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An economic study of the effect of the field irrigation development project on rationalizing water use in the old lands in Beheira Governorate

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Abstract: The issue of rationalizing irrigation water consumption by establishing field irrigation development projects in old lands has become one of the important and necessary issues in the Arab Republic of Egypt, these projects aim to reduce irrigation, maintenance, and operation costs, reduce water infiltration into adjacent areas and rationalize water lost through the network of water channels, And benefit from it in the reclamation and cultivation of new lands, working to raise the efficiency of irrigation water transfer, and finally increasing the area of cultivated lands as a result of the cancellation and development of irrigation channels within the field. Therefore, the research dealt with the study of the field irrigation development project established in the Beheira governorate and its expected effects in terms of rationalizing the use of irrigation water and bringing about positive economic changes in the total factor productivity of the crops in the research sample through a comparison between the crops grown in the agricultural associations implementing the project with those cultivated in the agricultural associations that non-implementing the project in the Beheira governorate. Therefore, the implementation of the field irrigation development project in the Beheira Governorate in the old lands increased the area cultivated with rice, watermelon pulp, sugar beet, Broad Bean, and finally artichoke as a result of the cancellation and development of water channels in the field, which is reflected in the increase in the productivity of the feddan of the crops under study by percentages. They amounted to about 10%, 7.1%, 4.5%, 9.1%, and 3.3%, respectively, Thus increasing the unit water productivity of those crops by about 17.1%, 24.5%, 17%, 21.3%, and 12.6%, respectively, and reducing the amount of water used in irrigation by about 6%, 14%, 10%, 10% and 8.3%, respectively, due to the reduction of water infiltration into adjacent areas and the reduction of water loss during its transportation through the network of various water channels. And also reducing variable production costs by about 15.3%, 12.3%, 11.3%, 14.3%, and 11.7%, respectively, and finally reducing irrigation costs by about 38.6%, 51.3%, 47.4%, 45.2%, 32.7% for the aforementioned crops, respectively, which led to an increase in the net return per feddan by about 55.4%, 36.9%, 25.4%, 29.6%, 42.2 %, respectively, and the consequent increase in the net water unit return by about 65.3%, 59.1%, 39.8%, 44%, and 55%, respectively, compared to the net water unit return for farms that use the traditional irrigation system. It was also shown from the indicators of the Malmquist analysis of total factor productivity when the farmer uses the field irrigation development project in the Beheira governorate as an alternative to the traditional irrigation system, which leads to a positive effect greater than one on the changes in the total factor productivity of the rice crop, watermelon pulp, sugar beet, Broad Bean, and artichoke, the total factor productivity of these crops increased by about 32.5%, 31.3%, 23.8%, 23.4%, and 19.2%, respectively, this increase is due primarily to the farmer's use of the field irrigation development project to irrigate the crops under study without the changes in the quantity of inputs, as technological change increased by about 42.5%, 30.6%, 18.6%, 16.9%, and 27.5% respectively, for the aforementioned crops compared to their counterparts with the traditional irrigation system. The results indicated that when the state completed and expands the field irrigation development project at the level of both the Beheira Governorate and Egypt in the old lands. This will contribute to the expansion of cultivation and production of yellow maize and wheat crops by directing the amount of rationalized water from the implementation of the project to reduce the gap between production and local consumption, by applying one of the following alternatives: **The first alternative:** When implementing and completing the field irrigation development project, it will lead to an increase in the quantity of yellow maize crop production at the levels of Beheira governorate and Egypt by about 17.7% and 14.7%, respectively, and the consequent reduction in the quantity of annual imports of the crop by about 4%. On the other hand, it leads to an increase in the production of the wheat crop at the levels of Beheira governorate and Egypt by about 2.6% and 2.1%, respectively, thus reducing the quantity of annual imports of the crop by 1.52%. **The second alternative:** when implementing the field irrigation development project and excluding the area of watermelon pulp and replacing it with the cultivation of yellow maize, this leads to an increase in the quantity of yellow maize production at the levels of the governorate of Beheira and Egypt by about 29.5% and 22.2%, respectively, which leads to a decrease in the quantity of annual imports of the crop increased by 6.4%.

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Keywords: Total factor productivity - Irrigation water rationalization - Field irrigation development project - Traditional irrigation.

Introduction:

The agricultural sector ranks first among the different sectors in water resource consumption, consuming about 85% of the total water resources available annually. Crops in old land use about 45 billion m3 annually, representing about 82% of Egypt's share of Nile River water. The remainder is used for industrial, navigational, and drinking purposes, with Egypt's average per capita freshwater in 2018 not exceeding 585 m3 annually. And with Egypt's share of water holding steady at 55.5 billion cubic meters annually and with a sustained population increase, the average per capita water is expected to reach 496 m3 annually by 2025, therefore, Egypt is currently below the global water poverty line of about 1,000 m3 annually according to the United Nations statistics, which results in a severe shortage of Egyptian water needs.

Therefore, the issue of water resources development in Egypt, maximizing benefits from it, and rationalizing its use is one of the most important challenges facing Egypt in the present and future, given that water represents the basic pillar to support economic development plans in general and agriculture in particular, and the importance of water for its important role in achieving sustainable development in the agricultural sector increases with attention to small farmers to achieve the optimal use of land and water resources, so the field of developing and modernizing the field irrigation system has been identified as a project national that raises the efficiency of water resources use, and field irrigation development projects have started in old lands Actually about 12 years ago, by unifying irrigation water lifting points through irrigation pumps and irrigation water pumping in pipes with relatively low pressure to transport irrigation water or irrigation water pumping in channels lined with cement, where a major butterfly valve is placed on the main water pipe at the beginning of a pipeline to feed the fields through pipes inside the field Which contributes to raising the efficiency of water use and providing a greater amount of justice in the distribution of water and reducing irrigation costs.

Research problem:

The research problem is represented in the limited Egyptian water resources from the Nile River and the increasing water gap between the available and required of those resources at the level of all sectors, and water use is also less efficient for agricultural purposes due to dependence on Traditional irrigation in the production of various crops, resulting in increased wastage and loss of irrigation water, Therefore, the issue of rationalizing the consumption of irrigation water through the establishment of projects for the development of field irrigation in old lands has become an important and necessary issue. These projects aim to reduce the leaching of water to neighboring areas and reduce irrigation, maintenance, and operating costs, also rationalizing the irrigation water lost through the waterways network and benefiting from it in the reclamation and cultivation of new lands. And working to raise the efficiency of irrigation water transport and finally increase the area of land cultivated as a result of the development of water channels. So, the research deals with the study of the field irrigation development project established in the Beheira governorate and its expected effects with regard to rationalizing the use of irrigation water and bringing about positive economic changes in (total factor productivity, the rate of technological change, the rate of technological growth of productivity) for the crops under study through a comparison between the Cultivation of crops in the associations agricultural implementers of the project are similar to those planted in the agricultural associations that have non-implemented by the field irrigation development project in Beheira Governorate.

Research objective:

The main objective of the research was to increase the efficiency of the use of traditional irrigation water in the old lands of Beheira Governorate by:

1. Study the economic effect of the rationalization of traditional irrigation water by implementing the field irrigation development project for summer and winter crops, in the research sample, in the old lands in Beheira Governorate for the productive season 2021/2022.
2. Measuring the effect of technological change in the traditional irrigation system by implementing the field irrigation development project on the production of summer and winter crops in the old lands in Beheira Governorate for the production season 2021/2022.
3. A study of the effect of rationalizing irrigation water for the crops of the research sample on the expanding cultivation of some competing crops in

the agricultural cycle, especially (yellow maize, wheat) in Egypt and Beheira Governorate.

Materials and methods:

In achieving its objectives, the research relied on the use of descriptive economic and econometric analysis, using some statistical methods and mathematical models that achieve the research objectives. An analysis of variance was used for the difference between the average per feddan productivity and the production inputs of the study crops in the old lands in Beheira Governorate within the agricultural associations implementing the field irrigation development project and compared them to the crops within the agricultural associations not implementing the development of field irrigation, and the non-parametric analysis method to analyze changes in total factors productivity (TFPCH) for the quantity of production of the study crops in the old lands according to the concept of production using the Malmquist for TFP index for farms that use field irrigation development, this method uses multiple production inputs and outputs without the need to maximize profit or minimize costs. This method includes Technical Efficiency Change (EFCh) and Technological Change (TecCh), this is expressed by the qualitative change without the change in the quantity of productive inputs, represented by the transition of the function to up, that is, the technological change is positive and is expressed by a number greater than one, which indicates a positive effect, but if the number is less than the correct one, then the technological change has a negative effect and is represented by The transition of the function downwards, which indicates that there is a deficit in efficiency, so it is necessary to move to better technology in order to reach full efficiency.

Data sources:

The study relied on published and unpublished secondary data issued by the Directorate of Agriculture in Beheira Governorate, where the directorate is divided into 15 centers. The field irrigation development project was implemented with 6 centers over part of its area, where the area in which the project was implemented under the management of the Ministry of Agriculture and Land Reclamation reached about 41,310 feddan in the Abu Hummus center, 30,970 feddan in the Damanhur center, 25,100 feddan in the Kafr El-Dawwar center, 12,719 feddan in the El-Mahmoudia center, 3,400 feddan in the Hosh Issa center, and finally 500 feddan in the El-Rahmaniya center, the study also relied on cross-sectional data in the light of a multi-stage random cluster sample whose data were collected through a questionnaire form from the center of Abu Hummus, Damanhur, Kafr El-Dawwar, El-Mahmoudia, Hosh Issa, representing about 99.6% of the total area in which the project was implemented, amounting to about 113,999 feddan in Beheira Governorate.

The research sample:

And for studying the effect of the field irrigation development project on rationalizing the use of irrigation water in the old lands of Beheira Governorate, The most important winter and summer crops prevailing in the study area were chosen, which are rice and watermelon pulp from summer crops, sugar beet, Broad Bean, and artichoke from winter crops, a questionnaire was prepared, and its data was collected from a random sample of farmers who applied the developed field irrigation system, in addition to a comparative sample representing a group of farmers who did not implement the project on their land area and implementation is underway by the Ministry of Water Resources and Irrigation, the selection of the sample took into account the adjacent fields, the convergence of the holdings, and the convergence of agricultural transactions as far as possible, both for the study sample and the comparative sample, so that any differences in productivity, the quantity of water used, or the net return could be returned to the field development process. The data of the questionnaire form were used in conducting the necessary statistical analyzes, where the analysis of variance method was used as one of the statistical methods to clarify the differences in the studied variables and the non-parametric analysis method to clarify the changes in the total factor productivity of the Quantity of production of the study crops in the old lands according to the production concept.

1. **The relative importance of summer crops under study in Beheira governorate for the production season 2022.**

Shown in Table No.1, Abu Hummus Center in Beheira Governorate is ranked first in the cultivation of the rice crop for 2022, with an area of about 24447 feddan representing about 17.7% of the total rice area at the governorate level amounting to 137870 feddan, and representing 21.8% of the total summer crop area. As for the watermelon pulp crop, the Abu Hummus Center was ranked first and the Hosh Issa Center was ranked second in the cultivation of the crop for the same year, Its area of 12796, 4154 feddan accounted for about 39.2%, 12.7% of the total area of watermelon pulp at Beheira Governorate level, and the area of watermelon pulp represents about 5.2% of the area of summer crops in agricultural credit associations in the governorate.

2. **The relative importance of winter crops under study in Beheira governorate for the production season 2021/2022.**

A. **sugar beet crop:** It is clear from the data in Table No.2, The Hosh Issa Center ranked first in terms of sugar beet cultivation in the Beheira governorate, where the crop area was about 5490 feddan, representing about 20.8% of the total sugar beet area 26455 feddan at Beheira governorate level and representing 4.2% of the total winter crop area in the governorate.

B. **Broad Bean crop:** And by reviewing the data contained in Table No.2, it was found that the total area cultivated with the Broad Bean crop in each of the centers of Abu Hummus, Hosh Issa, Damanhur, Kafr El-Dawwar, and El-Mahmoudia, which implemented the field irrigation development project reached to about 1675 feddan, representing about 40.8% of the total crop area in Beheira governorate and representing the area of Beheira crop of about 0.65% of the total winter crop area of about 632044 feddan in the governorate.

C. **Artichoke crop:** The area of the artichoke crop in the center of Kafr al-Dawwar was about 9071 feddan, representing about 52.8% of the total area cultivated with the crop at the level of Beheira governorate, which amounted to about 17182 feddan, and it represented about 1.44% of the total area of winter crops, as shown in Table No.2.

3. Determining the size of the research sample within the associations implementing and non-implementing the field irrigation development project, according to the relative importance of the farmers of the research sample crops in Beheira Governorate.

The number of observations of the research sample of crops for the summer and winter seasons was determined in each of the centers of Abu Hummus, Hosh Issa, Damanhur, Kafr El-Dawwar, and El-Mahmoudia, in the old lands in Beheira Governorate by taking 5% of the total number of farmers those crops who used and did not use the developed field irrigation system as follows:

Table1. The crop area of rice and watermelon pulp in Beheira governorate for summer production season 2022.

Area* / The Center	rice	%	watermelon pulp	%
Abu Hummus	24447	17.7	12796	39.2
Hosh Issa	7945	5.80	4154	12.7
Damanhur	23249	16.9	1997	6.10
Kafr El-Dawwar	11051	8.00	3495	10.7
El-Mahmoudia	12298	8.90	3666	11.2
El-Rahmaniya	4346	3.10	652	2.00
Itay El Barud	11160	8.10	389	1.20
Rashid	954	0.70	191	0.60
Edku	2040	1.50	0	0.00
Janakles	2868	2.00	694	2.10
Shubrakhit	10198	7.40	624	1.90
Koum Hamada	8950	6.50	450	1.40
Abu El-Matamir	1173	0.90	528	1.60
El-Delengat	17191	12.50	3028	9.30
Wadi El-Natrun	0	0.00	0	0.00
Total	**137870**	**100**	**32664**	**100**

*Area = feddan = 4200 m^2

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

Table2. The crop area of sugar beet, Broad Bean, and artichokes in Beheira governorate for the winter production season 2021/2022.

Area* / The Centers	Sugar beet	%	Broad Bean	%	Artichoke	%
Abu Hummus	3517	13.3	313	7.60	699	4.07
Hosh Issa	5490	20.8	433	10.6	10	0.06
Damanhur	3952	14.9	452	11.0	0	0
Kafr El-Dawwar	359	1.40	184	4.50	9071	52.8
El-Mahmoudia	817	3.10	293	7.10	0	0
El-Rahmaniya	1168	4.40	32	0.80	0	0
Itay El Barud	512	1.90	42	1.00	0	0
Rashid	0	0.00	166	4.00	0	0
Edku	1686	6.40	819	20.0	0	0
Janakles	1897	7.20	255	6.20	1045	6.08
Shubrakhit	1293	4.90	20	0.50	0	0
Koum Hamada	165	0.60	50	1.20	0	0
Abu El-Matamir	2785	10.5	70	1.70	6357	36.9
El-Delengat	2646	10.0	472	11.5	0	0
Wadi El-Natrun	168	0.60	500	12.2	0	0
Total	**26455**	**100**	**4101**	**100**	**17182**	**100**

*Area = feddan = 4200 m^2

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

A. Determine the number of observations of summer crops.

i. **Rice crop:** The data is shown in Table No.3, the agricultural associations implementing and non-implementing the field irrigation development project were selected, to determine the number of observations of the rice crop in the research sample at the Hummus Center according to the relative importance of the number of farmers, Where the number of crop farmers in the implemented and non-implemented associations reached about 2534 and 2534 farmers, respectively, representing approximately 44.7% of the total number of farmers in the developed associations, which amounted to 5674 rice farmers, and 65.8% of the total number of farmers in the non-developed associations, which amounted to 3853 farmers of the crop.

Based on the above, the number of selected observations of the rice crop in agricultural associations implemented and non-implemented for the field irrigation development project at the level of Abu Hummus Center was determined by taking 5% of the total number of farmers in those selected associations. Therefore, the number of observations of the rice crop in the research sample reached about 127 farmers using the developed field irrigation system and 127 farmers using the traditional irrigation system.

Table3. Determination of the sample size of the rice crop within agricultural associations implemented and non-implemented for the field irrigation development project at the Abu Hummus center.

The Center	project implemented			project non-implemented		
	the association	Area*	farmers	the association	Area*	farmers
Abu Hummus	Barsiq	700	1043	Eastern Balqatar	900	909
	Abukabariya	850	772	Western Balqatar	1091	963
	Abu hawash	948	719	Rawdat Khairy	569	662
Total	**3**	**2498**	**2534**	**3**	**2560**	**2534**

*Area = feddan = 4200 m^2

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

Table4. Determination of the sample size of the watermelon pulp crop within agricultural associations implemented and non-implemented for the field irrigation development project at the Abu Hummus and Hosh Issa center.

The Center	project implemented			project non-implemented		
	the association	Area*	farmers	the association	Area*	farmers
Abu Hummus	Mahalla Kail	418	543	Eastern Balqatar	401	428
	-	-	-	Western Balqatar	170	461
	1	**418**	**543**	**2**	**571**	**889**
Hosh Issa	Hosh Issa	810	340	Abu Ashuqaf	530	181
	Amara	715	328	Al-Abaqaeen	366	141
	2	**1525**	**668**	**2**	**896**	**322**
Total	**3**	**1943**	**1211**	**4**	**1467**	**1211**

*Area = feddan = 4200 m^2

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

ii. **Watermelon pulp crop:** Chosen implement and non-implementing agricultural associations of the field irrigation development project and representatives of the watermelon pulp crop in Abu Hummus Center Beheira Governorate according to the relative importance of the number of farmers, whose numeral is about 543, representing approximately 20.4% of the total numeral of them in the developed agricultural associations whose number is 2667, and the number of farmers in the non-developed agricultural associations reached 889, representing about 60.7% of the total numeral of them in those associations which numbered 1465 farmers for the crop. As for the Hosh Issa Center, the agricultural associations implementing the project, which are (Hosh Issa and Amara) identified the numeral of farmers for watermelon pulp as about 668 farmers, representing nearly73.2% of the total number in the developed associations reached their numeral is 912 farmers for the crop, the agricultural associations non-implementing the field irrigation development project Association (Abu Ashuqaf, Al-Abaqaeen) where the number of watermelon pulp farmers reached about 322, representing approximately19.7% of the total number of them in these associations, which numbered 1637, as shown in Table No.4.

Therefore, the selected observations of watermelon pulp crop were determined at the level of center (Abu Hummus, Hosh Issa) in the old lands in the Beheira Governorate by taking 5% of total farmers who used and did not use the field irrigation development project. Accordingly, the observations of the watermelon pulp crop reached about 61 farmers using the developed field irrigation system and 61 Farmers using the traditional irrigation system.

B. Determine the number of observations of winter crops.

i. **Sugar beet crop:** By reviewing the data contained in Table No.5, the agricultural associations that implemented and non-implement the field irrigation development project within the Hosh Issa Center, that represented the sample were selected according to the relative importance of sugar beet farmers, and it determined the number of farmers for the crop in the Hosh Issa Association which is about 1711 farmers, representing approximately 37.3% of the total sugar beet farmers at the level of the agricultural associations implementing the project, which are 4585 farmers, As for the Al-Abaqaeen Association, which is non-implementing the project, the number of sugar beet growers in it reached about 1711, representing approximately 11.3% of the total crop farmers at the level of agricultural associations non-implementing the project and the number of beet growers that association is 15158 farmers.

From the foregoing, the number of observations of the sugar beet crop was determined at the level of the Hosh Issa Center in Al-Beheira Governorate by taking 5% of the total sugar beet farmers in the Hosh Issa Association, where the number of selected observations reached about 86 farmers using field irrigation development, and the selected observations in the Al-Abaqaeen Association were about 86 farmers using the system traditional irrigation.

Table 5. Determination of the sample size of Sugar beet crop within agricultural associations implemented and non-implemented for the field irrigation development project at the Hosh Issa center.

The Center	project implemented			project non-implemented		
	the association	Area*	farmers	the association	Area*	farmers
Hosh Issa	Hosh Issa	5025	1711	Al-Abaqaeen	4689	1711
Total	**1**	**5025**	**1711**	**1**	**4689**	**1711**

*Area = feddan = 4200 m^2

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

ii. **Broad Bean crop:** The data contained in Table No.6, the number of agricultural associations implementing the field irrigation development project was determined within five centers in the research sample, which are (Abu Hummus, Hosh Issa, Damanhur, Kafr El Dawwar, al-Mahmoudia), where it reached fifteen agricultural associations according to the relative importance of the number of Broad Bean farmers, their number is 422 farmers, representing about 88.1% of the total number of crop farmers in the aforementioned associations, which are 479 farmers, the non-implementing agricultural associations for the project were selected about ten agricultural associations at the level of the previous five centers, and the number of crop growers in those associations reached about 422 farmers, representing about 50% of the total number of Broad Bean farmers, which numbered 847 at the level of the centers representing the research sample.

Table6. Determination of the sample size of Broad Bean crop within agricultural associations implemented and non-implemented for the field irrigation development project at the Abu Hummus, Hosh Issa, Damanhur, Kafr El Dawwar and El Mahmoudia center.

The Center	project implemented			project non-implemented		
	the association	Area*	farmers	the association	Area*	farmers
Abu Hummus	Al-Qarawi	3	5	Rawdat Khairy	29	42
	Rady	1	1	Al-Nakhla Al-Bahriya	70	63
	Basantawa	16	19	Al-Ashra	23	30
	Abukabariya	62	15	-	-	-
	Abu hawash	27	22	-	-	-
	5	**109**	**62**	**3**	**122**	**135**
Hosh Issa	Amara	150	46	Al-Kom Al-Akhdar	50	20
	Al-Rubama'a	98	48	Al-Abaqaeen	50	15
	2	**248**	**94**	**2**	**100**	**35**
Damanhur	Hamour	4	5	Sharnub	46.7	48
	Gharb Qabil	33	36	Ibrahimia	81.3	86
	Mansha'at Nassar	10	11	Sentis	67	71
	3	**47**	**52**	**3**	**195**	**205**
Kafr El-Dawwar	Mansha'at Bolin	64	47	Q. Abu Qir	9	15
	Sidi Ghazi	28	25	-	-	-
	Al-Arqoub	26	23	-	-	-
	3	**118**	**95**	**1**	**9**	**15**
El Mahmoudia	Sidi Oqba	38	36	Masna	33	32
	Al-Khaleej	89	83	-	-	-
	2	**127**	**119**	**1**	**33**	**32**
Total	**15**	**649**	**422**	**18**	**673**	**422**

*Area = feddan = 4200 m^2

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

And based on what was previously mentioned, the number of selected observations of Broad Bean crop was determined by the associations that implemented and non-implement the field irrigation

development project at the center level (Abu Hummus, Hosh Issa, Damanhur, Kafr al-Dawwar, al-Mahmoudia) by taking 5% of the total number of farmers in these selected associations, as the number The observations of the Broad Bean crop under study were about 21 farmers using field irrigation development and 21 farmers using traditional irrigation.

iii. **Artichoke crop:** Table No.7, Showed that the number of artichoke farmers within the associations implementing the field irrigation development project in the Kafr El Dawwar center amounted to about 4418 farmers. The association (Sidi Ghazi, Maroun) was chosen according to the relative importance of the number of farmers of the crop, as the number of artichoke growers within those associations reached 1810 farmers representing about 41% of the total artichoke farmers at the level of the associations implementing the project, the non-implementing associations of the project were determined according to the relative importance of the number of artichoke farmers, where the Kom al-Tarfaya association was chosen in the Kafr al-Dawwar center, and the numeral of farmers of the crop in that association is about 1810 farmers, representing approximately100% of the total artichoke farmers using the traditional system at the level of the Kafr al-Dawwar center, whose number is 1810 farmers.

Table7. Determination of the sample size of Artichoke crop within agricultural associations implemented and non-implemented for the field irrigation development project at the Kafr El Dawwar center.

The Center	project implemented			project non-implemented		
	the association	Area*	farmers	the association	Area*	farmers
Kafr El Dawwar	Sidi Ghazi	1656	750	Kom al-Tarfaya	2204	1810
	Maroun	1431	1060	-	-	-
Total	**2**	**3087**	**1810**	**1**	**2204**	**1810**

*Area = feddan = 4200 m^2

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

Accordingly, the number of observations of the artichoke crop was determined at the level of the center of Kafr El-Dawwar in the governorate of Beheira by taking 5% of the total number of artichoke farmers in the Sidi Ghazi and Maroun association. The number of selected observations was about 91 farmers who used the development of field irrigation, and the number of selected observations in the Kom Al-Tarfaya association reached about 91 users of farmers' traditional irrigation system.

Results and Discussion:

First: The economic effect of the rationalization of traditional irrigation water by implementing the field irrigation development project for summer and winter crops, in the research sample, in the old lands in Beheira Governorate for the productive season 2021/2022.

1. The effect of the implementation of the field irrigation development project on the productivity of feddan and the user from irrigation water and production inputs for the summer crops in the research sample in the old lands in Beheira Governorate.

The results of the analysis of variance are shown in Table No. 8, 9, that the average productivity of a feddan, the User from irrigation water and production inputs (agricultural labor, automated labor, irrigation hours, seeds, Manure, nitrogen units, phosphate units, pesticide cost) for the summer crops in the research sample, there are statistically confirmed significant differences between the user of the field irrigation development compared to the user of the traditional irrigation system in the old lands in Beheira Governorate.

A. **Rice crop:** Table No.8, shows that implementing the field irrigation development project in the Beheira governorate leads to an increase in cultivated land by developing irrigation water channels, therefore, it led to an increase in the productivity of feddan of rice by about 10%, which resulted in an increase in the productivity of irrigation water unit by 17.1%. The rice farms used to develop field irrigation achieved rationalization in the amount of irrigation water by 6% due to the reduction of irrigation water infiltration to adjacent areas and its loss in the irrigation water network, Also, a decrease in variable costs and irrigation costs by about 15.3% and 38.6%, respectively. As a result of the above, the net return of feddan of rice and the net return per unit of irrigation water increased by about 55.4% and 65.3%, respectively, compared to the traditional irrigation user.

Table8. The effect of implementing the field irrigation development project in Beheira Governorate in the old lands on the productivity, irrigation water and production inputs for rice crop.

Items	Unit	Irrigation system		t	Comparison	
		Traditional	Field irrigation development		rationalization	%
Quantity of water[1]	M^3/Fed.	6758	6350	(10)**	408	6.00
Productivity	Tons/fed.	3	3.3	8**	0.3	10.0
Revenues	EGP/Fed.	19702	21733	8**	2031	10.3
Agricultural labor	Laborer/Fed.	32	29	(13)**	3	9.40
Labor cost	EGP/Fed.	3202	2900	(8)**	302	9.40
The Automated labor	Hour/Fed.	6	5	(7)**	1	16.7
Automated cost	EGP/Fed.	1391	1163	(6.5)**	228	16.4
Irrigation hours	Hour/Fed.	38	28	(52)**	10	26.3
Irrigation hours cost	EGP/Fed.	684	420	(40)**	264	38.6
Seeds	KG/Fed.	60	55	(20)**	5	8.30
Seed cost	EGP/Fed.	660	605	(6)**	55	8.30
Manure	M^3/Fed.	-	-	-	-	-
Manure cost	EGP/Fed.	-	-	-	-	-
Nitrogen units	Unit /Fed.	92	69	(8)**	23	25.0
Nitrogen units cost	EGP/Fed.	1212	911	(8)**	301	24.8
Phosphate units	Unit /Fed.	37	30	(8)**	7	18.9
Phosphate units cost	EGP/Fed.	600	480	(8)**	120	20.0
Potassium units	Unit /Fed.	-	-	-	-	-
Potassium units cost	EGP/Fed.	-	-	-	-	-
Pesticide cost	EGP/Fed.	900	850	(10)**	50	5.60
Variable costs[2]	EGP/Fed.	8649	7329	(21)**	1320	15.3
Total costs[3]	EGP/Fed.	13649	12329	(21)**	1320	9.70
Net return	EGP/Fed.	6053	9404	12**	3351	55.4
Net water unit return[4]	EGP/1000 m^3	896	1481	14**	585.266	65.3
Water unit productivity[5]	Ton/1000 m^3	0.444	0.520	11**	0.076	17.1
Irrigation cost per ton[6]	EGP/Ton	228	127	(35)**	101	44.2

1. Quantity of water = (Irrigation hours x Rate of water discharge x 60 seconds x 60 minutes)/1000.
2. Variable costs = Cost (Labor + The Automated labor + Irrigation hours+ Seeds+ Manure+ Nitrogen units+ Phosphate units+ Potassium units+ Pesticide).
3. Total costs = (Variable costs + Feddan rent).
4. Net water unit return = (Net Return/quantity of water) x 1000.
5. Water unit productivity = (Productivity/Quantity of water) x 1000.
6. Irrigation cost per ton = (Irrigation hours cost/ Productivity).

- The Numbers in brackets are negative.
- EGP =Egyptian Pound

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

B. **Watermelon pulp crop:** By studying the effect of implementing the field irrigation development project in Beheira Governorate on the production of the watermelon pulp crop, it was found in Table No.9, the production of the watermelon pulp crop in the old lands achieved an increase in the productivity of feddan by about 7.1%, and thus an increase in the productivity of the irrigation water unit by about 24.5% as a result of the development and Canceling of irrigation water channels in the field. And Rationalization in the amount of water by about 14%, a decrease in each of the variable costs by 12.3%, and the irrigation costs by about 51.3% per feddan. The increase in the productivity of the feddan and the decrease in variable costs resulted in an increase in the net Return of rice feddan by 36.9%, and the net return of a water unit

by about 36.9% and 59.1% respectively compared to farms using the traditional irrigation.

Table 9. The effect of implementing the field irrigation development project in Beheira Governorate in the old lands on the productivity, irrigation water and production inputs for watermelon pulp crop.

Items	Unit	Irrigation system		t	Comparison	
		Traditional	Field irrigation development		rationalization	%
Quantity of water[1]	M^3/Fed.	2092	1800	(7)**	292	14.0
Productivity	KG/fed.	450	482	5**	32	7.10
Revenues	EGP/Fed.	15728	16865	5**	1137	7.20
Agricultural labor	Laborer/Fed.	15	14	(5)**	1	6.70
Labor cost	EGP/Fed.	1500	1401	(4.5)**	99	6.60
The Automated labor	Hour/Fed.	6	5	(5)**	1	16.7
Automated cost	EGP/Fed.	900	750	(5)**	150	16.7
Irrigation hours	Hour/Fed.	7	5	(15)**	2	28.6
Irrigation hours cost	EGP/Fed.	154	75	(26)**	79	51.3
Seeds	KG/Fed.	4	3	(9)**	1	25.0
Seed cost	EGP/Fed.	260	195	(9)**	65	25.0
Manure	M^3/Fed.	-	-	-	-	-
Manure cost	EGP/Fed.	-	-	-	-	-
Nitrogen units	Unit /Fed.	77	68	(5)**	9	11.7
Nitrogen units cost	EGP/Fed.	1468	1290	(7)**	178	12.1
Phosphate units	Unit /Fed.	37	30	(7)**	7	18.9
Phosphate units cost	EGP/Fed.	658	525	(7)**	133	20.2
Potassium units	Unit /Fed.	-	-	-	-	-
Potassium units cost	EGP/Fed.	-	-	-	-	-
Pesticide cost	EGP/Fed.	1540	1500	(3)**	40	2.60
Variable costs[2]	EGP/Fed.	6480	5681	(17)**	799	12.3
Total costs[3]	EGP/Fed.	10480	9681	(17)**	799	7.60
Net Return	EGP/Fed.	5248	7184	9**	1936	36.9
Net water unit return[4]	EGP/1000 m^3	2509	3991	10**	1482	59.1
Water unit productivity[5]	KG /1000 m^3	215	268	8**	53	24.5
Irrigation cost per ton[6]	EGP/100KG	34	16	(25)**	18	52.6

1. Quantity of water = (Irrigation hours x Rate of water discharge x 60 seconds x 60 minutes)/1000.
2. Variable costs = Cost (Labor + The Automated labor + Irrigation hours+ Seeds+ Manure+ Nitrogen units+ Phosphate units+ Potassium units+ Pesticide).
3. Total costs = (Variable costs + Feddan rent).
4. Net water unit return = (Net Return/quantity of water) x 1000.
5. Water unit productivity = (Productivity/Quantity of water) x 1000.
6. Irrigation cost per 100 KG = (Irrigation hours cost/ Productivity).

- The Numbers in brackets are negative.
- EGP =Egyptian Pound

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

2.The effect of the implementation of the field irrigation development project on the productivity of feddan and the user from irrigation water and production inputs for the winter crops in the research sample in the old lands in Beheira Governorate.

And by reviewing the results of the variance analysis in Tables No.10, 11, and 12, of average productivity, the user from irrigation water, and production inputs (agricultural labor, automated labor, irrigation hours, seeds, Manure, nitrogen units, phosphate units, potassium units, pesticide cost) for crops sugar beet, Broad Bean, and artichokes represented by the research sample, there are statistically confirmed significant differences between the farms used to develop field irrigation compared to the farms using traditional irrigation in old lands of Beheira Governorate as follows:

A.**Sugar beet crop:** The implementation of the field irrigation development project in the Beheira Governorate in the old lands resulted in an increase in the area cultivated with the sugar beet crop as a result of the development and canceling of irrigation water channels in the field, this was reflected in an increase in the productivity of a feddan of sugar beets by about 4.5%, and thus an increase in the productivity of a water unit by 17%, and a decrease in variable costs by about 11.3% and irrigation costs by 47.4%, and decrease in the quantity of water used for irrigation is about 10.3% due to reducing irrigation water leakage to adjacent areas and raising the efficiency of irrigation water transfer. This led to an increase in the net return per feddan of the crop by 25.4%, which led to an increase in the net return per unit of water by about 39.8% compared to the net return of a water unit for the traditional irrigation user, as shown in Table No.10.

Table10. The effect of implementing the field irrigation development project in Beheira Governorate in the old lands on the productivity, irrigation water and production inputs for Sugar beet crop.

Items	Unit	Irrigation system		t	Comparison	
		Traditional	Field irrigation development		rationalization	%
Quantity of water[1]	M^3/Fed.	2739	2457	(9)**	282	10.3
Productivity	Tons/fed.	22	23	5**	1	4.50
Revenues	EGP/Fed.	18078	18827	4**	749	4.10
Agricultural labor	Laborer/Fed.	39	37	(6)**	2	5.10
Labor cost	EGP/Fed.	3510	3329	(4.6)**	181	5.20
The Automated labor	Hour/Fed.	12	10	(11)**	2	16.7
Automated cost	EGP/Fed.	1020	850	(10)**	170	16.7
Irrigation hours	Hour/Fed.	16	13	(17)**	3	18.8
Irrigation hours cost	EGP/Fed.	321	169	(27)**	152	47.4
Seeds	KG/Fed.	5	4	(7)**	1	20.0
Seed cost	EGP/Fed.	226	180	(6)**	46	20.4
Manure	M^3/Fed.	-	-	-	-	-
Manure cost	EGP/Fed.	-	-	-	-	-
Nitrogen units	Unit /Fed.	88	84	(3)**	4	4.50
Nitrogen units cost	EGP/Fed.	1286	1194	(3)**	92	7.20
Phosphate units	Unit /Fed.	38	30	(7)**	8	21.1
Phosphate units cost	EGP/Fed.	455	360	(6)**	95	20.9
Potassium units	Unit /Fed.	-	-	-	-	-
Potassium units cost	EGP/Fed.	-	-	-	-	-
Pesticide cost	EGP/Fed.	878	744	(15)**	134	15.3
Variable costs[2]	EGP/Fed.	7696	6826	(15)**	870	11.3
Total costs[3]	EGP/Fed.	11696	10826	(15)**	870	7.40
Net Return	EGP/Fed.	6382	8001	9**	1619	25.4
Net water unit return[4]	EGP/1000 m^3	2330	3256	12**	926	39.8
Water unit productivity[5]	Ton/1000 m^3	8.0	9.40	10**	1.4	17.0
Irrigation cost per ton[6]	EGP/Ton	14.6	7.3	(27)**	7.3	50.0

1. Quantity of water = (Irrigation hours x Rate of water discharge x 60 seconds x 60 minutes)/1000.
2. Variable costs = Cost (Labor + The Automated labor + Irrigation hours+ Seeds+ Manure+ Nitrogen units+ Phosphate units+ Potassium units+ Pesticide).
3. Total costs = (Variable costs + Feddan rent).
4. Net water unit return = (Net Return/quantity of water) x 1000.
5. Water unit productivity = (Productivity/Quantity of water) x 1000.
6. Irrigation cost per ton = (Irrigation hours cost/ Productivity).

- The Numbers in brackets are negative.
- EGP =Egyptian Pound

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

B.**Broad Bean crop:** The data indicated in Table No. 11, with the implementation of the field irrigation development project in Al-Beheira Governorate in the old lands, the average productivity of a feddan of the crop increased by 9.1%, due to the development and Canceling of irrigation water channels in the field. It

also led to a rationalization of the amount of irrigation water by about 10%, which led to an increase in the productivity of the water unit by about 21.3%. In terms of costs, this resulted in a decrease in variable costs by 14.3% and irrigation costs by about 45.2%. The increase in feddan productivity and the decrease in costs resulted in an increase in the net return per feddan by 29.6%, and thus an increase in the net return per water unit by about 44% compared to the system of Traditional irrigation.

Table11. The effect of implementing the field irrigation development project in Beheira Governorate in the old lands on the productivity, irrigation water and production inputs for Broad Bean crop.

Items	Unit	Irrigation system		t	Comparison	
		Traditional	Field irrigation development		rationalization	%
Quantity of water[1]	M^3/Fed.	1674	1506	(7)**	168	10.0
Productivity	Ardab/fed.	11	12	6**	1	9.10
Revenues	EGP/Fed.	23633	26003	7**	2370	10.0
Agricultural labor	Laborer/Fed.	22	20	(7)**	2	9.10
Labor cost	EGP/Fed.	1981	1799	(6)**	182	9.20
The Automated labor	Hour/Fed.	7	6	(7)**	1	14.3
Automated cost	EGP/Fed.	588	504	(7)**	84	14.3
Irrigation hours	Hour/Fed.	10	8	(15)**	2	20.0
Irrigation hours cost	EGP/Fed.	219	120	(32)**	99	45.2
Seeds	KG/Fed.	55	50	(12)**	5	9.10
Seed cost	EGP/Fed.	1156	1050	(7)**	106	9.20
Manure	M^3/Fed.	-	-	-	-	-
Manure cost	EGP/Fed.	-	-	-	-	-
Nitrogen units	Unit /Fed.	22	19	(12)**	3	13.6
Nitrogen units cost	EGP/Fed.	349	302	(5)**	47	13.5
Phosphate units	Unit /Fed.	39	31	(8)**	8	20.5
Phosphate units cost	EGP/Fed.	415	331	(7)**	84	20.2
Potassium units	Unit /Fed.	46	35	(4)**	11	23.9
Potassium units cost	EGP/Fed.	1112	837	(4)**	275	24.7
Pesticide cost	EGP/Fed.	1000	900	(5)**	100	10.0
Variable costs[2]	EGP/Fed.	6820	5843	(13)**	977	14.3
Total costs[3]	EGP/Fed.	12320	11343	(13)**	977	7.90
Net Return	EGP/Fed.	11313	14660	9**	3347	29.6
Net water unit return[4]	EGP/1000 m^3	6758	9734	14**	2976	44.0
Water unit productivity[5]	Ardab/1000 m^3	6.6	8.0	12**	1.4	21.3
Irrigation cost per ton[6]	EGP/Ardab	20	10	(28)**	10	50.0

1. Quantity of water = (Irrigation hours x Rate of water discharge x 60 seconds x 60 minutes)/1000.
2. Variable costs = Cost (Labor + The Automated labor + Irrigation hours+ Seeds+ Manure+ Nitrogen units+ Phosphate units+ Potassium units+ Pesticide).
3. Total costs = (Variable costs + Feddan rent).
4. Net water unit return = (Net Return/quantity of water) x 1000.
5. Water unit productivity = (Productivity/Quantity of water) x 1000.
6. Irrigation cost per ardab = (Irrigation hours cost/ Productivity).

- The Numbers in brackets are negative.
- EGP =Egyptian Pound
- Ardab = 155 KG

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

C.**Artichoke crop:** The results in Table No.12, indicate an increase in the average productivity of an artichoke acre in the old lands in Beheira Governorate by 3.3% and a decrease in the amount of irrigation water by 8.3%, which resulted in an increase in the productivity of the water unit by about 12.6%, and this is due to the implementation of the field irrigation development project in Al-Beheira, the use of the field irrigation system resulted in a decrease in variable costs and irrigation costs by about 11.7% and 32.7%, respectively, and finally, the increase in productivity and the decrease in variable costs

resulted in an increase in the net return per feddan by about 42.2%, and thus an increase in the net return per unit of Water is about 55% compared to the traditional irrigation system.

Table12. The effect of implementing the field irrigation development project in Beheira Governorate in the old lands on the productivity, irrigation water and production inputs for Artichoke crop.

Items	Unit	Irrigation system		t	Comparison	
		Traditional	Field irrigation development		rationalization	%
Quantity of water[1]	M^3/Fed.	4489	4118	(11)**	371	8.30
Productivity	Flower/fed.	30500	31500	4**	1000	3.30
Revenues	EGP/Fed.	32438	33662	3**	1224	3.80
Agricultural labor	Laborer/Fed.	75	70	(12)**	5	6.70
Labor cost	EGP/Fed.	7483	6989	(9)**	494	6.60
The Automated labor	Hour/Fed.	11	10	(9)**	1	9.10
Automated cost	EGP/Fed.	826	749	(6)**	77	9.30
Irrigation hours	Hour/Fed.	29	26	(13)**	3	10.3
Irrigation hours cost	EGP/Fed.	695	468	(38)**	227	32.7
Seeds	CT/Fed.	10	9	(4)**	1	10.0
Seed cost	EGP/Fed.	2877	2599	(4)**	278	9.70
Manure	M^3/Fed.	16	14	(12)**	2	12.5
Manure cost	EGP/Fed.	1362	1190	(11)**	172	12.6
Nitrogen units	Unit /Fed.	100.7	87.4	(9)**	13.3	13.2
Nitrogen units cost	EGP/Fed.	1751	1537	(5)**	214	12.2
Phosphate units	Unit /Fed.	38	30	(10)**	8	21.1
Phosphate units cost	EGP/Fed.	402	322	(8)**	80	19.9
Potassium units	Unit /Fed.	92	69	(10)**	23	25.0
Potassium units cost	EGP/Fed.	2214	1645	(9)**	569	25.7
Pesticide cost	EGP/Fed.	800	750	(10)**	50	6.30
Variable costs[2]	EGP/Fed.	18410	16249	(17)**	2161	11.7
Total costs[3]	EGP/Fed.	24410	22249	(17)**	2161	8.90
Net Return	EGP/Fed.	8028	11413	9**	3385	42.2
Net water unit return[4]	EGP/1000 m^3	1788	2771	11**	983	55.0
Water unit productivity[5]	Flower/1000 m^3	6794	7649	11**	855	12.6
Irrigation cost per ton[6]	EGP/1000Flower	22.8	14.9	(31)**	7.9	34.6

1. Quantity of water = (Irrigation hours x Rate of water discharge x 60 seconds x 60 minutes)/1000.
2. Variable costs = Cost (Labor + The Automated labor + Irrigation hours+ Seeds+ Manure+ Nitrogen units+ Phosphate units+ Potassium units+ Pesticide).
3. Total costs = (Variable costs + Feddan rent).
4. Net water unit return = (Net Return/quantity of water) x 1000.
5. Water unit productivity = (Productivity/Quantity of water) x 1000.
6. Irrigation cost per 1000Flower = (Irrigation hours cost/ Productivity).

- The Numbers in brackets are negative.
- EGP =Egyptian Pound
- CT = carat of mind = $175m^2$

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

Second: The effect of technological change in the traditional irrigation system by implementing the field irrigation development project on the production of summer and winter crops in the old lands in Beheira Governorate for the production season 2021/2022.

This part of the research involves the results of the analysis of total factor productivity using the data envelope analysis method for the resources used in the production of crops represented by the research sample in Al-Beheira Governorate in the old lands for the production season 2021/2022, which is: (agricultural labor, automated labor, irrigation hours, quantity of irrigation water, seeds, Manure, nitrogen units, phosphate units, potassium units, pesticide), and the productivity of those crops, in order to find out whether the implementation of the field

irrigation development project in Beheira Governorate is more efficient than the traditional irrigation system as follows:

Through results of the analysis are shown in Table No. 13, it was found from the estimation of the Malmquist indicators of total factor productivity that when the farmer moves from the traditional irrigation system to the field development irrigation system, it has a positive effect greater than one number on the change in the total factor productivity of the crop (rice, watermelon Pulp, sugar beet, Broad Bean, artichokes), which amounted to about 1.325, 1.313, 1.238, 1.234, and 1.192, respectively, Any improvement in total factor productivity by32.5%, 31.3%, 23.8%, 23.4%, and 19.2%, respectively, compared to the traditional irrigation system for the crops under study in Beheira Governorate. This increase is primarily due to the change The technology that is due to the farmer's use of the field irrigation development project in irrigating the summer and winter crops under study without changing the amount of input, as it increased by about 42.5%, 30.6%, 18.6%, 16.9%, 27.5%, respectively, for the aforementioned crops, compared to the traditional irrigation system.

Table13. The effect of technological change in the traditional irrigation system on the production of summer and winter crops in the old lands in Beheira Governorate.

season	crops	Irrigation system	Techch[1]	techch%[2]	Tfpch[3]	tfpch%[4]
Summer	rice	traditional	1.000	0.00	1.000	0.00
		Field irrigation development	1.425	42.5	1.325	32.5
	watermelon pulp	traditional	1.000	0.00	1.000	0.00
		Field irrigation development	1.306	30.6	1.313	31.3
Winter	Sugar beet	traditional	1.000	0.00	1.000	0.00
		Field irrigation development	1.186	18.6	1.238	23.8
	Broad Bean	traditional	1.000	0.00	1.000	0.00
		Field irrigation development	1.169	16.9	1.234	23.4
	Artichoke	traditional	1.000	0.00	1.000	0.00
		Field irrigation development	1.275	27.5	1.192	19.2

() Technological change = (techch)
(2) % Technological change = (techch-1) x 100
(3) Total factor productivity = (tfpch)
(4) Productivity Growth = (tfpch-1) x 100
Source: collected and calculated from the data of the questionnaire form in the study sample.

Thirdly: The effect of rationalizing irrigation water for the crops of the research sample on the expanding cultivation of some competing crops in the agricultural cycle, especially (yellow maize, and wheat) in Egypt and Beheira Governorate.

Table No. 14, 15: The implementation of the field irrigation development project in the old lands in Beheira governorate has achieved an abundance of amount water used to irrigate the crops of the research sample, which includes rice, watermelon pulp, sugar beet, Broad Bean, and artichokes, about 408, 292, 282, 168, and 371 m^3/fed. Respectively, and since the average area of the previous crops during the period 2017-2021 in Beheira Governorate amounted to about 167992, 28510, 35774, 8202, and 16006 feddan, respectively, the amount of irrigation water for the crops under study upon completion of the implementation of the project at the Governorate level in all the old lands will result in rationalization in the amount of irrigation water will amount to about 68.54, 8.32, 10.1, 1.38 and 5.94 million m^3 for the crops under study, respectively.

Also, if the state generalizes the implementation of the field irrigation development project at the level of the Republic in the old lands, it will lead to rationalization in the amount of irrigation water for the crops under study, which will reach about 428.76, 38.58, 111.1, 7.74, 6.82 million m^3 for the average area of the aforementioned crops, respectively, and therefore this amount of rational water can be directed to the expansion of cultivation and production of Yellow maize and wheat crops and work to raise the percentage of self-sufficiency of them as the most important strategic crops related to Egyptian food security.

Table14. The average area of crops of the research sample at the level of Beheira Governorate and the Arab Republic of Egypt, in feddan, during the period 2017-2021.

crop / Item	summer crops		winter crops		
	Rice	Watermelon pulp	Sugar beet	Broad Bean	Artichoke
Beheira Governorate	167992	28510	35774	8202	16006
Egypt	1050878	132115	393938	46063	18395

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

Table15. The amount of water that was rationalized per feddan by implementing the field irrigation development project for crops under study in the old lands in Beheira Governorate.

crop / Item	summer crops		winter crops		
	rice	watermelon pulp	Sugar beet	Broad Bean	Artichoke
Quantity of water M^3/Fed.	408	292	282	168	371
Target water quantity m^3					
Beheira Governorate	68540736	8324920	10088268	1377936	5938226
Egypt	428758224	38577580	111090516	7738584	6824545

Source: Calculated from the data of Table 8, 9, 10, 11, 12, 14.

Table16. Average Area, Production and Productivity of Yellow maize Crop (Summer + Nile) and Wheat at the level of Beheira Governorate and Arab Republic of Egypt during the Period 2017-2021.

crop / Item	Yellow maize			Wheat		
	Area Fed.	Productivity Tons/fed.	Production Ton	Area Fed.	Productivity Tons/fed.	Production Ton
Beheira Governorate	123830	3.199	396132	356257	2.815	1002863
Egypt	906047	3.079	2789719	3207114	2.762	8858049

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

Table17. Average Egypt imports of yellow maize and wheat during the period 2017-2021.

Statement / Item	Quantity Ton	Value Thousand pounds
Yellow maize	9619770	33029095
Wheat	12155227	50646953

Source: Compiled and calculated from: Ministry of Agriculture, Economic Affairs Sector, Central Administration of Agricultural Economy, Foreign trade statistics for agricultural exports and imports Bulletin, Cairo, miscellaneous issues.

The data in Tables 16, and 17 during the average period 2017-2021 indicates that Egypt's production of Yellow maize and wheat crops amounted to about 2.78 and 8.86 million tons, respectively, and Egypt's imports of the two crops amounted to about 9.62 and 12.15 million tons, respectively, thus, the local consumption of the two crops is about 12.4 and 21.01 million tons, respectively, and therefore there is a gap between local consumption and production of the two crops, at a rate of about 77.5% and 57.8%, respectively. Therefore, it is possible to expand the cultivation and production of the two crops through the use of The amount of water that has been rationalized from the implementation of the field irrigation development project to reduce the gap between production and local consumption and thus reduce the value of imports of the two crops through the application of one of the following alternatives:

1. **The first alternative: in the case of implementing a field irrigation development project at the level of the governorate of Beheira and Egypt in the old lands:**

The data contained in the questionnaire form shows that the feddan needs of Yellow maize and wheat crops during the productive season of irrigation water in the lands in which the field irrigation development project was implemented amounted to

about 3510 and 1881 m3/fed, Respectively, the data in Table. No16, also shows that the average feddan productivity of maize and wheat crops during the study period 2017-2021 at the levels of Beheira governorate and Egypt amounted to 3.199 and 3.079 ton/feddan, respectively, for the yellow maize crop, and for the funnel crop, it amounted to about 2.815, and 2.762 ton/fed., respectively.

A. **The area of Yellow maize targeted to be cultivated in Beheira Governorate**

- The total amount of water to be rationalized for the rice crop and watermelon pulp in the research sample is 76865656 m^3, as shown in Table No.15.
- The Yellow maize area to be cultivated = the amount of water to be rationalized/the amount of irrigation water needed per feddan during the productive season = 76865656/3510 = 21899 feddan.
- The target production quantity of Yellow maize = the target area of the crop x the average production of Yellow maize = 21899 x 3.199 = 70055.1 tons.

B. **The area of Yellow maize targeted to be cultivated at the level of Egypt.**

- The total amount of water to be rationalized for the rice crop and watermelon pulp in the research sample is 467335804 m^3, as shown in Table No.15.
- The Yellow maize area to be cultivated = the amount of water to be rationalized/the amount of irrigation water needed per feddan during the productive season = 467335804/3510 = 133144.1 feddan.
- The target production quantity of Yellow maize = the target area of the crop x the average production of Yellow maize = 133144.1 x 3.079 = 409951 tons.

C. **The area of Wheat targeted to be cultivated in Beheira Governorate**

- The total amount of water to be rationalized for the rice crop and watermelon pulp in the research sample is 17404430 m^3, as shown in Table No.15.
- The Wheat area to be cultivated = the amount of water to be rationalized/the amount of irrigation water needed per feddan during the productive season = 17404430/1881 = 9253 feddan.
- The target production quantity of Wheat = the target area of the crop x the average production of Wheat = 9253 x 2.815 = 26047 tons.

D. **The area of Wheat targeted to be cultivated at the level of Egypt.**

- The total amount of water to be rationalized for the rice crop and watermelon pulp in the research sample is 125653645 m^3, as shown in Table No.15.
- The Wheat area to be cultivated = the amount of water to be rationalized/the amount of irrigation water needed per feddan during the productive season = 125653645 /1881 = 66802 feddan.
- The target production quantity of Wheat = the target area of the crop x the average production of Wheat = 66802 x 2.762 = 184506 tons.

2. The second alternative: in the case of implementing the field irrigation development project and excluding the area of watermelon pulp crop and replacing it with the cultivation of yellow maize at the level of the governorate of Beheira and Egypt in the old lands:

A. The area of Yellow maize targeted to be cultivated in Beheira Governorate.

- The quantity of the targeted production of yellow maize in the case of rationalization of water = 70055.1 tons.
- The target amount of water in case of excluding the area of watermelon pulp crop = the amount of water needed to irrigate the crop within the field irrigation system x the area of watermelon pulp during the study period = 1800 x 28510 = 51318000 m^3
- The area of yellow maize targeted for cultivation after replacing it with the place of planting watermelon pulp = the target amount of water in the event of exclusion/the amount of irrigation water required per feddan during the productive season = 51318000/3510 = 14621 feddan.
- The quantity of the targeted production of yellow maize = the target area of crop x the average productivity of yellow maize = 14621 x 3.199 = 46773 tons.
- The total quantity of targeted production of yellow maize in Beheira Governorate = the quantity of production in the case of rationalization + the quantity of production in the case of excluding the area of watermelon pulp = 70055.1 + 46773 = 116828.1 tons.

B. The area of Wheat targeted to be cultivated at the level of Egypt.

- The quantity of the targeted production of yellow maize in the case of rationalization of water = 409951 tons.
- The target amount of water in case of excluding the area of watermelon pulp crop = the amount of water needed to irrigate the crop within the field irrigation system x the area of watermelon pulp during the study period = 1800 x 132115 = 237807000 m^3
- The area of yellow maize targeted for cultivation after replacing it with the place of planting watermelon pulp = the target amount of water in the event of exclusion/the amount of irrigation water required per feddan during the productive season = 237807000/3510 = 67751.3 feddan.
- The quantity of the targeted production of yellow maize = the target area of crop x the average productivity of yellow maize = 67751.3 x 3.079 = 208606.2 tons.

- The total quantity of targeted production of yellow maize in Beheira Governorate = the quantity of production in the case of rationalization + the quantity of production in the case of excluding the area of watermelon pulp = 409951 + 208606.2 = 618557.2 tons.

It is clear from the results of the first alternative that the targeted production of yellow maize amounted to about 409951 tons at the level of Egypt and about 70055.1 tons at the level of Beheira Governorate, which leads to an increase in production by 14.7% at the level of Egypt, and by 17.7% in Beheira Governorate, increased production will reduce the annual amount of yellow maize imports by 4.3%. And on the other hand, the targeted production of wheat reached about 184506 tons at the level of Egypt, and about 26047 tons at the level of Beheira governorate, which will lead to an increase in production at the level of Egypt by 2.1% at the level of Beheira governorate by 2.6%, which will result in reducing the amount of annual imports of wheat by 1.52% at the level of the Arab Republic of Egypt.

As for the second alternative, the targeted production of yellow maize amounted to about 618557.2 tons at the level of Egypt, and about 116828.1 tons at the level of Al-Beheira governorate, this leads to an increase in the quantity of production by about 22.2% at the level of Egypt and about 29.5% at the level of the Beheira governorate, which leads to a decrease in annual imports of yellow maize by 6.4% at the level of the Arab Republic of Egypt.

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