Asian Journal of Agricultural Extension, Economics & Sociology
4(2): 195-201, 2015; Article no.AJAEES.2015.020
ISSN: 2320-7027

SCIENCEDOMAIN *international*
www.sciencedomain.org

Estimation of a Long-Run Cost Function for Bananas Cultivation in Jordan

Bassam Aldeseit[1], Ali AL-Sharafat[1*] and Maher Yousef[1]

[1] Department of Agricultural Economics and Extension, Faculty of Agriculture, Jerash University, P.O. Box-311, Jerash 26150, Jordan.

Authors' contributions

This work was carried out in collaboration between all authors. Authors BA designed the study, wrote the first draft of the manuscript and conducted some of the statistical analyses. Authors AAS and MY collected the data, managed the analyses of the study and wrote the final manuscript of the study. All authors read and approved the final manuscript of the study.

Article Information

DOI: 10.9734/AJAEES/2015/11419
Editor(s):
(1) Jamal Alrusheidat, Assistant and Consultant to Director general for Extension Education Director of Extension Education Department, National Centre for Agricultural Research and Extension (NCARE), Amman, Jordan.
(2) Anthony N. Rezitis, Department Business Administration of Food and Agricultural Products, University of Western, Greece.
Reviewers:
(1) Handan Akcaoz, Department of Agricultural Economics, Faculty of Agriculture, Department of Agricultural Economics, Turkey.
(2) Anonymous, Federal University Oye-Ekiti, Nigeria.
(3) Anonymous, Kasetsart University, Thailand.
(4) Anonymous, Federal University of Technology Owerri, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=710&id=25&aid=7030

Original Research Article

Received 15th May 2014
Accepted 4th November 2014
Published 21st November 2014

ABSTRACT

This study aimed at investigating bananas production in Jordan in terms of estimating the long run cost function and deriving the associated parameters. A field survey was carried out to collect the primary data in Ghore Area of Jordan (Jordan Valley). Simple random and purposive sampling procedure was followed in this study. Interviews were carried out and a questionnaire was constructed to collect the needed information from 66 sampled farmers. The findings of the study showed that both the long run marginal costs and long run average costs were estimated to be 0.05 and 0.13 JDs/kg of bananas respectively. The optimum size of production and the production level with maximum profit for the sampled farms were 8695.65 kgs 13043 kgs respectively. Both the optimum size of production and the production level with maximum profit of the sampled farms were much higher of the average production of these farms by 2260 and 3997 JDs respectively.

**Corresponding author: E-mail: bkhitan2@yahoo.com;*

The sampled farmers have a chance to increase their profits by adopting practices to decrease their long run production costs or by achieving cost efficiency.

Keywords: Bananas production; long run; short run; cost function; optimum size of production; production level with maximum profit.

1. INTRODUCTION

Bananas play a key role in the economies of many developing countries. Bananas are grown in all tropical and other suitable regions in the world. According to FAO report [1], Bananas are the world's fourth most important food crop after rice, wheat and maize in terms of gross value of production. Based on whether, bananas could be classified as local production, which is consumed locally, or as trade production which is being transported to a more or less distant markets [2].

Bananas cultivation is an economically profitable agricultural activity in many developing countries. It has become a key source of revenue as they are not only traded within countries but also exported [3].

In a study aimed at investigating the economical efficiency of bananas cultivation in plastic houses in Tartous Province in Syria [4] stated that the profitability rate for bananas cultivation under plastic houses was 53.8 % and the time for resuming the capital money was 1.56 years. In the same study, he stated that, in the case of double cropping, the profitability rate was 69% and the time for resuming the capital money was 1.45 years. In both cases banana cultivation was financially feasible.

In a study conducted by [5] based on data collected from 80 bananas farmers in 12 villages of two taluks in Tungabhadra and Malaprabha command areas of Karnataka in Bangladesh. Results of the study showed that the farmers can obtain positive net return from cultivation of bananas. The findings of the study also revealed that the trading of bananas is a profitable venture to different intermediaries.

In another study aimed at investigating some economic efficiency of bananas cultivation in Assiut Governorate in Egypt [6] concluded that this type of cultivation was profitable and the total areas of bananas cultivation as well as the total production in the area of the study was increased due to the economical benefits achieved from this type of cultivation.

In a study intended to regard the economic feasibility of bananas production activity in Jordan through evaluating the comparative advantage and analyzing the costs and returns of this activity, [7] investigated the economics of bananas production in Jordan, and concluded that in all of the investigated production areas bananas production was economically feasible and profitable.

The present study aimed at investigating bananas production in Jordan in terms of estimating the long run cost function and deriving the associated parameters.

1.1 Bananas Production and Consumption in Jordan

Among other agricultural cultivation areas in Jordan, bananas have been successfully cultivated in the Valley of Jordan (Ghor areas). Warm middle and southern Ghor areas helped largely in this success since bananas are very sensitive to cold and frost conditions [8]. Production cycle of bananas in Jordan is every 4 years. According to Jordanian Ministry of Agriculture (2013), the yearly average production per one dunum is 8–10 tons of bananas. Table 1 shows the total cultivated areas and the total quantities of bananas produced in Jordan for the period during the period 1994-2011.

Table 1 shows that there is an increase in both cultivated areas and production. The increase in the area was approximately 36% and it was approximately 12% in production. This increase may be attributed to the higher returns of unit area (dunum), higher producer prices, and higher protection procedures (4% tax on bananas imports).

Regarding bananas consumption, Table 2 shows the annual average consumption of bananas per Jordanian individual, imported quantities, and the total quantities of bananas consumed in the country for years 2006 – 2011.

Table 1. Total cultivated areas and total quantities of bananas produced in Jordan (1994-2011)

Year	Area (Dunum)	Production (Tons)
1994	16349.13	24717.90
1995	18225.60	29301.90
1996	21322.60	29094.00
1997	13303.20	18150.90
1998	16034.90	24477.40
1999	16812.50	36858.00
2000	20824.30	20832.00
2001	20924.90	24318.50
2002	22802.70	47402.80
2003	12267.40	21377.40
2004	12865.40	37050.00
2005	12865.40	32176.40
2006	14493.00	42112.70
2007	15418.00	34910.10
2008	16335.00	41540.20
2009	17437.00	43834.30
2010	18527.00	43753.30
2011	19710.00	48303.80

Source: [9]

Table 2. Individual average annual consumption of bananas (2006 - 2011)

	Individual average		
Year	Annual consumption (kgs)	Total consumption (Tons)	Imports (Tons)
2006	7.550	37400	9.60
2007	7.550	38200	20.4
2008	7.550	39100	33.0
2009	8.390	41900	40.0
2010	11.39	55300	40.2
2011	11.39	56500	64.2

Source: [9]

2. MATERIALS AND METHODS

2.1 Study Area, Sampling Procedure and Data Collection Techniques

Simple random and purposive sampling procedures were followed in this study. The sample size was determined according to the following equation [10]:

$$n = (p \times q)\ (Zx / e)^2$$

Where:

n = Sample size
p = Success in the proportion of the population
q = (1-P): Failure in the proportion of the population
Zx =1.645 (Z–value used in a 90% confidence interval)
e =Degree of error (10%)

Therefore, with p = 0.50 and (1-p) = 0.50, n will be:

$$n = (0.50 \times 0.50)\ (1.645 / 0.10)^2 = 68$$

The sample size according to the above-mentioned equation was 68. Additional 12 farmers were interviewed. The sample size was determined at a confidence level of 0.90; this level was an appropriate level due to the reason that the population itself was relatively small. The term error was 0.10 and the Z value corresponding to this level was 1.645. The success in the proportion of the population or the proportion that the sample will occur (p) was equal to 0.50 and the failure in the proportion of the population or the proportion that the sample will not occur (1-p) was equal to 0.5.

The field survey was carried out during the period from August 2012 to April 2013 to collect the primary data.

2.2 Cost Estimation

Long run cost functions are used in planning firm's investment decisions and to determine the extent of economies and diseconomies of scale in order to select the optimal plant size. Knowledge of the short run cost functions allows the decision makers to judge the optimality of present output levels and to solve decision problems of production manager. Knowledge of long run cost functions is important when considering the expansion or contraction of plant size, and for confirming that the present plant size is optimal for the output level that is being produced.

All costs are either Fixed or Variable. Fixed costs are costs that must be paid regardless of production or output. The total cost of production is the sum of total variable cost and total fixed cost [11]. All other costs are derived from these two cost concepts. In the present study, fixed costs were operational holding except rental value and interest on fixed capital. Variable costs are costs that change with the level of production; Variable costs are costs that in some way directly associated with output, such as hired human labor, suckers, natural manures, fertilizers, pesticides, irrigation charges, depreciation charges, and interest on working capital. Adding together Fixed Costs and Variable Costs will give Total Costs;

Fixed + Variable = Total Costs

The Average costs are Average Fixed Cost, Average Variable Cost, and Average Total Cost. To find the average costs, we divide total by the quantity produced at that point;

Average Variable Cost = Total Variable Cost / Quantity

Average Fixed Cost = Total Fixed Cost / Quantity

Average Total Cost = Total Cost / Quantity

Marginal Cost means the additional cost of producing the next unit of output, or the cost incurred of producing one additional item. The Marginal Cost of output #2 would be the difference in cost of output #2 and output #1; it is the cost of producing that extra unit.

The direct payments that farmers made to the factors of production are called explicit cost of production [12]. Implicit cost refers to the value of the inputs owned by the farm which is used by the farm in its own production processes [13]. Explicit and implicit costs of farm production constitute private cost [14]. If this money is invested elsewhere, it would earn a certain amount of dividends or interest [15].

Cost Function is a mathematical formula used to predict the cost associated with certain level of output. Agribusinesses use cost functions to forecast the expenses associated with production to achieve the desired profit margins.

2.3 Analytical Framework

Data were subjected to descriptive and inferential statistics. Descriptive statistics including means, percentages, and averages were used to achieve objective o the study. Regression model was used to estimate long run cost function. Regression analysis procedure was followed in this study for the purpose of estimation of the long run cost function of the sampled farms. Several reasons were behind the adoption of this procedure to estimate long run cost function in this study; first, the data is cross sectional data comes from different farms with variable quantity of output over wide ranges, second, all data from same point of time so technology will not change, third, there is no need to regard price changes.

2.3.1 Why long run total costs?

Long run is "when firms can change all their inputs". There is no fixed cost or fixed cost in the end is equal to zero. In long run, the firm has time to increase all factors of production. That is, the firm has time to adjust the use of inputs that are variable in the short run. The short run and the long run total cost functions relate the cost per unit of output against the quantity of goods produced. The long run is defined as the period of time in which no factor units of production are fixed, while the short run involves at least one unit of production as fixed. The difference between the long run and short run functions is that the long run allows for a variety of capital to labor combinations, which is applicable to the present study, while the short run generally allows a very limited number of combinations. Other important reasons to consider long run total costs in the analysis are the type of data (cross sectional) and the size of the farms. If cross sectional data of many firms, whose size varies substantially (this is the case in our study) the estimated cost function would be the long run one.

3. RESULTS AND DISCUSSION

There are three functional forms of cost functions, which are popular; they are; linear, quadratic, and cubic. The choice of a particular function depends upon the correspondence of the economic properties of the data to the mathematical properties of the alternative hypotheses of total cost function. Cost function expresses the relationship between cost and its determinants such as the size of plant, level of output, input prices, technology, managerial efficiency, etc. In a mathematical form, it can be expressed as;

$$C = f(x.)$$

Where, C = cost (it can be unit cost or total cost) and x = output level. Output level and total cost are positively related, as the total cost increases with increase in output and total cost decreases with decrease in output. This is because increased production requires increased use of raw materials, labor, etc., and if the increase is substantial, even fixed inputs like plant and equipment, and managerial staff may have to be increased. The usefulness of any cost function for practical application depends, largely, on appropriateness of the functional form chosen.

In the present study, among the other two forms of cost functions (linear and quadratic), the cubic form was found to be the most suitable one depending on the statistical tests (R Square = 0.732, Adjusted R Square =.719, F Value = 57.415). The simplified cubic form of the long run cost function is given by:

$$TC = f(x, x^2, x^3)$$

The general cubic form of the long run cost function is given by:

$$LRTC = \beta_1 x - \beta_2 x^2 + \beta_3 x^3 + u_i$$

Where;

LRTC = Long run total costs
X = Quantity of production/dunum
U = Random variable

Variables x^2 and x^3 are functionally related to variable x with non-linear relationship, which supports the suggestion, that there is no multicollinearity problem. The estimated long run cost function of bananas production in the study area was as follows (Tables 3, 4 and 5 show model summary, analysis of variance (anova), and parameters of the model (coefficients), and Fig. 1 shows the shape of the model);

$$LRTC = 0.23x - 0.00004x^2 + 0.0000000023x^3$$
$$(0.047) \quad (0) \quad (0)$$

The estimated cost function was correspondent with the statistical logic regarding model and variables significances. The typical long run average costs (LRAC) and long run marginal costs (LRMC) functions that are based on the estimated cubic cost function were derived;

$$LRAC = 0.23 - 0.00004X + 0.0000000023X^2$$
$$LRMC = 0.23 - 0.00008X + 0.0000000069X^2$$

The average production of the sampled farms was 3050 kgs/ dunum. Depending on this average both long run marginal costs and long run average costs were estimated to be 0.05 and 0.13 JDs/kg respectively. The optimum size of production for the sampled farms was estimated to be 8695.65 kgs. This level is the level of production at which the economies of size of the farm is maximum. This value was obtained as follows;

$$LRAC = 0.23 - 0.00004X + 0.0000000023X^2$$
$$\partial LRAC/\partial x = 0.00004 + 0.0000000046\ X$$
Setting $\partial LRAC/\partial x = 0$
$$X = 8695.65 \text{ kgs}$$

Production level with maximum profit is when MC = Dominant farm price (MR). The dominant price at the study area during study survey was 0.40 JDs/ kg, and $LRMC = 0.23 - 0.00008X + 0.0000000069X^2$, then;

$$0.23 - 0.00008X + 0.0000000069X^2 = 0.40$$
Hence, x = 13043 kgs

Table 3. Model summary*

Correlation coefficient (R)	R square	Adjusted R square	Std. error of the estimate
0.856	0.732	0.719	214.303

**The independent variable is X*

Table 4. Analysis of variance (Anova*)

	Sum of squares	df	Mean square	F	Sig.
Regression	7910550.107	3	2636850.036	57.415	0.000
Residual	2893331.893	63	45925.903		
Total	1.080E7	66			

**The independent variable is X*

Table 5. Coefficients

	Unstandardized coefficients		Standardized coefficients		
	B	Std. error	Beta	t	Sig.
X	0.234	0.047	2.084	4.934	0.000
X^2	-4.147E-5	0.000	- 2.241	- 1.962	0.050
X^3	2.333E-9	0.000	0.916		

**The independent variable is X*

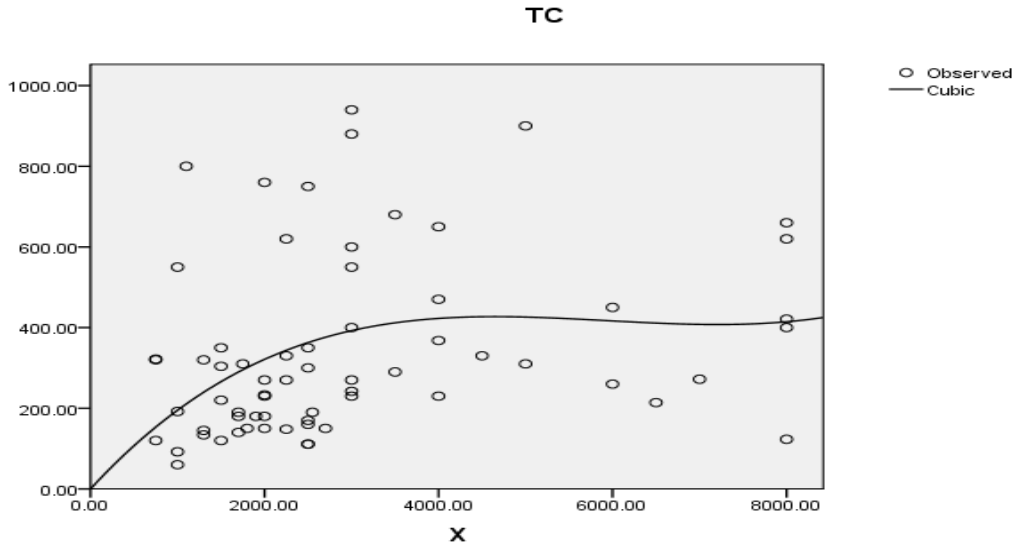

Fig. 1. Shape of the model

Due to the effect of other factors and not only production costs (mainly farm size, selling price of production unit, and size of production), it not possible to achieve the computed level of production (13043 kgs). The level of production with maximum profit is exceeding the present average level of production by 9993 kgs (3997 JDs based on price of 0.40 JDs/ kg). Both the optimum size of production and the production level with maximum profit of the sampled farms were much higher of the average production of these farms by 2260 and 3997 JDs respectively.

Among investment analysis and project management tools, cost function is one of the essential tools to be used. In the process of decision-making, a manager should understand clearly the relationship between the inputs and output on one hand and output and costs on the other. Depending on this, there is a chance for bananas farmers in study area to increase their profits through decreasing their production costs or by achieving cost efficiency to reach the optimum size of production and the production level with maximum profit (2260 and 3997 JDs respectively). Cost efficiency is the ability of a farmer to produce the maximum level of output possible at a minimum cost outlay under a given technology [16].

4. CONCLUSION

The main objective of this study was to investigate bananas production sector in Jordan in terms of long run cost functions. After estimating the long run cost functions, the findings of the study showed that both the long run marginal costs and long run average costs were estimated to be 0.05 and 0.13 JDs/kg respectively. The findings of the study also showed that the optimum size of production (the level of production at which the economies of size of the farm is maximum) and the production level with maximum profit for the sampled farms were 8695.65 kgs 13043 kgs respectively. Both the optimum size of production and the production level with maximum profit of the sampled farms were much higher of the average production of these farms by 2260 and 3997 JDs respectively. By adopting practices to decrease their production costs or by achieving cost efficiency the sampled farmers have a chance to increase their profits. Based on the above findings, it is recommended that methods of gathering and dissemination of information that is vital for bananas farmers should be improved; this requires increasing the current level of extension services. In the light of low level of banana production in Jordan, credit facilities that will enable bananas farmers to access such credit at a reasonable cost should be provided. These procedures will end in decreasing the long run costs of production in bananas production sector and allow producers to achieve effective cost efficiency.

ACKNOWLEDGMENTS

The authors wish to express their deep sense of gratitude to the Department of Statistics staff and

the Agricultural Directorates in Jordan Valley. They would also like to convey thanks to the Faculty of Agriculture staff at Jerash University for their help.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bingen J, Munyankusi A. Farmer associations, decentralization and, development in Rwanda: Challenges Ahead. MINAGRI; 2002.
2. Stover RH, Simmonds N, Bananas W. Longman Group UK Ltd. The World Report Economy, 1985-2002; 1987.
3. Ortiz R, Vuylsteke D. Improving plantain and banana-based systems. Proc. Regional Workshop on Plantain and Banana Production and Research in West and Central Africa. Onne, Nigeria, 25-27 September. 1996;2-7.
4. Nizar Qanno. A study of the economical efficiency of banana cultivation in plastic houses in Tartous Province. The Tishreen University Journal for Studies and Scientific Researches-Economic and Legal Science Series. 2006;28:(2):88-102.
5. Kerutagi MG, Patil BL, Kanamadi VC, Bankar B. Comparative economic analysis of tissue culture banana and sucker propagated banana production in Karnataka. Karnataka J. Agric. Sci. 2009;22(4):810-815.
6. Abd-Almageed A Ali, Ahmed A Mohamed, Abd-Al-wakeel Mohamed, Amr HA Hammad. A study of some economic features of bananas in Assiut Governorate. Assuit Journal of Agricultural Sciences. 2010;41(3):105-130.
7. Almuheisen Khalid. Economics of bananas production in jordan, master thesis, faculty of graduate studies. The University of Jordan, Amman –Jordan; 1997.
8. Ministry of Agriculture (MOA). Study of banana crop in Jordan. Directorate of Agricultural Policies and Studies, Amman – Jordan; 2013.
9. Department of Statistics of (DOS). Agricultural Annual Report, Amman – Jordan; 2012.
10. James Terrell, Wayne W Daniel. Business statistics: Basic concepts and methodology. Fourth Edition. Houghton Mifflin School; 4th Sub edition; 2012. ISBN-13: 978-0395356517.
11. Mc Guigan JR, Moyer RC, Harris FHD. Managerial economics: Applications, strategy and tactics. USA. Thompson/ South –western. 2005;A:340 – 370.
12. Pindyck RS, Rubinfield DL. Microeconomics. 6th Edition. Pearson, Prentice Hall. 2005;213–214.
13. Salvatore D. Microeconomic theory. 3rd edition. Tata McGraw – Hill Publishing Company Ltd; 2005.
14. Olayemi JK. Principles of microeconomics for applied economic analysis. Ibadan, Nigeria. SICO Publishers. 2004;107-133.
15. Reddy SS, Ram P. Agricultural finance and management. India. Oxford and IBH Publishing Company PVT. Ltd. 2004;62–86.
16. Anyaegbunam HN, Okoye BC, Asumugha GN, Madu T. A translog stochastic frontier analysis of plot size and cost inefficiency among small holder cassava farmers in southeast agro-ecological zone of Nigeria. Nigerian Agricultural Journal. 2009;40(1):23-28.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=710&id=25&aid=7030