academicJournals

Vol. 8(33), pp. 4380-4385, 29 August, 2013
DOI: 10.5897/AJAR09.637
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

An economics survey of barley crop, implications on optimized farm size and land consolidation: A case of Tehran Province of Iran

Syamak Mashayekhi[1] and Hamed Ghaderzadeh[2]*

[1]Agricultural Economics, Natural Resources and Agricultural Research Center, P. O. Box: 15715 – 151, Taleghani Ave., Tehran, Iran.
[2]Department of Agricultural Economics, College of Agriculture, University of Kurdistan, Kurdistan Province, Iran.

Accepted 13 August, 2013

The current study attempted to investigate the economic issues of Barely crops in Tehran Province of Iran. The data were collected in association with Tehran province Agricultural – Jahad Organization. Two-stage stratified random sampling method used to select samples and sample size is about 250 farms. The Trans log and polynomial function was used to estimate cost functions. The results showed that, the optimum size of barley farms in the case of small and medium, large and total farms groups were 17.08, 41.96 and 46.43 ha, respectively. It was greater than the average sample farm size in the case of small and medium farms group (2.96 ha) and total farms group (18.21 ha). The average total cost decreases with increase in farm size and reaches its minimum when area is 17.08, 41.96 and 46.43 ha in small, medium, large and pooled sample farmers groups, respectively. Beyond these levels of area, the average total cost increases at increasing rate. The estimated optimum size of farms showed the fact that the most profitable farm size for all farm size groups belongs to large category of farms.

Key words: Cost function, optimum size, Tehran province, barely crop, Trans log cost function.

INTRODUCTION

Agriculture contributed to more than 11.5% of the GDP at current prices in Iran in 2005 (Anonymous (2005). Barley as the fourth largest grain crop after wheat, rice, and corn in the world and second major crops in agricultural sector in Iran need more attention. Its area under cultivation occupied about 15.6% of total cultivated area under agricultural crops. It was extensively used as animal feed. Iran as one of the largest barley importers ranked fifth out of 127 Barley-importing countries in 2005 (FAO, 2008).

Tehran province is the smallest but most populous of the provinces in Iran. Agriculture is the main occupation in sub-urban plains and highlands. Land is the scarcest resource and improvement in crop productivity is the main source of growth.

The paper attempt to study the optimum size of barley crop and it may help the policy makers regarding the scope for consolidation of holdings in order to harness the economies of scale in barley production. This also may help to reduce the dependence on imports as well as the costs of production of livestock and poultry products. In attention to the importance of barley crop as major crop of Iran, this leads to system improvement of its economy. 1990, The matter of size-productivity relations is a major and continuing interest in Iranian agriculture. Afrakhteh (1997) in his study in Tea cultivation in north of Iran showed a positive and significant relationship between these two variables. Helfand and

*Corresponding author. E-mail: hamedar2002@uok.ac.ir.

Levine (2004) explored the determinants of technical efficiency, the relationship between farm size and efficiency in the center-west of Brazil in the agricultural year 1995 to 1996 using data envelopment analysis (DEA). The results indicated that the relationship between farm size and efficiency is non-linear with efficiency first falling and then the rising with size. Debates concerning the ‘optimal farm structure’ and ‘optimal farm size’ have a long history in agricultural economics (2004). In this study, the economics of farm size – productivity is analyzed using the long run average cost (LRAC) framework with the hypothesis that farm size expands when there is opportunity to gain efficiencies from size. The main object of the study is to find optimum size of farm in the study area.

MATERIALS AND METHODS

The data on Barley crop were collected in association with Tehran province Agricultural – Jahad Organization affiliated to Ministry of Agricultural – Jahad of Iran, during the agricultural year 2000-1. In this study, two-stage stratified random sampling method is followed. At first, 5% of villages with a population of below than 5000 from each of the eight townships, where Barley is largely cultivated (that is, Ray, Robatkarim, Firoozkooh, Savojbolag, Shahriyar, Varamin, Islamshahr and Karaj) were selected. In addition, this has to be marked that in Iran, each township includes some number of towns and a set of villages. Thus, total number of 55 sample barley growing villages covering all barley-cultivated areas in the Tehran province was chosen. At the second stage, the sampling units were selected randomly based on 20% of barley farm households of the sample villages. Thus, the total of 179 farms was the respondents for primary data. The farms were post-stratified into small, medium and large based on the criteria of small (below two hectares), medium (two to ten hectares) and large (above ten hectares). The data were collected in the year 2002 using a structured pre-tested questionnaire.
The cost function is defined as:

$$c(w,y) = \min_{x \geq o} \; [w \cdot x : x \in V(y)] \quad (1)$$

$$(\sum w_i x_i) \quad (2)$$

Where w = Vector of strictly positive input prices and $w \cdot x$ = Inner product.

The cost function thus is the minimum cost of producing a given output level during a given time period expressed as a function of input prices and output (Chambers, 1988). The cost function must be non-negative, non-decreasing, concave and linear homogeneous in input prices. Second, it should be capable of estimation with zero values of some outputs, which implies that it should allow for economies of scale and scope and sub-additively (Greer, 2003).

The most commonly employed functional forms in cost estimation are the Translog and the polynomial, both of which offer flexibility to avoid a priori restrictions on the elasticities of substitution among the variables. Studies by Carter and Dean (1961), Binswanger (1974), Paul (1987), Kuroda (1988), Mukhtar and Dawson (1990), Paul and Mehta (1991), Kuroda (1995), Salman (1999), Koo et al. (2001), Emadzadeh et al. (2002), demonstrate the application of Translog cost function in agriculture and farm production economics. Bacsi (1997) applied polynomial (quadratic) cost function to describe the production technology of agricultural producers. In this study polynomial cost function is estimated. Karaki (1998) studied the cost of production in cattle farms in Jordan using a cubic cost function and found that both borrowers and non-borrowers were far from the optimum size of farm. Kiani (1999) applied the polynomial cost function to determine the optimal input use (seed, fertilizer, labor, and so on) in irrigated wheat cultivation in 21 provinces of Iran. Elhendy and Alzoom (1961) examined the cost of Tilapia farming in the central region of Saudi Arabia from 23 intensive fish farms using the cubic cost function which provided the best fit. The optimum level of production per farm was 201 tones of tilapia per year.

A polynomial function is given by:

$$F(X) = a_n + a_{n-1}X^{n-1} + \ldots + a_1X + a_0 \quad (3)$$

Where n = Non negative integer, the degree of the polynomial function is the highest value of “n”.

The average total cost function is formulated as:

$$ATC = f(X) \quad (4)$$

Where ATC = Average total Cost (Rupees / hectare)

X = Area (ha)

The linear, quadratic and cubic cost functions as in (5), (6) and (7) were estimated using OLS in order to analyze the cost per hectare - area relationship.

$$ATC = a_0 + a_1X \quad (5)$$

$$ATC = a_0 + a_1X + a_2X^2 \quad (6)$$

$$ATC = a_0 + a_1X + a_2X^2 + a_3X^3 \quad (7)$$

The linear and quadratic polynomial cost function are estimated using ordinary least squares (OLS) method and the method of fitting a linear and quadratic polynomial cost function is extended to polynomials of higher degrees. A particular degree of polynomial regression is selected as the best regression model based on error sum of squares, R^2, F-value and significance level of “F”. The best model is one that has least amount of ‘ESS’, highest ‘R^2 ‘and ‘F’ values and high significance level of ‘F’.

As the variance of farm size in small size group was (0.432), the small and medium categories of farmers were pooled and a single cost function is estimated. The cost function is estimated for two size groups namely small and medium (below ten hectares) and large (above ten hectares) as: To select a particular degree of polynomial regression as the best regression model, theoretically, the subsequent two degrees of polynomial regression models should have “F” non-significant because the objective is to find the degree of polynomial cost function that provides an adequate fit. Consequently, the reduction in error sum of squares is tested by F - test as each successive term is added (Snedecor and Cochran, 1989).

For practical purposes, one can choose the model based on the quantity of error sum of squares (ESS), which is given by:

$$ESS = TSS - RSS \quad (8)$$

Where; TSS = Total sum of squares, RSS = Regression sum of squares.

The researcher can decide based on the objective of research whether the ESS quantity is small or large. In other words, if reduction in error sum of squares (ESS) and increase in F-value or increase in coefficient of multiple determinations (R^2) in higher degree of polynomial function is found to be negligibly more than previous degree of polynomial function; because of simplicity of the model, it is better to select simpler model.

The optimum size of farm (X) is derived from the estimated cost function solving the first and second order conditions as in (9) and (10):

$$\frac{dATC}{dX} = 0 \quad (9)$$

$$\frac{d^2 ATC}{d X^2} > 0 \quad (10)$$

In order to understand whether small and medium farms significantly differ from the large group, Chow's test (Gujarati, 2003) is applied.

The test procedure involves the residual sum of squares (RSS) of three cost functions (for small and medium size group, large size group and aggregate). The entire samples are broken into small and medium, and large sub samples. By using the RSS of these two sub samples and the entire samples, the Chow F-test is applied as follow:

$$F = \frac{\{RSS_A - (RSS_S + RSS_L)\} / K}{(RSS_S + RSS_L) / (n_1 + n_2 - 2K)} \quad (11)$$

Where RSS_A = Residual sum of squares for the aggregate samples, RSS_S = Residual sum of squares for small and medium samples, RSS_L = Residual sum of squares for large samples, K = Number of parameters involved in the cost function model, n_1 = Number of observations in small and medium size group, n_2 = Number of observations in large size group, The 'F' calculated is compared to 'F' table which is given by:

$$\mathbf{F(\alpha, K, n_1 + n_2 - 2K)} \quad (12)$$

Where α = Significance level, K = Degrees of freedom for numerator, $n_1 + n_2 - 2K$ = degrees of freedom for denominator, If 'F' calculated is higher than 'F' table, then the null hypothesis of equity of the coefficients of cost function of two sub- samples is rejected. Therefore, two sub-samples are significantly different from each other, which is due to impact of size on cost of cultivation.

RESULTS AND DISCUSSION

The different degrees of polynomial cost function were estimated for each of these groups separately by using ordinary least squares (OLS) method and the results shown in Tables 1 to 4.

It should be noted that if reduction in error sum of squares (ESS) and increase in F-value or increase in coefficient of multiple determination (R^2) in higher degree of polynomial function is found to be negligibly more than previous degree of polynomial function, it is better to select more simple model because of simplicity of the model. The selection of best degree of polynomial cost function for different size groups is presented in Table 1. For all small and medium farmers group, large farmers group and entire sample farmers group cubic cost function provided the best fit.

The results of regression coefficients in respect of the cubic cost function for small and medium farmers group is presented in Table 2. The results showed that the coefficient of multiple determinations (R^2) was found to be 0.995 indicating that the variables included in the model had explained 99.5% of variations in the average total cost of barley cultivation per hectare. The adjusted coefficient of multiple determinations ($\bar{R}^2$) was found to be 0.995, which is equal to coefficient of multiple determinations indicating the goodness of fit. The observed "F" was found to be highly greater than the theoretical "F" value even at one percent level of significance which also reveals the goodness of fit.

The results of estimation of cubic polynomial cost function for large farmers group is presented in Table 3. This table shows very high values of R^2 (0.969) and adjusted R^2 (0.967) indicating goodness of fit. The coefficient of area (X) was negative and significantly different from zero, at one percent level of significance. The coefficient of quadratic term (X^2) was positive and significant at one percent level of significance. In the case of cubic term (X^3), the coefficient was found to be negative and significant at one percent level of significance. The F-value was found to be high and significant at one percent level of significance indicating goodness of fit.

The cubic polynomial cost function estimates for entire sample farmers is presented in Table 4. As already mentioned for the small and medium farmers group, and large farmers group, the estimation results of cubic polynomial cost function for entire sample farmers also showed the goodness of fit.

The Chow test was applied to test whether there is a significant change in the structural relationships of the regression coefficients of cost function of small and medium size with large size group. The F-ratio calculated in Chow test was found to be 866.193, which was highly greater than the theoretical "F" value ($F(\alpha, K, n_1 + n_2 - 2K) = F(0.01, 4, 171) = 3.32$) even at one percent level of significance, therefore the null hypothesis of the equity of the coefficients of two sub-samples is rejected. It indicates that small and medium farmers group and large farmers group are significantly different from each other which are due to impact of size on cost of cultivation.

In economic terminology, the "most profitable' amount can also be called the "optimum" amount (Doll and Orazem, 1978). The optimum size of farm, which is the most profitable amount of area, in the cases of small and medium, large and pooled groups was 17.08, 41.96 and 46.43 ha, respectively. It indicates that the average total cost decreases with increase in farm size and reaches its minimum when area is 17.08, 41.96 and 46.43 ha in small and medium, large and pooled sample farmers

Table 1. Selection of best degree of polynomial cost function.

Particulars (1)	No. of obs. (2)	ESS (3)	F-value (4)	R^2(%) (5)	$\bar{R}^2$(%) (6)
Small and medium farmers (≤ 10 ha)					
Linear	122	22,208,822	386.74*	76.3	76.1
Quadratic	122	2,482,635	2188.18*	97.4	97.3
Cubic	122	444,850	8253.02*	99.5	99.5
Quartic	122	512,922	7152.50*	99.5	99.4
Quintic	122	418,522	6525.23*	99.6	99.5
Large farmers (> 10 ha)					
Linear	57	14,513,860	152.86*	73.5	73.1
Quadratic	57	12,959,589	87.28*	76.4	75.5
Cubic	57	1,695,169	553.99*	96.9	96.7
Quartic	57	1,619,998	580.51*	97.0	96.9
Quintic	57	1,682,825	558.18*	96.9	96.8
Overall (0.15 - 200 ha)					
Linear	179	226,000,000	2.59	1.4	0.9
Quadratic	179	139,000,000	57.72*	39.6	38.9
Cubic	179	45,500,676	235.80*	80.2	79.8
Quartic	179	35,269,094	239.47*	84.6	84.3
Quintic	179	36,491,274	229.99*	84.1	83.7

*Significant at 1% level.

Table 2. Estimated cubic cost function for small and medium farmers groups.

Particulars (1)	Coefficient (2)	Standard error (3)	t-value (4)
Variable			
Intercept	8580*	16.344	524.981
X	- 851.147*	17.183	- 49.534
X^2	- 154.932*	4.456	- 34.771
X^3	7.021*	0.302	23.249
Model summary			
R^2	0.995*		
$\bar{R}^2$	0.995		
ESS	122		
N	2.96		
Average farm size (ha)	17.08		

*Significant at 1% level.

groups, respectively. No, this is not the result in a cubic function. Just look at the cubic function scatter and scatter diagram.

Conclusion

The optimum size of farm which gives the most profitable output or produces the output at the least cost is crucial for farmers in agriculture sector. The results showed that the optimum size of barley farms in the case of small and medium, large and total farms groups were 17.08, 41.96 and 46.43 ha, respectively. It was greater than the average sample farm size in the case of small and medium farms group (2.96 ha) and total farms group (18.21 ha).

The study of the optimum size of farm revealed that the average total cost decreases with increase in farm size

Table 3. Estimated cubic cost function for large farmers groups.

Particulars (1)	**Coefficient (2)**	**Standard error (3)**	**t-value (4)**
Variable			
Intercept	6288*	97.708	64.364
X	-87.541*	5.352	-16.356
X^2	1.295*	0.066	19.550
X^3	-0.004*	0.0002	-18.767
Model summary			
R^2	0.969		
$\bar{R}^2$	0.967		
ESS	1,695,169		
F –statistic	553.987*		
N	57		
Average farm size (ha)	50.84		

*Significant at 1% level.

Table 4. Estimated cubic cost function for entire farmers.

Particulars (1)	**Coefficient (2)**	**Standard error (3)**	**t-value (4)**
Variable			
Intercept	7327.113*	53.715	136.408
X	-153.643*	6.062	-25.346
X^2	2.119*	0.095	22.255
X^3	-0.0067*	0.0004	-18.918
Model summary			
R^2	0.802		
$\bar{R}^2$	0.798		
ESS	45,500,676		
F –statistic	235.801*		
N	179		
Average farm size (ha)	18.21		

*Significant at 1% level.

and reaches its minimum when area is 17.08, 41.96 and 46.43 ha in small, medium, large and pooled sample farmers groups, respectively. Beyond these levels of area, the average total cost increases at increasing rate. The estimated optimum size of farms showed the fact that the most profitable farm size for all farm size groups belongs to large category of farms.

Policy implication

Based on the results of the study, most of the barley farms were less than optimum size which directly influences the farm's profitability. Therefore, land reform could contribute to bring close together actual farm size with optimum farm size. The government could encourage farmers to come forward in the locally suitable land consolidation programs and agricultural cooperatives to operate around the optimum size of the farm which is the most profitable point.

REFERENCES

Afrakhteh H (1997). "The effective factors in quantity and quality of tea in Iran". Dev. Agric. Econ. 30:85-108.

Anonymous (2005).Iran Statistical Yearbook, . Statistical Center of Iran, Government of Iran, Tehran, Iran.

Bacsi Z (1997). "Modelling chaotic behaviour in agricultural prices using a discrete deterministic nonlinear price model". Agric. Syst. 55(3):445-459.

Binswanger HP (1974). "A cost function approach to the measurement of elasticities of factor demand and elasticities of substitution". Am. J. Agric. Econ. 56(2):377-386.

Carter OH, Dean GW (1961). “Cost-size relationship for cash crop farms in a highly commercialized agriculture”. J. Agric. Econ. 43:264-277.

Chambers RG (1988). Applied production analysis a dual approach. First Edn., Cambridge University Press, Cambridge, U.K.

Doll JP, Orazem F (1978). Production Economics: Theory with Application. First Edn., John Wiley & Sons inc., New York, USA.

Elhendy AM, Alzoom AA (1961). “Economics of fish farming in Saudi Arabia:analysis of costs of tilapia production”. Aquacult. Econ. Manage. 5(3-4):264-277.

Emadzadeh M, Akbari N, Ghasemi M (2002). “Estimation of translog cost function and floor price of Date production in Fars province of Iran”. Dev. Agric. Econ. 40: 67-88.

FAO (2008). Statistical database, On-line data (http//: www.faostat.fao.org), Accessed 2 July 2008.

Gujarati DN (2003). Basic Econometrics. Fourth Edn., Boston, MA: McGraw-Hill.

Greer ML (2003). “Can rural electric cooperatives survive in a restructured US electric market? An empirical analysis”. Energy Econ. 25(5):487-508.

Helfand SM, Levine ES (2004), “Farm size and determinants of productive efficiency in the Brazilian center-west”. Agric. Econ. 31(2-3):241-249.

Karaki A (1998). “The impact of credit on small farm cost of production: The case of cattle farms in Jordan”. Dirasat Agric. Sci. 25(2):7-41.

Kiani KH (1999). “Determination of optimal input use in irrigated wheat cultivation in Iran”. Dev. Agric. Econ. 37:7-41.

Koo WW, Weining M, Sakurai T (2001). “Wheat demand in Japanese flour milling industry: a production theory approach”. Agric. Econ. 24:167-178.

Kuroda Y (1988). “The output bias of technological change in postwar Japanese agriculture”. Am. J. Agric. Econ. 70(3):663-673.

Kuroda Y (1995). “Labor productivity measurement in Japanese agriculture: 1956-1990”. Agric. Econ. 12(1):167-178.

Mukhtar SM, Dawson PJ (1990). “Herd size and unit cost of production in the England and Wales dairy sector”. J. Agric. Econ. 41:9-20.

Paul S (1987). “A cost function analysis of wheat production in India”. Eur. Rev. Agric. Econ. 14:221-238.

Paul S, Mehta R (1991). “Technology, factor demand and substitution in Indian agriculture 1960-1983”. Indian J. Agric. Econ. 46(4):530-542.

Salman AZ (1999). “Econometric analysis of Barley production in low rainfall areas in Jordan”. J. Dirasat-Agric. Sci. 50(4):584-605.

Snedecor GW, Cochran WG (1989). Statistical Methods. Eighth Edn., Lowa state University Press, Lowa, U.S.