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An economic analysis of the wheat crop wastes in Egypt.

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Abstract : The importance of this study relies on the fact that there is a considerable amount of wheat wastes during the different stages of processing in Egypt. Wheat is an important food commodity for the Egyptians for its high nutritive values. The waste in wheat crops accounted for 6.5% of wheat production; therefore, this analytical study covering the period between 1995 and 2015 attempted to analyze the effect of different factors contributing in wheat waste. The study presented the most important factors including amount of wheat production, wheat imports and net return per acre of wheat during this period. The results of the pilot study carried out in Sharkya governorate on a sample of 100 randomly chosen farmers showed that the most important affecting factors on wheat waste included area cultivated in acres (X1) where one unit increase led to an increase in wheat waste by 38.6 units. Similarly, there was an increase in wheat waste by 3.55 units with one unit increase in wheat seedlings for cultivation (X3). While in the case of applying modern agriculture practices, the study concluded that both farming time and mechanical wheat harvesting and seed separation had a reduced effect on wheat waste. The results showed that 64.5% of changes in wheat waste are due to these factors.
We finally concluded that with the application of best agriculture practices in wheat farming and with the increase of wheat production and wheat imports farmers can decrease wheat waste.
Key words: wheat, waste, production, agriculture, practices, factors.

1. Introduction

The waste in food crops is one of the most important problematic issues in agriculture; especially in the developing countries[1]. This waste is due mainly to the lack of technical and technological methods used in modern agriculture. The agriculture technology by itself contributed about 75% in agriculture production compared to other methods adopted in agriculture.

In fact, wheat crops represent a strategic element in the food of developing countries occupying 17% of the total cultivated land in the world [2]. The importance of wheat as an important food commodity is due to its high nutritive value. The whole grain wheat is a rich source of various antioxidants, protein (gluten), vitamins, minerals and fibers [3]. African countries are the world's biggest wheat importer with more than 45 MT in 2013 where North African countries have the highest per capita wheat consumption[4].

There is a rising demand for wheat estimated to be one billion tons of grain annually by 2020 to feed people around the world [2]. As a result, it is important to study factors affecting waste in wheat crops to reduce the gap between production and consumption in Egypt. The consumption of wheat in Egypt was estimated to be

17 Mt where production was only 8 Mt with 9 MT wheat gap. In addition, the waste in Egyptian wheat crops estimated to be 3.2 MT on average[5].

2. The study problem:

The importance of this study relies on the fact that there is a big amount of wheat crop waste estimated to be 6.5% of the total wheat production (2013-2015) in Egypt. This waste has a negative impact on the cost of wheat seedlings, application of fertilizers and water demands increasing the financial demands for this industry and widening the food gap with little return.

3. The main study goal:

This study aims to analyze the most important economic factors governing wheat production and their effects on wheat waste in the period between 1995 and 2015. The study also focuses on the application of agriculture practices and their effects on wheat waste in a pilot study carried out in Sharkya governorate, Egypt.

4. Sources of data and methodology:

We collected data from both published and unpublished sources, including the Egyptian ministry of agriculture and the central institute of mobilization and statistics. The sources of data also included previous studies that employed quantitative and qualitative analysis of similar works during the period between 1995 and 2015.

The current study used simple linear, log-linear and stepwise regression models to achieve its goal. Data collected for this analysis included wheat wastes in MT, wheat production in MT, wheat consumption in MT, wheat imports in MT, subsidies in 1000 million pounds, per capita wheat consumption in Kg and net return in pounds. We used these data and carried out a quantitative data analysis covering the period from 1995 to 2015 and using the prescribed mathematical models. We also carried out a pilot study on a random sample of 100 farmers in Sharkya governorate in 2014/2015 to identify the most important affecting factors on wheat losses. Variables included in this study are: wheat cultivated area in acres, productivity per acre, amount of wheat seedlings for cultivation and the agriculture practices as dummy variables.

5. Results and Discussion:

5.1-The waste in wheat:

Table (1) presents the waste in local wheat in relation to other parameters during 1995-2015. The minimum amount of wheat waste was 393 MT during 2001 that represented a decrease by 71.4% of the annual production average in that period (1373.7MT). Whereas the maximum waste was 2994.6 MT in 2015 with a percentage of increase by 117.9% of the annual production average in that period. The results of the time series analysis for wheat waste during the study period showed a statistically significant increase of 162.1MT representing 11.5% of the average waste with 0.82 coefficient of determination (table 2, equation # 1). The amount of wheat production ranged between a minimum of 5725 MT in 1995 with a percentage of decrease by 22.8% of the annual production average in the period (1995-2015) and a maximum of 9286MT in 2015 with a percentage of increase by 25.3% of the annual production average (Table 1). The results of the time series equation for wheat production during the study period showed that there was a statistically significant increase of 187.2 MT representing 2.5% of the annual production average with a coefficient of determination of 0.89 (Table 2, equation # 2).

In case of wheat consumption as shown in Table (1), it ranged between a minimum of 9073% MT in 2001 with a percentage of decrease by 32.2% in the period (1995-2015) and a maximum of 17565.9 MT in 2015 with a percentage of increase by 31.25% from the annual consumption average. We estimated the equation of the time series for the local wheat consumption which indicated a significant annual increase of 418.2 MT representing 2.15% of the average consumption with a coefficient of determination of 0.84 as shown by Table (2), equation # 3).

As shown in Table (1) the amount of wheat imports during the period (1995-2015) ranged between a minimum of 2818.3 MT in 2001 with a percentage of decrease by 48.9% and a maximum of 9787.3 MT in

2015 with a percentage of increase by 77.6% from the annual average. The analysis of the time series equation for imports showed a significant annual increase of 180.3 MT representing 3.3% of the average with a coefficient of determination of 0.37 (Table 2, equation #4). The amount of monetary subsidies for wheat and wheat flour, on the other hand ranged between 1.4 thousand million pounds in 1995 with a percentage of decrease by 81.1% of the average in 1995-2015 that valued 7.4 thousand million pounds and 15.6 thousand million pounds in 2015 with a percentage of increase by 110.9% of the average (Table 1). The results of the time series equation for wheat subsidies during the study period showed a significant annual increase of 0.882 thousand million pounds representing 11.9% of the average with a coefficient of determination of 0.89 (Table 2 equation #5). The per capita wheat share during (1991-2015) ranged between a minimum of 139 kg/ year in 1995 with a percentage of decrease by 24.5% of the annual average (184.kg/year) and a maximum of 205kg/year in 2015 with a percentage of increase by 11.3% of the annual average. By estimating the time series equation there was a significant increase in per capita wheat and wheat flour share of 2.1kg/year representing 1.13%of the average imports with a coefficient of determination of 0.42 (Table 2, equation #6).

The net return of wheat production per acre ranged between a minimum of 850 pounds in 1995 with a percentage of decrease by 60.1% of the annual average (21319.9 pounds) during1995-2015 and a maximum of 4169.4 pounds in 2015 with a percentage of increase by 95.5%. The analysis of the time series equation of the net return on wheat per acre during the study period showed to be 196.8 Egyptian pounds representing 9.2% of the average net return with a coefficient of determination of 0.71(Table 2, equation #7).

Table (1): Amount of wheat wastes and the affecting factors in the period 1995-2015

Years	Wastes MT	Production MT	Consumption MT	Imports MT	Subsidies 1000million pounds	Per capita consumption kg/year	Return/pound
1995	410	5725	10795	5243	1.4	182	850
1996	433	5735	10693	4958.2	2.4	180	922.9
1997	416	5848	10690	4579.3	2	176	963.5
1998	448	6093	11524	5005.7	1.9	188	657.9
1999	385	6347	10450	4102.9	1.4	167	876.3
2000	445	6564	10866	4302	1.5	170	907
2001	393	6255	9073	2818.3	1.9	139	896.8
2002	465	6625	11156	4530.7	2.3	164	972.3
2003	437	6845	10910	3399.6	3	160	1016
2004	470	7178	11545	4286.4	5.8	167	1666
2005	1167	8141	13914	5632.5	6.3	167	1956
2006	1390	8274	14094	5804.6	6.3	193	1863
2007	1377	7379	13290	5900.3	8	180	1769
2008	1600	7977	15358	4077.5	15.2	204	5159
2009	1605	8523	15456	3974.2	16.5	201	2190
2010	1872	7169	15107	9646.6	12.3	192	1977
2011	3276	8371	18182	9787.3	15.3	226	3884
2012	3157	8796	16564	6471.4	10.8	204	4358
2013	3275	9460	16678	6784.6	11	197	3753.9
2014	2832.6	9098.8	17147.7	7134.8	14.8	202.9	3961.7
2015	2994.7	9286	17565.9	7315.1	15.7	205	4169.4
Average	1373.7	7413.8	13383.7	5512.1	7.4	184	2131.89
Min	393	5725	9073	2818.3	1.4	139	850
Average%	71.4	22.8	32.2	48.9	81.1	24.5	60.1
Max	2994.7	9286.1	17565.9	9787.3	15.6	205	4169.4
average%	*117.99*	*25.3*	*31.3*	*77.6*	*110.9*	*11.4*	*95.6*

Sources: (6, 7, 8).

MT: metric tons

Table (2): Trend analyses equation of wheat wastes and other influencing factors in the period (1995-2015)

Independent variable	Estimated Equations	T	Period mean	R^2	Annual growth rate%
Wheat waste 1000MT	**y ^ = 409.3 +162.1 x**	**9.5**	**1373.7**	**0.82**	**11.8**
Production 1000MT	**y ^ = 5354.2+187.2 x**	**23.4**	**7413.8**	**0.89**	**2,52**
Consumption 1000MT	y ^ = 8738.3 +418.2 x	**10**	**13383.8**	**0.84**	**3.12**
Imports 1000MT	y ^ = 3528.9 +180.3 x	**3.3**	**5512.1**	**0.37**	**3.3**
Subsidies 1000million	y ^ = 1.63 +0.822 x	**8.8**	**7.4**	**0.89**	**11.2**
Per capita consumptionkg/year	y ^ = 160.9 +2.1 x	**3.7**	**184**	**0.42**	**1.13**
Return	y ^ = 33.8 +196.8 x	**9.2**	**2131.9**	**0.71**	**9.2**

Sources: Calculated from table (1)

5.2 -The relationship between wheat waste and each influencing factor in the period (1995-2015):

We used simple linear regression between wheat waste (y) as a dependent variable and the most important production and economic factors including wheat production, consumption, imports subsidies and net return per acre of wheat as independent variables (x). In table (3) the first equation indicates that by one unit increase of production there was 0.797 units increase in wheat waste with a coefficient of determination equal to 0.79 (F=70.3).The second equation indicates that with one unit increase in consumption there was 0.373 units of increase in wheat waste with a coefficient of determination of 0.91 (F=197.5).

Equation #3 indicates that with one unit increase in wheat imports there was an increase of waste estimated as 40.446 units with a coefficient of determination of 0.55 (F= 23.3).

Equation #4 indicates that with one unit increase in wheat subsidies there was an increase in wheat waste estimated as 163.7 units with a coefficient of determination of 0.7 (F=46.8).

Equation #5 indicates that with one unit increase in per capita of wheat there was an increase in wheat waste estimated as 43.9 with a coefficient of determination of 0.64(F=33) . Equation #6 indicates that with one unit increase in net return per acre there was an increase in wheat waste by 0.672 units with a coefficient of determination of 0.77 (F=62.6).

Table (3): Simple liner regression between wheat wastes and other influencing factors in the period (1995-2015).

Topic	Estimated Equations	T	R^2	F
Production &losses (1000MT)	**y ^ = 4538.1+0.797 x**	**8.4**	**0.79**	**70.3**
consumption &losses (1000MT)	**y ^ = 3621.9+0.373 x**	**14.1**	**0.91**	**197.5**
imports &losses (1000MT)	**y ^ = 1087.9 +40.446 x**	**4.8**	**0.55**	**23.3**
subsidies &losses	**y ^ = 159.4 +163.7 x**	**6.8**	**0.71**	**46.8**
Per capita wheat &losses	**y ^ = 6706.1 +43.9 x**	**5.8**	**0.64**	**33**
net return per acre/pound of wheat production	**y ^ = 58.9 +0.672 x**	**7.9**	**0.77**	**62.6**

Sources: Calculated from table (1)

5.3- Wheat waste and factors collectively affecting it in the period between 1995 and 2015:

We studied the relationship between wheat waste and factors collectively affecting it during the period between 1995 and 2015. The amount of wheat waste was assigned as a dependent variable (Yi) and other factors including amount of wheat production (X1i), amount of wheat consumption(X2i), amount of wheat and wheat flour imports (X3i), subsides of wheat and wheat flour (X4i), per capita wheat and wheat flour consumption (X5i) and net return per acre of wheat in Egyptian pounds (X6i). We used some models including multiple linear, log-log regression and stepwise regression to get the best fit of the results.

Table (4)shows that by the use of stepwise regression , the log-log regression was the best model which indicated that with 1% increase of production , imports and return there was a significant increase in wheat waste by 2.07 %, 0.043 and 0.499%, respectively ($p<0.01$). The results showed that 95% of these changes were due to these factors acting collectively.

Table 4: the most important factors affecting wheat losses in Egypt (1995-2015).

Topic	model	Equation	R2	F
Wheat waste	linear	Y^i = 3198.2+ 0.379 X1i + 0.219 X3i + 0.261 X6i (3.9)** (5.3)** (3.1)* *	0.94	92.4
	Log	Ln Y^i= 22.4 + 2.07 ln X1i + 0.043 ln X3i + 0.499 ln X6i (2.4)** (5.3)** (2.9)**	0.95	135.9

Yi=wheat loss in 1000 MT
X1i=wheat production in 1000 MT
X2i= wheat consumption in 1000 MT
X3i= wheat and wheat flour imports in 1000 MT
X4i = subsidies for wheat in 1000 million pounds
X5i= per capita wheat consumption, kg/year
X6i=net return per acre of wheat in pounds
i=duration (1995-2015)

**significant at<0.01,*significant at <0.05.Values between brackets are calculated t values.
Source: calculated from table (1)

5.4-A pilot study of wheat wastes:-

This study assumed that the local farmers apply all agriculture practices recommended by the Egyptian ministry of agriculture (9).We described these agricultural practices as follows:

5.4.1. Farming

Farming starts by servicing the land and determining the best timing for wheat cultivation between 15-30 November in northern Egypt and between 10-25 November in southern Egypt. It was evident that early or late cultivation of wheat would lead to a dramatic drop in wheat production by 25%.

5.4.2- Harvesting

The wheat crop matures after 160 to 180 days from planting depending on wheat cultivar and the prevailing Climatic conditions and land fertility. In southern Egypt wheat, harvesting begins in late April or early May while in northern Egypt it begins in late May or early June. The early signs of wheat maturation include the yellowing of leaves and stems with dryness of seeds. Harvesting of wheat is usually done manually or mechanically either before sunset or in the early morning to decrease the amount of wheat wastage.

5.4.3- Dryness of wheat crops:-

Wheat crop is dried by leaving the seeds under direct sunlight for 2-5 days. If the seeds are over exposed to sunlight for longer time the rate of wheat waste will increase.

5.4.4-Separtion of wheat seeds:

Wheat seeds are mechanically separated from stems leaving straw that is used as animals' fodder. During this operation wheat loss increases when laborers transfer wheat crops to the separating machine.

5.4.5 Packaging and storing wheat crops:

Packaging and storing wheat crops is an important stage in wheat harvesting process where wheat wastage experiences the least possible waste in this stage. Wheat is packaged in either polyethylene bags or cloth bags where the former is less expensive and the latter is less durable. The cloth bags made of Jute proved to be very effective standing bad weather for long time and allow for wheat aeration.

5.4.6-Transporting wheat crops:

This process aims to transfer wheat crops after packaging to the milling factories or to storage houses.

In this pilot study, we identified the relationship between wheat waste and other affecting factors. The amount of wheat waste was represented by (Y) variable in kilogram (dependent variable) where other factors including the cultivated area in acres (X1), the productivity per acre in kg (X2), the amount of wheat seedlings in kg (X3), and the agriculture practices as dummy variables (1= used, 0= non used). We assigned dummy variables as D1 for farming timing, D2 for methods of cultivation, D3 for timing of harvest and D4 for mechanical harvest. We identified the log-log regression and the linear regression as the best models producing the best fit. It was clear that by one unit increase in cultivated area there was an increase of wheat waste by 38.6 units. In case of wheat seedlings, it was clear that with one unit increase in wheat seedlings there was an increase in wheat wastage by 3.55 units. Meanwhile it was evident that there was a direct proportional relation between the best timing of cultivation (D1), mechanical harvesting (D4) with wheat waste (Table 5).

Table (5): The most important factors affecting wheat wastage in the pilot study(2014/2015).

Topic	model	Equation	R2	F
Wheat wastage	linear	Y^ = 123.6+ 38.6 X1 + 3.55 X3 + 38.4 D1+26.4 D4 (6.9)** (2.8)** (2.6)* * (2)*	0.64	20.6
	log	Ln Y^ = 116 + 0.374 ln X1 + 1.2 ln X3+ +0.384 D1 (3.1)** (2.5)** (3.99)**	0.61	17.7

In general, it was clear that among all the influencing factors wheat production, imports and net return per acre of wheat were the most significant influential factors on wheat waste during the period between 1995 and 2015. Our pilot study in Sharkya governorate indicated that to reduce wheat waste farmers had to select the best timing of cultivation and adopt the mechanical harvesting and seed separation technique. Good wheat cultivation timing along with the application of weed control and good water management scheme [10] have a potential positive effect on wheat yield. Other studies [11] concluded that other variables included farmers' awareness rate and education levels had the highest effect in reducing wheat crop losses.

Conclusion:

We can conclude that there was a significant positive relationship between the amount of wheat waste and factors like wheat production, wheat imports, wheat consumption, subsidies and net return per acre. Many other factors concluded in our pilot study like area cultivated, productivity per acre, and the amount of wheat seedlings, cultivation timing and mechanical harvesting influenced the amount of wheat waste with more influence to the latter two factors. Our study, therefore recommends the application of the best agricultural practices adopted by the Egyptian ministry of agriculture to decrease wheat waste.

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