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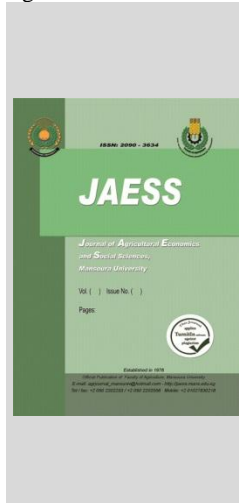
## The Economic Return of Recycling Agricultural Wastes for Production of Unconventional Fodders for Animal Production in Kafr El-Sheikh Governorate



El-Dnasury, M. F. ; A. K. El-Noby and Noura M. Tantawy\*

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Agricultural Economic Research Institute - Agricultural Research Center - Egypt.



### ABSTRACT

The research aims to determine the economic return of recycling agricultural wastes for production of unconventional fodders for animal production in Kafr El-Sheikh Governorate., the research relies on some descriptive and quantitative economic analysis methods to analyze the primary data. The results showed that it is possible to rank agricultural wastes in terms of the return on the invested pound resulting from recycling one ton of waste, with summer rice straw ranking first at approximately 1.06 Egyptian Pound, followed by sugar beet straw, wheat straw, dry stalks of summer maize, and dry stalks of cotton at approximately 0.82, 0.7, 0.69, and 0.68 EGP, respectively. The methods and approaches of farmers towards crops dealing with wastes were represented in; producing unconventional fodder, making silage for animals, using waste for animals feeding, direct selling, using it as organic fertilizer, and storage it on rooftops, burning it, and using it as fuel for ovens. The top problem facing farmers who recycle agricultural wastes was the lack of experience among farmers in how to recycle agricultural wastes, which represents about 90.4%, and the top proposed solution was to suggest holding training courses for farmers on how and the importance of recycling agricultural wastes, which represents about 89.6%. The research recommended the following: Cooperation and coordination between the Ministry of Agriculture and the Ministry of Environment to implement and apply modern agricultural technologies in processing and recycling agricultural wastes and benefiting from it in production of unconventional feed.

**Keywords:** Recycling agricultural wastes, Economic return, Unconventional fodders, and Economic indicators.

### INTRODUCTION

Egypt faces economic and environmental challenges that hinder its ability to achieve sustainable development, through the optimal use of available economic resources, it is possible to contribute to face these challenges (Mona, Eman, 2018). Plant agricultural wastes, which are represented by all by-products during the production of field crops which cannot be produced in isolation from by-products, which is considered one of the economic resources whose use efficiency is low. Therefore, recycling agricultural crops wastes and reusing it optimally by benefiting from it for many agricultural or industrial purposes leads to increase the economic efficiency of these crops thus increasing farmers' returns and total agricultural income, which leads to increase the national income, which leads to improve the standard living for the members of society. (Hana, 2019).

The value of plant by-products of field crops at the republic amounted to approximately 23.16 billion EGP, which represents about 9.29% of the total value of field crop production, which amounted to approximately 249.43 billion, and about 6.98%, 5.17% of net plant income, and net agricultural income at the republic level, respectively, amount to approximately 331.91 billion EGP, 447.64 billion EGP, respectively, for the average period (2020-2023) (Ministry of Agriculture and Land Reclamation, various issues).

The updated strategy for sustainable agricultural development in Egypt 2030 and its action plan aimed to

maximize the benefit from agricultural wastes. Therefore, the Egyptian state has shown increasing interest in the issue of agricultural wastes as a national wealth, by recycling it using optimal, economically feasible and environmentally friendly methods to obtain many primary and final products, including unconventional fodders, organic fertilizers (compost) necessary for clean and organic agriculture and environmental protection, the production of high-value materials (silage), cultivation on rice straw bales, and the production of bioenergy through biogas units, which contributes to the implementation of national and global sustainable development goals (Nassar, 2022). In addition, the waste of agricultural wastes leads to economic burdens and environmental risks, such as disposing of it by burning it in the field, which leads to an increase in the percentage of carbon dioxide (CO<sub>2</sub>) and other toxic gases that work on global warming and rising temperatures, in addition to polluting agricultural soil (Hadhoud, Elham, 2023).

#### Research problem:

Despite the severe deficit in available fodder materials used in feeding animal production, the burden of this deficit represents on the state as a result of importing raw materials used in the composition of animal fodder, by-products of field crops (agricultural wastes) can contribute to cover the part of this deficit, although Kafr El-Sheikh Governorate is one of the most important governorates in production of the field crops at the republic, thus the type and quantity of plant by-products of field crops increases, which amounts to approximately 2.5 million ton, which

\* Corresponding author.

E-mail address: [Noura.tantawy39@gmail.com](mailto:Noura.tantawy39@gmail.com)

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represents about 9% from the total production of field by-products in the republic, which amounts to approximately 28.10 million ton for the average period (2020-2023) (Ministry of Agriculture and Land Reclamation, various issues), However, most farmers in the governorate dispose of these wastes in uneconomical and environmentally unsafe ways on the one hand, and lose part of the return that helps farmers to increase their incomes ,thus increase the national income on the other hand, which requires studying how to benefit from these wastes by recycling them, how to identify the problems and how to face obstacles which farmers suffer in recycling agricultural wastes, in addition to identifying the economic return of recycling these agricultural wastes to produce unconventional fodder that are alternative and complementary to animal production.

## MATERIALS AND METHODS

### Research objective:

The research mainly aims to determine the economic return of recycling agricultural wastes for production of unconventional fodders for animal production in Kafr El-Sheikh Governorate. This can be achieved through the following sub-objectives: (1) Study the development of agricultural wastes (dry stalks of summer maize, dry stalks of cotton, summer rice straw, wheat straw, and sugar beet stalk) in Kafr El-Sheikh Governorate and the Republic during the period (2006-2023). (2) Analysis the structure of the cost items and revenues from recycling one ton of agricultural wastes resulting from the crops subject to the study in the research sample in Kafr El-Sheikh Governorate during the season 2023/2024. (3) Measure some economic indicators for recycling one ton of agricultural wastes resulting from the crops subject to the study in the research sample. (4) Identify the methods and techniques of dealing with the farmers of the research sample with the agricultural wastes of the crops subject to the study in the research sample. (5) Analysis the opinions of the farmers of the research sample regarding the problems and obstacles facing the process of recycling agricultural waste, the subject of the study, and the proposed solutions from their point of view to overcome them in order to benefit from agricultural wastes as unconventional fodder.

### Research methods:

To conduct this research and extract its results, some descriptive and quantitative economic analysis methods were used, specifically the following methods and approaches were used: (1) Some statistical methods such as arithmetic averages, percentages, frequencies, standard deviation, and coefficient of variation, (2) Annual rates of change of economic variables using the growth function, (3) Some economic indicators to measure profitability, which are: net return, benefit-cost ratio, profit margin ratio, return on the EGP invested, and added value. (4) Chi-square test.

### Data sources:

The research relied on two main sources to complete its data, which are: (1) Primary data, which were collected through a random sample via a questionnaire directed to farmers of summer maize, cotton, summer rice, wheat, and sugar beet in Kafr El-Sheikh Governorate. The questionnaire was collected through a personal interview with sample members during 2023/2024, (2) Secondary data published and unpublished from bulletins of: the Agricultural Statistics,

the Agricultural Prices Statistics, and Estimates Agricultural Income issued by the Economic Affairs Sector at the Ministry of Agriculture and Land Reclamation, and the Information and Decision Support Center at the Kafr El-Sheikh Agriculture Directorate, in addition to using some researches, studies, magazines, scientific books, and arab and foreign references related to the research topic. The data were analyzed on the computer using SPSS Statistics v.30.0.

### Research sample:

The research relied on a simple random sample in the sampling method that was selected from the acquisition lists of farmers of summer maize, cotton, summer rice, wheat, and sugar beet in El-Hamool Center, represented by the villages of Al-Kafr Ash-Sharqi and Kom Al-Hajar in Kafr El-Sheikh Governorate during 2023/2024, through a questionnaire form that was distributed to farmers of the crops subject to the study after testing it in the field, reviewing it, and making some amendments to it until it became suitable for collecting field data that achieves the research goal. The research sample consisted of 125 individuals in a cultivated area of about 278 feddan, as the number of summer maize farmers reached 18 farmers, which represents about 14.4% of the total number of research sample individuals in a cultivated area of about 33 feddan, while the number of cotton farmers reached 21 farmers, which represents about 16.8% of the total number of the research sample individuals in a cultivated area of about 42 feddan, and the number of summer rice farmers was 33 farmers, which represents about 26.4% of the total number of research sample individuals in a cultivated area of about 83.5 feddan, while the number of wheat farmers was 28 farmers, which represents about 22.4% of the total number of research sample individuals in a cultivated area of about 66.5 feddan, while the number of sugar beet farmers was 25 farmers, which represents about 20% of the total number of research sample individuals in a cultivated area of about 53 feddan- Table (1).

**Table 1. The relative importance of the research sample individuals in Kafr El-Sheikh Governorate during season 2023/2024.**

Statement Crop	Farmers		Cultivated area
	Number	(%)	(Feddan)
Summer maize	18	14.4	33.0
Cotton	21	16.8	42.0
Summer rice	33	26.4	83.5
Wheat	28	22.4	66.5
Sugar beet	25	20.0	53.0
Total	125	100.0	278.0

Source: Compiled and calculated from the questionnaire data for the research sample.

## RESULTS AND DISCUSSION

**First: The development of agricultural wastes, the subject of the research in Kafr El-Sheikh Governorate and the republic during (2006-2022).**

### 1- Summer maize:

**The data in Table (2) shows the following:**

**The cultivated area with summer maize:**

The cultivated area of summer maize crop at the republic during (2006-2023) ranged between a minimum was approximately 1.71 million feddan in 2006, and a maximum was approximately 2.34 million feddan in 2018,

with an annual average estimated at approximately 2.08 million feddan, and with a coefficient of variation indicating that the cultivated areas are distributed around their mean at about 9.35%. The cultivated area of the summer maize at the republic increased at a statistically significant annual change rate at the probability level of 0.01 estimated at about 1.30% of the annual average, and with an annual increase was approximately 27.04 thousand feddan.

The cultivated area of the summer maize in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 44.24 thousand feddan in

2023, and a max. was approximately 90.36 thousand feddan in 2017, with an annual average estimated at approximately 65.30 thousand feddan, equivalent to about 3.14% of the average at the republic, and with a coeff. of variation indicating that the cultivated areas are distributed around their mean about 24.49%. The statistical significance of the annual rate of change in the cultivated area of the summer maize has not been established in Kafr El-Sheikh Govern., which indicates that the cultivated area fluctuated between increase and decrease around the average during the research period.

**Table 2. Total area, yield per feddan and production of dry stalks of summer maize in Egypt and Kafr-El Sheikh Governorate during (2006-2023).**

Years	Total area (Thousand Feddan)			Yield of dry stalks of summer maize (Heml*/Fed.)			Production of dry stalks of summer maize (Thousand Heml)		
	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)
2006	1708	46.54	2.72	9.87	12.87	130.44	16851.75	598.76	3.55
2007	1781.84	45.59	2.56	9.52	11.98	125.87	16959.29	546.39	3.22
2008	1860.36	54.03	2.9	9.33	11.95	128.1	17354.68	645.89	3.72
2009	1977.57	53.68	2.71	10.14	10.18	100.35	20062.29	546.53	2.72
2010	1998.25	61.1	3.06	8.84	14.02	158.63	17660.62	856.63	4.85
2011	1758.56	55.22	3.14	10.31	11.86	114.98	18139.13	654.89	3.61
2012	2157.08	79.91	3.7	9.04	12.59	139.29	19496.57	1005.98	5.16
2013	2139.2	70.43	3.29	9.69	14.01	144.61	20724.93	986.58	4.76
2014	2185.53	48.88	2.24	9.59	12.55	130.85	20961.64	613.59	2.93
2015	2259.73	68.33	3.02	10.1	12.38	122.58	22821.91	845.65	3.71
2016	2214.66	89.11	4.02	10	13.76	137.56	22152.97	1226.11	5.53
2017	2299.72	90.36	3.93	10.53	13.71	130.16	24223.51	1238.84	5.11
2018	2335.63	66.79	2.86	10	10	100	23356.25	667.87	2.86
2019	2148.16	87.12	4.06	12.04	12	99.69	25857.05	1045.45	4.04
2020	2152.48	60.63	2.82	12.38	12.5	100.97	26647.9	757.93	2.84
2021	2246.9	89.12	3.97	13.18	13	98.65	29609.55	1158.56	3.91
2022	2000.2	64.23	3.21	11.68	13	111.34	23353.57	835.02	3.58
2023	2213.44	44.24	2	12.02	13.61	113.23	26605.55	602.12	2.26
Average	2079.85	65.3	3.14	10.46	12.55	119.98	21824.4	824.04	3.78
Min.	1708	44.24		8.84	10		16851.75	546.39	
Max.	2335.63	90.36		13.18	14.02		29609.55	1238.84	
B	27.04	-		0.178	-		654.73	-	
Annual Ch. Rate <sup>(1)</sup> (%)	1.30**	-		1.70**	-		3.00**	-	
STD.	194.42	15.99		1.25	1.14		3790.94	235.56	
C. V. <sup>(2)</sup> (%)	9.35	24.49		11.95	9.08		17.37	28.59	

\* Heml = 250 Kg.

(1) Annual change rate = (β/Average) \* 100.

Source: Compiled and calculated from:

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of The Agricultural Statistics, Arab Republic of Egypt, Various issues during (2006-2023).

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Prices Statistics, Arab Republic of Egypt, Various issues during (2006-2023).

- Ministry of Agriculture and Land Reclamation (2024), Agriculture Directorate of Kafr-El Sheikh, Unpublished data, Arab Republic of Egypt.

**The yield of dry stalks of summer maize:**

The yield per feddan of dry stalks of summer maize at the republic during the research period ranged between a minimum was approximately 8.84 heml in 2010, and a max. was approximately 13.18 heml in 2021, with an annual average estimated at approximately 10.46 heml, and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 11.95%. The yield per feddan of the dry stalks of summer maize at the republic increased at a statistically signif. annual change rate at 0.01 estimated at approximately 1.70% of the annual average, and an annual increase about 0.178 heml.

The yield of the dry stalks of summer maize in Kafr El-Sheikh Governorate during the research period ranged between a min. at approximately 10 heml in 2018, and a max. at approximately 14.02 heml in 2010, with an annual

average estimated at approximately 12.55 heml, which is at approximately 2.09 heml more than the average of yield per feddan of the dry stalks of summer maize at the republic, and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 9.08%. The statistical significance of the annual rate of change in the yield per feddan has not been established in Kafr El-Sheikh Govern., which indicates that the fluctuation of yield per feddan around the average during the research period.

**Production of dry stalks of summer maize:**

The production of the dry stalks of summer maize at the republic during the research period ranged between a minimum was approximately 16.85 million heml in 2006, and a max. was approximately 29.61 million heml in 2021, with an annual average estimated at approximately 21.82 million heml, and with a coeff. of variation indicating that the

production is distributed around the mean about 17.37%. The production of the dry stalks of summer maize at the republic increased at a statistically signif. annual change rate at 0.01 estimated at about 3% of the annual average, and with an annual increase at approximately 654.73 thousand heml.

The production of the dry stalks of summer maize in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 546.39 thousand heml in 2007, and a max. was approximately 1.24 million heml in 2017, with an annual average estimated at approximately 824.04 thousand heml, equivalent to about 3.78% of the average at the republic, and with a coeff. of variation indicating that the production are distributed around their mean about 28.59%. The statistical significance of the annual rate of change in the production has not been established in Kafr El-Sheikh Govern., which indicates that the fluctuation of production around the average during the research period.

**2- Cotton:**

The data in Table (3) show the following:

**The cultivated area with cotton:**

The cultivated area of the cotton crop at the republic during (2006-2023) ranged between a min. was

approximately 131.75 thousand feddan in 2016, and a max. was approximately 574.57 thousand feddan in 2022, with an annual average estimated at approximately 320.66 thousand feddan, and with a coefficient of variation indicating that the cultivated areas are distributed around their mean about 37.71%. The cultivated area of the cotton at the republic decreased at a statistically significant annual change rate at 0.01 estimated at about 4.20% of the annual average, and with an annual decrease was about 13.47 thousand feddan.

The cultivated area of the cotton in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 47.23 thousand feddan in 2016, and a max. was approximately 134.54 thousand feddan in 2011, with an annual average estimated at approximately 89.13 thousand feddan, equivalent to 22.79% of the average at the Republic, and with a coeff. of variation indicating that the cultivated areas are distributed around their mean at approximately 26.01%. The statistical significance of the annual rate of change in the cultivated area of the cotton has not been established in Kafr El-Sheikh Govern., which indicates that the cultivated area fluctuated between increase and decrease around the average during the research period.

**Table 3. Total area, yield per feddan and production of dry stalks of cotton in Egypt and Kafr-El Sheikh Governorate during (2006-2023).**

Years	Total area (Thousand Feddan)			Yield of dry stalks of cotton (Heml/Fed.)			Production of dry stalks of cotton (Thousand Heml)		
	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)
2006	536.4	122.5	22.84	7.7	10.26	133.25	4130.28	1256.93	30.43
2007	574.57	116.13	20.21	7.8	9.86	126.41	4481.65	1145.36	25.56
2008	312.71	65.4	20.91	7.8	9.87	126.54	2439.14	645.79	26.48
2009	284.43	70.62	24.83	7.2	7.93	110.14	2047.9	559.76	27.33
2010	369.14	100.24	27.16	7.37	10.76	146	2720.56	1078.69	39.65
2011	520.12	134.54	25.87	7.47	9.33	124.9	3885.3	1254.63	32.29
2012	333.36	90.24	27.07	7.73	10.12	130.92	2576.87	913.45	35.45
2013	286.72	84.42	29.44	7.79	10.06	129.14	2233.55	849.63	38.04
2014	369.18	105.01	28.44	7.54	9.63	127.72	2783.62	1011.67	36.34
2015	240.87	73.69	30.59	7.29	7.94	108.92	1755.94	584.96	33.31
2016	131.75	47.23	35.85	6.67	6.9	103.45	879.13	325.9	37.07
2017	216.95	79.31	36.56	7.11	7.5	105.49	1542.17	594.8	38.57
2018	335.98	106.54	31.71	7.36	7.75	105.3	2472.79	825.69	33.39
2019	239.39	70.59	29.49	7.82	8	102.3	1872.36	564.72	30.16
2020	183.06	60.62	33.11	9.26	9.5	102.59	1695.44	575.9	33.97
2021	237.72	85.46	35.95	9.56	10	104.6	2273.44	854.58	37.59
2022	344.46	107.5	31.21	10.42	11	105.57	3589.28	1182.49	32.95
2023	255.12	84.28	33.04	9.08	10	110.13	2315.69	842.26	36.37
Average	320.66	89.13	22.79	7.94	9.25	116.50	2538.62	837.07	32.97
Min.	131.75	47.23		6.67	6.9		879.13	325.9	
Max.	574.57	134.54		10.42	11		4481.65	1256.93	
B	-13.47	-		0.095	-		-	-	
Annual Ch. Rate (%)	(4.2)**	-		(1.20)**	-		-	-	
STD.	120.91	23.18		0.98	1.23		948.78	276.51	
C. V. (%)	37.71	26.01		12.34	13.29		37.37	33.03	

(\*\*) Indicates statistically significant. at 0.01 level.

Source: Compiled and calculated from:

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of The Agricultural Statistics, Arab Republic of Egypt, Various issues during (2006-2023).
- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Prices Statistics, Arab Republic of Egypt, Various issues during (2006-2023).
- Ministry of Agriculture and Land Reclamation (2024), Agriculture Directorate of Kafr-El Sheikh, Unpublished data, Arab Republic of Egypt.

**The yield of dry stalks of cotton:**

The yield per feddan of the dry stalks of cotton at the republic during the research period ranged between a minimum was approximately 6.67 heml in 2016, and a max. was approximately 10.42 heml in 2022, with an annual average estimated at approximately 7.94 heml, and with a

coeff. of variation indicating that the yield per feddan are distributed around their mean about 12.34%. The yield per feddan of the dry stalks of cotton at the republic increased at a statistically signif. annual change rate at 0.01 estimated at about 1.20% of the annual average, and with an annual increase at approximately 0.095 heml.

The yield of the dry stalks of cotton in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 6.90 heml in 2016, and a max. was approximately 11 heml in 2022, with an annual average estimated at approximately 9.25 heml, which is about 1.31 heml more than the average of yield per feddan of the dry stalks of cotton at the republic, and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 13.29%. The statistical significance of the annual rate of change in the yield per feddan has not been established in Kafr El-Sheikh Govern., which indicates that the fluctuation of yield per feddan around the average during the research period.

**Production of dry stalks of cotton:**

The production of the dry stalks of cotton at the republic during the research period ranged between a minimum was approximately 879.13 thousand heml in 2016, and a max. was approximately 4.48 million heml in 2007, with an annual average estimated at approximately 2.54 million heml, and with a coeff. of variation indicating that the production is distributed around the mean about 37.37%. The statistical significance of the annual rate of change in the production has not been established in the republic which indicates that the fluctuation of production around the average during the research period.

The production of the dry stalks of cotton in Kafr El-Sheikh Governorate during the research period ranged

between a min. was approximately 325.90 thousand heml in 2016, and a max. was approximately 1.26 million heml in 2006, with an annual average estimated at approximately 837.07 thousand heml, equivalent to 32.97% of the average of production at the republic, and with a coeff. of variation indicating that the production are distributed around their mean about 33.03%. The statistical significance of the annual rate of change in the production has not been established in Kafr El-Sheikh Govern., which indicates that the fluctuation of production around the average during the research period.

**3- Summer rice:**

**The data in Table (4) show the following:**

**The cultivated area with summer rice:**

The cultivated area of the rice crop at the republic during (2006-2023) ranged between a min. was approximately 858.74 thousand fed. in 2018, and a max. was approximately 1.77 million feddan in 2008, with an annual average estimated at approximately 1.35 million fed., and with a coefficient of variation indicating that the cultivated areas are distributed around their mean of about 16.98%. The cultivated area of the summer rice at the republic decreased at a statistically significant annual change rate at 0.05 estimated at approximately 1.60% of the annual average, and an annual decrease was approximately 21.57 thousand feddan.

**Table 4. Total area, yield per feddan and production of summer rice straw in Egypt and Kafr-El Sheikh Governorate during (2006-2023).**

Years	Total area (Thousand Feddan)			Yield of summer rice straw(Heml/Fed.)			Production of summer rice straw (Thousand Heml)		
	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)
2006	1592.82	271.47	17.04	8.9	8.03	90.17	14176.1	2178.69	15.37
2007	1672.71	293.14	17.52	9	7.71	85.61	15054.39	2258.69	15
2008	1769.78	358.3	20.25	8.8	7.82	114.26	15574.06	2802.59	18
2009	1369.24	324.63	23.71	8.5	8	94.17	11638.54	2598.36	22.33
2010	1093.3	276.44	25.28	8.5	8.52	100.27	9293.05	2356.04	25.35
2011	1409.16	296.52	21.04	8.52	8.29	97.35	12006.04	2459.36	20.48
2012	1472.14	290.13	19.71	8.57	7.89	92.09	12616.24	2289.76	18.15
2013	1419.38	291.87	20.56	8.57	8.12	94.77	12164.09	2370.56	19.49
2014	1363.81	276.15	20.25	8.59	8.18	95.27	11715.13	2259.86	19.29
2015	1215.83	248.99	20.48	8.58	8.21	95.74	10431.82	2045.36	19.61
2016	1353.27	271.7	20.08	8.58	7.5	87.41	11613.87	2037.74	17.55
2017	1307.1	258.34	19.76	8.59	7.5	87.31	11231.78	1937.54	17.25
2018	858.74	190.46	22.18	8.83	8	90.6	7580.11	1523.68	20.1
2019	1303.56	265.9	20.4	9.37	9	96.05	12209.25	2393.13	19.6
2020	1188.48	256.13	21.55	10	9.5	95	11880.33	2433.21	20.48
2021	1104.86	251.86	22.8	10.54	10	94.88	11644.65	2518.57	21.63
2022	1149.43	244.14	21.24	11.28	9	79.79	12969.18	2197.29	16.94
2023	1619.66	333.16	20.57	10.12	8	79.05	16386.77	2667.78	16.28
Average	1347.96	277.74	20.60	9.1	8.29	91.09	12232.52	2296.01	18.77
Min.	858.74	190.46		8.5	7.5		7580.11	1523.68	
Max.	1769.78	358.3		11.28	10		16386.77	2802.59	
B	-21.57	-		0.1	0.058		-	-	
Annual Ch. Rate (%)	(1.60)*	-		1.10**	0.70*		-	-	
STD.	228.98	37.58		0.827	0.677		2127.04	295.12	
C. V.(%)	16.98			9.09	8.17		17.39	12.85	

(\*\*) Indicates statistically significant. at 0.01 level.

Source: Compiled and calculated from:

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of The Agricultural Statistics, Arab Republic of Egypt, Various issues during (2006-2023).

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Prices Statistics, Arab Republic of Egypt, Various issues during (2006-2023).

- Ministry of Agriculture and Land Reclamation (2024), Agriculture Directorate of Kafr-El Sheikh, Unpublished data, Arab Republic of Egypt.

The cultivated area of the summer rice in Kafr El-Sheikh Governorate during the research period ranged

between a min. was approximately 190.46 thousand feddan in 2018, and a max. was approximately 358.30 thousand fed.

in 2008, with an annual average estimated at approximately 277.74 thousand fed., equivalent to 20.6% of the average at the republic, and with a coeff. of variation indicating that the cultivated areas are distributed around their arithmetic mean about 13.53%. The statistical significance of the annual rate of change in the cultivated area of the summer rice has not been established in Kafr El-Sheikh Govern., which indicates that the cultivated area fluctuated between increase and decrease around the average during the research period.

**The yield of summer rice straw:**

The yield of the summer rice straw at the republic during the research period ranged between a minimum was approximately 8.50 heml/fed. in 2009, 2020 and a max. was approximately 11.28 heml/fed. in 2022, with an annual average estimated at approximately 9.10 heml/fed., and with a coeff. of variation indicating that the yield per feddan are distributed around their mean of about 9.09%. The yield per feddan of the summer rice straw at the republic increased at a statistically signif. annual change rate at 0.01 estimated at about 1.1% of the annual average, and with an annual increase was approximately 0.10 heml/feddan.

The yield of the summer rice straw in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 7.50 heml/fed. in 2016, and a max. was approximately 10 heml/fed. in 2021, with an annual average estimated at approximately 8.29 heml, which is about 0.81 heml less than the average of yield per feddan of the summer rice straw at the republic, and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 8.17%. The yield per feddan of the summer rice straw in Kafr El-Sheikh Governorate increased at a statistically signif. annual change rate at 0.05 estimated at about 0.70% of the annual average, and with an annual increase was approximately 0.058 heml/ feddan.

**Production of summer rice straw:**

The production of the summer rice straw at the republic during the research period ranged between a minimum was approximately 7.58 million heml in 2018, and a max. was approximately 16.39 million heml in 2023, with an annual average estimated at approximately 12.23 million heml, and with a coeff. of variation indicating that the production is distributed around the mean of about 17.39%. The statistical significance of the annual rate of change in the production has not been established in the republic which indicates that the fluctuation of production around the average during the research period.

The production of the summer rice straw in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 1.52 million heml in 2018, and a max. was approximately 2.80 million heml in 2008, with an annual average estimated at approximately 2.29 million heml, equivalent to 18.77% of the average of production at the republic, and with a coeff. of variation indicating that the production are distributed around their mean about 12.85%. The statistical significance of the annual rate of change in the production has not been established in Kafr El-Sheikh Govern., which indicates that the fluctuation of production around the average during the research period.

**4 Wheat:**

**The data in Table (5) show the following:**

**The cultivated area with wheat:**

The cultivated area of the wheat at the republic during (2006-2023) ranged between a min. was approximately 2.72

million fed. in 2007, and a max. was approximately 3.47 million feddan in 2015, with an annual average estimated at was approximately 3.18 million fed., and with a coefficient of variation indicating that the cultivated areas are distributed around their mean about 6.72%. The cultivated area of the wheat at the republic increased at a statistically significant annual change rate at 0.01 estimated at was approximately 0.70% of the annual average, and with an annual increase at approximately 22.27 thousand feddan.

The cultivated area of the wheat in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 201.69 thousand feddan in 2007, and a max. was approximately 261.82 thousand fed. in 2009, with an annual average estimated at approximately 233.03 thousand feddan, equivalent to 7.32% of the average at the republic, and with a coeff. of variation indicating that the cultivated areas are distributed around their mean about 6.61%. The statistical significance of the annual rate of change in the cultivated area of the wheat has not been established in Kafr El-Sheikh Govern., which indicates that the cultivated area fluctuated between increase and decrease around the average during the research period.

**The yield of wheat straw:**

The yield of the wheat straw at the republic during the research period ranged between a minimum was approximately 10.72 heml/fed. in 2017 and a max. was approximately 16.37 heml/fed. in 2022, with an annual average estimated at approximately 12.18 heml/fed., and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 13.22%. The yield per feddan of the wheat straw at the republic increased at a statistically signif. annual change rate at 0.05 estimated at approximately 1.2% of the annual average, and with an annual increase about 0.146 heml/feddan.

The yield of the wheat straw in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 10 heml/fed. in 2017, and a max. was approximately 14.5 heml/fed. in 2021, 2023 with an annual average estimated at was approximately 12.14 heml/fed., which is about 0.04 heml less than the average of yield per feddan of the wheat straw at the republic, and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 9.8%. The yield per feddan of the wheat straw in Kafr El-Sheikh Governorate increased at a statistically signif. annual change rate at 0.01 estimated at was approximately 1% of the annual average, and with an annual increase about 0.121 heml/ feddan.

**Production of wheat straw:**

The production of the wheat straw at the republic during the research period ranged between a minimum was approximately 31.33 million heml in 2017, and a max. was approximately 55.92 million heml in 2022, with an annual average estimated at approximately 38.85 million heml, and with a coeff. of variation indicating that the production is distributed around the mean of about 16.96%. The production of the wheat straw in the republic increased at a statistically signif. annual change rate at 0.01 estimated at approximately 2% of the annual average, and with an annual increase about 777.09 thousand heml.

The production of the wheat straw in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 2.06 million heml in 2017, and a

max. was approximately 3.56 million heml in 2022, with an annual average estimated at approximately 2.83 million heml, equivalent to 7.29% of the average of production at the republic, and with a coeff. of variation indicating that the production are distributed around their arithmetic mean

about 12.85%. The statistical significance of the annual rate of change in the production has not been established in Kafr El-Sheikh Govern., which indicates that the fluctuation of production around the average during the research period.

**Table 5. Total area, yield per feddan and production of wheat straw in Egypt and Kafr-El Sheikh Governorate during (2006-2023).**

Years	Total area(Thousand Feddan)			Yield of wheat straw(Heml/Fed.)			Production of wheat straw(Thousand Heml)		
	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)
2006	3063.7	229.15	7.48	12	11.11	92.62	36764.4	2546.92	6.93
2007	2715.53	201.69	7.43	12.1	12.17	100.54	32857.91	2453.68	7.47
2008	2920.38	233.7	8	11.8	11.38	96.4	34460.48	2658.36	7.71
2009	3147.03	261.82	8.32	11.65	12.41	106.55	36662.9	3250.12	8.86
2010	3001.38	234.82	7.82	11.63	11.27	96.88	34906.05	2645.77	7.58
2011	3048.6	239.6	7.86	11.29	11.64	103.12	34418.69	2789.45	8.1
2012	3160.66	236.28	7.48	11.23	11.65	103.78	35494.21	2753.69	7.76
2013	3377.88	240.01	7.11	11.28	12.06	106.88	38102.49	2893.45	7.59
2014	3393	245.84	7.25	11.06	12.12	109.54	37526.58	2978.45	7.94
2015	3468.86	231.81	6.68	11.08	11.27	101.74	38434.97	2613.12	6.8
2016	3353.15	235.16	7.01	11.05	11.44	103.5	37052.31	2689.43	7.26
2017	2921.72	206.24	7.06	10.72	10	93.28	31327.57	2062.42	6.58
2018	3156.84	232.84	7.38	12.14	12	98.84	38324.04	2794.02	7.29
2019	3134.95	217.11	6.93	11.64	12	103.09	36491.53	2605.34	7.14
2020	3402.65	246.74	7.25	12.16	13	106.91	41390.59	3207.65	7.75
2021	3419.44	232.55	6.8	15.63	14.5	92.77	53429	3372.02	6.31
2022	3417.02	254.21	7.44	16.37	14	85.52	55920.6	3558.98	6.36
2023	3166.52	214.89	6.79	14.47	14.5	100.21	45819.9	3115.86	6.8
Average	3181.63	233.03	7.32	12.18	12.14	99.67	38854.68	2832.71	7.29
Min.	2715.53	201.69		10.72	10		31327.57	2062.42	
Max.	3468.86	261.82		16.37	14.5		55920.6	3558.98	
B	22.27	-		0.146	0.121		777.09	-	
Annual Ch. Rate (%)	0.70**	-		1.20*	1.00**		2.00**	-	
STD.	213.89	15.41		1.61	1.19		6588.24	363.99	
C. V. (%)	6.72	6.61		13.22	9.8		16.96	12.85	

(\*\*) Indicates statistically significant. at 0.01 level.

Source: Compiled and calculated from:

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of The Agricultural Statistics, Arab Republic of Egypt, Various issues during (2006-2023).
- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Prices Statistics, Arab Republic of Egypt, Various issues during (2006-2023).
- Ministry of Agriculture and Land Reclamation (2024), Agriculture Directorate of Kafr-El Sheikh, Unpublished data, Arab Republic of Egypt.

**5- Sugar beet:**

The data in Table (6) show the following:

**The cultivated area with Sugar beet:**

The cultivated area of the sugar beet at the republic during (2006-2023) ranged between a min. was approximately 186.40 thousand fed. in 2006, and a max. was approximately 682.77 thousand feddan in 2022, with an annual average estimated at approximately 460.5 thousand fed., and with a coefficient of variation indicating that the cultivated areas are distributed around their arithmetic mean about 32.21%. The cultivated area of the sugar beet at the republic increased at a statistically significant annual change rate at 0.01 estimated at approximately 6.5% of the annual average, and with an annual increase about 29.92 thousand feddan.

The cultivated area of the sugar beet in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 81.02 thousand feddan in 2007, and a max. was approximately 155.52 thousand fed. in 2015, with an annual average estimated at approximately 121.31 thousand fed., equivalent to 26.35% of the average at the republic, and with a coeff. of variation indicating that the cultivated areas are distributed around their mean about 19.6%. The cultivated area of the sugar beet in Kafr El-Sheikh Governorate increased at a statistically significant

annual change rate at 0.01 estimated at approximately 2.8% of the annual average, and with an annual increase about 3.4 thousand feddan.

**The yield of Sugar Beet Straw:**

The yield of the sugar beet straw at the republic during the research period ranged between a minimum was approximately 9.9 heml/fed. in 2006 and a max. was approximately 22.67 heml/fed. in 2023, with an annual average estimated at approximately 15.89 heml/fed., and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 19.95%. The yield per feddan of the sugar beet straw at the republic increased at a statistically signif. annual change rate at 0.01 estimated at approximately 3.4% of the annual average, and with an annual increase about 0.54 heml/feddan.

The yield of the sugar beet straw in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 16.5 heml/fed. in 2020, and a max. was approximately 23 heml/fed. in 2023 with an annual average estimated at approximately 18.12 heml/fed., which is about 2.23 heml more than the average of yield per feddan of the sugar beet straw at the republic, and with a coeff. of variation indicating that the yield per feddan are distributed around their mean about 9.71%. The statistical significance of

the annual rate of change in the yield has not been established fluctuation of the yield around the average during the in Kafr El-Sheikh Govern., which indicates that the research period.

**Table 6. Total area, yield per feddan and production of sugar beet straw in Egypt and Kafr-El Sheikh Governorate during (2006-2023).**

Years	Total area (Thousand Feddan)			Yield of sugar beet straw (Heml/Fed.)			Production of sugar beet straw (Thousand Heml)		
	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)	Egypt	K. El Sheikh	(%)
2006	186.4	81.69	43.83	9.9	20.15	203.56	1845.36	1646.28	89.21
2007	248.31	81.02	32.63	10	20.76	207.65	2483.1	1682.34	67.75
2008	257.67	88.42	34.32	10	19.52	195.2	2576.7	1725.98	66.98
2009	264.6	93.09	35.18	15.73	19.17	121.87	4162.16	1784.53	42.88
2010	385.69	114.39	29.66	16.15	17.35	107.41	6228.89	1984.35	31.86
2011	361.9	108.75	30.05	16.2	17.28	106.68	5862.78	1879.35	32.06
2012	423.76	124.55	29.39	16.24	16.76	103.23	6881.86	2087.94	30.34
2013	460.49	124.83	27.11	16.26	17.19	105.7	7487.57	2145.36	28.65
2014	504.3	139.18	27.6	16.28	16.93	104.02	8210	2356.84	28.71
2015	554.94	155.52	28.02	16.31	16.65	102.08	9051.07	2589.36	28.61
2016	559.74	148.25	26.49	16.35	17.14	104.86	9151.75	2541.69	27.77
2017	523.38	130.06	24.85	16.18	17.17	106.12	8466.24	2233.06	26.38
2018	492.71	124.22	25.21	16.12	17	105.46	7942.49	2111.67	26.59
2019	605.25	147.41	24.36	17.17	17	99.01	10392.8	2506.02	24.11
2020	517.95	132.59	25.6	17.24	16.5	95.71	8928.7	2187.79	24.5
2021	682.77	152.71	22.37	18.16	18	99.12	12400.21	2748.74	22.17
2022	597.92	128.48	21.49	19.06	18.5	97.06	11397.77	2376.86	20.85
2023	658.6	108.47	16.47	22.67	23	101.46	14928.09	2494.88	16.71
Average	460.35	121.31	26.35	15.89	18.12	114.03	7688.75	2171.28	28.24
Min.	186.4	81.02		9.9	16.5		1845.36	1646.28	
Max.	682.77	155.52		22.67	23		14928.09	2748.74	
B	29.92	3.4		0.54	-		761.19	54.28	
Annual Ch. Rate (%)	6.50**	2.80**		3.40**	-		9.90**	2.50**	
STD.	148.28	23.78		3.17	1.76		3498.91	337.54	
C. V. (%)	32.21	19.6		19.95	9.71		45.51	15.55	

(\*\*) Indicates statistically significant at 0.01 level.

Source: Compiled and calculated from:

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of The Agricultural Statistics, Arab Republic of Egypt, Various issues during (2006-2023).

- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Prices Statistics, Arab Republic of Egypt, Various issues during (2006-2023).

- Ministry of Agriculture and Land Reclamation (2024), Agriculture Directorate of Kafr-El Sheikh, Unpublished data, Arab Republic of Egypt.

**Production of sugar beet straw:**

The production of the sugar beet straw at the republic during the research period ranged between a minimum was approximately 1.85 million heml in 2006, and a max. was approximately 14.93 million heml in 2023, with an annual average estimated at approximately 7.69 million heml, and with a coeff. of variation indicating that the production is distributed around the mean of about 45.51%. The production of the sugar beet straw in the republic increased at a statistically signif. annual change rate at 0.01 estimated at approximately 9.9% of the annual average, and with an annual increase about 761.19 thousand heml.

The production of the sugar beet straw in Kafr El-Sheikh Governorate during the research period ranged between a min. was approximately 1.65 million heml in 2006, and a max. was approximately 2.75 million heml in 2021, with an annual average estimated at approximately 2.17 million heml, equivalent to 28.24% of the average of production at the republic, and with a coeff. of variation indicating that the production are distributed around the mean about 15.55%. The production of the sugar beet straw in Kafr El-Sheikh Governorate increased at a statistically signif. annual change rate at 0.01 estimated at approximately 2.5% of the annual average, and with an annual increase about 54.28 thousand heml.

From the above, it is possible to rank the agricultural wastes in terms of the production in Kafr El-Sheikh Governorate for the average (2006-2023), with wheat straw ranking first with an average at approximately 2.83 million heml, followed by summer rice straw, sugar beet straw, dry stalks of cotton, and dry stalks of summer maize with an average at approximately 2296.01, 2171.28, 837.07, and 824.04 thousand heml, respectively.

**Second: The structure of the cost items and revenues from recycling one ton of agricultural wastes resulting from the crops under study in the research sample**

**1- Dry stalks of summer maize:**

The data contained in Table (7) shows the following: The costs of recycling one ton of dry stalks of summer maize, amounting to approximately 1650 EGP/ton for use as unconventional fodder, are distributed among its cost items, which are the price of one ton of dry stalks, the cost of human labor, the value of machinery work, and the price of plastic, with a value at approximately 1040, 360, 120, 130 EGP for each, respectively, which are represent about 63.03%, 21.82%, 7.27%, 7.88% for each, respectively, of the total costs of recycling one ton of dry stalks of summer maize in the research sample. The output of the recycling process for one ton of dry stalks of summer maize to be used as unconventional fodder was approximately 0.96



ton, with an average price per ton at approximately 2900 EGP, and a return at approximately 2784 EGP.

**Table 7. The structure of the cost items and revenues from recycling one ton of dry stalks of summer maize waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Items	Unit	Dry stalks of summer maize	
		Value	(%)
Dry stalks of summer maize	EGP	1040	63.03
Human labor	EGP	360	21.82
Machinery work	EGP	120	7.27
Plastic	EGP	130	7.88
Total	EGP	1650	100.00
Qty.	Ton	0.96	
Price	EGP/ton	2900	
Return	EGP	2784	

Source: Compiled and calculated from the questionnaire data for the research sample.

**2- Dry stalks of cotton:**

The data contained in Table (8) shows the following:

The costs of recycling one ton of dry stalks of cotton, amounting to approximately 1410 EGP/ton for use as unconventional fodder, are distributed among its cost items, which are the price of one ton of dry stalks, the cost of human labor, the value of machinery work, and the price of plastic, with a value at approximately 800, 360, 120, 130 EGP for each, respectively, which represent about 56.74%, 25.53%, 8.51%, 9.22% for each, respectively, of the total costs of recycling one ton of dry stalks of cotton in the research sample. The output of the recycling process for one ton of dry stalks of cotton to be used as unconventional fodder was approximately 0.95 ton, with an average price per ton at approximately 2500 EGP, and a return at approximately 2375 EGP.

**Table 8. The structure of the cost items and revenues from recycling one ton of dry stalks of cotton waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Items	Unit	Dry Stalks of Cotton	
		Value	(%)
Dry Stalks of Cotton	EGP	800	56.74
Human labor	EGP	360	25.53
Machinery work	EGP	120	8.51
Plastic	EGP	130	9.22
Total	EGP	1410	100.00
Qty.	Ton	0.95	
Price	EGP/ton	2500	
Return	EGP	2375	

Source: Compiled and calculated from the questionnaire data for the research sample.

**3- Summer Rice straw:**

The data contained in Table (9) shows the following: The costs of recycling one ton of summer rice straw, amounting to approximately 1270 EGP/ton for use as unconventional fodder, are distributed among its cost items, which are the price of one ton of straw, the cost of human labor, the value of machinery work, and the price of plastic, with a value at approximately 820, 200, 120, 130 EGP for each, respectively, which represent about 64.57%, 15.74%, 9.45%, 10.24% for each, respectively, of the total costs of recycling one ton of summer rice straw in the research sample. The output of the recycling process for one ton of summer rice

straw to be used as unconventional fodder was approximately 0.97 ton, with an average price per ton at approximately 2700 EGP, and a return at approximately 2619 EGP.

**Table 9. The structure of the cost items and revenues from recycling one ton of summer rice straw waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Items	Unit	Summer rice straw	
		Value	(%)
Summer rice straw	EGP	820	64.57
Human labor	EGP	200	15.74
Machinery work	EGP	120	9.45
Plastic	EGP	130	10.24
Total	EGP	1270	100.00
Qty.	Ton	0.97	
Price	EGP/ton	2700	
Return	EGP	2619	

Source: Compiled and calculated from the questionnaire data for the research sample.

**4- Wheat straw:**

The data contained in Table (10) shows the following: The costs of recycling one ton of wheat straw, amounting to approximately 2230 EGP/ton for use as unconventional fodder, are distributed among its cost items, which are the price of one ton of wheat straw, the cost of human labor, the value of mechanical work, and the price of plastic, with a value at approximately 1780, 200, 120, 130 EGP for each, respectively, which represent about 79.82%, 8.97%, 5.38%, 5.83% for each, respectively, of the total costs of recycling one ton of wheat straw in the research sample. The output of the recycling process for one ton of wheat straw to be used as unconventional fodder was approximately 0.98 ton, with an average price per ton at approximately 3800 EGP, and a return at approximately 3724 EGP.

**Table 10. The structure of the cost items and revenues from recycling one ton of wheat straw waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Items	Unit	Wheat straw	
		Value	(%)
Wheat straw	EGP	1780	79.82
Human labor	EGP	200	8.97
Machinery work	EGP	120	5.38
Plastic	EGP	130	5.83
Total	EGP	2230	100.00
Qty.	Ton	0.98	
Price	EGP/ton	3800	
Return	EGP	3724	

Source: Compiled and calculated from the questionnaire data for the research sample.

**5- Sugar beet straw:**

The data contained in Table (11) shows the following: The costs of recycling one ton of sugar beet straw, amounting to approximately 1430 EGP/ton for use as unconventional fodder, are distributed among its cost items, which are the price of one ton of straw, the cost of human labor, the value of mechanical work, and the price of plastic, with a value at approximately 980, 200, 120, 130 EGP for each, respectively, which represent about 68.53%, 13.99%, 8.39%, 9.09% for each, respectively, of the total costs of recycling one ton of sugar beet straw in the research sample. The output of the recycling process for one ton of sugar beet straw to be used as

unconventional fodder was approximately 0.98 ton, with an average price per ton at approximately 2650 EGP, and a return at approximately 2597 EGP.

**Table 11. The structure of the cost items and revenues from recycling one ton of sugar beet straw waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Items	Unit	Sugar beet straw	
		Value	(%)
Sugar beet straw	EGP	980	68.53
Human labor	EGP	200	13.99
Machinery work	EGP	120	8.39
Plastic	EGP	130	9.09
Total	EGP	1430	100.00
Qty.	Ton	0.98	
Price	EGP/ton	2650	
Return	EGP	2597	

Source: Compiled and calculated from the questionnaire data for the research sample.

From the above, it is possible to rank agricultural wastes in terms of the return resulting from recycling one ton of waste, with wheat straw ranking first at approximately 3724 EGP, followed by dry stalks of summer maize, summer rice straw, sugar beet straw, and dry stalks of cotton at approximately 2784, 2619, 2597, and 2375 EGP, respectively.

**Third: Economic indicators for recycling one ton of agricultural wastes resulting from the crops subject to the study in the research sample**

By measuring some economic indicators, it is possible to determine the profitability of these wastes or not in the research sample in Kafr El-Sheikh Governorate 2023/2024, as follows:

**1- Dry stalks of summer maize:**

The data contained in Table (12) shows the following:

The net return from recycling one ton of dry stalks of summer maize for use as unconventional fodder was approximately 1134 EGP, while the benefit-cost ratio per ton was approximately 1.69, while the profit margin ratio for the producer amounted to about 40.73%, while the return on the invested pound per ton was approximately 0.69 EGP, meaning that the return on each invested pound gains approximately 69 piaster. The added value from converting a ton of the dry stalks of summer maize waste for use as unconventional fodder was approximately 1860 EGP/ton.

**Table 12. Economic indicators for recycling one ton of dry stalks of summer maize waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Indicator	Unit	Value
Net return <sup>(1)</sup>	EGP	1134
Benefit-Cost ratio <sup>(2)</sup>	-	1.69
Profit margin ratio <sup>(3)</sup>	%	40.73
Return on the invested pound <sup>(4)</sup>	EGP	0.69
Added value <sup>(5)</sup>	EGP	1860

(1) Net return = Total Return – Total Costs.

(2) Benefit-Cost ratio = Total Return/Total Costs.

(3) Profit margin ratio = (Net Return/Total Return) \* 100.

(4) Return on the invested pound = Net Return/Total Costs.

(5) Added value = Sale price per ton after recycling - Sale price per ton of waste before recycling.

Source: Compiled and calculated from the questionnaire data for the research sample.

**2- Dry stalks of cotton:**

The data contained in Table (13) shows the following:

The net return from recycling one ton of dry stalks of cotton for use as unconventional fodder was approximately 965 EGP, while the benefit-cost ratio per ton was approximately 1.68, while the profit margin ratio for the producer amounted to about 40.63%, while the return on the invested pound per ton was approximately 0.68 EGP, meaning that the return on each invested pound gains approximately 68 piaster. The added value from converting a ton of the dry stalks of cotton waste for use as unconventional fodder was approximately 1700 EGP/ton.

**Table 13. Economic indicators for recycling one ton of dry stalks of cotton waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Indicator	Unit	Value
Net return	EGP	965
Benefit-Cost ratio	-	1.68
Profit margin ratio	%	40.63
Return on the invested pound	EGP	0.68
Added value	EGP	1700

Source: Compiled and calculated from the questionnaire data for the research sample.

**3 - Summer rice straw:**

The data contained in Table (14) shows the following: The net return from recycling one ton of summer rice straw for use as unconventional fodder was approximately 1349 EGP, while the benefit-cost ratio per ton was approximately 2.06, while the profit margin ratio for the producer amounted to about 51.51%, while the return on the invested pound per ton was approximately 1.06 EGP, meaning that the return on each invested pound gains approximately 1.06 EGP. The added value from converting a ton of the summer rice straw waste for use as unconventional fodder was approximately 1700 EGP/ton.

**Table 14. Economic indicators for recycling one ton of summer rice straw waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Indicator	Unit	Value
Net return	EGP	1349
Benefit-Cost ratio	-	2.06
Profit Margin ratio	%	51.51
Return on the invested pound	EGP	1.06
Added value	EGP	1880

Source: Compiled and calculated from the questionnaire data for the research sample.

**4- Wheat straw:**

The data contained in Table (15) shows the following: The net return from recycling one ton of wheat straw for use as unconventional fodder was approximately 1567.5 EGP, while the benefit-cost ratio per ton was approximately 1.70, while the profit margin ratio for the producer amounted to about 41.28%, while the return on the invested pound per ton was approximately 0.70 EGP, meaning that the return on each invested pound gains approximately 70 piaster.

The added value from converting a ton of the wheat straw waste for use as unconventional fodder was approximately 2095 EGP/ton.

**Table 15. Economic indicators for recycling one ton of wheat straw waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Indicator	Unit	Value
Net return	EGP	1567.50
Benefit-Cost ratio	-	1.70
Profit margin ratio	%	41.28
Return on the invested pound	EGP	0.70
Added value	EGP	2095

Source: Compiled and calculated from the questionnaire data for the research sample.

**5- Sugar beet straw:**

The data contained in Table (16) shows the following: The net return from recycling one ton of sugar beet straw for use as unconventional fodder was approximately 1167 EGP, while the benefit-cost ratio per ton was approximately 1.82, while the profit margin ratio for the producer amounted to about 44.94%, while the return on the invested pound per ton was approximately 0.82 EGP, meaning that the return on each invested pound gains approximately 82 piaster. The added value from converting a ton of the sugar beet straw waste for use as unconventional fodder was approximately 1670 EGP/ton.

**Table 16. Economic indicators for recycling one ton of sugar beet straw waste in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Indicator	Unit	Value
Net return	EGP	1167
Benefit-Cost ratio	-	1.82
Profit margin ratio	%	44.94
Return on the invested pound	EGP	0.82
Added value	EGP	1670

Source: Compiled and calculated from the questionnaire data for the research sample.

From the above, it is possible to rank agricultural wastes in terms of the return on the invested pound resulting from recycling one ton of waste, with summer rice straw ranking first at approximately 1.06 Egyptian Pound, followed by sugar beet straw, wheat straw, dry stalks of summer maize, and dry stalks of cotton at approximately 0.82, 0.7, 0.69, and 0.68 EGP, respectively.

**Fourth: Methods of farmers in the research sample dealing with agricultural wastes of the crops subject of the study**

By surveying the opinions of farmers in the research sample in Kafr El-Sheikh Governorate on how to deal with agricultural wastes of the crops subject of the study, it became clear that there are multiple methods and approaches from one farmer to another, and it was possible to limit these methods as follows:

**1 - Dry stalks of summer maize:**

The methods and approaches of farmers of summer maize crop dealing with dry stalks according to their relative importance were represented in; producing unconventional fodder, making silage for animals (green fodder), using dry stalks directly for animals feeding, direct selling, using it as organic fertilizer, and storage it on rooftops, as shown from the data in Table (17) as follows: 6 farmers representing about 33.33% of the total number of the summer maize farmers, which are 18 farmers, produced unconventional fodder from an amount of dry stalks that amounted to about 168 heml representing about 33.94% of the total amount of

dry stalks of summer maize produced, which amounted to about 495 heml, and 5 farmers representing about 27.78% of the summer maize farmers in the sample made silage for animals from an amount of dry stalks of summer maize estimated at about 137 heml, representing about 27.68% of the total amount of the dry stalks of summer maize in the sample, while 3 farmers representing about 16.66% of the summer maize farmers in the sample used the dry stalks directly for animals feeding with an amount estimated at about 81 heml, representing about 16.36% of the total amount of the dry stalks of summer maize in the sample, while 2 farmers representing about 11.11% of the summer maize farmers in the sample with direct selling of an amount of dry stalks estimated at about 53.5 heml, representing about 10.81% of the total amount of the dry stalks of summer maize in the sample, while one farmer representing about 5.56% of the summer maize farmers in the sample used an amount of the dry stalks as organic fertilizer (compost) estimated at about 27.5 heml, representing about 5.55% of the total amount of the dry stalks of summer maize in the sample, Finally, one farmer representing about 5.56% of the summer maize farmers in the sample, stored an amount of dry stalks on the rooftops estimated at about 28 heml, representing about 5.66% of the total amount of the dry stalks of summer maize in the sample.

**Table 17. Methods and techniques of farmers' dealing with dry stalks of summer maize according to its relative importance in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Methods	Farmers		Qty. of dry stalks of summer maize	
	Number	(%)	Heml	(%)
Producing unconventional fodder	6	33.33	168.00	33.94
Making silage for animals	5	27.78	137.00	27.68
Using it directly for animals feeding	3	16.66	81.00	16.36
Direct selling	2	11.11	53.50	10.81
Using it as organic fertilizer (compost)	1	5.56	27.50	5.55
Storage it on the rooftops	1	5.56	28.00	5.66
Total	18	100.00	495.00	100.00

Source: Compiled and calculated from the questionnaire data for the research sample.

**2- Dry stalks of cotton:**

The methods and approaches of farmers of cotton crop dealing with dry stalks according to their relative importance were represented in; producing unconventional fodder, burning it, using it as fuel for ovens, as shown from the data in Table (18) as follows: 12 farmers representing about 57.14% of the total number of the cotton farmers, which are 21 farmers, produced unconventional fodder from an amount of dry stalks of cotton that amounted to about 317.5 heml representing about 58.15% of the total amount of dry stalks of cotton produced, which amounted to about 546 heml, and 6 farmers representing about 28.57% of the cotton farmers in the sample burning an amount of dry stalks estimated at about 153 heml, representing about 28.02% of the total amount of the dry stalks of cotton in the sample. Finally, 3 farmer representing about 14.29% of the cotton farmers in the sample, used an amount of dry stalks as fuel for ovens estimated at about 75.5 heml, representing about 13.83% of the total amount of the dry stalks of cotton in the sample.

**Table 18. Methods and techniques of farmers' dealing with dry stalks of cotton according to its relative importance in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Method	Farmers		Qty. of dry stalks of cotton	
	Number	(%)	Heml	(%)
Producing unconventional fodder	12	57.14	317.50	58.15
Burning it	6	28.57	153.00	28.02
Using it as fuel for ovens	3	14.29	75.50	13.83
Total	21	100.00	546.00	100.00

Source: Compiled and calculated from the questionnaire data for the research sample.

### 3 Summer rice straw:

The methods and approaches of farmers of summer rice dealing with straw according to their relative importance were represented in; Producing unconventional fodder, using straw directly for animals feeding, direct selling, and storage it on the rooftops, as shown from the data in Table (19) as follows: 16 farmers representing about 48.48% of the total number of the summer rice farmers, which are 33 farmers, produced unconventional fodder from an amount of straw that amounted to about 472 heml representing about 49.15% of the total amount of summer rice straw produced, which amounted to about 960.25 heml, and 8 farmers representing about 24.24% of the summer rice farmers in the sample used the straw directly for animals feeding with an amount estimated at about 224 heml, representing about 23.33% of the total amount of summer rice straw in the sample, while 6 farmers representing about 18.18% of the summer rice farmers in the sample with direct selling of an amount of straw estimated at about 177 heml, representing about 18.43% of the total amount of the summer rice straw in the sample, Finally, 3 farmer representing about 9.1% of the summer rice farmers in the sample, stored an amount of straw on the rooftops estimated at about 87.25 heml, representing about 9.09% of the total amount of the of summer rice straw in the sample.

**Table 19. Methods and techniques of farmers' dealing with summer rice straw according to its relative importance in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Method	Farmers		Qty. of summer rice straw	
	Number	(%)	Heml	(%)
Producing unconventional fodder	16	48.48	472.00	49.15
Using directly for animals feeding	8	24.24	224.00	23.33
Direct selling	6	18.18	177.00	18.43
Storage it on the rooftops	3	9.10	87.25	9.09
Total	33	100.00	960.25	100.00

Source: Compiled and calculated from the questionnaire data for the research sample.

### 4 Wheat Straw:

The methods and approaches of farmers of wheat crop dealing with straw according to their relative importance were represented in; using straw directly for animals feeding, producing unconventional fodder, direct selling, using it as organic fertilizer, as shown from the data in Table (20) as follows: 11 farmers representing about 39.29% of the total number of the wheat farmers, which are 28 farmers, used the straw directly for animals feeding with an amount estimated at about 434.5 heml, representing about 40.84% of the total amount of wheat straw produced, which amounted to about 1064 heml, while 8 farmers representing

about 28.57% of the total number of the wheat farmers in the sample produced unconventional fodder from an amount of straw that amounted to about 304 heml representing about 28.57% of the total amount of wheat straw produced, and 5 farmers representing about 17.86% of the wheat farmers in the sample with direct selling of an amount of straw estimated at about 185 heml, representing about 17.39% of the total amount of the wheat straw in the sample, Finally 4 farmer representing about 14.28% of the wheat farmers in the sample used an amount of the straw as organic fertilizer (compost) estimated at about 140.5 heml, representing about 13.2% of the total amount of the wheat straw in the sample.

**Table 20. Methods and techniques of farmers' dealing with wheat straw according to its relative importance in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Method	Farmers		Qty. of wheat Straw	
	Number	(%)	Heml	(%)
Using directly for animals feeding	11	39.29	434.50	40.84
Producing unconventional fodder	8	28.57	304.00	28.57
Direct selling	5	17.86	185.00	17.39
Using it as organic fertilizer (compost)	4	14.28	140.50	13.20
Total	28	100.00	1064.00	100.00

Source: Compiled and calculated from the questionnaire data for the research sample.

### 5- Sugar beet straw:

The methods and approaches of farmers of sugar beet crop dealing with straw according to their relative importance were represented in; direct selling, producing unconventional fodder, using straw directly for animals feeding, and making silage for animals (green fodder), as shown from the data in Table (21) as follows: 9 farmers representing about 36% of the total number of the sugar beet farmers, which are 25 farmers, with direct selling of an amount of straw estimated at about 481.5 heml, representing about 37.08% of the total amount of the sugar beet straw produced, which amounted to about 1298.5 heml, and 8 farmers representing about 32% of the sugar beet farmers in the sample produced unconventional fodder from an amount of straw that amounted to about 412 heml, representing about 31.73% of the total amount of sugar beet straw produced, while 5 farmers representing about 20% of the sugar beet farmers in the sample used the straw directly for animals feeding with an amount estimated at about 262.5 heml, representing about 20.22% of the total amount of sugar beet straw in the sample, Finally, 3 farmers representing about 12% of the sugar beet farmers in the sample made silage for animals from an amount of straw estimated at about 142.5 heml, representing about 10.97% of the total amount of the sugar beet straw in the sample

**Table 21. Methods and techniques of farmers' dealing with sugar beet straw according to its relative importance in the research sample in Kafr El-Sheikh Governorate 2023/2024.**

Statement Method	Farmers		Qty. of summer rice straw	
	Number	(%)	Heml	(%)
Direct selling	9	36.00	481.50	37.08
Producing unconventional fodder	8	32.00	412.00	31.73
Using directly for animals feeding	5	20.00	262.50	20.22
Making silage for animals	3	12.00	142.50	10.97
Total	25	100.00	1298.50	100.00

Source: Compiled and calculated from the questionnaire data for the research sample.

**Fifth: The opinions of the farmers of the research sample regarding the problems and obstacles facing the recycling of agricultural wastes, and the proposed solutions to benefit from it as unconventional fodder.**

Through the research form and sample, it was possible to determine the problems and obstacles facing farmers who recycle agricultural wastes for the crops that are the subject of the study in the research sample in Kafr El-Sheikh Governorate during 2023/2024, which are in Table (22), and the most important proposed solutions according to their opinions to benefit from agricultural wastes as unconventional fodder, which are in Table (23) as follows:

**1- Problems and obstacles:**

The number of problems and obstacles facing farmers who recycle agricultural wastes in the research sample amounted to 6 problems and obstacle ranked according to their relative importance as in the table, and the

top problem was the lack of experience among farmers in how to recycle agricultural wastes, which represents about 90.4%, followed by the problem of the lack of awareness of livestock fattening producers of the importance of unconventional fodder, which represents about 80.8%, followed by the problem of weak financial capabilities for the farmers who carry out the recycling process, which represents about 74.4%, followed by the problem of the lack of training programs to aware the farmers about the importance of recycling agricultural wastes, representing about 72%, followed by the problem of the high costs of collecting agricultural wastes, which represents about 55.9%, and finally the problem of the lack of the role of agricultural guidance in aware the farmers about the importance and how to recycle wastes, which represents about 51.2%. The existence of four of these problems was statistically confirmed through the estimated (Chi-square) values, while the existence of the other two problems was not statistically confirmed - Table (22).

**Table 22. The relative importance of the problems and obstacles facing farmers who recycle agricultural wastes in the research sample in Kafr El-Sheikh Governorate according to their opinions during 2023/2024.**

NO.	Problems	Frequency	%	Ch <sup>2</sup> (1)
1	The lack of experience among farmers in how to recycle agricultural wastes	113	90.4	81.61**
2	The lack of awareness of livestock fattening producers of the importance of unconventional fodder	101	80.8	47.43**
3	weak financial capabilities for the farmers who carry out the recycling process	93	74.4	29.77**
4	The lack of training programs to aware the farmers about the importance of recycling agricultural wastes	90	72.0	24.20**
5	The high costs of collecting agricultural wastes	71	55.9	2.31
6	The lack of the role of agricultural guidance in aware the farmers about the importance and how to recycle wastes	64	51.2	0.072
Total		125	-	-

(1)  $Ch^2 = \sum [(O_i - E_i)^2 / E_i]$ .

(\*\*) Indicates statistical significant. at 0.01 level.

Source: Compiled and calculated from the questionnaire data for the research sample.

**2- Proposed solutions:**

The number of proposed solutions, according to the opinions of farmers, to overcome the problems and obstacles they face in order to benefit from agricultural wastes as unconventional fodder, was 5 solutions ranked according to their relative importance as shown in the table, the top proposed solution was to suggest holding training courses for farmers on how and the importance of recycling agricultural wastes, which represents about 89.6%, followed by the proposal to increase the role of agricultural associations and agricultural guidance in aware the livestock breeders about the importance and role of unconventional fodder in fattening, which represents about 78.4%, followed

by the proposal to provide government agencies and associations with small equipment to recycle agricultural wastes, which represents about 70.4%, followed by the proposal to increase the role of the Ministry of Agriculture in carrying out training programs on the importance of recycling agricultural wastes, which represents about 64.8%, and in fifth and last place is the proposal to provide simple loans to farmers to carry out the recycling process, which represents about 50.4%, and it has been statistically confirmed that there is four proposed solutions were identified through the estimated Chi-square values, while the fifth proposal was not statistically confirmed - Table (23).

**Table 23. The relative importance of the proposed solutions by farmers who recycle agricultural wastes in the research sample in Kafr El-Sheikh Governorate to benefit from agricultural waste as unconventional fodder during 2023/2024.**

NO.	Solutions	Frequency	%	Ch <sup>2</sup>
1	Holding training courses for farmers on how and the importance of recycling agricultural wastes.	112	89.6	78.41**
2	Increasing the role of agricultural associations and agricultural guidance in aware the livestock breeders about the importance and role of unconventional fodder in fattening.	98	78.4	40.33**
3	Providing the government agencies and associations with small equipment to recycle agricultural wastes	88	70.4	20.81**
4	Increasing the role of the Ministry of Agriculture in carrying out training programs on the importance of recycling agricultural wastes	81	64.8	10.95**
5	Providing simple loans to farmers to carry out the recycling process	63	50.4	0.008
Total		125	-	-

(\*\*) Indicates statistical significant. at 0.01 level.

Source: Compiled and calculated from the questionnaire data for the research sample.

**RECOMMENDATION**

In light of the research findings, a mechanism can be developed to promote the recycling of agricultural wastes, the subject of the research, to obtain unconventional fodder, which helps the concerned parties to make appropriate decisions. Therefore, the research recommends the following:

- (1) Cooperation and coordination between the Ministry of Agriculture and the Ministry of Environment to implement and apply modern agricultural technologies in processing and recycling agricultural wastes (by-products) and benefiting from it in production of unconventional feed to compensate for the shortage of concentrated fodders.

- (2) Encourage investors to establish factories for unconventional fodders and to benefit from the increasing quantities of agricultural wastes due to the high rate of return on the EGP invested resulting from recycling agricultural wastes.
- (3) Encourage scientific research in the field of recycling agricultural waste by working to create a unified database at the national level for farmers, crops and quantities of agricultural wastes to maximize their benefits.
- (4) Encourage investment in various fields of agricultural wastes recycling, which help creating job opportunities and increasing national income.
- (5) Activating and implementing the role of agricultural guidance in holding courses, seminars and guidance fields for agricultural waste recycling in order to aware farmers about its economic importance and how to exploit it to maximize its benefit and achieve profitable economic returns, and to preserve the environment and public health from unsafe handling of this wastes.

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## المردود الاقتصادي لتدوير المخلفات الزراعية لإنتاج أعلاف غير تقليدية للإنتاج الحيواني بمحافظة كفر الشيخ

محمد فوزي الدناصري، الحسين خليل النوبي ونورا ممدوح طنطاوي

معهد بحوث الاقتصاد الزراعي، مركز البحوث الزراعية، مصر.

### المُلخَص

استهدف البحث تحديد المردود الاقتصادي لتدوير المخلفات الزراعية والتي تتمثل في (حطب الذرة الشامي الصيفي، حطب القطن، قش الأرز الصيفي، تبن القمح، وعرش بنجر السكر) لإنتاج أعلاف غير تقليدية للإنتاج الحيواني بمحافظة كفر الشيخ، وقد اعتمد البحث على استخدام بعض أساليب التحليل الاقتصادي الوصفي والكمي، وذلك إستناداً إلى البيانات الأولية والتي تم تجميعها من خلال عينة عشوائية بلغ قوامها 125 مفردة خلال 2023/2024. وأوضحت النتائج أنه بترتيب المخلفات الزراعية بالعينة البحثية من حيث العائد على الجنيه المنفق من تدوير الطن من المخلف، احتل المرتبة الأولى قش الأرز بحوالي 1.06 جنيه، يليه عرش بنجر السكر، تبن القمح، حطب الذرة، وحطب القطن بحوالي 0.82، 0.70، 0.69، 0.68 جنيه على الترتيب. كما تحدث طرق تعامل المزارعين مع المخلفات وهي: عمل أعلاف غير تقليدية، عمل سباج للحيوانات، إستخدامه مباشرة في تغذية الحيوانات، البيع المباشر، إستخدامه كسماد عضوي، التخزين على أسطح المنازل، الحرق، الإستخدام كوقود للأفران البلدية. وتعتبر مشكلة عدم توافر الخبرة لدى المزارعين في كيفية تدوير المخلفات الزراعية من أهم المشكلات التي واجهت المزارعين بنسبة تمثل نحو 90.4%، كما يُعتبر مُقترح إقامة نورات تدريبية بكيفية وأهمية تدوير المخلفات الزراعية بنسبة تمثل نحو 89.6% أهم الحلول من وجهة نظرهم للاغلب على المشكلات. وأوصى البحث بضرورة التعاون والتنسيق بين وزارة الزراعة ووزارة البيئة لتنفيذ وتطبيق التقنيات الزراعية المُستخدمة في معالجة وتدوير المخلفات الزراعية والإستفادة منها في إنتاج أعلاف غير تقليدية لتعويض النقص في الأعلاف المُركزة، وتشجيع المُستثمرين على إنشاء مصانع للأعلاف غير التقليدية والإستفادة من الكميات المُتزايدة من المخلفات الزراعية نظراً لإرتفاع مُعدل العائد على الجنيه المنفق الناتج من تدوير المخلفات الزراعية.

**الكلمات الدالة:** تدوير المخلفات الزراعية، المردود الاقتصادي، أعلاف غير تقليدية، والمؤشرات الاقتصادية.