Journal of Agricultural Economics and Social Sciences

Journal homepage & Available online at: www.jaess.ekb.eg

Data Envelopment Analysis for Chickpeas Production in Egypt

Elasraag, Y. H.* and Y. N. Ahmed

Department of Agricultural Economics, Faculty of Agriculture, Cairo University

ABSTRACT

The study uses Data Envelopment Analysis (DEA) through an output-oriented model and Constant Returns to Scale (CRS) to estimate the efficiency of chickpeas production in the Egyptian main governorates during 2006-2019. During the period of the study 2006-2019, the mean of production, area, and yield is 5390.36 ton, 6027.71 feddan, and 0.91 ton/feddan, respectively. Assuit has the highest production mean and the largest area mean, while Luxor has the lowest production mean and the lowest area mean. The minimum mean value of yield is 0.72 ton/feddan at Luxor, while the maximum mean value of yield is 1.14 ton/feddan at Menia. The results of the study indicate that the mean of efficiency for chickpeas production in the main governorates is 94.5%. The minimum value of efficiency is 0.876 at governorate of Aswan, while the maximum value of efficiency is 1.000 at governorate of Assuit. The study recommends implementing the system of land consolidation to increase the efficiency of chickpeas production in Egypt.

Keywords: Chickpeas, Constant Returns to Scale, DEA, Output-Oriented Model

INTRODUCTION

Chickpeas are a winter crop (DAFF, 2012) and a staple food in the Middle East and the Indian subcontinent. About 80% of the total dry seed weight of chickpeas are proteins and carbohydrates. The proteins of chickpea seed were found to be of higher nutritive value than those of other grain legumes. Chickpeas have a high protein digestibility and are richer in phosphorus and calcium than other pulses. Chickpeas meet adult human requirements for all essential amino acids except methionine and cysteine. Total seed carbohydrates vary from 52 to 71%. Crude fiber, an important constituent of chickpeas, is mostly located within the seed coat (GRDC, 2016).

Problem

Although the chickpeas is an important crop in Egypt, there is a decreasing in the production and area of chickpeas during the period of study (2006-2019).

Objective

The study aims to analyze the production, area and yield of chickpeas in Egypt during 2006-2019. The study also aims to estimate the technical efficiency of chickpeas production in the main governorates in the studied period.

METHODOLOGY

One of the methods used to assess efficiency is the nonparametric model or DEA (Farrell, 1957). Data Envelopment Analysis (DEA) models can be output-oriented (objective: increasing outputs with the same level of inputs) or input-oriented (objective: minimizing inputs while maintaining the same level of outputs) (Malana and Malano, 2006). The technical efficiency obtained in this way points out the capability of a "Decision Making Units" (DMU) to maximize produced outputs or minimize disposable inputs (Coelli et al., 2005). In this study the efficiency was estimated through an output-oriented model and Constant Returns to Scale (CRS).

(1) $$SE = \frac{TE}{PTE}$$

The output-oriented DEA model uses the following formulae (Zhu, 2009):

(2) $$Max\phi + \varepsilon\left[\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+\right]$$

(3) $$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{i0}, i = 1,2\ldots,m;\ j = 1,2\ldots,n;\ \lambda_j, s_i^- \geq 0$$

(4) $$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = \phi y_{r0}, r = 1,2\ldots,s;\ j = 1,2\ldots,n;\ \lambda_j, s_i^- \geq 0$$

Where: 'n' number of DMU; 'm' inputs; 's' outputs; a DMU_j consumes x_{ij} of input i and produces y_{rj} of output r; 'λ_j' the weights assigned by the linear program; 'ϕ' the calculated efficiency; 'ε' is a non-Archimedean element defined to be smaller than any positive real number.

Data

The data in this study obtained from the Ministry of Agriculture and Land Reclamation (MALR), Egypt. The data represents the production, area and yield of chickpeas in the main governorates during 2006-2019. To measure the technical efficiency for chickpeas production we used DEA program (Coelli, 1996). Table (1) shows the production, area and yield of chickpeas (2006-2019), while figure (1) shows the production and area of chickpeas in Egypt during the studied period. Table (2), (3), and (4) shows the production, area and yield of chickpeas in the main governorates during the time period 2006-2019.

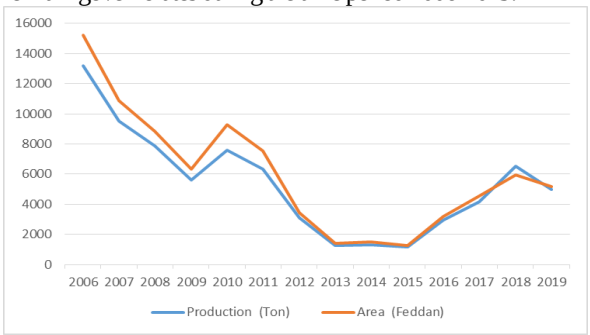

Figure 1. Production and Area of Chickpeas in Egypt (2006-2019).

Source: Own elaboration

* **Corresponding author.**
E-mail address: yahiah7@agr.cu.edu.eg
DOI: 10.21608/jaess.2023.185600.1136

Table 1. Production, Area and Yield of Chickpeas in Egypt (2006-2019).

Year	Production (Ton)	Area (Feddan)	Yield (Ton/Feddan)
2006	13172	15214	0.87
2007	9527	10859	0.88
2008	7866	8820	0.89
2009	5624	6335	0.89
2010	7581	9276	0.82
2011	6316	7537	0.84
2012	3106	3417	0.91
2013	1250	1382	0.90
2014	1323	1483	0.89
2015	1137	1267	0.90
2016	2943	3198	0.92
2017	4140	4524	0.92
2018	6520	5921	1.10
2019	4960	5155	0.96
Mean	5390.36	6027.71	0.91

Sources: MALR, Egypt and own elaboration

Table 2. Chickpeas Production (Ton) in the Main Governorates in Egypt (2006-2019).

Year	Beni Suef	Menia	Assuit	Luxor	Aswan
2006	97	1152	11315	60	45
2007	68	501	8051	5	83
2008	36	304	6949	-	49
2009	35	445	5003	28	56
2010	89	595	5812	60	974
2011	36	707	5438	77	46
2012	32	547	2505	1	5
2013	29	158	978	2	45
2014	73	241	911	13	70
2015	187	322	600	13	-
2016	431	1495	853	24	129
2017	1140	828	1981	8	178
2018	1795	3136	1357	36	192
2019	-	2993	485	26	-
Mean	311.38	958.86	3731.29	27.15	156

Sources: MALR, Egypt and own elaboration

Table 3. Chickpeas Area (Feddan) in the Main Governorates in Egypt (2006-2019).

Year	Beni Suef	Menia	Assuit	Luxor	Aswan
2006	125	1357	12994	70	59
2007	85	582	9048	6	109
2008	46	339	7757	-	65
2009	46	493	5600	35	79
2010	104	810	7279	81	946
2011	43	883	6424	111	61
2012	43	541	2807	1	6
2013	35	52	1097	3	50
2014	98	208	1021	19	121
2015	229	306	697	18	-
2016	489	1515	910	55	215
2017	1173	953	2080	14	296
2018	1709	2269	1556	61	320
2019	-	2066	539	36	-
Mean	325	883.86	4272.07	39.23	193.92

Sources: MALR, Egypt and own elaboration

Table 4. Chickpeas Yield (Ton/Feddan) in the Main Governorates in Egypt (2006-2019).

Year	Beni Suef	Menia	Assuit	Luxor	Aswan
2006	0.78	0.85	0.87	0.86	0.76
2007	0.80	0.86	0.89	0.83	0.76
2008	0.78	0.90	0.90	-	0.75
2009	0.76	0.90	0.89	0.80	0.71
2010	0.86	0.73	0.80	0.74	1.03
2011	0.84	0.80	0.85	0.69	0.75
2012	0.74	1.01	0.89	1.00	0.83
2013	0.83	3.04	0.89	0.67	0.90
2014	0.74	1.16	0.89	0.68	0.58
2015	0.82	1.05	0.86	0.72	-
2016	0.88	0.99	0.94	0.44	0.60
2017	0.97	0.87	0.95	0.57	0.60
2018	1.05	1.38	0.87	0.59	0.60
2019	-	1.45	0.90	0.72	-
Mean	0.83	1.14	0.89	0.72	0.74

Sources: MALR, Egypt and own elaboration

RESULTS AND DISCUSSION

Table (5) shows the descriptive statistics for production, area and yield of chickpeas in Egypt (2006-2019). The minimum value of production is 1137 ton in 2015, while the maximum value of production is 13172 ton in 2006. The mean of production for the period 2006-2019 is 5390.36 ton. The minimum value of area is 1267 feddan in 2015, while the maximum value of area is 15214 feddan in 2006. The mean of area for 2006-2019 is 6027.71 feddan. The minimum value of yield is 0.82 ton/feddan in 2010, while the maximum value of yield is 1.10 ton/feddan in 2018. The mean of yield for 2006-2019 is 0.91 ton/feddan.

Table 5. Descriptive Statistics for Production, Area and Yield of Chickpeas in Egypt (2006-2019).

Variable	Unit	Minimum	Maximum	Mean
Production	Ton	1137	13172	5390.36
Area	Feddan	1267	15214	6027.71
Yield	Ton/Feddan	0.82	1.10	0.91

Source: Own elaboration

Table (6) shows the descriptive statistics for production, area and yield of chickpeas in the main governorates in Egypt (2006-2019). The minimum value of production is 1 ton at Luxor governorate in 2012, while the maximum value of production is 11315 ton at Assuit governorate in 2006. The minimum value of area is 1 feddan at Luxor governorate in 2012, while the maximum value of area is 12994 feddan at Assuit governorate in 2006. The minimum value of yield is 0.44 ton/feddan at Luxor governorate in 2016, while the maximum value of yield is 3.04 ton/feddan at Menia governorate in 2013.

Table 6. Descriptive Statistics for Production, Area and Yield of Chickpeas in the Main Governorates in Egypt (2006-2019)

	Production (Ton)			Area (Feddan)			Yield (Ton/Feddan)		
Governorate	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Beni Suef	29	1795	311.38	35	1709	325.00	0.74	1.05	0.83
Menia	158	3136	958.86	52	2269	883.86	0.73	3.04	1.14
Assuit	485	11315	3731.29	539	12994	4272.07	0.80	0.95	0.89
Luxor	1	77	27.15	1	111	39.23	0.44	1.00	0.72
Aswan	5	974	156.00	6	946	193.92	0.58	1.03	0.74

Source: Own elaboration

Table (7) shows the time trend equations for production, area and yield of chickpeas in Egypt (2006-2019). The time trend equations $Y_i = \beta_0 + \beta_1 t_i$, where: Y_i is the dependent variable, β_0 is the constant, t is the time variable, β_1 is a vector of parameter to be estimated. The time trend

equations for production, area, and yield are significant. The time trend equations for production and area illustrates a negative relationship with the time as the production and area of chickpeas decreasing in the studied period. The time trend equation for yield illustrates a positive relationship with the time as the yield increasing during the period of study.

Table 7. Time Trend Equations for Production, Area and Yield of Chickpeas in Egypt (2006-2019).

Variable	Time Trend Equation	F	R^2	t-Statistic
Production	$Y_i = 8.96 - 0.09\,t_i$	3.96	0.25	-1.99*
Area	$Y_i = 9.13 - 0.10\,t_i$	5.21	0.30	-2.28**
Yield	$Y_i = -0.17 + 0.01\,t_i$	9.39	0.44	3.06***

Source: Own elaboration

*****, **, and * indicates significance at 1%, 5%, and 10% respectively**

Table (8) shows the technical efficiency (TE) for chickpeas production in the main governorates (2006-2019). The minimum value of TE is 0.876 at Aswan, while the maximum value of TE is 1.000 at Assuit (figure 2). The technical efficiency of Luxor in the second level because technical efficiency shows the ability of the firm (governorate) to produce the maximum output from its resources. The technical efficiency of Menia in the third level, while Beni Suef in the fourth level.

Table 8. TE for Chickpeas Production in the Main Governorates in Egypt (2006-2019).

Governorate	TE
Beni Suef	0.891
Menia	0.975
Assuit	1.000
Luxor	0.984
Aswan	0.876
Mean	0.945

Source: Own elaboration

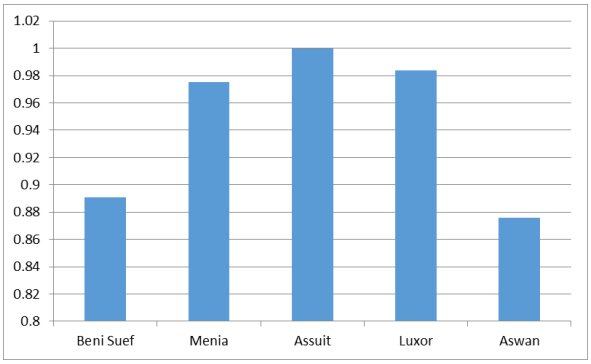

Figure 2. TE for Chickpeas Production in the Main Governorates in Egypt (2006-2019).

Source: Own elaboration

CONCLUSION

Chickpeas are a good source of proteins and carbohydrates. Chickpeas are a staple food in the Middle East and the Indian subcontinent. The objective of this study is to estimate the technical efficiency for chickpeas production in the main governorates in Egypt during 2006-2019. The study used DEA approach. During 2006-2019, the mean of production, area, and yield is 5390.36 ton, 6027.71 feddan, and 0.91 ton/feddan, respectively. Assuit governorate has the highest production mean (3731.29 ton), while Luxor governorate has the lowest production mean (27.15 ton). The results indicate that TE of chickpeas production (2006-2019), vary from a minimum value of 0.876 at Aswan and a maximum value of 1.000 at Assuit.

RECOMMENDATION

The study recommends implementing the land consolidation system and increase the chickpeas area through reclamation of new land.

REFERENCES

Coelli, T.J. (1996). A guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program. CEPA Working Paper, No. 8/96, Centre for Efficiency and Productivity Analysis, University of New England, Armidale, Australia.

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J., Battese, G.E. (2005). An Introduction to Efficiency and Productivity Analysis. 2nd Edition, Springer Science and Business Media, New York.

DAFF (2012) Chickpea-overview. Department of Agriculture Fisheries and Forestry, Queensland.

Farrell, M.J. (1957). The measurement of productive efficiency of production. *Journal of the Royal Statistical Society*, Series A, 120: 253-281.

GRDC (2016). Chickpeas. Grow Notes, Grains Research and Development Corporation.

Malana, N.M., Malano H.M. (2006). Benchmarking productive efficiency of selected wheat areas in Pakistan and India using data envelopment analysis. *Irrigation and Drainage* 55: 383-394.

MALR (2006-2019). Agricultural Statistics. Economic Affairs Sector, Ministry of Agriculture and Land Reclamation, Egypt.

Zhu, J. (2009). Quantitative Models for Performance Evaluation and Benchmarking- Data Envelopment Analysis with Spreadsheets. 2nd Edition, Springer.

تحليل مغلف البيانات لإنتاج الحمص في مصر

يحيي حامد الاسرج و يسري نصر أحمد

قسم الإقتصاد الزراعي، كلية زراعة، جامعة القاهرة

الملخص

يعتبرالحمص مصدر جيد للكربوهيدرات والبروتينات، التي تشكل معا حوالي 80٪ من مجموع وزن البذرة الجافة. تهدف الدراسة إلى تحليل الإنتاج والمساحة والإنتاجية لمحصول الحمص في مصر خلال الفترة 2006-2019، ايضا تهدف الدراسة إلى تقدير الكفاءة الفنية لإنتاج الحمص في المحافظات الرئيسية في مصر خلال فترة الدراسة. تشير النتائج إلى أن الكفاءة الفنية لإنتاج الحمص في المحافظات الرئيسية في مصر خلال الفترة الزمنية 2006-2019 تتراوح من حد أدنى 0.876 في محافظة أسوان و حد أقصى 1.000 في محافظة أسيوط.

الكلمات الدالة: الحمص، العوائد الثابتة للسعة، تحليل مغلف البيانات، نموذج الناتج الموجة