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RESEARCH ARTICLE OPEN ACCESS

EFFICIENCY OF THE USING OF HUMAN AND MACHINE THE SOURCES IN WHEAT PRODUCTION IN BEHEIRA GOVERNORATE

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ABSTRACT

The research problem is represented in the high costs of producing wheat crop as a result of the high prices of production requirements, which may affect the cultivated areas of it, and due to the rapid and successive progress in the transfer of technology in the field of agriculture, especially agricultural operations, it has been possible to replace human work with automated work, after the high wages of rural labor trained women in the fields of agriculture and continuous migration to urban areas as a result of the seasonality of agricultural production on the one hand, and the low wages in the country side compared to the urban ones, which prompted farmers to move towards using automated work in farming methods, to reduce production costs and reduce the time period. The research reached a set of research results, the most important of which are the following:

1-Related to measuring the economic efficiency of the agricultural resources used in the production of wheat in the research sample using the human labor component, it was found that the value of the efficiency coefficient for the first category amounted to about 1.01, which means complete efficiency in the use of the mechanized labor component, and by estimating the efficiency of using the component of the quantity of seeds, and the amount of nitrogen fertilizer in the production Wheat, where the value of its efficiency coefficient is about 5.9, 4.76, and by estimating the efficiency of using the human labor element in wheat production, where the value of its efficiency coefficient is about 0.74, while the value of the efficiency coefficient for the second category is about 1.96, which means that producers can achieve efficiency in the use of wheat. The element in the production of wheat by increasing the quantities used of it until the value of the marginal yield of the element equals the unit price of it. And by estimating the efficiency of using the element of machine work in wheat production, where the value of its efficiency coefficient is about 0.91, which means that producers can achieve efficiency in using the two elements in wheat production by reducing the quantities used of it until the value of the marginal yield of the element equals the unit price of it.

2- It is clear from estimation of the marginal rate of technological substitution of mechanical work with human labor for the wheat crop for the first holding category that to increase the amount of mechanical work by one working hour, it is necessary to dispense with an amount of human work amounting to about 1.64 men / day in order to achieve the same level of production, while it is clear to increase the amount of mechanical work by one hour of work, it is necessary to dispense with the amount of human labor of about 1 man / day, in order to achieve the same level of production for the second class of ownership. The obtained results are consistent with the economic logic, whereby the marginal rate of technological substitution of robotic labor with human labor decreases with the increase in the quantities used.

3- It was found that the most important obstacles to automated work were represented in the rise of the purchase price for the machine with a repetition of about 44 at a rate of about 88%, with a minimum of about 0.79 and a maximum of about 0.97 for the first category, while the repetition amounted to about 47 at a rate of about 88%, and the confidence interval ranged the probability of the problem occurring is between a minimum of about 0.87 and a maximum of about 1.01 for the second category. In the second and third place came the lack of funding and the inadequacy of the machine with a frequency of about 38, 22 with a rate of about 76%, 44% with a minimum of about 0.64, 0.30 and a maximum of about 0.88, 0.58 for each of them, respectively, for the first category, while the frequency was about 36, 21 at a rate of about 72%, 42% with a minimum of about 0.60, 0.28 and a maximum of about 0.84, 0.56 for each of them, respectively, for the second category.

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INTRODUCTION

The issue of food is one of the most important strategic issues which concern on developing economies in general and the Egyptian economy in particular as a result of the steady increase in population numbers, which has caused an increase in the size of the gap between production and consumption. Wheat crop is one of the strategic crops and the most important food grain crop in Egypt as it is the main component of bread in its various forms and shapes in the Egyptian countryside and urban alike, and it occupies a large area in the winter crop structures in Egypt, where the cultivated area of it reached about 3.13 million feddans (Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Winter Agricultural Statistics Bulletin)

With a total production of about 8.56 million tons, while the quantities consumed amounted to about 20.85 million tons, and the amount of wheat imports in Egypt amounted to about 12.49 million tons, with a self-sufficiency rate of about 41.06% in 2019 (Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Food Balance Bulletin, 2019), This makes the reliance on global markets a huge burden on the trade balance in the future, which makes it imperative to seek to use policies and methods in order to provide the largest possible amount of local wheat and reduce imports that require a large amount of foreign exchange. Agricultural policy programs are trying to increase production of the wheat crop through horizontal expansion by adding new lands and increasing the cultivated area, but there is a limited water resource that controls the increase in the cultivated area, and the state has tended to focus on vertical expansion programs to increase the feddan productivity by raising the efficiency of the use and management of agricultural resources in the production of the wheat crop, in addition to trying to reduce the wastage of the crop during its various stages (Elham Abdel Moati, 2018). Beheira governorate is one of the most important governorates producing the wheat crop in Egypt, as it came in second place in terms of the cultivated area, amounting to about 334 thousand feddans, representing about 11% of the total area of wheat in the Republic out of the total area cultivated with wheat in Egypt, which amounted to about 3.08 million feddans during the average period from (2017-2019).

Research problem: The research problem is represented in the high produce frome costs of wheat crop as a result of the high prices of production requirements, which may affect the cultivated areas of it, and due to the rapid and successive progress in technology transfer in the field of agriculture, especially agricultural operations, starting from preparing the land and preparing it for agriculture and using improved high-productivity varieties, up to the stage of Combining and harvesting the crop, On the one hand, it has been possible to replace human work with mechanization especially in large agricultural holdings (more than an feddan) after the rise in wages of trained rural workers in the fields of agricultural production and lower wages in the countryside compared to the urban areas. On the other hand, this prompted farmers to move towards the use of automated work in farming methods, and to include and study the crop to reduce production costs as well as to reduce the time period. Which necessitates studying the efficiency of the use of agricultural resources, especially the suppliers of human and mechanical labor in wheat production in the Beheira Governorate? The research aims to identify the efficiency of the use of human and machine labor suppliers in wheat production in the research sample in Beheira Governorate by studying the following sub-objectives: First: The productive and economic indicators of the wheat crop in Egypt. Second: Productive and economic indicators of wheat crop in the research sample. Third: The efficiency of using the human and machine labor suppliers to produce the wheat crop in the research sample. Fourth: The relative importance of problems and obstacles to human and mechanical work for wheat farmers in the research sample.

MATERIALS AND METHODOLOGY

To achieve the objectives, the research relied on the methods of descriptive statistical analysis, which is represented in simple descriptive statistical methods such as arithmetic averages, percentages and growth rates, as well as the use of many other indicators. In addition to quantitative statistical analysis, which consists of using the general time trend, estimation of production functions and the method of analysis of variance in one direction. The research relied on two sources in collecting data. Firstly, the published and unpublished secondary statistical data represented in the data of the Ministry of Agriculture and Land Reclamation, as well as studies, journals, periodicals, research and scientific messages closely related to the subject of the study. Secondly, the primary data that were collected through a questionnaire with a personal interview from wheat farmers Field research sample for the 2019/2020 agricultural season in Beheira Governorate.

Sampling size: Beheira Governorate was chosen as one of the largest governorates in terms of cultivated reins, reaching about 942.4 thousand feddans, representing about 10.1% of the total cultivated area in Egypt. It is also one of the largest governorates producing field crops, especially wheat. By reviewing the winter crop composition of the Beheira governorate as shown in Table (1), it is clear that the wheat crop came in the first place in terms of the total cultivated area, amounting to about 386.7 thousand feddans, representing about 41.04% of the total cultivated reins. Whereas the Trifolium crop came in second place in terms of the total cultivated area, amounting to about 199.4 thousand feddans, representing about 21.17% of the total cultivated area. On the other hand, orchards and palm crops ranked third in terms of the total cultivated area in the governorate, which amounted to about 176.2 thousand feddans, representing about 18.7% of the total cultivated reins. Other crops and the beet and fava bean crop came in the last rank in terms of area, with a total area of about 132.8 thousand feddans, 38 thousand feddans, and 9 thousand feddans, representing about 14.10%, 4.03%, and 0.95% of the total cultivated reins for each of them, respectively. The primary data collected from the questionnaire prepared for this purpose was based on the Abu Hummus Center in Beheira Governorate, where it was found that the Abu Homs Center came in the first place in terms of the area cultivated with wheat, with a total area of about 44.86 thousand feddans, representing about 11.6% of the total wheat grown in the governorate And a stratified, multi-stage random research sample of 5% of the total number of holders of the winter agricultural season for the agricultural season of 2019/2020 was selected, representing the study community in the villages of Abu Homs Center (Talabat Bersiq village and Boutros village) with 100 forms, 50 forms for each of the categories Possession under study through personal interview.

Data analysis: In achieving its objectives, the research relied on the methods of descriptive statistical analysis, which is represented in simple descriptive statistical methods such as arithmetic averages, percentages and growth rates, as well as the use of many other indicators in addition to quantitative statistical analysis, which consists in using the general time trend, estimating production functions and the method of analysis of variance in one direction. The study relied on two sources in collecting data: the published and unpublished secondary statistical data, and the primary data, which were collected through a questionnaire with a personal interview from wheat farmers in the field research sample for the agricultural season 2019/2020 in Beheira Governorate.

RESULTS AND DISCUSSION

First: the productive and economic indicators of the wheat crop in Egypt: By reviewing the data in Table No. (2)and Table No (3), it was found that

productivity indicators: It was found that the area planted with the wheat crop ranged between a minimum of about 2.45 million feddans

Table 1. The winter crop composition of the Beheira governorate for the agricultural season 2019/2020

Center	Wheat		Broad beans		palms and orchards		suger beet		Clover		other crops		total
	1000feddans	the relative importance	1000feddans	the relative importance	1000feddans	the relative importance	1000feddans	the relative importance	1000feddans	the relative importance	1000feddans	the relative importance	1000feddans
Kom Hamada	18.8	30.67	0.12	0.2	5.81	9.5	0.13	0.21	15.03	24.56	21.33	34.86	61.2
Itay El Barud	19.5	45.19	0.09	0.21	0.67	1.56	0.86	1.99	14.01	32.53	7.97	18.52	43.1
Shabrakhit	17.8	50.72	0.11	0.31	1.05	2.99	1.09	3.11	11.27	32.16	3.75	10.71	35
Rahmaniya	9.8	60.62	0.05	0.28	0.14	0.86	1.64	10.14	3.66	22.72	0.87	5.39	16.1
Damanhour	40	68.09	0.54	0.92	0.38	0.64	2.68	4.56	14.25	24.24	0.91	1.55	58.8
El Delengat	38.7	54.45	0.56	0.79	7.14	10.06	3.23	4.54	14.93	21.02	6.48	9.13	71
Abu El Matamir	20.3	51.32	0.13	0.33	0.34	0.86	2.84	7.17	3.78	9.53	12.2	30.79	39.6
Gianaclis	10.2	45.14	0.09	0.4	1.25	5.53	2.79	12.31	4	17.67	4.29	18.95	22.6
Hosh Essa	17.8	34.2	0.16	0.31	9.73	18.67	5.06	9.72	14.14	27.14	5.19	9.96	52.1
Abu Hummus	44.9	55	0.76	0.93	8.52	10.45	3.72	4.56	21.34	26.16	2.36	2.9	81.6
Kafr El Dawwar	35.7	50.24	0.26	0.37	14.93	21.02	0.33	0.46	9.59	13.51	10.24	14.42	71
Mahmoudiyah	19.5	59.76	0.44	1.35	3.1	9.48	0.56	1.72	8.49	25.98	0.56	1.71	32.7
Rosetta	1.5	7.03	0.11	0.49	15.54	71.4	0	0.01	3.27	15.04	1.31	6.03	21.8
Edku	3.7	18.1	0.78	3.76	11.88	57.59	1.44	6.99	2.29	11.1	0.5	2.44	20.6
Natrn Valley	1.2	25.34	0	0	2.66	57.23	0.81	17.43	0	0	0	0	4.65
Agricultural credit	299.3	47.37	4.2	0.66	83.13	13.16	27.17	4.3	140.1	22.17	77.97	12.34	632
Agricultural reform	71.6	49.12	1.18	0.81	14.12	9.69	4.02	2.76	32.96	22.62	21.85	14.99	146
Reclamation	15.8	9.6	3.58	2.18	78.98	47.97	6.79	4.13	26.44	16.06	33.03	20.06	165
Total	386.7	41.04	8.97	0.95	176.2	18.7	37.98	4.03	199.5	21.17	132.8	14.1	942

Source: Compiled and calculated from :the Directorate of Agriculture in Beheira, Statistics Department, unpublished data.

Table 2. Productive and economic indicators of the wheat crop in Egypt during the period (2002-2019)

Year	Area (million feddan)	production (million ton)	productivity (ton/feddan)	Crop price (pound/ton)	Total Cost (pound/feddan)	Total Revenue (pound/feddan)	Net Return (pound/feddan)	Return on the invested pound	Cost Return Ratio
2002	2.45	6.63	2.7	718	1558	2531	972.3	0.62	1.62
2003	2.53	6.84	2.71	760	1715	2731	1016	0.59	1.59
2004	2.61	7.18	2.76	1000	1904	3570	1666	0.88	1.88
2005	2.99	8.14	2.73	1120	1981	3937	1956	0.99	1.99
2006	3.06	8.27	2.7	1127	2143	4006	1863	0.87	1.87
2007	2.72	7.38	2.72	1153	2444	4213	1769	0.72	1.72
2008	2.92	7.98	2.73	2553	3145	8304	5159	1.64	2.64
2009	3.15	8.52	2.71	1613	3459	5649	5300	1.53	1.63
2010	3	7.17	2.39	1813	3680	5657	1977	0.54	1.54
2011	3.05	8.37	2.75	2347	4069	7953	3884	0.95	1.95
2012	3.16	8.8	2.78	2520	4425	8783	4358	0.98	1.98
2013	3.38	9.46	2.8	2580	4808	9082	4274	0.89	1.89
2014	3.39	9.28	2.74	2740	5271	9318	4047	0.77	1.77
2015	3.47	9.61	2.77	2753	5627	9568	3941	0.7	1.7
2016	3.35	9.34	2.79	2773	7054	9627	2573	0.36	1.36
2017	2.92	8.42	2.88	3760	9019	12815	3796	0.42	1.42
2018	3.16	8.35	2.64	3760	10631	12773	2142	0.2	1.2
2019	3.13	8.56	2.73	4407	11326	14912	3586	0.32	1.32
Average	3.02	8.24	2.72	2194	4681	7524	3016	0.78	1.73

Source: Compiled and calculated from: Ministry of Agriculture, Economic Affairs Sector, Central Administration for Agricultural Economy, Bulletin of Agricultural Statistics, Cairo, miscellaneous issues.

Table 3. Equations for the general trend of the Productive and economic indicators of wheat crop in Egypt during the period (2002-2019)

Item	Unit	The Equation	R^2	F	Rate of change %
Area	million feddan	$Ln\hat{Y}_i = 0.97 + 0.014\ T_i\ (4.46)^{**}$	0.56	19.93^{**}	1.4
Production	million ton	$Ln\hat{Y}_i = 1.96 + 0.015\ T_i\ (4.36)^{**}$	0.54	18.99^{**}	1.5
Crope Price	pound/ton	$Ln\hat{Y}_i = 6.60 + 0.101\ T_i\ (13.16)^{**}$	0.92	173.14^{**}	10.1
Total Cost	pound/ feddan	$Ln\hat{Y}_i = 7.17 + 0.116\ T_i\ (31.43)^{**}$	0.98	987.8^{**}	11.6
Total Return	pound/feddan	$Ln\hat{Y}_i = 7.86 + 0.098\ T_i\ (14.21)^{**}$	0.93	202.05^{**}	9.8
Net Return	pound/feddan	$Ln\hat{Y}_i = 7.32 + 0.061\ T_i\ (3.10)^{**}$	0.38	9.6^{**}	6.1
Return on the invested pound	pound	$Ln\hat{Y}_i = 0.15 - 0.055\ T_i\ (-2.66)^{**}$	0.31	7.08^{**}	5.5

Significance at 0.01 level. **
Source: Calculated from Table (2).

Table 4. Productive and economic indicators of wheat crop feddan in the research sample in Beheira Governorate For the agricultural season 2019/2020

Item	Unit	first category	second category
		feddan for less than 3 feddans	more than 3 feddans
Input			
Seeds	Kg	58	45.8
My fertilizer	M3	4	2.4
Nitrogen fertilizer	effective unit	32	22
Phosphate fertilizer	effective unit	22	15.4
Foliar fertilizer	pound	262	115.2
Pesticides	pound	181	88.5
Human work	man/day	29	22
Automation	hour	35	39.6
Out put			
Main product	Ardab	19	20.3
secondary product	Heml	11	12
Main product price	pound	670	670
secondary product price	pound	430	430
Total return		17460	18761
Variable costs		5080	4920
Fixed costs		5750	5500
Total costs		10830	10420
Net return		6630	8341
Marginal surplus		12380	13841
Return on the pound		0.6	0.8
Cost return ratio		1.6	1.8

Source: collected and computed from data from the research sample

Table 5. The standard model of wheat production functions in the research sample in Beheira Governorate for the agricultural season 2019/2020

Item	The Equation	R^2	F
first category	$Ln\hat{Y}_i = -0.35 + 0.13\ LnX_1 + 0.22\ LnX_2 + 0.26\ Ln\ X_3 + 0.13\ LnX_5 + 0.19\ LnX_6$ $(3.99)^{**}\quad (5.8)^{**}\quad (2.6)^{*}\quad (2.1)^{*}\quad (5.6)^{**}$	0.92	87.9
Second category	$Ln\hat{Y}_i = 0.48 + 0.295\ LnX_1 + 0.528\ LnX_2 + 0.74\ LnX_8$ $(4.7)^{**}\quad (9.3)^{**}\quad (2.3)^{*}$	0.74	94.8

Yi = the estimated productivity per fedden of wheat in ardab. X_1 = = Quantity of human labor, man/day. X_2 = Quantity of machine work/hour. X3 = Quantity of seeds used in agriculture in kilogram. X_4 = Quantity of municipal fertilizers in cubic meters. X_5 = Quantity of nitrogen fertilizer in effective unit. X_6 = Quantity of phosphate fertilizers in effective unit. X_7 = the value of the foliar fertilizer in pounds. X_8 = Value of pesticides in pound. **Source**: calculated from data from the research sample.

Table 6. Estimating the economic efficiency of the elements of wheat crop production according to the estimated indications in the research sample farms in Beheira Governorate in 2019/2020

categories	productive element	unit	Productive Flexibility	Average output	Marginal product	Unit price	Marginal product value	Economic efficiency
Frist category	Human work	man/day	0.128	0.66	0.08	72	53.6	0.74
	Automation	hour	0.217	0.56	0.12	79	80.4	1.01
	Seeds	kg	0.257	0.33	0.08	9	53.6	5.9
	nitrogen fertilizer	effective unit	0.133	0.6	0.08	11.25	53.6	4.76
	Phosphate fertilizer	effective unit	0.193	0.89	0.17	11.6	113.9	9.82
second category	Human work	man/day	0.295	0.68	0.2	68.3	134	1.96
	Automation	hour	0.528	0.38	0.19	139.6	127.3	0.91
	pesticides	pound	0.074	0.17	0.01			

(1) Wheat ardeb price = 670 pounds.
(2) Value of marginal product = price of the unit sold of the product x marginal product of the element.
(3) The economic efficiency of using the productive element = value of marginal product / unit price of the element.
(4) The average hourly rate of automated work was calculated using the weighted average of the number of hours worked for each machine for each category.
(5)The average human labor wage was calculated using the weighted average of the number of workers in each agricultural operation for each category.
Source: Calculated from the data of the questionnaire forms the research sample 2019/2020.

Table 7. Estimation of the marginal rate of technological substitution of the element of automated work with human work in the tenure categories of wheat crop in the research sample in Beheira Governorate 2019/2020

Item	Automation(hour)		Human labor (man/day)		marginal rate technology substitution
	Elasticity	average	Elasticity	average	
First possession category	0.217	30	0.128	29	1.64
Second possession category	0.528	39.6	0.295	22	0.99

Source: calculated from data from the research sample.

Table 8. The relative importance and its probabilistic distribution of the problems and obstacles of human and mechanical work facing the farmers of the wheat crop in the research sample in Beheira Governorate 2019/2020

the problem			the first category						the second category					
			Repetition	The ratio	Possibility	Stander error	Confidence period for probability		Repetition	The ratio	Possibility	Stander error	Confidence period for probability	
			Number			Confidence Level 95%	Maximum	Minimum	Number			Confidence Level 95%	Maximum	Minimum
Obstacles human work	Wage difference		29	58	0.58	0.14	0.72	0.44	34	68	0.68	0.13	0.81	0.55
	Lack of labor		26	52	0.52	0.14	0.66	0.38	18	36	0.36	0.13	0.49	0.23
	Reasons for higher wages	Unavailability of labor	31	62	0.62	0.13	0.75	0.49	30	60	0.6	0.14	0.74	0.46
		Labor migration to other sectors	37	74	0.74	0.12	0.86	0.62	39	78	0.78	0.11	0.89	0.67
		Short working day	25	50	0.5	0.14	0.64	0.36	22	44	0.44	0.14	0.58	0.3
Obstacles automated work	High purchase price of the machine		44	88	0.88	0.09	0.97	0.79	47	94	0.94	0.07	1.01	0.87
	Lack of funding		38	76	0.76	0.12	0.88	0.64	36	72	0.72	0.12	0.84	0.6
	inappropriateness of the machine		22	44	0.44	0.14	0.58	0.3	21	42	0.42	0.14	0.56	0.28
	Unavailability of maintenance centers		28	56	0.56	0.14	0.7	0.42	32	64	0.64	0.13	0.77	0.51
	Not having automation all the time		13	26	0.26	0.12	0.38	0.14	12	24	0.24	0.12	0.36	0.12

Source: collected and computed from data from the opinion poll form for the farmers of the research sample in Beheira Governorate in 2002 and a maximum of about 3.47 million feddans in 2015 with a general average of about 3.02 million feddans, while wheat production ranged between a minimum of about 6.63 million tons in 2002 and a maximum It reached about 9.61 million tons in 2015 with an annual average of about 8.24 million tons, while the productivity of the wheat crop in Egypt ranged between a minimum of about 2.39 tons / feddan in 2010 and a maximum of about 2.88 tons / feddan in 2017 with a general average of about 2.72 tons / feddan. By estimating the equations of the general time trend for each of the cultivated area and wheat crop production in Egypt, it was found that each of them takes an increasing general trend at a significant level of 0.01 with an annual growth rate of about 1.4%, 1.5% and an annual increase of about 42 thousand feddans, 124 thousand tons for each respectively, while it was found that the productivity of wheat crop in Egypt was not significant at different levels of significance.

Economic Indicators: It was found that the price of the crop ranged between a minimum of about 718 pounds/ton in 2002 and a maximum of about 4406.7 pounds/ton in 2019 with a general average of about 2197.3 pounds/ton, while the total costs ranged between a minimum of about 1558.4 pounds/ feddan and a maximum It amounted to about 11,326 pounds/feddan in 2019 with a general average of about 4681.08 pounds/feddan, while the total return ranged between a minimum of about 2530.7 pounds/feddan and a maximum of about 14,912 pounds/feddan in 2019 with a general average of about 7523.82 pounds/feddan, The net return per feddan also ranged between a minimum of about 972.3 pounds in 2002 and a maximum of about 5300 pounds in 2009, with a general average of about 3015.52 pounds. The return on the invested pound also ranged between a minimum of about 0.62 pounds in 2019 and a maximum of about 0.47 pounds in 2005, with a general average of about 0.78 pounds. While costs return ratio ranged between a minimum of about 1.62 in 2018 and a maximum of about 1.32 in 2010 with a general average of about 1.73. By estimating the equations of the general time trend of total costs, total return and net return, it was found that they take an increasing general trend at a significant level of 0.01 with an annual growth rate of about 11.6%, 9.8%, 6.1% with an annual increase of about 221.63 pounds/feddan, 543.01 pounds/feddan, 737.3 pounds/feddan each, respectively. While the return on the invested pound took a general decreasing trend with an annual decreasing rate of about 5.5% at a significant level of 0.01 and an annual decrease of about 183.95 pounds.

Second: Productive and economic indicators of wheat crop in the research sample: By reviewing the data in Table No. (4), it was found that

- **Productivity indicators:** The quantity of seeds used in agriculture for wheat crop reached about 58 and 45.8 kg for each category for each category, while the amount of municipal fertilizers used in agriculture for wheat production for each category amounted to about 4,2.4 m^3, and the amount of nitrogenous fertilizers About 32 and 22 effective units, while the amount of phosphate fertilizers reached about 22, 15.4 effective units for each holding category, respectively, while the value of foliar fertilizers amounted to about 262, 115.2 pounds, while the value of pesticides reached about 181, 88.5 pounds for each category, respectively.
- **Economic indicators:** The feddan productivity of the wheat crop for the holding categories in the research sample amounted to about 19,20.3 Ardabs/feddan, with an average farm price of about 670 pounds, while the secondary product amounted to about 11 and 12 hemls/feddans, with an average heml price of about 430 pounds. The total return for each category amounted to about 17.4 and 18.7 thousand pounds, while the total costs for the two categories amounted to about 10.8 and 10.4 thousand pounds, and the net return for the two holding categories was about 6.63 and 8.34 thousand pounds for each of them, respectively, and the marginal surplus amounted to about 12.38 and 13.84 thousand pounds. For each category, the return on the invested pound was about 0.6 and 0.8 for each of them, respectively.

Third: Efficiency of using human and machine labor suppliers to produce the wheat crop in the research sample:

Standard estimation of wheat production functions: Before distributing the research sample to the tenure categories, it is necessary to conduct an analysis of variance test according to automated labor costs to ensure that there are significant differences between the tenure categories or not or whether the sample is treated as one category. It was found that there are significant differences between the tenure categories, which necessitates the study of each category separately. The research sample was divided into two categories, the first category included areas of more than one feddan for less than three acres, and the second category included holdings of more than three feddans. By conducting the standard estimation of the production functions of wheat crop in the categories of the study sample in Beheira Governorate, The double logarithmic image was chosen as the best statistical model, which represents the function according to the significance of F, R^{-2}, and the results were as follows, as shown in Table (5):

Production function of wheat crop for the first holding category: The estimated production function indicates the statistical significance of the estimated function at the probability level of 0.01, where the calculated (F) value was about 87.9, and the adjusted coefficient of determination (R^{-2}), which amounted to about 0.92, which confirms that The included (independent) explanatory variables explain about 92% of the changes occurring in the dependent variable (the quantity of production), and the remaining percentage, which is about 8%, is due to other factors that were not included in the estimated function. The estimated coefficients refer to the statistical significance of (X_1), (X_2), (X_6). The amount of human work/man/day, the amount of machine work/working hour, the amount of phosphate fertilizers (effective unit) at the probability level 0.01 and the modulus of elasticity reached 0.13, 0.22, 0.19, which means that an increase in their use by 1% leads to an increase in wheat production at a rate of 0.13 %, 0.22%, 0.19%, respectively, and the estimated coefficients indicate the statistical significance of each of (X_3), (X_5) at the probability level of 0.05, and the elasticity coefficient reached 0.26, 0.13, which means that an increase in their use by 1% leads to an increase in production from Wheat at a rate of 0.26% and 0.13%, respectively, and the production flexibility of these elements shows their use in the second stage of production, which is the stage of rational production. It reflects the total elasticity of the factors of production in the estimated function, which amounted to about 0.9. The nature of diminishing return to capacitance. The estimated values of the standard partial regression coefficient (β)) indicate the arrangement of the variables according to their relative importance in influencing the dependent variable, where the amount of nitrogen fertilizers shows the most effect, followed by the amount of seeds, the amount of phosphate fertilizers, the amount of mechanical work/hour, the amount of work The human human/day, which amounted to about 0.477, 0.445, 0.428, 0.412, and 0.324 for each of them, respectively.

Production function of wheat crop for the second holding category: The estimated production function refers to the statistical significance of the estimated function at the probability level of 0.01, where the calculated value (F) reached about 94.8, as indicated by the modified coefficient of determination (R^{-2}), which amounted to about 0.74, which confirms that The (independent) explanatory variables explain about 74% of the changes in the dependent variable (the quantity of production), and the remaining percentage, which is about 26%, is due to other factors that were not included in the estimated function. The estimated coefficients in the previous production function refer to the statistical significance of each of (X1), (X2), the amount of human labor, man/day, the amount of automated work at the probability level of 0.01, (X_8) The value of pesticides at the probability level is 0.05, and the elasticity modulus is about 0.30, 0.53, which means that an increase in its use by 1% leads to an increase in wheat production at a rate of 0.30%, 0.53%, 0.07. Productive flexibility shows the use of these elements in the second economic stage, The total elasticity of the factors of production in the estimated function, which amounted to about 0.90, reflects the nature of the diminishing return to capacity. The estimated values of the standard partial regression coefficient (β)) indicate the arrangement of the variables according to their importance in influencing the dependent variable, where the amount of automated work was shown to be the most influential, followed by human work per man/day, and the value of pesticides/pound, which amounted to about 0.84, 0.56, 0.31 each, respectively.

The economic efficiency of the wheat production farms in the research sample: By measuring the economic efficiency of the farm resources used in the production of wheat in the research sample, a review of the results obtained in Table (6) shows the following:

By estimating efficiency of the first category: by using the element of automated work in the production of wheat in the study sample, where the value of its efficiency coefficient was about 1.01, which means complete efficiency in using the element of automated work, and by estimating the efficiency of using the element of the quantity of seeds, and the amount of nitrogen fertilizer in wheat production, where the value Its efficiency coefficient is about 5.9, 4.76, which means that producers can achieve efficiency in using the two elements in wheat production by increasing the quantities used of it until the value of the marginal yield of the element equals the unit price of it, and by estimating the efficiency of using the human labor element in wheat production where the value of its efficiency coefficient is about 0.74, which means that producers can achieve efficiency in using the two elements in wheat production by reducing the quantities used of it until the value of the marginal yield of the element equals the unit price of it.

By estimating efficiency of the second category by using the human labor element in wheat production in the study sample (the value of its efficiency coefficient was about 1.96, which means that producers can achieve efficiency in using the element in wheat production by increasing the quantities used of it until the value of the marginal yield of the element equals with The unit price of it, and by estimating the efficiency of using the element of automated work in wheat production, where the value of the efficiency coefficient is about 0.91, which means that producers can achieve efficiency in using the two elements in wheat production by reducing the quantities used from it until the value of the marginal yield of the element is equal to the price of unit of it.

Marginal rate of technological substitution for machine and human labor: By reviewing the marginal rate of technological substitution of mechanical work with human labor for the wheat crop in the research sample of the tenure categories as shown in Table (7), the following appears:

The first holding category: It is clear that to increase the amount of automated work by one hour of work, it is necessary to dispense with the amount of human work amounting to about 1.64 men / day in order to achieve the same level of production.

The second holding category: It is clear that to increase the amount of automated work by one working hour, it is necessary to dispense with the amount of human work of about 1 man / day, in order to achieve the same level of production.

Fourth: The relative importance of problems and obstacles to human and mechanical work for wheat farmers in the research sample: By reviewing the results of the analysis contained in Table No. (8), which shows the relative importance of the problems and obstacles of human and mechanical work facing the farmers of the research sample of the wheat crop and its probabilistic distribution at a confidence level of 95%, it was found that the most important obstacles to human work is the difference in wages. The frequency reached about 29 with a percentage of about 58.

It ranged between a minimum of about 0.44 and a maximum of about 0.72 for the first category, while the frequency of wages difference was about 34 with a rate of about 68%, and the confidence interval for the possibility of the problem occurring ranged between a minimum of about 0.55 and a maximum of about 0.81 for the second category. In the second place, the obstacles to human work were the lack of labor, which frequency amounted to about 26, at a rate of about 52%, and ranged between a minimum of about 0.38 and a maximum of about 0.66 for the first category, while the frequency of the lack of labor for the second category amounted to about 18, with a rate of about 36%, and the confidence interval for the possibility of the problem occurring ranged between a minimum of about 0.23 and a maximum of about 0.49 for the second category.

By reviewing the most important obstacles to automated work, it was found that they were represented in the rise in the purchase price of the machine with a frequency of about 44, at a rate of about 88%, with a minimum of about 0.79 and a maximum of about 0.97 for the first category, while the repetition amounted to about 47 at a rate of about 88%, and the confidence interval ranged The probability of the problem occurring is between a minimum of about 0.87 and a maximum of about 1.01 for the second category. In second and third place came the lack of funding and the inadequacy of the machine. By surveying the opinions of producers regarding automated work about the reasons for not using mechanization in some agricultural operations, about 75% of the farmers of the research sample answered that this is due to the fragmentation of tenure and the inappropriateness of the machine to the farm area. The survey indicated that using the machine when there is sluggishness, there is a difficulty in using the machine as there is no increase in the wastage of the crop. In the case of the most widespread machines are the agricultural tractor and irrigation machines, and the demand for agricultural machines increases in the harvest season.

Recommendation

The research recommends the need to expand the replacement of human work by mechanization in large feddan holdings in the case of using modern farming methods that aim to provide wastage in seeds on the one hand and control the intensity of seed distribution during the cultivation process in order to avoid the dormancy of the wheat crop during the maturity stage and what may result from it From a decrease in productivity, in addition to the expansion of merging and threshing operations using the machine at the expense of manual methods, which results in saving effort, reducing the time period and reducing the costs of the production process 2- Working on designing and finding light equipment to be used in small spaces or dwarf holdings, in addition to using high-quality varieties that contribute to saving effort and money in the cultivation and harvesting operations.

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