Measuring Efficiency of Egyptian Lentil Production

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ABSTRACT

The study estimates the efficiency of lentil production in the Egyptian main governorates at 2006-2015. The study uses the nonparametric approach. The results indicate that the efficiency of lentil production in the main governorates in Egypt at 2006-2015 vary from a minimum value of 0.619 to a maximum value of 1.000.

INTRODUCTION

In many parts of the world, lentil forms an essential part of regular diet notably in the Indian subcontinent where vegetarian diets are common and fresh meat is expensive. Lentil is a good source of iron and lower in fat than chickpea. With approximately one-quarter of its calorific value coming from protein content, lentil is third only to soybeans and hemp in its level of protein by weight. Lentil has a shorter cooking time than other pulses and is mostly used for human consumption (Centre State Exports, 2016). Compared to other pulse crops, such as pea and faba bean, lentil usually commands a premium price, with many world markets demanding lentil graded for human consumption (Pulse Australia, 2016). Lentil prices can be volatile due to fluctuating production world-wide. Lentil prices are often higher than most other pulses (faba bean, lupin and field pea). Lentil that fails to meet human consumption grade may suffer a significant price drop due to potential lack of livestock feed markets (GRDC, 2017; Pulse Australia, 2015).

Problem and Objective

The production of lentil in Egypt is low during 2006-2015. This study aims to estimate the technical efficiency (TE) for lentil production in the main governorates during 2006-2015.

Methodology

One of the methods used to assess efficiency is the nonparametric model or the Data Envelopment Analysis (DEA) (Farrell, 1957). This mathematical optimization model generates a hypothetical function of production (frontier of production) and the distance to the frontier permits the determination of the technical efficiency indicators. The DEA models can be output-oriented or input-oriented (Malana and Malano, 2006). The technical efficiency obtained in this way points out the capability of a DMU to maximize produced outputs or minimize disposable inputs (Coelli et al., 2005). Because each Decision Making Units (DMU) uses a variable quantity of inputs to produce different levels of output, the method compares each Decision Making Units with the most efficient DMU. In the paper the efficiency was estimated through an output-oriented model.

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

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

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

$$(3)$$

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

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

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. In this study, the input is the lentil area, while the output is the lentil production. Lentil production has been estimated in ton and lentil area has been estimated in feddan. In the following part the Annual average percentage growth rate represented by the abbreviation of AAPGR.

Data and Analysis

Table (1) and figure (1, 2) show lentil in Egypt (production, area and yield) at 2006-2015. The lowest production is 719 ton in 2012, while the highest production is 2178 ton in 2010. The average of production at 2006-2015 is 1302.70 ton and the rate is 0.04%. The lowest area is 807 feddan in 2012, while the highest area is 3285 feddan in 2010. The average of area at 2006-2015 is 1666.30 feddan and the rate is declining -0.43%. The lowest yield is 0.66 ton/feddan in 2010 while the highest yield is 0.89 ton/feddan in 2012. The average of yield at 2006-2015 is 0.81 ton/feddan and the rate is 0.48%.

Table 1. Lentil in Egypt: Production, Area and Yield (2006-2015).

Year	Production (Ton)	Area (Feddan)	Yield (Ton/Feddan)
2006	1245	1515	0.82
2007	1537	1875	0.82
2008	1241	1456	0.85
2009	1484	1908	0.78
2010	2178	3285	0.66
2011	1795	2523	0.71
2012	719	807	0.89
2013	735	862	0.85
2014	843	975	0.87
2015	1250	1457	0.86
Average	1302.70	1666.30	0.81
Rate[a]	0.04	-0.43	0.48

Sources: Ministry of Agriculture and Land Reclamation in Egypt, and researcher preparation
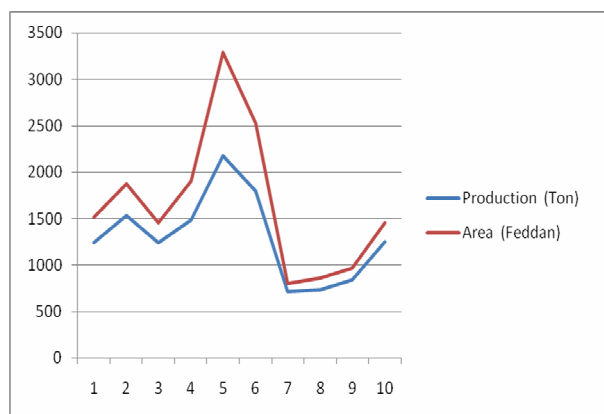**(a) AAPGR (2006-2015)**

Figure 1. Lentil in Egypt: Production and Area (2006-2015).
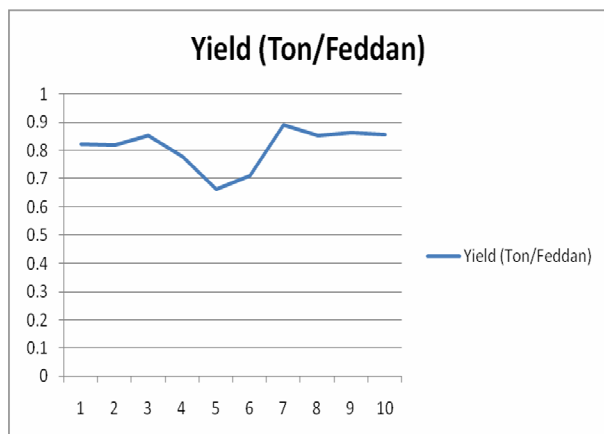Source: Researcher preparation

Figure 2. Yield of Lentil in Egypt (2006-2015).
Source: Researcher preparation

Table (2) and figure (3) show the production of lentil in the main governorates in Egypt at 2006-2015. In 2006 the lowest production is 3 ton in Dakahlia, while the highest production is 838 ton in Assuit. In 2015 the lowest production is 23 ton in Qena, while the highest production is 488 ton in Sharkia.

Table 2. Lentil Production (Ton) in the Main Governorates in Egypt (2006-2015).

Year	Dakahlia	Sharkia	Assuit	Qena	Damietta
2006	3	391	838	8	-
2007	3	509	1003	-	7
2008	25	449	652	105	4
2009	62	453	840	97	13
2010	136	738	1209	17	20
2011	104	554	1013	17	14
2012	48	329	267	16	40
2013	32	216	423	1	43
2014	129	292	317	1	98
2015	336	488	238	23	138
Average	87.80	441.90	680.00	28.50	37.70
Rate[a]	68.92	2.49	-13.05	12.45	45.16[b]

Sources: Ministry of Agriculture and Land Reclamation in Egypt, and researcher preparation
(a) AAPGR (2006-2015), (b) AAPGR (2007-2015)

Table (3) shows the area of lentil in the main governorates in Egypt at 2006-2015. In 2006 the lowest area is 4 feddan in Dakahlia, while the highest area is 32

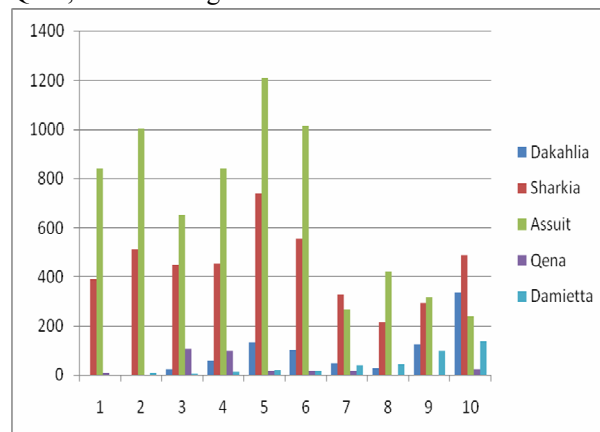feddan in Assuit. In 2015 the lowest area is 32 feddan in Qena, while the highest area is 535 feddan in Sharkia.

Figure 3. Lentil Production (Ton) in the Main Governorates in Egypt (2006-2015).
Source: Researcher preparation

Table 3. Lentil Area (Feddan) in the Egyptian Main Governorates (2006-2015).

Year	Dakahlia	Sharkia	Assuit	Qena	Damietta
2006	4	363	1129	12	-
2007	3	516	1314	-	8
2008	40	451	806	146	5
2009	77	471	1166	134	25
2010	183	1144	1809	24	37
2011	160	689	1491	25	15
2012	61	322	325	23	43
2013	40	214	516	2	44
2014	165	302	405	1	92
2015	429	535	296	32	129
Average	116.20	500.70	925.70	39.90	39.80
Rate[a]	68.11	4.40	-13.82	11.51	41.56[b]

Sources: Ministry of Agriculture and Land Reclamation in Egypt, and researcher preparation
(a) AAPGR (2006-2015), (b) AAPGR (2007-2015)

Table (4) shows the yield of lentil in the Egyptian main governorates at 2006-2015. In 2006 the lowest yield is 1.08 ton/feddan in Sharkia, while the highest yield is 0.67 ton/feddan in Qena. In 2015 the lowest yield is 0.72 ton/feddan in Qena, while the highest yield is 1.07 ton/feddan in Damietta.

Table 4. Lentil Yield (Ton/Feddan) in the Main Governorates in Egypt (2006-2015).

Year	Dakahlia	Sharkia	Assuit	Qena	Damietta
2006	0.75	1.08	0.74	0.67	-
2007	1.00	0.99	0.76	-	0.88
2008	0.63	1.00	0.81	0.72	0.80
2009	0.81	0.96	0.72	0.72	0.52
2010	0.74	0.65	0.67	0.71	0.54
2011	0.65	0.80	0.68	0.68	0.93
2012	0.79	1.02	0.82	0.70	0.93
2013	0.80	1.01	0.82	0.50	0.98
2014	0.78	0.97	0.78	1.00	1.07
2015	0.78	0.91	0.80	0.72	1.07
Average	0.77	0.94	0.76	0.64	0.77
Rate[a]	0.48	-1.83	0.89	0.84	2.54[b]

Sources: Ministry of Agriculture and Land Reclamation in Egypt, and researcher preparation
(a) AAPGR (2006-2015), (b) AAPGR (2007-2015)

Table (5) and figure (4) show the TE of lentil production in the Egyptian main governorates at 2006-2015. The lowest TE is 0.619 at the governorates of Qena and Damietta, while the highest TE is 1.000 at the governorate of Sharkia.

Table 5. TE of Lentil Production in the Main Governorates in Egypt (2006-2015).

Governorate	TE
Dakahlia	0.696
Sharkia	1.000
Assuit	0.689
Qena	0.619
Damietta	0.619
Average	0.725

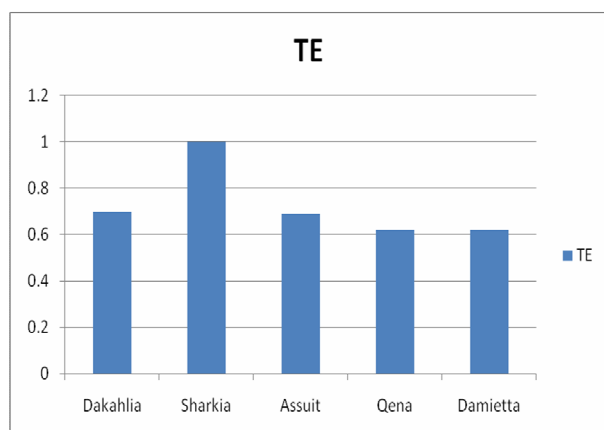**Source: Researcher preparation**

Figure 4. TE of Lentil Production in the Main Governorates in Egypt (2006-2015).
Source: Researcher preparation

CONCLUSION AND RECOMMENDATION

Lentil has a shorter cooking time than other pulses and it is a good source of iron. This study aims to estimate the technical efficiency for lentil production in the main governorates in Egypt during the time period 2006-2015. The study used the nonparametric approach. For 2006-2015, the average of production is 1302.70 ton and AAPGR is 0.04%. The average of area is 1666.30 feddan and AAPGR is declining -0.43%. The average of yield is 0.81 ton/feddan and AAPGR 0.48%. In 2015, lowest production is 23 ton in Qena, while the highest production is 488 ton in Sharkia. The results indicate that the technical efficiency of lentil production in the main governorates in Egypt at 2006-2015 vary from a lowest value of 0.619 at the governorates of Qena and Damietta and a highest value of 1.000 at the governorate of Sharkia. The study recommends implementing the land consolidation system this will increase the efficiency of lentil production, increase the lentil production through the using of new varieties with higher productivity, and increase the lentil area through the reclamation of new land.

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قياس كفاءة إنتاج العدس في مصر
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العدس من المحاصيل البقولية الهامة و يعتبر مصدر جيد للحديد وله وقت طهي أقصر من البقول الأخرى. تهدف هذه الدراسة إلى تقدير الكفاءة الفنية لإنتاج العدس في المحافظات الرئيسية في مصر خلال الفترة 2006-2015. بالنسبة للفترة الزمنية 2006-2015، بلغ متوسط الإنتاج 1302.70 طن، و معدل النمو السنوي السنوي 0.04%. متوسط المساحة 1666.30 فدان، و معدل النمو السنوي ينخفض بنسبة -0.43%. متوسط الانتاجية 0.81 طن/فدان ومعدل النمو السنوي 0.48%. في عام 2015، بلغت القيمة الدنيا للإنتاج 23 طنا في قنا، بينما بلغت القيمة القصوى للإنتاج 488 طنا في الشرقية. تشير النتائج إلى أن الكفاءة الفنية لإنتاج العدس في المحافظات الرئيسية في مصر خلال الفترة الزمنية 2006-2015 تتتراوح من حد أدنى 0.619 في محافظتي قنا ودمياط و حد أقصى 1.000 في محافظة الشرقية. توصي الدراسة بتطبيق نظام التجميع الحيازي مما يزيد من كفاءة إنتاج العدس، زيادة إنتاج العدس من خلال استخدام أصناف جديدة ذات إنتاجية أعلى، زيادة مساحة العدس من خلال استصلاح الأراضي الجديدة.

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