the marginal product of the resources used (quantity of seeds, nitrogen fertilizer quantity, and pesticide quantity) in producing this variety is decreasing and falls within the second, rational production stage, except for the agricultural labor resource, which is in the third non-economic productive stage, the total production elasticity of the resources used in the production process reached about 1.09, which is greater than one, this means that the function has an increasing return on capacity, which means that increasing the quantity of resources used (the quantity of seeds, the quantity of nitrogen fertilizer, the quantity of pesticides) and reducing

agricultural labor, together by about 10%, leads to an increase in the quantity of production of the Super 300 variety in the Beheira Governorate at a rate greater than the rate of increase in production resources.

Reviewing the results of the production function analysis for the Super 300 rice variety in Beheira Governorate, as shown in Table7, reveals that the marginal product of the resources used in the production process, specifically the quantity of (seeds, nitrogen fertilizer, and pesticides) reached approximately 523EGP, 259 EGP, and 427 EGP, respectively. These values exceed the cost of the production input. Therefore, rice farmers cultivating the Super 300 variety in the study area should increase the quantities of the aforementioned resources used in the production process. Conversely, reducing the agricultural labor resources until the value of the marginal product of the resource equals its price will result in increased profitability for rice farmers of the Super 300 variety.

Table 7. Economic efficiency of resources used in the production of the Super 300 rice variety in Beheira Governorate for the production season 2024.

| Items | Unit | agricultural labor | Seeds | nitrogen fertilizer | Pesticides |
|---|-------------|--------------------|---------|---------------------|------------|
| | | Laborer/Fed. | KG/Fed. | KG/Fed. | Liter/Fed. |
| Price of unit of output | EGP/Ardebs | 4796 | 4796 | 4796 | 4796 |
| average production | Ardebs/Fed. | 12.3 | 12.3 | 12.3 | 12.3 |
| Average quantity of the resource | - | 28 | 55 | 150 | 7 |
| Average output of the resource ¹ | Ardebs | 0.44 | 0.223 | 0.082 | 1.777 |
| Elasticity of resource ² | - | -0.11 | 0.49 | 0.66 | 0.05 |
| marginal product of resource ³ | Ardebs | -0.048 | 0.109 | 0.054 | 0.089 |
| Value Marginal product of resource ⁴ | EGP | -230 | 523 | 259 | 427 |
| Resource price | EGP | 200 | 30 | 10.5 | 379 |
| Economic efficiency ⁵ | - | -1.15 | 17.43 | 24.66 | 1.13 |

1. Average output of the resource = average production/ Average quantity of the resource.
 2. Elasticity of resource = average output of the resource*the marginal product of the resource.
 3. Marginal product of resource = Elasticity of resource*average output of the resource.
 4. Value Marginal product of resource = Marginal product of resource* Price of unit of output.
 5. Economic efficiency = Value Marginal product of resource / Resource price.
- Source: collected and calculated from the data of the questionnaire form in the study sample.

B. Production functions for a Sakha 108 rice variety.

$$\text{LnY} = -4.93 + 0.48\text{LnX}_2 - 1.1\text{LnX}_3 + 1.88\text{LnX}_4 + 0.19\text{LnX}_6 \rightarrow (2)$$

(2.2)** 3.2** (4)** 5.3** 3**
 $\bar{R}^2 = 0.97$ F = 283**

Based on the (t-test) and (f-test) values for production resources: (Automated labor, seeds quantity, nitrogen fertilizer quantity, and pesticide quantity), the overall significance of function No. 2 was established at the level of 0.01, and the adjusted coefficient of determination \bar{R}^2 reached about 0.97. This means that the independent variables included in

function No.2 explain about 97% of the changes that occur in the production of Sakha 108 rice variety and 3% of the changes are caused by other factors.

The results of the analysis of production function No.2 showed that the elasticity coefficients for the production resources (labor Automated, seeds quantity, nitrogen fertilizer quantity and pesticide

quantity) amounted to approximately 0.48, (1.1), 1.88, and 0.19 respectively, this means that there is a direct relationship between the quantity of rice production of the Sakha 108 variety in Beheira Governorate and the resources of labor Automated, the quantity of nitrogen fertilizer and the quantity of pesticides. Consequently, when the quantities of the aforementioned resources used in the production of Sakha 108 change by 10%, it can lead to an increase in the production of this variety by 25.5%, as this reflects that the marginal product of the resources used (labor Automated, quantity of pesticides) in the production of this variety is decreasing and is in the second rational production stage, except for the quantity of nitrogen fertilizer in the first non-economic productive stage, and the quantity of seeds in the third non-economic productive stage, Since the total elasticity of function No.2 reached 1.45, which is greater than one, the function has an increasing return on capacity, and when increasing the quantities of resources used (labor

Automated, quantity of nitrogen fertilizer, quantity of pesticides) and reducing the quantity of seeds by about 10%, it leads to an increase in the production of Sakha 108 rice variety in Beheira Governorate at a rate greater than the rate of increase in the quantities of resources used in the production of this variety.

The marginal product values for the resources used (labor Automated, quantity of nitrogen fertilizer, and quantity of pesticides) for the Sakha 108 rice variety in Beheira, as shown in Table 8, amounted to approximately 858, 597, and 1317 EGP respectively. These values are greater than the opportunity cost of the resource. Therefore, farmers of the Sakha 108 variety in Beheira Governorate should increase the quantities of these resources, and reduce the quantity of the seed resource included in Model 2 until the marginal product value of the resource equals the opportunity cost, resulting in increased profits for farmers of this variety.

Table 8. Economic efficiency of resources used in the production of the Sakha 108 rice variety in Beheira Governorate for the production season 2024.

| Items | Unit | Labor automated Hour/Fed. | Seeds KG/Fed. | nitrogen fertilizer KG/Fed. | Pesticides Liter/Fed. |
|---|-------------|------------------------------|------------------|--------------------------------|--------------------------|
| Price of unit of output | EGP/Ardebs | 4739 | 4739 | 4739 | 4739 |
| average production | Ardebs/Fed. | 11.7 | 11.7 | 11.7 | 11.7 |
| Average quantity of the resource | - | 31 | 58 | 175 | 8 |
| Average output of the resource ¹ | Ardebs | 0.377 | 0.202 | 0.067 | 1.463 |
| Elasticity of resource ² | - | 0.48 | -1.1 | 1.88 | 0.19 |
| marginal product of resource ³ | Ardebs | 0.181 | -0.222 | 0.126 | 0.278 |
| Value Marginal product of resource ⁴ | EGP | 858 | -1052 | 597 | 1317 |
| Resource price | EGP | 180 | 31 | 10.5 | 409 |
| Economic efficiency ⁵ | - | 4.77 | -33.9 | 56.9 | 3.22 |

1. Average output of the resource = average production/ Average quantity of the resource.

2. Elasticity of resource = average output of the resource*the marginal product of the resource.

3. Marginal product of resource = Elasticity of resource*average output of the resource.

4. Value Marginal product of resource = Marginal product of resource* Price of unit of output.

5. Economic efficiency = Value Marginal product of resource / Resource price.

Source: collected and calculated from the data of the questionnaire form in the study sample.

C. Production functions for a Giza 177 rice variety.

$$\ln Y = 24.9 - 0.51 \ln X_2 - 0.88 \ln X_3 - 1.33 \ln X_4 - 1.77 \ln X_5 \rightarrow (3)$$

$$(6.2)^{**} \quad (3.3)^{**} \quad (2.2)^* \quad (3.6)^{**} \quad 9.5^{**}$$

$$\bar{R}^2 = 0.98 \quad F = 475^{**}$$

With reference to function 3, the partial significance (t-test) for productive resources and the overall significance (f-test) for the model as a whole were established at a probability level of 0.01, and the value of the adjusted coefficient of determination \bar{R}^2 was approximately 0.98, This means that the production resources (labor automated, quantity of

seeds, quantity of nitrogen fertilizer, quantity of phosphate fertilizer) in the estimated function are responsible for 98% of the changes that occur in the quantity of rice production of the Giza 177 variety in Beheira Governorate, and 2% of the changes are responsible for other factors.

The results of the analysis of the production function No.3, revealed an inverse relationship

between the quantity of rice production of the Giza 177 variety in Beheira and the resources used in the production process (labor automated, quantity of seeds, quantity of nitrogen fertilizer, quantity of phosphate fertilizer), as the elasticity coefficients for these resources were estimated at 0.51, 0.88, 1.33, and 1.77 respectively. This means that when the quantity of resources used in the production of this variety changes by 10%, it can lead to a reduction in the quantity of rice production of the Giza 177 variety by about 5.1%, 8.8%, 13.4%, and 17.7%, this indicates an overuse of the aforementioned resources, i.e., it falls within the third non-economic productive stage. Therefore, farmers of the Giza 177 rice variety should reduce the quantities used of these resources, and the total elasticity of the function is negative, meaning that the total product is decreasing, and the marginal product is negative, and continuing to add units of the

resources used during this stage is illogical, farmers of the Giza 177 variety can increase their production and profits by reducing the quantities used of the resource (labor Automated, quantity of seeds, quantity of nitrogen fertilizer, quantity of phosphate fertilizer).

By examining the analysis data in Table 9, it became clear from the values of the marginal product of the resources used (labor automated, quantity of seeds, quantity of nitrogen fertilizer, quantity of phosphate fertilizer) in the production process of the Giza 177 rice variety in Beheira, which amounted to approximately (774, 755, 347, 305) EGP respectively, which are values less than the price of the resources. Therefore, farmers of this aforementioned variety in Beheira Governorate should reduce the quantity used of these resources to increase their production and profits.

Table 9. Economic efficiency of resources used in the production of the Giza 177 rice variety in Beheira Governorate for the production season 2024.

| Items | Unit | Labor automated | Seeds | nitrogen fertilizer | phosphate fertilizer |
|---|-------------|-----------------|---------|---------------------|----------------------|
| | | Hour/Fed. | KG/Fed. | KG/Fed. | KG/Fed. |
| Price of unit of output | EGP/Ardebs | 4688 | 4688 | 4688 | 4688 |
| average production | Ardebs/Fed. | 11 | 11 | 11 | 11 |
| Average quantity of the resource | - | 34 | 60 | 200 | 300 |
| Average output of the resource ¹ | Ardebs | 0.324 | 0.183 | 0.055 | 0.037 |
| Elasticity of resource ² | - | -0.51 | -0.88 | -1.33 | -1.77 |
| marginal product of resource ³ | Ardebs | -0.165 | -0.161 | -0.073 | -0.065 |
| Value Marginal product of resource ⁴ | EGP | -774 | -755 | -343 | -305 |
| Resource price | EGP | 190 | 33 | 11 | 6 |
| Economic efficiency ⁵ | - | -4.1 | -22.9 | -31.1 | -50.8 |

1. Average output of the resource = average production / Average quantity of the resource.

2. Elasticity of resource = average output of the resource*the marginal product of the resource.

3. Marginal product of resource = Elasticity of resource*average output of the resource.

4. Value Marginal product of resource = Marginal product of resource*Price of unit of output.

5. Economic efficiency = Value Marginal product of resource / Resource price.

Source: collected and calculated from the data of the questionnaire form in the study sample.

Third: the proposed scenarios for increasing production of the most important rice varieties of the research sample in Beheira governorate.

Based on the previous findings regarding the economic importance of the most important rice varieties of Beheira Governorate and the estimated production functions of those varieties, and assuming the continued cultivation of the aforementioned varieties of the future, two scenarios were developed that could be implemented to increase rice production in Beheira, as follows:

The first Scenario: Using the maximum inputs quantities with a positive effect and the limited minimum inputs quantities with a negative effect

on the production function of the most important rice varieties of Beheira Governorate for the summer production season of 2024.

Table 10. Shows that when the first scenario is applied, it leads to an increase in the average productivity per feddan of rice in Beheira Governorate for the varieties Super 300, Sakha 108, and Giza 177 by about 0.47, 1.06, and 1.86 ardebs/fed. Respectively, which results in an increase in the net return per feddan of these varieties by about 929, 3194, and 2219 EGP/fed. Respectively, Since the area planted with the Super 300 variety at the level of the (Damanhour, Abu Hummus) center in the research area amounted to about 11,421 feddans, and the area planted with the Sakha 108 variety at the level of the (El-Delengat, Itay

El-Baroud) center amounted to 14,898 feddans, and the area planted with the Giza 177 variety at the level of the (Damanhour, Abu Hummus) center amounted to 9,360 feddans, as shown in Table1, It is possible to increase the production of those rice varieties by (5368, 15792, 17410) ardebs respectively, with a total of 38570 ardebs, resulting in an increase in the net return for those varieties at the level of the research area by about (12.5, 29.7, 22.7) million EGP respectively. This leads to an increase in the quantity of production in Beheira Governorate by 2.04% of the quantity of production of Beheira, which amounts to about 1892865 ardebs during the production season under study.

The second scenario: Replacing the greatest productive variety with the less productive variety of rice in the research area.

It became clear from the data in Table11, that when expanding the cultivation of the Super 300 rice variety in the study area and at the level of Beheira Governorate, given that it gives the highest average productivity per feddan compared to other varieties, replacing the cultivation of the Super 300 rice variety in place of Sakha 108 and Giza 177 leads to an increase in the average productivity per feddan of rice in the research area by about (0.6, 1.3) ardebs/fed., which results in an increase in the net return per feddan of about 1127, 1696 EGP/fed. Respectively.

From the previous presentation of the data contained in Table (1, 11), it appears that the area cultivated with the rice variety Sakha 108 and the rice variety Giza 177 at the level of the center of (Damanhour, Abu Hummus, El-Delengat, Itay El-Baroud) is about 26898 and 12736 feddans respectively, if the farmer of those varieties makes a replacement with the rice variety Super 300, this leads to an increase in rice production in the research area by about (16139, 16557) ardebs, this results in an increase in the net return of about (30.33, 21.61) million pounds for the area replaced with the Super 300 variety, and at the level of Beheira Governorate, rice production can be increased by replacing the Sakha 108 and Giza 177 varieties with the Super 300 rice variety, as the production quantity of the two varieties during the summer production season of 2024 reached about 553,517 and 355,680 ardebs respectively, therefore, rice production in Beheira can be increased by cultivating and replacing the two aforementioned varieties with the Super 300 rice variety to 26,150 and 38,532 ardebs respectively, with an increase of about 4.7% and 10.8% respectively. This leads to an increase in the governorate's production quantity by 3.4% of the Beheira production quantity, which is about 1,892,865 ardebs during the season under study.

Table 10. Using the maximum inputs quantities with a positive effect and the limited minimum inputs quantities with a negative effect on the production function of the most important rice varieties of Beheira Governorate for the summer production season of 2024.

| Items | Inputs | Unit | Rice varieties | | |
|------------------------|----------------------|--------------|----------------|-----------|----------|
| | | | Super 300 | Sakha 108 | Giza 177 |
| Positive effect | Labor Automated | Hour/Fed. | - | 34 | - |
| | Seeds | KG/Fed. | 56 | - | - |
| | Nitrogen fertilizer | KG/Fed. | 159 | 183 | - |
| | Pesticide units | Liter/Fed. | 8 | 9 | - |
| Negative effect | Agricultural labor | Laborer/Fed. | 23 | - | - |
| | Labor Automated | Hour/Fed. | - | - | 32 |
| | Seeds | KG/Fed. | - | 56 | 59 |
| | Nitrogen fertilizer | KG/Fed. | - | - | 191 |
| | Phosphate fertilizer | KG/Fed. | - | - | 285 |
| The Production | Estimated | Ardebs/Fed. | 12.77 | 12.76 | 12.86 |
| | Actual | Ardebs | 12.3 | 11.7 | 11 |
| The increase in | Feddan production | Ardebs | 0.47 | 1.06 | 1.86 |
| | Net return feddan | EGP | 1092 | 1992 | 2427 |

Source: collected and calculated from the data of the questionnaire and calculated by substituting the quantity of inputs in the production function for each variety.

Table 11. Cultivating the greatest productive rice variety in place of the less productive varieties of the research area.

| Production | Unit | Rice varieties | | |
|--|-------------|----------------|-----------|----------|
| | | Super 300 | Sakha 108 | Giza 177 |
| Greatest Productivity Variety | Ardebs/Fed. | 12.3 | 12.3 | 12.3 |
| Actual Productivity | Ardebs/Fed. | 12.3 | 11.7 | 11.1 |
| The increase in feddan productivity | Ardebs/Fed. | - | 0.6 | 1.3 |
| The increase in feddan return | EGP/Fed. | - | 2843 | 6094 |
| The increase in feddan costs | EGP/Fed. | - | 1716 | 4398 |
| The increase in feddan net return | EGP/Fed. | - | 1127 | 1696 |

Source: Collected and calculated from the data of the questionnaire and tables.3, 4

From the above, it is clear that the varieties of rice cultivated in the Beheira Governorate must be redistributed in a way that ensures the optimal use of resources in crop production, which will result in maximizing the net farmer's return from its production. It is necessary to provide modern improved rice seeds with higher productivity by developing high-productivity varieties at moderate prices and encouraging farmers to cultivate them to increase crop production. The role of the agricultural extension service and research centers must be activated in convincing farmers of the modern production method by using high-productivity varieties that consume little water and make optimal use of production inputs.

References

1. Abdul Qadir Mohamed Abdul Qadir, **Econometrics between Theory and Application**, Second Edition, University House, Alexandria, 1998.
2. Fatima Mohamed Abdullah, Hussein El -Sayed Hussein, **Standard Analysis of the impact of Variety Change on Maize Production**, Egyptian Journal of Agricultural Economics, Volume (11), Issue (1), March 2001.
3. El -Sayed. Mohamed Abouzeid, Ahmed Abou El Fadl Ali, **A comparative analytical study of the most important varieties of summer maize crop in Egypt**, Assiut University, Faculty of Agriculture, Assiut Journal of Agricultural Sciences, Volume (35), Issue (1), 2004.
4. Ibrahim El-Sayed Issa, **The Economic Effects of the Most Important Improved Varieties of Summer White maize in Gharbia Governorate**, Egyptian Journal of Agricultural Economics, Volume (14), Issue (4), December 2004.
5. Mahmoud Abd - El Hady Shafey and others, **Hadith in production economics and Efficiency analysis between theory and application**, Chapter Seven, Al-Marqab University, Libya, 2009.
6. Hanaa Shaddad Mohamed Abdel Latif, **An Economic Study of the impact of Using New Varieties on the Transfer of the Supply Function for Maize**, Egyptian Journal of Agricultural Economics, Volume (19), Issue (2), June 2009.
7. Enas Mohamed Abbas Mohamed Saleh, **An Economic Study of the impact of Using Improved Varieties on Maize Production: A Case Study in Assiut Governorate**, Egyptian Journal of Agricultural Economics, Volume (23), Issue (3), September 2013.
8. Ahmed Mohamed Farrag Kassem, **Productive and Economic Efficiency of the Most Important Wheat Varieties cultivated in Beheira Governorate**, Egyptian Journal of Agricultural Economics, Volume (23), Issue (2), June 2013.
9. Walaa Mahmoud Mohamed Mahmoud, **An Economic Study of the Impact of Using Variety Technology on Developing the Production of White Summer Maize in Egypt**, Egyptian Journal of Agricultural Economics, Volume (24), Issue (4) (B), December 2014.
10. Jihan Abdel Moez Mohamed, **The Economic Impact of Applying Varieties Technology to the Most Important Agricultural Crops**, Assiut University, Faculty of Agriculture, Assiut Journal of Agricultural Sciences, Volume (45), Issue (1), 2014.
11. Osama Kazem Jabara Al-Akeeli, **A Comparative Study of the Technical and Economic Efficiency of Yellow Maize Production Farms for Local and Hybrid Varieties in Babylon Governorate for the Agricultural Season 2013**, University of Baghdad, College of Agriculture, Iraqi Journal of Agricultural Sciences, Volume (46), Issue (4), 2015.
12. Naglaa Mohamed Waly, Mohamed El – Sayed Rageh and others, **Production And Economic Efficiency of Rice Crop In Egypt**, Egyptian

- Journal of Agricultural Economics, Volume (26), Issue (2), June (B) 2016.
13. Ramadan Ahmed Mohamed Hassn, Mohamed Ali Fathallah, **An economic study of the most important varieties of wheat and maize yellow in Beheira Governorate**, Damanhour University - Egypt, Faculty of Agriculture, Journal of Agricultural and Environmental Sciences, Volume (16), Issue (2), August 2017, pp. 20-49.
 14. Mahmoud Abd - El Hady Shafey, **Advanced Econometrics**, Lectures for Postgraduate Students, Alexandria University, Faculty of Agriculture, Department of Agricultural Economics, 2017.
 15. Ramadan Ahmed Mohamed Hassn, **An Economic Study for Estimation of Profit Function and Economic Efficiency of Producing the most Important Varieties of Summer Potatoes in Beheira Governorate**, Egyptian Journal of Agricultural Economics, Volume (28), Issue (4), December 2018, pp. 1585-1604.
 16. Enas M. A. Saleh, **Assessment of Land Economic Efficiency in Producing Faba Beans and Lentils in the Old Lands**, Mansoura University, Faculty of Agriculture, Journal of Agricultural Economics and Social Sciences, Volume (9), Issue (6), 2018.
 17. Alham Abdelmoaty Abas, Emad Hassanin Ahmed, **An Economic Study For The Efficiency Of The Use Of Agricultural Resources In The Production Of Sugar Beet In Dakahlia Governorate**, Egyptian Journal of Agricultural Economics, Volume (28), Issue (2), June (B) 2018.
 18. W. A. E. Al-Abed, F. F. Abdullah, S. M. Abdel Moneim, **Estimating the Technological and Economic Efficiency of Some Improved Varieties for Rice Crop Production in Kafr El-Sheikh Governorate**, Damanhour University - Egypt, Faculty of Agriculture, Journal of Agricultural and Environmental Sciences, Volume (19), Issue (1), 2020.
 19. Hesham Aly El-Gendy, **Estimate the efficiency of using Economic Resources in the Production of Maize in Assiut Governorate**, Egyptian Journal of Agricultural Economics, Volume (30), Issue (1), March 2020.
 20. Abdel Sattar Abdel Hamid Al-Tarawi, Mohamed Abdel Hamid Al-Demeery, **Economic Analysis of the Productivity of the most Important Varieties Developed for the Rice Crop in Kafr El-Sheikh Governorate**, Mansoura University, Faculty of Agriculture, Journal of Agricultural Economics and Social Sciences, Volume (14), Issue (1), 2023.
 21. Hodhod, H. A.; M. A. Shata and A. E. I. Sarhan, **An Economic Study of Resource Use Efficiency in Strawberry Production in Ismailia Governorate**, Mansoura University, Faculty of Agriculture, Journal of Agricultural Economics and Social Sciences, Volume (14), Issue (2), 2023.
 22. Ahmed Mohamed Farrag Kassem, Ramadan Ahmed Mohamed Hassn, Abdelgaid hamdy fadl allh abdelkawy, **Economic efficiency of resources used in the production of the most important Varieties of yellow maize in Beheira Governorate**, Alexandria University, Faculty of Agriculture, Alexandria Journal of Agricultural Sciences, Volume (69), Issue (3), July - August - September 2024, pp. 328-344.
 23. Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration for Agricultural Economics, **Agricultural Statistics Bulletin**, Various Issues.
 24. Ministry of Agriculture and Land Reclamation, Beheira Agriculture Directorate, **Statistics Department**, Unpublished Data.
 25. Ministry of Agriculture and Land Reclamation, Beheira Agriculture Directorate, Damanhour Agricultural Administration, Abu Hummus, El-Delengat, Itay El-Baroud, **Statistics Department**, Unpublished Data.
 26. Jon P.Doll, Frank Orazem, **Production Economics Theory with Applications**, eBook, English, Grid Inc., Columbus, Ohio, 1978.
 27. Wolfgang Härdle, **Robust Regression Function Estimation**, Journal of Multivariate Analysis, Volume 14, Issue 2, April 1984, 1984.
 28. James G. Mackinnon, **Bootstrap Methods in Econometrics**, Department of Economics, and Queen's University, Kingston, Ontario, Canada, the Economic Record, Vol.82, Special Issue, S2-S18, and Sep.2006.
 29. Stefan Van Aelst, Gert Willems, Ruben H. Zamar, Apr. **Robust and efficient estimation of the residual scale in linear regression**, Journal of Multivariate Analysis, Vol.116, April 2013.
 30. C.Croux, G.Haesbroeck, C.Ruwe, , **Robust estimation for ordinal regression**, Journal of Statistical Planning and Inference, Vol.143, Iss.9, Sep.2013.
 31. Graciela Boente, Juan Carlos Pardo-Fernández, **Robust testing for superiority between two regression curves**, Journal of Computational Statistics & Data Analysis, Vol. 97, May 2016.
 32. Anthony C. Atkinson, M. Riani, F. Torti, **Robust methods for heteroskedastic regression**, Journal of Computational Statistics & Data Analysis, Vol.104, Dec.2016.
 33. Rand Wilcox, Chapter 10 **-Robust Regression, Journal of Introduction to Robust Estimation and Hypothesis Testing (Fourth Edition)**, A

volume in Statistical Modeling and Decision Science, 2017.

34. Ka-Veng Yuen, Gilberto A. Ortiz, **Outlier detection and robust regression for correlated**

data, Journal of Computer Methods in Applied Mechanics and Engineering, Vol.313, Jan.2017.

9/2/2025