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RESEARCH ARTICLE

Analysis of sorghum production costs in Egypt

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Abstract

Sorghum is an important crop in Egypt. This study analyze the costs of sorghum production in Egypt during the time period 2000-2019. The study employed the Cobb-Douglas production function to show the relationship between the sorghum production and the production inputs costs. During the time period 2000-2019, the mean of sorghum production is 821.92 thousand ton and the mean of sorghum area is 151.30 thousand hectare. In 2019, the highest production and the largest area at Fayoum governorate, while the lowest production and the lowest area at Giza governorate. The insecticides have the minimum value (26.02 L.E./Feddan) for the mean of production inputs costs, while the labor wages have the maximum value (833.99 L.E./Feddan) for the mean of production inputs costs. The results of the study indicate that labor wages and seeds cost are significant at the level of 5%. The study recommends improve the skills and training of labor.

Keywords: Costs; production; sorghum.

1. Introduction

Sorghum is one of the important crops in the world. It is considered the fourth cereal crops after maize, wheat and rice (MALR, 1995 as cited in Hassanein *et al.*, 2010). Sorghum is a staple food, nutrition and income security crop for many people. It is utilized as food, animal feed and industrial raw material. As food for human beings, the grain is used in making fermented and non-fermented traditional dishes as well as value added food products. In livestock sorghum is used as feed in form of forage, while the grains can be processed for poultry feeding. Industrially, the grain is used to manufacture wax, starch, syrup, dextrose agar, and edible oils. Sorghum is mainly grown in both semi-arid regions that experience limited rainfall and areas with adequate rainfall. Sorghum varieties are known to be highly resistant to drought conditions, can grow under relatively low soil fertility and can withstand water logging better than other cereal crops such as wheat and maize (MALFC, 2013). Most of the world's sorghum area lies in the developing countries, mainly in Africa and Asia (Deb *et al.*, 2004). In Egypt, sorghum is concentrated in the middle and upper parts (Hassanein *et al.*, 2010). The objective of this study is to analyze the costs of sorghum production in Egypt from 2000 to 2019, this period of time will allow to show the changes in costs of sorghum production.

2. Methodology

Regression shows the relationship between one independent variable (X_i) and a dependent variable (Y_i), $Y_i = \beta_0 + \beta_1 X_i + u_i$. The magnitude and direction of that relation are given by a parameter (β_1) and an intercept term (β_0). The error term (u_i) captures the amount of variation that is not predicted by the slope and

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intercept terms (Pepinsky and Tobin, 2003). The study employed the Cobb-Douglas production function to examine the input-output relationship. The Cobb-Douglas production function is simple functional form, convenient to use, reflects actual input-output relationship, and easy to estimate and interpret (Abu Samah and Suandi, 1999). In the case of sorghum production costs in Egypt, the Cobb-Douglas production function can be represented in the following logarithmic transformation form:

$$Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + u$$

Where Y is the costs of sorghum production in Egypt (2000-2019), X_1 is labor wages, X_2 is machinery cost, X_3 is seeds cost, X_4 is manure cost, X_5 is fertilizers cost, X_6 is insecticides cost, β is vector of parameter to be estimated, u is the error. The following hypotheses are formulated to test the relationship between the independent variable and the dependent variable:

$H_0 : \beta_i = 0$, indicating there is no impact from the independent variable on the dependent variable.

$H_1 : \beta_i \neq 0$, indicating the independent variable affect the dependent variable.

Decision on whether to reject or fail to reject the null hypothesis is based on the values of calculated t-statistic and the critical (t-table).

3. Results and discussion

The data of this study obtained from FAOSTAT and MALR. The data represents the production, area, yield, and inputs costs of sorghum in Egypt (2000-2019). Table (1) illustrates production, area, and yield of sorghum. The mean of sorghum production is 821.92 thousand ton,

Table 1. Production, Area, and Yield of Sorghum in Egypt (2000-2019).

Year	Production (Thousand Ton)	Area (Thousand Hectare)	Yield(Ton/Hectare)
2000	941.19	162.60	5.79
2001	862.30	148.76	5.80
2002	902.25	156.22	5.78
2003	959.10	167.23	5.74
2004	863.72	152.40	5.67
2005	853.00	152.00	5.61
2006	887.00	156.00	5.69
2007	843.84	148.66	5.68
2008	866.95	154.10	5.63
2009	780.95	141.25	5.53
2010	701.63	140.16	5.01
2011	839.20	156.99	5.35
2012	757.04	142.74	5.30
2013	761.63	141.63	5.38
2014	804.05	148.47	5.42
2015	720.29	150.20	4.80
2016	723.79	148.07	4.89
2017	807.38	152.17	5.31
2018	804.85	154.92	5.20
2019	758.36	151.38	5.01
Mean	821.92	151.30	5.43

Sources: FAOSTAT and own elaboration

the mean of sorghum area is 151.30 thousand hectare and the mean of sorghum yield is 5.43 ton/hectare in the period 2000-2019.

Table (2) illustrates sorghum production, area and yield in the main governorates. Fayoum governorate has the highest production (248.06 thousand ton) and the largest area (129.65 thousand Feddan), while Giza governorate has the lowest production (2.76 thousand ton) and the lowest area (1.16 thousand Feddan), in 2019.

Table (3) illustrates the total cost and production inputs costs of sorghum (L.E./Feddan) from 2000 to 2019. The mean of production inputs costs vary from a minimum value of 26.02 L.E./Feddan (insecticides) to a maximum value of 833.99 L.E./Feddan (labor wages).

Table 2. Production, Area and Yield of Sorghum in the Main Governorates in Egypt (2000-2019).

Governorate	Production (Thousand Ton)		Area (Thousand Feddan)		Yield (Ton/Feddan)	
	2000	2019	2000	2019	2000	2019
Giza	5.35	2.76	2.27	1.16	2.36	2.38
Beni Suef	24.17	13.03	10.55	5.61	2.29	2.32
Fayoum	157.07	248.06	75.57	129.65	2.08	1.91
Menia	21.53	33.85	9.90	17.45	2.17	1.94
Assuit	366.03	143.85	133.73	60.81	2.74	2.37
Suhag	303.40	211.61	125.27	92.82	2.42	2.28
Qena	50.77	83.10	22.85	37.84	2.22	2.20
Aswan	11.36	10.78	6.04	9.72	1.88	1.11
Luxor	0.34	7.53	0.18	3.12	1.90	2.41
New Valley	1.17	3.81	0.61	2.10	1.91	1.81
Mean	94.12	75.84	38.70	36.03	2.20	2.07

Sources: MALR and own elaboration

Table 3. Production Inputs Costs of Sorghum in Egypt (L.E./Feddan).

Year	Total Cost	Labor Wages	Machinery	Seeds Cost	Manure	Fertilizers	Insecticides
2000	1198	258	218	32	35	142	0.20
2001	1164	248	216	33	36	123	0.20
2002	1208	297	197	33	26	133	2
2003	1301	293	213	40	60	128	19
2004	1397	351	214	56	52	136	12
2005	1625	426	214	57	51	189	13
2006	1642	435	222	51	52	167	3
2007	1707	412	256	67	44	185	5
2008	2247	487	245	87	51	245	5
2009	2433	557	286	88	34	277	27
2010	2651	619	300	101	90	263	32
2011	2813	661	363	120	104	276	23
2012	2822	715	383	132	119	280	22
2013	3131	802	442	140	116	295	20
2014	3221	883	416	158	119	300	23
2015	3517	1071	373	191	118	326	24
2016	5203	1347	510	241	112	334	24
2017	6431	1997	668	309	141	456	108
2018	6944	2174	809	340	165	562	90
2019	7836	2647	898	374	323	642	68
Mean	3024.56	833.99	372.16	132.50	92.39	272.91	26.02

Sources: MALR and own elaboration

Table (4) illustrates the descriptive statistics for the variables (2000-2019). The sorghum production range from 701.63 thousand ton to 959.10 thousand ton. Labor wages are the highest cost among the other inputs costs (L.E./Feddan).

Table (5) illustrates the annual average percentage growth rate for the variables (2000-2019). There are a decreasing in the rate of production, area and yield by 1.13%, 0.38% and 0.76%, respectively. Insecticides cost has the highest rate among the other inputs costs (35.91%).

Table 4. Descriptive Statistics for the Variables (2000-2019).

Variable	Unit	Minimum	Maximum	Mean	Std. Dev.
Production	Thousand Ton	701.63	959.10	821.92	72.44
Area	Thousand Hectare	140.16	167.23	151.30	6.91
Yield	Ton/Hectare	4.80	5.80	5.43	0.32
Labor Wages	L.E./Feddan	247.60	2647	833.99	689.73
Machinery Cost	L.E./Feddan	197.00	898	372.16	205.17
Seeds Cost	L.E./Feddan	32.20	374	132.50	106.27
Manure Cost	L.E./Feddan	26.00	323	92.39	68.20
Fertilizers Cost	L.E./Feddan	122.60	642	272.91	142.75
Insecticides Cost	L.E./Feddan	0.20	108	26.02	29.41

Source: Own elaboration

Table 5. Annual Average Percentage Growth Rate for the Variables (2000-2019).

Variable	Rate
Production	-1.13%
Area	-0.38%
Yield	-0.76%
Labor Wages	13.03%
Machinery Cost	7.74%
Seeds Cost	13.78%
Manure Cost	12.37%
Fertilizers Cost	8.28%
Insecticides Cost	35.91%

Source: Own elaboration

Table (6) illustrates results of analysis for sorghum production inputs costs (2000-2019). R^2 = 0.994, this indicates that about 99.4% of the variance in the sorghum production costs is explained by the labor wages, machinery cost, seeds cost, manure cost, fertilizers cost, and insecticides cost. Durbin-Watson equal 2.288 at the level of significance 1%, this value is greater than the upper limit (1.918) conclude that there is no evidence of autocorrelation between the independent variables. The value of F-Statistic more than the value of F-tab conclude that the regression model fits the data at 1% level of significance and the inputs affect the sorghum production costs. The machinery cost, manure cost, fertilizers cost and insecticides cost are not significant, conclude that there is no impact from the machinery cost, manure cost, fertilizers cost and insecticides cost on the sorghum production costs, this may be due to that in the small farms, the farmer use the animals instead of machinery for the agricultural process, the farmer can get the manure from his farm and the fertilizers subsidized from the government, also some farmers apply the program of integrated pest management without the need to use insecticides. Labor wages and seeds cost are significant at 5%, the regression coefficient of labor wages equal 0.337 indicates that 1% increase in labor wages resulted in an increase in the sorghum production costs by 0.337% and the regression coefficient of seeds cost equal 0.273 indicates that 1% increase in seeds cost resulted in an increase in the sorghum production costs by 0.273%.

Table 6. Results of Analysis for Sorghum Production Inputs Costs in Egypt (2000-2019).

Variable	Coefficient	Std. Error	t-Statistic
Constant	2.392	0.382	6.257***
X_1	0.337	0.136	2.472**
X_2	0.216	0.136	1.595
X_3	0.273	0.110	2.489**
X_4	-0.064	0.053	-1.210
X_5	0.188	0.127	1.483
X_6	-0.002	0.014	-0.159

R^2 = 0.994
Durbin-Watson = 2.288
F-Statistic = 361.041 *Source: Own elaboration*
**** and ** indicates significance at 1% and 5% level, respectively.*

4. Conclusion

Sorghum is one of the important crops in the world. The goal of the study is to analyze the costs of sorghum production in Egypt from 2000 to 2019. The study used the regression as a statistical approach to show the relationship between the independent variables and the dependent variable. During 2000-2019, the mean of sorghum production is 821.92 thousand ton. In 2019, Fayoum governorate has the highest production (248.06 thousand ton) and the largest area (129.65 thousand Feddan). The results indicate that labor wages and seeds cost are significant at 5%. The study recommends improve the skills and training of labor, improve the technology and procedures of work, implement the land consolidation system, all of this will help to decrease the costs of sorghum production.

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Not applicable
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Not applicable.
Conflicts of Interest
No conflict of interest starting from the conduct of the study, data analysis, and writing until the publication of this research work.

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