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An Economic Study of the Impact of Applying Technology Packages on Wheat Crop Production in Al-Sharqia Governorate

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Abstract: The study addresses the persistent wheat production-consumption gap, estimated at around 47.5%, driven by population growth and increasing wheat demand. This situation necessitates bridging the gap by boosting per-acre wheat productivity, expanding both horizontally and vertically, and utilizing technology to increase self-sufficiency and reduce import dependence.
Objectives: The study aims to improve the economic efficiency of wheat production by encouraging farmers to adopt modern technological packages.
Key Findings: Results indicate that the total revenue from wheat in demonstration fields reached approximately 38,600 EGP per acre in Abu Hammad, around 35,920 EGP per acre in Zagazig, and 37,250 EGP per acre on average. In contrast, revenue from traditional fields was approximately 31,450 EGP per acre in Abu Hammad, around 29,600 EGP per acre in Zagazig, and averaged 30,575 EGP per acre for the sample.
It is evident that the total revenue for wheat in demonstration fields exceeds that of traditional fields by around 6,675 EGP per acre on average. This discrepancy in total revenue represents an estimated loss of 2.8 billion EGP in total wheat revenue for Al Sharqia Governorate and around 22.8 billion EGP nationwide for the same year. The results also reveal that the net income from wheat in demonstration fields reached about 16,790 EGP per acre in Abu Hammad, around 14,270 EGP per acre in Zagazig, and an average of 15,520 EGP per acre. By contrast, net income from traditional fields was around 8,700 EGP per acre in Abu Hammad, approximately 6,800 EGP per acre in Zagazig, and an average of 7,800 EGP per acre.
This analysis highlights a difference in net income of about 7,720 EGP per acre between demonstration and traditional fields.
Recommendations:
1. Collect farmers' feedback on improving performance efficiency and addressing issues to enhance wheat production in terms of quantity and quality.
2. Reinforce the role of agricultural cooperatives in providing high-quality seeds in the required quantities, at fair prices, and at suitable times and locations.
3. Place demonstration fields at village entrances and in visible locations to encourage farmers to observe results multiple times at different stages.
4. Expand the use of wheat planting with seed drills, given their economic and productive efficiency.
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Introduction:

The use of modern technology in the production of field crops has become essential in light of local and global economic changes, necessitating production according to quality and efficiency standards to increase the competitive advantage of Egyptian agricultural products. Agricultural development fundamentally depends on close cooperation between three key institutions: agricultural research, agricultural extension, and farmers. This collaboration is achieved through conducting various agricultural research, extracting and verifying its results, and transferring these findings to practical fields in both plant and animal agricultural production. Farmers are encouraged to adopt and implement these results, and obstacles hindering increased production are identified and addressed to enhance the income of rural households and improve their standard of living [(6)].

Technological applications can be used in both plant and animal agricultural production, but this study focuses on the technological application in wheat production. Wheat occupies a significant area among all crops, especially winter crops, with around 3.42 million feddans (approximately 1.43 million hectares) planted in 2022. It is one of the most important cereal crops on which the Egyptian population relies for food, as its grains are used in producing various types of bread and pasta. Wheat straw is also a key source of fodder for livestock. Wheat has high total and net returns and is a crucial ingredient in subsidized and rural bread, thus receiving special attention from the state to increase productivity, whether through vertical or horizontal expansion.

Wheat is Egypt's top imported food commodity, with a food gap of approximately 11.5 million tons in 2022 and a self-sufficiency rate of around 47.5% in the same year. The state has worked to reduce this gap through vertical expansion by developing high-yield wheat varieties and introducing new technological methods for wheat cultivation, while also promoting and stimulating scientific research. Horizontal expansion involved increasing the area of wheat cultivation by reclaiming and cultivating new lands in addition to the existing agricultural land area[(5)].

Study Problem:

The study problem lies in the persistent wheat gap between production and consumption, estimated at about 47.5%, due to population growth and increased demand for wheat. This necessitates covering the gap by increasing per-feddan productivity of wheat, expanding both vertically and horizontally, and adopting modern technological alternatives to enhance self-sufficiency and reduce the volume of wheat imports.

Study Objective:

The study aims to improve the efficiency of wheat production's economic performance through farmers' adoption of the modern technological packages recommended by the Ministry of Agriculture. The study focuses on:

1. The level of per-feddan productivity in demonstration fields that adopt modern varieties compared to traditional ones.
2. The impact of using technological packages on economic efficiency indicators.
3. Reasons for farmers' reluctance to adopt technology and suggestions for overcoming these obstacles.

It is worth noting that the study is limited to the use of technological packages specifically in demonstration fields compared to traditional fields (control fields).

Study Importance:

The importance of the study lies in its ability to reveal the average per-feddan productivity in both demonstration fields using technological packages and traditional fields that do not, and the difference between them. The study also highlights the effect on wheat crop production's economic efficiency indicators and identifies the reasons for farmers' reluctance to adopt technology, along with providing proposals to address these reasons. This, in turn, helps improve the economic efficiency of wheat production, leading to increased production, reduced food gaps, and decreased imports, which in turn relieves the burden on the state's public treasury[(4)]. Furthermore, the results of this and other similar field studies can assist agricultural economic decision-makers in Egypt when formulating future agricultural policies.

Data Sources: The study relies on two main sources of data:

Secondary Data: Published by the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration of Agricultural Economics, Agricultural Economics Bulletin.

Unpublished data from the Statistics and Agricultural Extension Department of the Agricultural Directorate in Al-Sharqia**.**

Primary Data: A field study using a specially designed questionnaire applied in the villages of Al-Sharqia Governorate during the 2022/2023 agricultural season. The sample selection was as follows:

Selection of Al-Sharqia Governorate:

Al-Sharqia was chosen due to its relative importance in wheat cultivation, covering approximately 394.1 thousand feddans (around 11% of the total wheat-cultivated area in Egypt, which reached 3.05 million feddans in 2022/2023). Al-Sharqia also hosts comparative experiments between demonstration fields and traditional fields across various centers and villages. Additionally, Al-Sharqia is home to the Agricultural Economics Research Unit, reinforcing the principle that scientific research should serve the community and environment**.**

Selection of Administrative Centers:

Al-Sharqia comprises 13 administrative centers (Abu Kabir, Faqous, Al-Husseiniya, Awlad Saqr, Kafr Saqr, Abu Hammad, Hehia, Deyerb Negm, El Ibrahimia, Zagazig, Minya El Qamh, Mashtool Al-Souk, and Belbeis) and two cities (Al-Qurain and Al-Qanayate). Two industrial cities (10th of Ramadan and New Salhia) were also included. For this study, the centers of Zagazig and Abu Hammad were selected due to the high number of demonstration fields present**.**

Selection of Observations:

Based on field surveys and visits to demonstration fields by the General Agricultural Extension Department of the Agricultural Directorate in Al-Sharqia, 20 random demonstration fields were selected from the study centers, in addition to 20 comparative fields in the same areas[10]. This resulted in a total sample size of 40 fields distributed between demonstration and comparative fields within the centers of Zagazig and Abu Hammad.

Research Methodology: The study employs both descriptive and quantitative methods to analyze and present data, including averages and economic efficiency indicators, such as total revenue, total costs, net return per feddan in Egyptian pounds, and the net return on invested capital, among others.

Definition of Technology: Technology refers to the set of production elements collaborating to perform a specific task, yielding the best results with the lowest possible costs[3].

Technological Packages: The modern technological packages in the Egyptian agricultural sector include[3]:

- **Biological technology** (improved seeds),
- **Mechanical technology** (modern agricultural machinery),
- **Chemical technology** (chemical fertilizers and pesticides).

Agricultural Technological Levels: The technological levels used in wheat cultivation are categorized as follows[7]:

1. **First Level – Technological:**

○ Operations include:

1. Laser leveling.
2. Ridge planting: Sowing at the appropriate time using drills, implementing modern and suitable irrigation methods, and adhering to irrigation schedules.
3. Biological technology: Sowing improved seeds and recommended varieties (Misr 3, Misr 4, Sids 14, Sakha 95, Giza 171), which are recommended for the Delta region based on wheat variety policy by the Wheat Research Department at the Crop Research Institute.
4. Chemical technology: Using fertilizers and pesticides in prescribed quantities and at the required times.
5. Mechanical technology: Harvesting, threshing, winnowing, and packaging using combine harvesters, and transporting the crops from the field to the farmer's home mechanically (using trucks or tractors).

2. **Second Level – Hybrid:**

○ This level combines both technological and traditional practices, including the use of recommended and traditional varieties, laser leveling, ridge planting, and sowing with drills. Harvesting is done both manually and mechanically, and the crops are gathered manually, with threshing and winnowing carried out using mechanical threshers and winnowers. Finally, packaging is done manually, and transportation is done both mechanically and using animals.

3. **Third Level – Traditional:**

○ This level primarily uses traditional practices, with limited use of recommended varieties. Most seeds come from local sources (home, market, or trader), sowing is done by broadcasting, and leveling is done using manual tools. Harvesting and gathering are done manually, with mechanical threshing and winnowing, and transportation is done traditionally with animals.

In the Al-Sharqia Governorate, the area cultivated with wheat for the 2023/2024 agricultural season reached approximately 394,049 feddans, representing about 43.5% of the winter crop composition. This includes about 26,008 feddans planted using ridge planting and 18,015 feddans planted by broadcasting, while the remainder consists of traditional cultivation methods. This highlights the importance and necessity of applying agricultural technology in wheat production to increase per-feddan productivity and, consequently, total production, aiming to mitigate the worsening food gap in the future.

1-Development of Total Wheat Production in Egypt and Al-Sharqia

- **Total wheat production** in Egypt depends on both the **cultivated area** (in thousand feddans) and the **yield per feddan** (in ardeb). The following section sheds light on both aspects, followed by an overview of total production.

Table (1) shows the development of the area, productivity, and total production of wheat in Egypt during the period (2010-2022). The average wheat-cultivated area in Egypt during this period was approximately 3,249.8 thousand feddans. This area reached its peak at around 3,469 thousand feddans in 2015, an increase of 219.2 thousand feddans, representing a 6.7% rise from the average cultivated area in thousand feddans during the same period. The lowest recorded area was in 2010, amounting to about 2,922 thousand feddans.

Regarding the **average wheat yield per feddan** in Egypt during the period (2010-2022), Table (1) indicates that the average yield per feddan was about 18.27 ardeb/feddan. The yield peaked at approximately 19.21 ardeb/feddan in 2017, an increase of 0.94 ardeb/feddan, representing a 5.1% rise from the average yield per feddan for the same period. The lowest recorded yield was in 2010, at approximately 15.92 ardeb/feddan.

The same table reveals that the **average total wheat production** in Egypt during the period (2010-2022) was approximately 59,439.4 thousand ardeb. Production peaked at around 65,615 thousand ardeb in 2021, an increase of 6,175.6 thousand ardeb, representing a 10.3% rise from the average total production in thousand ardeb during the same period. The lowest production was recorded in 2010, at around 47,793 thousand ardeb.

Table (1): Development of Area, Productivity, and Total Production of Wheat in Egypt (2010-2022).

Years	Area (thousand feddans)	Yield (ardab/feddan)	Total Production (thousand ardabs)
2010	3,001	15.92	47.793
2011	3,049	18.30	55.803
2012	3,161	18.55	58.636
2013	3,378	18.67	63.068
2014	3,393	18.23	61.865
2015	3,469	18.46	64.051
2016	3,353	18.57	62.283
2017	2,922	19.21	56.140
2018	3,157	17.63	55.657
2019	3,135	18.20	57.059
2020	3,394	17.85	60.589
2021	3,419	19.19	65. 615
2022	3,417	18.77	64.153
Average	3,249.8	18.27	59.439.4

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Economics Bulletin, various issues[9].

2- Development of Total Production in Al-Sharqia Governorate

Table (2) indicates that the average area cultivated with wheat in **Al-Sharqia Governorate** during the period (2010-2022) was approximately 394.4 thousand feddans. The area reached its peak at around 432.4 thousand feddans in 2013, an increase of 38 thousand feddans, representing a 9.6% rise from the average cultivated area in thousand feddans during the same period. The lowest recorded area was in 2018, at approximately 311.4 thousand feddans.

The same table also shows that the **average wheat yield per feddan** in Al-Sharqia Governorate during the period (2010-2022) was approximately 18.19 ardeb/feddan. The yield peaked at around 19.31 ardeb/feddan in 2018, an increase of 1.12 ardeb/feddan, representing a 6.1% rise from the average yield in ardeb for the same period. The lowest recorded yield was in 2010, at around 15.45 ardeb/feddan.

As for the **average total wheat production** in Al-Sharqia Governorate during the period (2010-2022), it amounted to approximately 7,244.6 thousand ardeb. Production peaked at around 7,815.4 thousand ardeb in 2021, an increase of 570.8 thousand ardeb, representing a 7.8% rise from the average total production in thousand ardeb during the same period. The lowest recorded production was in 2018, at around 6,013.1 thousand ardeb

Total Wheat Production in Al-Sharqia:

Table (2): Development of Area, Productivity, and Total Production of Wheat in Al-Sharqia (2010-2023).

Years	Area (thousand feddans)	Yield (ardab/feddan)	Total Production (thousand ardabs)
2010	339.9	15.45	6.178.8
2011	403.9	16.99	6.863.6
2012	425.8	17.95	7.630.8
2013	432.4	18.01	7.787.9
2014	424.5	17.28	7.335.4
2015	416.7	20.10	8.376.0
2016	414.4	18.75	7.770.0
2017	371.7	19.24	7.151.5
2018	311.4	19.31	6.013.1
2019	369.7	17.70	6,544.1
2020	399.4	18.10	7.221.7
2021	408.9	19.10	7.815.4
2022	423.2	18.23	7.716.1
2023	380.1	18.50	7.020.1
Average	394.4	18.19	7.244.6

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Economics Bulletin, various issues[9].

Cultivated Area, Yield per Feddan, and Total Production of Wheat in the Districts of Al-Sharqia Governorate

The data in **Table (3)**, showing the cultivated area in feddans for wheat in Al-Sharqia Governorate by administrative districts during the **2022/2023 winter agricultural season**, indicate the following:

- The largest **cultivated area** was in **Al-Husseiniya District**, where it reached 94.433 thousand feddans, followed by **Faqous District** with 41.815 thousand feddans, and then **Zagazig District** with approximately 36.724 thousand feddans. The smallest area was recorded in **Mashtoul Al-Souq District**, with about 8.565 thousand feddans.

Regarding the **wheat yield per feddan** in Al-Sharqia Governorate, according to administrative districts for the same season, the data shows that:

- The highest yield per feddan was recorded in **Mashtoul Al-Souq District**, reaching 20.77 tons per feddan, followed by **Deirb Negm District** with 19.94 tons per feddan, and then **Zagazig District**, with approximately 19.70 tons per feddan. The lowest yield was in **Abu Hammad District**, where it was about 15.5 tons per feddan.

Finally, regarding the **total wheat production** in Al-Sharqia Governorate by administrative districts during the same season:

- The highest total production was in **Al-Husseiniya District**, amounting to 1.68 million tons, followed by **Faqous District**, with 784.031 thousand tons, and **Zagazig District**, with approximately 723.463 thousand tons. The lowest total production was in **Ibrahimia District**, with about 154.314 thousand tons

Table (3): Cultivated Area (Feddans), Yield per Feddan (Ardeb/Feddan), and Total Wheat Production (in Thousand Ardeb) by Administrative Districts in Al-Sharqia Governorate for the 2022/2023 Agricultural Season

Administrative District	Cultivated Area (Feddans)	Yield per Feddan (Ardeb/Feddan)	Total Production (Thousand Ardeb)
Zagazig	36.724	19.7	723.463
Minya Al-Qamh	27.790	18	500.220
Belbeis	28.916	18.41	532.344
Mashtoul Al-Souq	8.565	20.77	177.895
Abu Hammad	20.138	15.5	312.139
Hehia	12.259	19.09	234.024
Ibrahimia	8.573	18	154.314
Deirb Negm	22.920	19.94	457.025
Abu Kabir	24.783	19.04	471.868
Kafr Saqr	23.816	19.08	454.409
Awlad Saqr	23.899	18.75	448.106
Faqous	41.815	18.75	784.031
Al-Husseiniya	94.433	17.81	1.681.852
Total	380.061	18.47	7.020.066

Source: Al-Sharqia Agricultural Directorate, unpublished data, 2023[(11)].

Economic and Productivity Indicators for Wheat Production

Agricultural technology can be applied to all forms of agricultural production, both plant and animal. However, we will focus on the application of agricultural technology in **wheat production**, as it occupies a significant area among agricultural crops in general and winter crops in particular, reaching around **3.42 million feddans** in 2019. Wheat is one of the most important grain crops, relied upon by the Egyptian population for food. Its grains are used to produce bread and all types of pasta. Additionally, wheat straw is a basic feed for livestock[(1)].

Wheat production offers both high gross and net returns, and it is the primary ingredient in **subsidized baladi bread** and traditional rural bread. Therefore, the state places special importance on wheat production to increase productivity, whether through **vertical expansion** (enhancing yields) or **horizontal expansion** (increasing cultivated area)

Second: Structure of Wheat Production Costs in Al-Sharqia Governorate

The production costs of any crop vary based on location, region, and farm capacity, which in turn affects production efficiency. **Table (4)** presents the relative importance of production costs per feddan for wheat in **demonstration fields** and **comparison fields** from the study sample for the **2022/2023 agricultural season[(2)]**.

(A) Variable Costs:

1. **Cost Breakdown by Agricultural Operations**: The data from **Table (4)** shows that wheat production requires various agricultural operations, the most significant of which in the study sample was **threshing**, with an average cost of about **2,000 EGP/feddan** in demonstration fields and **2,150 EGP/feddan** in comparison fields. In Zagazig, it was **2,100 EGP/feddan**, while in Abu Hammad, it was **2,050 EGP/feddan**. This was followed by **harvesting and bundling**, with an average cost of **1,300 EGP/feddan** in comparison fields and **1,250 EGP/feddan** in demonstration fields. In Zagazig, it was **1,325 EGP/feddan**, and in Abu Hammad, it was **1,225 EGP/feddan**. Other operations such as irrigation, plowing, laser leveling, and transportation had costs of **1,250 EGP**, **900 EGP**, **725 EGP**, and **325 EGP/feddan**, respectively, as part of the total cost for the average sample. The total agricultural operation costs in comparison fields in Zagazig were higher than in Abu Hammad, averaging **7,600 EGP/feddan** and **7,450 EGP/feddan**, respectively, with an overall average of **7,525 EGP/feddan**. This difference is due to higher labor costs in Zagazig compared to Abu Hammad.
2. **Cost Breakdown by Production Inputs**: The results from **Table (4)** show that the cost of production inputs for wheat was high, with **seeds** being the largest component. The seed cost was **1,200 EGP/feddan** in comparison fields in both Abu Hammad and Zagazig, as well as in the overall sample. In demonstration fields, the seed cost was **900 EGP/feddan** for both centers. **Chemical fertilizers** ranked second, with a cost of **1,200 EGP**, **1,100 EGP**, and **1,150 EGP/feddan** in comparison fields in Abu Hammad, Zagazig, and the overall sample, respectively. In demonstration fields, the cost was **1,000 EGP/feddan** in both centers. **Pesticides** ranked third in comparison fields, with a cost of **500 EGP**, **450 EGP**, and **475 EGP/feddan** in Abu Hammad, Zagazig, and the overall sample, respectively.
3. **Total Variable Costs**: According to **Table (4)**, the total variable costs for wheat in **demonstration fields** were approximately **9,310 EGP/feddan** in Abu Hammad, **9,300 EGP/feddan** in Zagazig, and **9,305 EGP/feddan** for the overall sample. In **comparison fields**, the total variable costs were approximately **10,450 EGP/feddan** in Zagazig, **10,250 EGP/feddan** in Abu Hammad, and

10,350 EGP/feddan for the overall sample. The highest variable costs for wheat in comparison fields were in Zagazig.

It is clear that the variable costs for wheat in demonstration fields in both Abu Hammad and Zagazig were lower than those in comparison fields in both centers and the overall sample.

(B) Fixed Costs:

Fixed costs for wheat include taxes, land rent, and irrigation maintenance expenses. **Table (4)** shows that the total fixed costs, including these items, were higher in **Abu Hammad** compared to **Zagazig**, at **12,500 EGP/feddan** and **12,350 EGP/feddan**, respectively. This is due to higher land rent in Abu Hammad. The total fixed costs for the overall sample were **12,425 EGP/feddan** for Al-Sharqia Governorate. The rent costs were the same in both demonstration and comparison fields in the same center and region.

(C) Total Production Costs (Fixed and Variable):

Total production costs include both fixed and variable costs. The data from **Table (4)** indicates that the total cost of wheat production in **demonstration fields** was approximately **21,810 EGP/feddan** in Abu Hammad, **21,650 EGP/feddan** in Zagazig, and **21,730 EGP/feddan** for the overall sample. This means that the highest total cost was in **Abu Hammad**, and the lowest was in **Zagazig**.

In **comparison fields**, the total cost was approximately **22,800 EGP/feddan** in Zagazig, **22,750 EGP/feddan** in Abu Hammad, and **22,775 EGP/feddan** for the overall sample. Again, the highest total cost was in Abu Hammad, and the lowest was in Zagazig.

From the above, it is clear that the total cost of wheat production in demonstration fields in both Abu Hammad and Zagazig was lower than in comparison fields in both centers and the overall sample. The total cost of wheat in demonstration fields was lower than in comparison fields, with a difference of approximately **1,045 EGP/feddan** in the overall sample.

This indicates a higher total cost for comparison fields compared to demonstration fields due to the use of advanced technological packages in wheat cultivation and operations in the demonstration fields, which require specialized agricultural practices

Table (4): Production Cost Components of Wheat Crop in the Sample Areas of Field Study in Al Sharqia Governorate, Season 2022/2023

Agricultural Operations	Abu Hammad (EGP/Feddan)		Zagazig (EGP/Feddan)			
	Demonstration Fields	Comparative Fields	Demonstration Fields	Comparative Fields	Demonstration Fields	Comparative Fields
Plowing (2 rounds)	900	900	900	900	900	900
Levelling	-	350	-	400	-	375
Laser Leveling	700	-	750	-	725	-
Planting	450	600	500	600	475	600
Irrigation	1160	1350	1000	1300	1080	1325
Weed Control	200	400	150	300	175	350
Chemical Fertilization	200	200	200	200	200	200
Harvesting & Binding	1200	1250	1300	1350	1250	1300
Threshing	2000	2100	2000	2200	2000	2150
Transportation	300	300	350	350	325	325
Total Agricultural Operations	7110	7450	7150	7600	7130	7525
Production Inputs	Production Inputs					
Seeds	900	1200	900	1200	900	1200
Chemical Fertilizers	1000	1100	1000	1200	1000	1150
Pesticides	300	500	250	450	275	475
Total Production Inputs	2200	2800	2150	2850	2175	2825
Total Variable Costs	9310	10250	9300	10450	9305	10350
Fixed Costs	12500	12500	12350	12350	12425	12425
Total Costs	21810	22750	21650	22800	21730	22775

Source: Collected and calculated from the field study sample

Economic Efficiency Indicators for Wheat Farmers in Al Sharqia Governorate:

Production and economic efficiency indicators are essential tools for economic analysis. They help measure the profits of production units and ways to enhance them by improving the efficiency of agricultural resource use. This section assesses the efficiency of available agricultural resources used in wheat production in the study sample to determine their effectiveness. The following are key measures of economic efficiency and their significance[8]:

1. **Average Yield per Feddan (Ardeb)**:

The results in Table (5) show that the average wheat yield per feddan in demonstration fields was

around 23.0 ardebs in Abu Hammad, 22.0 ardebs in Zagazig, and 22.5 ardebs for the sample average. This means the highest yield was in Abu Hammad, while the lowest was in Zagazig, making Abu Hammad's yield 104.5% of Zagazig's yield.

In traditional fields (control fields), the average yield was about 19 ardebs in Abu Hammad, 18 ardebs in Zagazig, and 18.5 ardebs for the sample average. Thus, the highest yield was also in Abu Hammad, and the lowest was in Zagazig, with Abu Hammad's yield being 105.5% of Zagazig's.

This indicates that the yield in demonstration fields exceeds that of control fields by about 4.0 ardebs across the sample, which amounts to a loss of approximately 600 kg per feddan. Given the cultivated area in Al Sharqia in 2022, this loss equals about 253.9 thousand tons of wheat at the governorate level and around 2.05 million tons nationwide

2- Total Revenue (EGP/Feddan):

The results of Table (8) indicate that the total revenue for wheat in demonstration fields reached approximately EGP 38,600 per feddan in Abu Hammad district, around EGP 35,920 per feddan in Zagazig district, and about EGP 37,250 per feddan for the average study sample. This means that the highest total revenue for the wheat crop was in Abu Hammad, followed by Zagazig. Consequently, the total revenue in Abu Hammad represents 107.5% of that in Zagazig.

When analyzing total revenue in conventional fields (comparison fields), it was found that the total revenue was around EGP 31,450 per feddan in Abu Hammad, EGP 29,600 per feddan in Zagazig, and EGP 30,575 per feddan for the average study sample. This means that the highest total revenue for wheat was also in Abu Hammad, followed by Zagazig, with total revenue in Abu Hammad representing 106.1% of that in Zagazig.

From the above, it is clear that total revenue for wheat in demonstration fields exceeds that in comparison fields. In light of this, we can estimate a difference of about EGP 6,675 per feddan in total revenue at the sample level. Based on the cultivated wheat area in 2022, the estimated loss in total wheat revenue in Sharqia Governorate is approximately EGP 2.8 billion, and around EGP 22.8 billion nationwide for the same year.

3- Net Return per Feddan (EGP/Feddan):

Table (8) shows that the net return per feddan for wheat in demonstration fields was about EGP 16,790 per feddan in Abu Hammad, EGP 14,270 per feddan in Zagazig, and around EGP 15,520 per feddan for the average study sample. This means that the highest net return per feddan for the wheat crop was in Abu Hammad, followed by Zagazig.

When analyzing net return per feddan in conventional fields (comparison fields), it reached about EGP 8,700 per feddan in Abu Hammad, around EGP 6,800 per feddan in Zagazig, and EGP 7,800 per feddan for the average study sample. This indicates that the highest net return per feddan was also in Abu Hammad, followed by Zagazig.

From the above, it is evident that net return per feddan in demonstration fields surpasses that in comparison fields. The difference in net return per feddan between demonstration and comparison fields is estimated at about EGP 7,720 per feddan at the sample level.

4- Gross Margin (EGP/Feddan):

Gross margin is a measure used to determine the net return per feddan from variable costs, calculated by subtracting variable costs from total revenue.

The results of Table (5) show that the gross margin for wheat in demonstration fields was about EGP 29,290 per feddan in Abu Hammad, around EGP 26,620 per feddan in Zagazig, and around EGP 27,945 per feddan for the average study sample. This indicates that the highest gross margin for wheat was in Abu Hammad, followed by Zagazig.

In conventional fields (comparison fields), the gross margin was about EGP 21,200 per feddan in Abu Hammad, around EGP 19,150 per feddan in Zagazig, and EGP 20,225 per feddan for the average study sample. This shows that the highest gross margin was also in Abu Hammad, followed by Zagazig.

From the above, it is clear that the gross margin for wheat in demonstration fields exceeds that in comparison fields. The difference in gross margin between demonstration and comparison fields is estimated at around EGP 7,720 per feddan at the sample level.

5- Total Revenue to Total Cost Ratio:

This ratio measures the overall productivity of all production factors combined. It is calculated by dividing total revenue by total costs.

The results of Table (5) indicate that the ratio of total revenue to total costs for wheat in demonstration fields was about 1.76% per feddan in Abu Hammad, 1.65% per feddan in Zagazig, and 1.71% per feddan for the average study sample. This indicates that the highest ratio was in Abu Hammad, followed by Zagazig.

In conventional fields (comparison fields), the ratio was about 1.38% per feddan in Abu Hammad, 1.29% per feddan in Zagazig, and 1.34% per feddan for the average study sample. This indicates that the highest ratio was in Abu Hammad, followed by Zagazig.

It is clear from the above that the ratio of total revenue to total costs in demonstration fields exceeds that in comparison fields.

6- Total Revenue to Variable Cost Ratio:

Given that fixed costs may represent a significant portion of total costs, this ratio assesses the productivity of only variable factors.

The results of Table (5) show that the ratio of total revenue to variable costs for wheat in demonstration fields was about 4.1% per feddan in Abu Hammad, 3.9% per feddan in Zagazig, and around 4.0% per feddan for the average study sample. This indicates that the highest ratio was in Abu Hammad, followed by Zagazig.

In conventional fields (comparison fields), the ratio was around 3.1% per feddan in Abu Hammad, 2.8% per feddan in Zagazig, and 2.9% per feddan for the average study sample. This shows that the highest ratio was in Abu Hammad, followed by Zagazig.

7- Value Added (EGP/Feddan):

Value added is the production value per unit area minus the total input costs per unit area.

The results of Table (5) indicate that the value added for wheat in demonstration fields was about EGP 36,400 per feddan in Abu Hammad, around EGP 33,770 per feddan in Zagazig, and about EGP 35,075 per feddan for the average study sample. This means that the highest net value added was in Abu Hammad, followed by Zagazig.

In conventional fields, the value added was about EGP 28,650 per feddan in Abu Hammad, around EGP 26,750 per feddan in Zagazig, and around EGP 27,750 per feddan for the average study sample.

From the above, it is clear that value added in demonstration fields exceeds that in comparison fields by about EGP 7,325 per feddan for the study sample.

8- Return on Investment (ROI):

Return on investment (ROI) is a measure of the profitability of the funds spent in the production process. It is calculated by dividing the net return by the total production costs. The higher this value, the greater the return on investment.

The results of Table (5) indicate that the ROI for wheat in demonstration fields was around 0.76% per feddan in Abu Hammad, around 0.65% per feddan in Zagazig, and around 0.71% per feddan for the average study sample. This shows that the highest ROI was in Abu Hammad, followed by Zagazig.

In conventional fields, the ROI was around 0.38% per feddan in Abu Hammad, around 0.29% per feddan in Zagazig, and around 0.34% per feddan for the average study sample. This indicates that the highest ROI was in Abu Hammad, followed by Zagazig.

It is evident from the above that the ROI for wheat in demonstration fields exceeds that in comparison fields. The difference in ROI between demonstration and comparison fields is estimated at around 0.36% per feddan for the study sample. This suggests that the use of modern technological practices in wheat cultivation in demonstration fields results in a higher net return on investment by 36 piasters per invested pound compared to traditional fields. This encourages farmers to expand wheat cultivation and adopt modern technological practices, leading to higher yields, better-quality crops, and ultimately higher prices when selling the wheat.

Table (5): Economic Efficiency Indicators per Feddan of Wheat Crop in Sharqia Governorate during the 2022/2023 Season

Indicator	Unit	Abu Hammad		Zagazig		Average Sample	
		Advisory Fields	Comparative Fields	Advisory Fields	Comparative Fields	Advisory Fields	Comparative Fields
Main Production Quantity	Ardeb	23	19	22	18	22.5	18.5
Price	EGP	1600	1550	1560	1550	1580	1550
Secondary Production Quantity		9	10	8	9	8.5	9.5
Price	Qintar	200	200	200	200	200	200
Main Revenue	EGP	36800	29450	34320	27900	35550	28675
Secondary Revenue	EGP	1800	2000	1600	1800	1700	1900
Total Revenue	EGP	38600	31450	35920	29600	37250	30575
Net Revenue	EGP	16790	8700	14270	6800	15520	7800
Total Marginal Surplus	EGP	29290	21200	26620	19150	27945	20225
Total Revenue to Total Costs Ratio	%	1.8	1.4	1.6	1.3	1.7	1.3
Total Revenue to Variable Costs Ratio	%	4.1	3.1	3.9	2.8	4.0	2.9
Added Value	EGP	36400	28650	33770	26750	35075	27750
Profitability of the Pound Invested	%	0.76	0.38	0.65	0.29	0.71	0.34

Source: Collected and calculated from the field study sample

Fourth: Problems Faced by Farmers in Adopting Technology in Wheat Production (Sample Study):

The results of Table (6) indicate the presence of several problems and obstacles that hinder farmers from adopting technological packages in wheat

production in the field study sample from Sharqia Governorate during the 2022/2023 agricultural season. Foremost among these challenges is the unavailability of improved varieties at the right time and at reasonable prices, representing 23.1% of farmers' responses. This is followed by the lack of availability of sowing machines (seed drills) at the appropriate time, which constitutes 21.6% of the farmers' opinions. Another challenge is the lack of attention given to field demonstration days, which serve as a mirror for farmers to learn about the positive results of adopting modern varieties, accounting for approximately 14.9% of the farmers' responses.

The results also indicate other problems and obstacles that prevent or deter farmers from using technological packages in wheat production, such as limiting demonstration fields to large farmers only, representing 13.4% of the farmers' opinions. The small size and fragmentation of agricultural holdings are also significant, representing 11.2% of farmers' responses. Additionally, farmers' lack of awareness due to outdated training methods, which do not incorporate modern technological techniques, represents 9.7% of the farmers' responses.

Moreover, the findings highlight the inefficiency of the agricultural extension system and its various levels, as farmers have not been adequately trained on the benefits and advantages of using different technological packages, including biological ones, in wheat production. This represents 5.9% of the farmers' opinions. In addition, the weakness of the agricultural extension system is attributed to the lack of focus on training agricultural advisors.

Rural households also suffer from unemployment among many of their members, meaning that the use of modern technologies may increase this problem. Finally, some farmers hold traditional beliefs, resisting anything new until they see firsthand the benefits of using modern technologies. These issues summarize farmers' views regarding the challenges of adopting and utilizing modern technologies in wheat production.

Fifth: Means to Improve Farmers' Adoption of Technology in Wheat Production (Sample Study):

The above analysis reveals numerous problems and challenges that prevent farmers from adopting and using modern technologies in wheat production, particularly biological technologies. The results of Table (5) reflect farmers' suggestions on how these problems can be resolved, thereby enhancing performance and encouraging farmers to adopt and use technological packages in wheat production.

At the top of these suggestions is the availability of improved varieties at the right time and at reasonable prices, accounting for 23.3% of the farmers' responses. This is followed by providing sowing machines, especially seed drills, at agricultural mechanization stations, representing 20.9% of the farmers' responses. Third, increasing the spread of demonstration fields in villages to allow broader farmer participation, which accounts for 15.5% of farmers' responses. Furthermore, greater attention to field demonstration days, allowing farmers to witness practical applications, should receive significant media coverage (national radio, television, and agricultural programs) to provide correct information while also showcasing results from demonstration fields. This would encourage farmers to adopt improved varieties, representing 13.9% of the farmers' responses.

Additionally, there is a recommendation to consolidate small holdings to implement technology more efficiently, overcoming the issue of fragmented holdings. Farmers should be encouraged to form friendly crop groups and rotational farming cycles to facilitate the use of technology over larger areas, as opposed to smaller, fragmented areas. This represents 10.8% of farmers' responses. The next suggestion is to conduct regular extension seminars for farmers, which accounts for 9.3% of the farmers' opinions.

Another important suggestion is continuous training for agricultural advisors to keep them updated on the latest technical developments. Additionally, the role of agricultural extension should be activated and reinforced by holding regular seminars with farmers, ensuring that the agricultural extension system operates at a high level of efficiency. This would require ongoing training for extension engineers and financial and technological support, representing 6.2% of the farmers' responses.

Furthermore, it is crucial to adapt new technologies to the conditions of Egyptian agriculture, whether imported or locally developed, especially given the widespread problem of rural unemployment. Finally, rural and agricultural leaders should be involved in convincing farmers—especially illiterate ones—of the importance of adopting modern, particularly biological, technologies in wheat cultivation. Doing so would increase productivity, improve quality, boost farmers' incomes, and contribute to achieving greater self-sufficiency and food security in this vital crop, which is the main ingredient in subsidized and traditional bread.

Table (6): Main Problems and Proposals for the Use of Technology in Wheat Production (Field Study Sample - Sharqia Governorate, 2022/2023 Agricultural Season)

Problems	Frequency	%	Proposals	Frequency	%
Lack of availability of improved varieties	31	23.1	Provide improved varieties at the right time and price	30	23.3
Lack of sowing machine (seed drill) availability	29	21.6	Provide sowing machines, especially seed drills	27	20.9
Lack of attention to field demonstration day	20	14.9	Expand the spread of demonstration fields	20	15.5
Demonstration fields limited to large farmers	18	13.4	Increase attention to field demonstration days	18	13.9
Small and fragmented agricultural holdings	15	11.2	Consolidate small holdings for technological application	14	10.8
Lack of training awareness among farmers	13	9.7	Conduct regular extension seminars for farmers	12	9.3
Agricultural advisors unaware of modern techniques	8	5.9	Continuous training for agricultural advisors	8	6.2
Total	**134**	**100%**	**Total**	**129**	**100%**

Source: Primary data from a field study conducted in Sharqia Governorate during the 2022/2023 season.

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