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ECONOMIC EFFICIENCY OF GREEN BEAN PRODUCTION

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Abstract

Green beans is the second vegetable export crop in Egypt, exporting about 24 thousand ton, acre revenue is about 5321 pounds for average period (2011-2015). The research aims at determining influencing factors on production of green beans using different irrigation methods and modern technologies in order to determine effect of each of these factors on production and to show production and economic efficiency of producers and to study indicators that show efficiency of production process using these methods, a random sample of 100 producers were chosen of green bean crop farmers in El-Beheira Governorate using different irrigation methods during 2016. The results of production functions of green beans showed that most important factors are quantity of seeds, quantity of human labor, quantity of nitrates and quantity of irrigation water. economic and productive efficiency confirmed that water component is element with value of marginal product is greater than price of resource in case of spray irrigation and irrigation in modern lining, superiority and efficiency of phosphate fertilizer element in case of flooding irrigation, identify preference and efficiency of green bean producers and users of spray irrigation where average production is estimated to be 4728 kg / acre, cost of tone is lower for spray irrigation users and increased acre revenue is estimated at 16056 pounds while return on cost for spray irrigation users is about 1.44 pounds. As for return of water unit, it amounts to about 13.63 pounds for bean producers who use spray irrigation, while it is estimated at 9.57, 8.96 pounds for users of lining irrigation and flooding irrigation. The study recommends attempt to rationalize use of irrigation water and adoption of modern methods with use of improved seeds give high productivity for its importance in vertical expansion and return to nature has a good impact on production using municipal fertilizer resulting from use of rice straw in new land so as not to transfer soil diseases from old lands, with interest in human element in modernizing its skills in modern organic agriculture to increase exports of green beans and other Egyptian agricultural exports.

***Keywords*:** Green beans, Economic Efficiency, spray irrigation, irrigation methods, modern technologies, marginal output value.

Introduction

The study of vegetable crops production, the most important of which are green beans, is important in order to determine extent to which production can be covered by local needs, and possibility of achieving a surplus that allows export to abroad, as well as increase amount destined for industrialization. Vegetable crops are characterized by ugly nature that makes them perishable, damaged, and impact of various weather conditions and difficult to bear for transport and handling, resulting in higher losses, especially during peak periods of production, and increasing supply of demand leads to lower prices. Then, revenue is reducing and incomes of producers are decreasing, which are making them reluctant to produce these crops. Green beans are grown in Egypt in an area of about 64.4 thousand acres, giving a production of about 268 thousand tons. Green beans are second export vegetable crop in Egypt, exporting about 24 thousand tons. The acres revenue is about 5321 pounds for average period (2011-2015).

Problem of research is that although green beans are considered second export crop in Egypt, it did not find enough attention to improve productive efficiency of producers and did not care about production elements that entered and affected on production which increased their prices a lot during this period, especially after float of Egyptian pound. As well as water component currently scarce in Egyptian conditions and difficulty of using modern technologies may negatively affect on production process.

Materials and Methods

Research aims at determining influencing factors on production of green beans using different irrigation methods and modern technologies in order to determine effect of each of these factors on production and to show production and economic efficiency of producers and to study indicators that show efficiency of production process using these methods. Research depends on descriptive and quantitative analysis using some different measures such as relative importance and averages use simple regression analysis, stepwise regression in more than one mathematical form, such as linearity and double logarithms, to determine which images its results are consistent with economic and statistical logic. The research consisted mainly of statistical data published and unpublished data from various sources such as Ministry of Agriculture in addition to a random sample of 100 producers of green bean crop in El-Beheira Governorate using different irrigation methods during 2016.

The sample was distributed in El-Beheira Governorate (Abu Homs center) on three areas, one of which is irrigated with spray and includes two villages (Elisha and Adam), and second includes village (Zawyet Naim), a village that applied a system of lining canals and drivers which is modern way to rationalize water, In addition to area of Taybeh, third region, which is irrigated by flooding, and collected forms of 100 producers in a simple random method from number of holders at about 5134 holders to be 22 producers of green beans from Adam and about 32 producers from Elisha, that is spray irrigation with 54 producers, and then 26 producers from village of Zawyet Naim, who are using modern lined irrigation, while about 20 producers are using flooded irrigation from Taybeh.

Table 1 : Distribution of study sample for green bean producers in El-Beheira Governorate

Items	Number of holders	Area / acre	Holders %	Area %	Holders x area %	rate engineering	Engineering average	Sample size	Type irrigation
Adam	980	3385	19.08	24.27	463	21.55	22.40	22	spray irrigation
Elisha	1147	5737	22.3	41.13	918.9	30.31	31.55	32	spray irrigation
Zawyet naim	1987	2300	38.7	16.41	638.2	25.26	26.29	26	lined
Taybah	1020	2525	19.8	18.1	359.61	18.96	19.74	20	flooded
Total	5134	1394	100	100	10000	96.06	100	100	

Source: collected and calculated from data of Agriculture Directorate, El-Beheira Governorate

Results and Discussion

Development of green beans cultivation and factors influencing on production: Study of area planted with green beans during period (2000 - 2015) shows in Table (**2**) that it was at beginning of period about 52 thousand acres in 2000, while at end of period about 67 thousand acres in 2015 and increase of 15 thousand acres representing about 29% for beginning of period, estimating equation of general time trend of cultivated area during period of study (2000-2015) shows annual statistical significance increase estimated at 0.943 thousand acres representing about 1.57% of average area estimated at 60 thousand acres, determination coefficient estimated at 0.33, value of (F) was calculated 6.9, as can be seen from equation (1) in Table (1).

Table 2 : Evolution of agriculture and production for green bean and affecting factors on production

Years	Area thousand acre	Productivity tone/acre	Production thousand/acre	Costs pounds/acre	Farm price pounds/tone	Revenue pounds/acre	Profit pounds/acre
2000	52	3.88	202	1346	1180	4578	3232
2001	51	4.22	215	1484	944	3984	2500
2002	55	4.25	234	1417	877	3727	2310
2003	65	4.33	281	1435	804	3481	2046
2004	51	4.9	250	1650	882	4322	2672
2005	52	4.73	246	1795	763	3609	1814
2006	52	5.0	260	1954	930	4650	2696
2007	73	4.52	330	2080	1556	7033	4953
2008	56	4.41	247	3316	1472	6492	3176
2009	67	4.2	282	3069	1404	5897	2828
2010	63	4.3	271	3807	1600	6880	3073
2011	71	4.3	306	3967	2133	9172	5205
2012	58	4.34	272	4272	2303	9995	5723
2013	57	4.5	258	4403	2378	10701	6298
2014	69	4.5	311	4843	2415	10868	6025
2015	67	4.5	301	7759	2465	11113	3353
average	59.9	4.4	265.4	3037.3	1506.6	6656.3	3619.0

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, agricultural economy publications, miscellaneous numbers

As for acre productivity of green beans during study period (2000 - 2015), Table (**2**) shows that at beginning of period it reached 3.9 tons / acre in 2000, while at end of period it is 4.5 tons / acres in 2015, increase is 0.6 tons / acre representing about 16.2% from beginning of period. Estimating equation of general trend of acre productivity during period of study is not clear statistical morale. As for total production data of green beans during period (2000 - 2015), Table (2) shows that at beginning of period it reached about 202 thousand tons in 2000, while at end of period it will reach about 301 thousand tons in 2015. The increase is 99 thousand acres representing about 49% for beginning of period. estimate equation of general time trend for total production during study period (2000-2015) shows an annual statistical significance increase estimated at 4.8 thousand tons representing about 1.79%, average of total production estimated at 265 thousand tons, determination coefficient about at 0.42 and was calculated value (F) about 10, as shown in equation (3) in Table (3).

Data of acre cost for green bean crop in Table (2) shows that it reached 1346 pounds in beginning of period in 2000; it reached in end of period 7759.3 pounds in 2015. The increase amounted to 6416 pounds representing about 477% from beginning of period. In estimating general time trend equation of acre cost during study period (2000-2015), it is clear that annual statistical significance increase estimated at 337 pounds represents about 11.1% from average of acre cost estimated at 3037 pounds, determination coefficient was 0.83 and value of (F) is about 68.3 as shown in equation (4) in Table (3).

As farm prices for green bean, it was found that at beginning of period it reached about 1180 pounds in 2000, while at end of period it is about 2465 pounds in 2015 and increase is 1285 pounds representing about 109% from beginning of period, in estimating general time trend equation for farm price during study period (2000-2015), annual statistical significance increase is estimated at 122 pounds representing 8.1% of average farm price estimated at 1507 pounds, coefficient of determination was 0.82, and value of (F) calculated about 63 as shown in equation (5) in Table (3).

In study of total revenue for green beans it was found that at beginning of period about 4567 pounds in 2000, while at end of period about 10841 pounds in 2015, increase is

6263 pounds representing about 137% from beginning of period, By estimating general time trend of total revenue of green beans during study period (2000-2015), annual statistical significance increase is estimated at 553 pounds representing about 8.3% of average revenue estimated at 6656 pounds, coefficient of determination was 0.86 and value of (F) calculated about 86 as shown in equation (6) in Table (3).

It was also found that net revenue of green beans reached 3232.4 pounds in beginning of period in 2000, reaching 3353 pounds in end of period in 2015, increase is 120.6 pounds representing about 3.7% for beginning of period, estimating equation of general time trend of farm price during study period (2000 - 2015) shows annual statistical significance increase estimated at 217 pounds representing about 5.9% of average net return estimated at 3619 pounds, coefficient of determination was 0.48 and value of (F) calculated to about 3.6 as shown in equation (7) in Table (3).

Table 3 : Equations of general time trend for development of production, costs, revenue and profit of green beans in period (2000-2015)

Items	A	B^	Average	(T)	R^2	(F)	Change rate %
Area cultivated (thousand acres)	51.9	.943	60	(7)**	0.33	6.9	1.57
Acres productivity (tons)	4.3	0.01	4.43	(0.67)	0.03	0.46	0.23
Total production (thousand tons)	225	4.8	265	(3.2)**	0.42	10	1.8
Acre costs (LE)	174	337	3037	(8.3)**	0.83	68.3	11.1
Farm price (pound/ton)	473	122	1507	(7.9)**	0.82	63	8.1
Acre revenue (LE)	1952	.553	6656	(9.3)**	0.86	9.3	8.3
Net acre profit (LE)	1779	217	3619	(3.6)**	0.48	3.6	5.9

Source: compiled and calculated from data of table (1) in appendix, (**) moral at level of 0.01, (*) moral at level of 0.05

Functions of green bean production in study sample: Correlation matrix between factors affecting on production was used to indicate existence of problems in estimation or not, following are most important factors in productive function of green beans in different irrigation methods, namely irrigation by lined and irrigation using modern irrigation systems that guide and reduce waste, which is process of lining canals and drivers, spray irrigation. It is clear from equations that dependent variable is amount of production from green beans per ton (Y), and independent factors are quantity of seedling (kg) (X_1), amount of municipal fertilizer per m^3 (X_2), amount of human working (man/day/work) (X_3), quantity of machine working per hour (X_4), quantity of nitrates in effective unit (X_5), quantity of phosphate in active unit (X_6), value of pesticides in pounds (X_7), and amount of consumed water in agriculture per m^3 (X_8). This has been used in some mathematical models, and function was estimated in linear form and double logarithm using Multiple Regression Analysis then use Stepwise Regression Analysis, In order to reach most important factors affecting on amount of green beans production and best images and results correspond with economic and statistical logic.

By studying relationship between production of green beans using method of irrigation by flooding and factors that are supposed to influence, as shown in Table (4), which shows results of estimation for preference of double logarithmic model where statistical significance of elasticity of seeds elements and quantities of nitrogen fertilizer and phosphate fertilizer, on basis of availability of method of lower squares conditions in estimate, increase of seeds by 1% with stability of other elements, but lead to increase quantity of green beans, a significant increase of about 0.279%, as for amount of nitrogen fertilizers, increase of 1% to increase quantity produced a significant increase of about 0.294%, Therefore, for amount of phosphate fertilizer, increase of 1% to increase amount of output, a significant increase of about 0.564%. The total elasticity confirms that by increasing previous combined elements by 1%, resulting production quantity increased by 1.137%, which means that producers used for flooding irrigation are produced in non-economic stage. The value of coefficient of determination (R^2) is about 0.80, meaning that previous elements responsible for interpretation of about 80% from total change in production of green beans, significance of model was confirmed as value of (F) calculated by 26.3, which confirms significance of model.

For production of beans with lining of canals and drivers, statistical significance for elasticity of human labor quantity element, amount of nitrogen fertilizer and quantity of irrigation water were determined. Under conditions of lower squares method, increase in human labor by 1%, but lead to increase quantity produced a significant increase of about 0.197%, while nitrates fertilizer, increase of component by 1% with stability of other elements on what it, increase in quantity produced a significant increase of about 0.173%. As for quantity of water, increase in quantity by 1% led to an increase in quantity of product significant increased by about 0.415%, overall elasticity confirms that by increasing previous affecting components combined by 1%, it leads to an increase of production by about 0.785%, which means that producers and users of lining for canals and drivers in agriculture are produced in economic stage, and value of determination coefficient (R^2) about 0.75, that is, previous elements responsible for interpretation of about 75% of total change in production, morality of model was confirmed as value of (F) calculated was estimated by about 21,2.

Table 4 : Gradual regression equations for production of acres of beans from different irrigation methods in sample of study

Items	Arithmetic image	Equation	R^2	F
irrigation by flooding	linear	$Y^{\wedge}_e=427.42+19.5X_{1e}+3.4X_{5e}+27.1X_{6e}$ (2.4)* (2.2)* (3.7)**	0.79	26
	logarithmic	$\log Y^{\wedge}_e=2.68+ 0.02 \log X_{1e}+ 0.294 \log X_{5e}+0.564 \log X_{6e}$ (2.5)* (2.7)** (3.8)**	0.80	26.3
lining of canals and drivers	linear	$Y^{\wedge}_e=902+22.2X_{3e}+2.2X_{5e}+0.67X_{8e}$ (2.7)** (2.0)* (2.8)**	0.74	20.1
	logarithmic	$\log Y^{\wedge}_e=3.4+ 0.197 \log X_{3e}+0.173 \log X_{5e}+0.4158 \log X_{8e}$ (3.0)** (2.1)* (2.9)**	0.75	21.2
spray irrigation	linear	$Y^{\wedge}_e= 633+21X_{1e}+40.6X_{3e}+4.3X_{5e}+0.564X_{6e}$ (2.4)* (3.4)** (2.1)* (2.2)*	0.86	32.7
	logarithmic	$\log Y^{\wedge}_e=1.1+ 0.209 \log X_{1e}+ 0.126 \log X_{2e}+ 0.036 \log X_{3e}+ 0.611 \log X_{8e}$ (2.0)* (2.3)* (6.3)** (4.2)**	0.87	35

Where $Y^{\wedge}_e$ = quantity of production per ton, X_{1e} = quantity of seedling kg, , X_{2e} = quantity of compost /m^3, X_{3e} = quantity of human labor man / working day, X_{4e} = quantity of work hourly, X_{5e} = quantity of nitrates per unit, X_{6e} = phosphate per unit, , X_{7e} = value of pesticides in pounds, X_{8e} = amount of irrigation water /m^3, e = 1, 2, 3, number of farmers in region, **, * significant at two levels 0.01, 0.05
Source: Computed from questionnaire forms for sample of study in Behyra Gov. 2016.

In case of production of green beans by using spray irrigation, statistical significance of elements elasticity of quantities of seeds, manure, human labor and irrigation water has been proved. Therefore, increase of quantity of seeds by 1% increases produced quantity by a significant increase by 0.209%, While increase in amount of compost by 1% but lead to increase quantity produced a significant increase of 0.126%, and increase in amount of human labor by 1% led to increase quantity produced a significant increase of about 0.036%, As for the quantity of water, estimated flexibility of function, which has proved its significance, so increase in amount of water by 1%, lead to an increase in amount of green beans, a significant increase of about 0.611%, total elasticity confirms that by increasing previous affecting elements combined by 1%, it leads to an increase of production by 0.982%. This means that producers who use spray irrigation are producing in economic stage; value of limiting factor (R^2) about by 0.87 indicates that previous elements were responsible for interpretation of about 87% of total change in bean production, morality of model confirms that value of (F) was estimated at 32.13.

Economic efficiency of affecting factors on production of green beans in different irrigation methods: Table (**5**) shows that most important affecting factors on production of green beans using different irrigation methods are in use of irrigation by flooding; amounts of seeds, nitrates and phosphates fertilizers, in order to achieve efficiency of use of these elements in cultivation of crop, which shows that value of marginal product is greater than price of resource, it was found that element of phosphate fertilizer is only element used efficiently since value of marginal output of about 6.4 pounds against unit price estimated at 2.5 pounds, economic efficiency of elements of seeds and nitrogen fertilizer was not confirmed, while quantities of human labor, fertilizer of nitrates and water are affecting on production of beans with modern lined irrigation, efficiency of water component was confirmed as marginal output value was about 2.63 pounds and value of unit was estimated at 0.60 pounds.

Table 5 : Economic efficiency of affecting factors on production of beans using different irrigation methods

Irrigation methods	Economic efficiency	Seeds	Local fertilizer	Human work	Nitrogen fertilizer	Phosphates fertilizer	Water quantity
irrigation by flooding	marginal output	0.75	-	-	0.422	1.06	-
	marginal output value	3.438	-	-	2.529	6.402	-
	element price	15	-	-	3.25	2.5	-
lining of canals and drivers	marginal output	-	-	0.459	0.25	-	0.439
	marginal output value	-	-	2.75	1.502	-	2.63
	element price	-	-	50	3.25	-	0.60
spray irrigation	marginal output	0.437	0.254	0.086	-	-	0.676
	marginal output value	2.62	1.52	0.51	-	-	4.06
	element price	15	5	50	-	-	0.60

Source: collected and calculated from data of study sample in Behyra Gov. in 2016

In case of spray irrigation, quantities of seeds, local fertilizer, human labor and water were effective, efficiency of water component was confirmed, value of marginal product was 4.06 pounds and unit price was 0.603 pounds as shown in Table (5).

From functions of production for green beans showed that most important effected factors are quantities of seeds, human labor, nitrates and irrigation water. Therefore, these factors should be considered by improving quality of seeds using modern technologies of varieties and rationalizing use of other factors while trying to rationalize water component in current conditions which are rare in water component, economic and productive efficiency confirmed that water component is element with marginal product value greater than resource price in case of spraying and lining irrigation, superiority and efficiency of phosphate fertilizer element in case of flooding irrigation.

Efficiency measures of beans production using different irrigation methods in sample of study:

1. **Efficiency measure of land element using (average acre productivity):** The substitution of high-productivity varieties to low-productivity varieties is of paramount importance for vertical expansion in context of limited land resources. Acre productivity is final outcome of package of technical and technological recommendations in context of agricultural policy, and therefore any changes in acre productivity is a reflection of many technical, economic and social measures. Table (6) shows acre productivity of green beans, where it was found that highest efficiency is for producers with spray irrigation about at 4728 kg followed by flooding irrigation about at 4080, 3884 kg.
2. **Cost of productive unit:** cost of unit produced is dividing of total cost on acre productivity can be compared to produced unit price from crop of study sample. Table (6) shows that cost of produced unit from green beans used for spray irrigation, users of modern lined irrigation and users of flooding irrigation is about 2600, 3230 and 3300 pounds / ton, respectively.
3. **Total revenue scale:** Total revenue is expressed as monetary value of both main and secondary output, which depends on two main factors, namely, acre productivity and farm prices, Therefore, changes in either of them will have an effect on total revenue. Table (6) shows that highest total revenue for irrigated beans by spring at 28368 pounds / acre following both lining and flooding irrigation at 24480, 23304 pounds / acre.
4. **Acre profitability scale (net acre profit):** net profitability of area unit depends on prices of production inputs, as well as prices of final and secondary products for crop, in addition to average productivity of area unit. It reflects use of improved seeds, new technologies, production requirements or improved farm management. This scale can be calculated from following equation: net acre profit = total revenue value - total costs. Table (6) shows increase in acre revenue of bean producers by spraying irrigation estimated value of 16056 pounds / acre, followed by producers are using (lining, and flooded irrigation) about at 11304 and 10500 pounds / acre.
5. **Measure of net return to total production costs:** This measure refers to economic efficiency of variable production elements only, and shows amount of return realized from use of variable assets in production process, higher value of this measure, also it refers to increase return for costs. Table (6) shows increase in return / cost for bean producers by spray irrigation, estimated at 1.44 pounds, while product of beans is covered with lining and flooding irrigation about at 0.94 and 0.90 pounds, respectively.
6. **Measure of return on use of cubic meter from irrigation water:** This criterion is useful in identifying optimal use of irrigation water as one of determinants of agricultural production with land, and higher its value refers to increase return achieved from cubic meter used in production process. Table (6) shows increase in return / water for beans with spray irrigation, estimated at 13.63 pounds / m^3, following by producers using (modern lining irrigation, flooding irrigation) are about 9.57 and 8.96 pounds / m^3
7. **Measure of cube meter productivity from irrigation water:** Total amount of physical production in kilograms achieved by using cubic meter of irrigation water in production process, and it is higher value of this measure, it refers to higher quantity of physical production achieved by using (m^3) of water irrigation, This is also showed by economic efficiency of irrigation water use in production of green beans. Table (6) shows a productivity increase of cubic meter from irrigation water for green bean producers with spray irrigation, estimated at 1.75, while green bean producers with lining irrigation estimated at 1.51 and flooding irrigation users are estimated at 1.44.

Table 6 : Efficiency measures of green beans production from different irrigation methods in sample in Bahyra Gov. in 2016

Scale	Flooding	Lining	Spraying
Average acre productivity (tons)	3.884	4.080	4.728
Average production unit cost (pound/tons)	3300	3230	2600
Total acre cost	12304	13176	12312
Total acre revenue	23304	24480	28368
Net acre profit	10500	11304	16056
Profit/costs	0.82	0.86	1.3
Return from water unit	8.96	9.57	13.62
Productivity of water unit	1.44	1.51	1.75

Source: compiled and calculated from questionnaire forms data in sample of study in 2016

Conclusions

From above, it was shown preference and efficiency of green bean producers and spray irrigation users where average production is estimated at 4728 kg / acre, cost of tone is also lower for spray irrigation users and increases acre revenue is estimated at 16056 pounds while cost return of spraying irrigation is about 1.44 pounds. As for return of water unit, it is about 13.63 pounds for bean producers with spray irrigation, while it is estimated at 9.57, 8.96 pounds for users of lining and flooding irrigation. Productivity of water unit for bean producers by spray irrigation is estimated at 1.75 while it is about 1.51, 1.44 for bean producers using modern lined and flooding irrigation, respectively.

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