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Analysis of the Structure and Savings of the Potato Production Scale Using the Translog Cost Function (Ardabil County)

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Abstract

The present study aimed at investigating the production costs and economic benefits of the potato production in Ardabil country, Iran. To do so, 183 potato producers were randomly selected and were asked to present their ideas concerning the production costs and benefits through a questionnaire and an interview. A field study was also taken into consideration to enrich the data. The collected data were analyzed through measures of Chi-square, Wald test, and Translog cost function. The results revealed that the cost function structure was non-hemotetic with respect to the Chi-square statistics (36.8) and results of the constant non-returns and non-homogeneous Wald test to the scale's F- statistics (17.04) were non-cobb Douglas. Allen cross replacement relationship was positive for the dichotomies such as workforce and machinery, machine and seed, workforce and seed, workforce and water, and finally seed and water. However, it was negative for machinery and land inputs, machinery and water, land and machinery, land and labor force, land and seeds, and land and water. The calculated cost elasticity was -1.5044 which indicated a decrease in the average costs for an output increase as the production cost was found in the downstream part of the cost curve. The economies of scale of 2.504 indicated a 2.5 percent increase in the yield for one-percent increase in the cost.

Keywords:
Ardabil City, Cost elasticity, Scale savings, Potato, Translog cost function

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INTRODUCTION

Meeting human beings' basic needs has been the main focus of agriculture. The earliest ancient civilizations were formed in the regions of the world where geographical and environmental features paved the ground for the emergence of agricultural activities (Tehranchian & Behravesh, 2014). Economists believe that a strong and advanced agricultural sector is essential to economic development (Mohammadi, 2012). Hence, such a sector enjoys variety of functions including playing a major role in achieving sustainable development and poverty reduction in the third millennium. Hence, notions such as income generation of the poor in the rural areas in the developing countries (Willan, 2007), creating food security (Kilis, 2007), decreasing food expenditure in the household budget RAHIMI and MIR (2008), restructuring the consumer economy to the production economy (Ghadiri Masoum, 2004). creating a market for the production of industrial goods Hashemi and Nahavandi (1996), as well as price stabilization of agricultural products and proper use of geographical infrastructure in the rural areas (Fallahi & Gholinezhad, 2018). could be considered among the functions of agriculture sector in any country.

In the past, researchers Sen (1962). believed in an inverse relationship between farm size and input productivity, meaning that small farms were better and more efficient than large farms. The reason, as they proposed, was that such farms did not require the rental labor; instead the family labor enjoyed the comparative advantage. In Iran, for the same reasons, in 1941, in order to develop agriculture and move from the traditional phase to the modern one, the government then began to modify the land. (Coornia, 1985) showed that the inverse relationship between farm size and efficiency of inputs is not accepted at the level of modern technology and that large farms are more efficient. He argues that the use of other inputs, including modified seeds, fertilizers and pesticides, are more important than the family workforce. Also, small farms cause disruption to the land use and other factors of production, including inability to use machinery properly and new agricultural production methods. Therefore, it is of paramount significance to investigate whether potato production technology in Ardabil has a rate-of-return, and if any, to specify this rate. Accordingly, the existing potentials of the region could be used in the potato production.

The United Nations has named potatoes *a hidden gem*. The title is due to the colorful role it plays in the global crisis such as poverty and hunger. Many experts believe that potato planting is the only way to combat world-wide hunger (Arzani, 2004; FAO, 2008). FAO experts believe that 20 tonnes of potatoes can be produced per hectare in 50 days. Only 10 tonnes of grain can be obtained from the same land for a longer period of time (Bagheri & Javadi, 2016). It is the first crop after milk to be considered as complete food because it is packed with vitamin C and carbohydrates, and among the most needed human products, its amino acids are favorable and have a lot of protein (Mohammadi & Rezaei, 2001). Following wheat (Triticum Aestivum), rice (Orissa sativa), and maize (Zea mays), potatoes are ranked fourth in the world in terms of nutritional importance and in Iran it is also considered as an important and strategic product. It is ranked second in terms of production and third in terms of nutritional importance among other food products (HassanPanah, 2016). The annual production of more than 5/1 million tonnes of potatoes in the country has made it one of the most important foodstuffs consumed after wheat (Parsa Pour & Waleem, 2004). This production comprises 6.67 percent of the total crop production and 29.65 percent of the total vegetable production. In addition, 99.77 percent of potato yields in the irrigated land (Nameless, 2016). Ardebil province not only satisfies the needs of the province with its annual production of more than 800,000 tonnes of potatoes, but it can also easily respond to the needs of the country and in addition, this province has a good capacity to produce and export potatoes to other countries. Studying the production of potatoes in the region has revealed irregular use of scarce resources and production inputs in the city in spite of its potentials. Accordingly, the present study seeks to identify the production structure, cost elasticity, and economies of scale to optimize production of this strategic product. There have been many studies on the cost structure of various agricultural products to estimate the optimal size of production unit, the relationship of input compositions, and costs of production factors. Among them one can refer to Yazdani and Abedi (2009) study on the grain maize production through Translog cost function which resulted in the fact that Allen cross replacement relationship existed between the paired inputs such as water and seeds or fertilizers and work force. Likewise, a complementary relationship was s found between the machinery and work force. In addition, the price elasticity of labor input was non-elastic and the economies of scale were less than one in corn production. In other words, returns to the descending scale was found dominant in the fields. jafari et al. (2012) studied milk production economic structure in industrial dairy farms of Kurdistan province using transgressive cost function and apparently unrelated equation systems. The results showed that there were no economies of scale in the units studied. Due to their price elasticity, demand for concentrate and other forage inputs had been the highest price elasticity and the producer was not responsive to changes in alfalfa inputs, animal health, environment, and energy. In another study, Hosseini et al. (2013) analyzed the production structure and economic benefits of sugar beet production in Iran through Translog cost function to estimate function coefficients, scale returns and substitution elasticities. This function was estimated along with cost-share equations using seemingly unrelated iterative regressions for the period 1987-2009. Partial cross-sectional stretches of Allen for each pair of inputs indicated that the chemical fertilizer input was a substitute for the workforce but complementary to the ground entity. The results also indicated that there was a complementary relationship between land and labor. Besides, calculating the price elasticity of demand showed that the labor force was the most attractive and the most inelastic input in the sugar beet production process. In addition, the results indicated that sugar beet production in Iran had an upward return to scale. Accordingly, a proportionate increase in input consumption was recommended in order to make the production process economical. Bakhshahyesh and Yazdani (2015) in a study estimated the demand function of energy carriers in Iranian agricultural sector. The study investigated the demand functions of energy inputs in agriculture including electricity and gas oil, and estimated the price elasticity and substitution (Allen and Morishima) among consumer inputs. For this purpose, the Translog cost function was used and the results showed that oil, gas, and capital inputs were alternatives, and the two entities were complementary to each other, while gas oil in general was more sensitive to changes in oil and gas prices than electricity. Therefore, it was recommended that given the cheaper and cleaner electricity, policies should be in place to increase electricity demand and reduce gas oil consumption, and to this end, it is advisable to adopt price policies the way that directly and consequently would affect electricity (Asadollahpour et al., 2016). examined production structure and efficiency of rapeseed product scale in Iran. For this purpose, the Translog cost function for this product was estimated using cross-sectional information from 2009 to 2009 and structural variables were calculated. The results of the study showed that the structural characteristic of scale efficiency in Iranian rapeseed crop was increasing, which meant that production costs were reduced by increasing the size of rapeseed fields. In other words, by an increase in crop yields, the average cost is reduced and thus, larger crops have a comparative advantage in terms of cost and efficiency in production compared to smaller crops. Therefore, an effective policy for rapeseed farms can be to increase the scale of production to reduce production costs. Ganji et al. (2018) identified the factors affecting water productivity in Alborz province wheat production using the data envelopment analysis method and completed 200 questionnaires in 2015. The results showed that the average technical efficiency of the studied units in the constant and variable efficiency compared to the scale were 74 and 78 percent, respectively, and the average water use efficiency in both cases was 88 and 90 percent, respectively. Ray (1982) provided a framework for examining the structure of US agricultural production in two parts (crop and livestock) using the cost function of the Translog. The results showed that the degree of substitution between labor and capital inputs was decreasing and that the price elasticities of demand for all inputs had increased over time.

These studies have mainly estimated the Translog cost function and cost share equations and have calculated the partial elasticity as well as the price elasticity of inputs and cost elasticity. Sang King (2006) studied the extent and economic efficiency of Chinese agricultural research farms using the generalized quadratic cost function. The results indicated that there were economies of scale in the new maize and wheat varieties. Kavoi et al. (2009), using the duality theory of production and cost, examined the structure of Kenyan farms and used the Translog cost function to obtain the demand function of inputs. The price elasticity of inputs and the economic scale were also calculated. The results showed that the production structure was appropriate and the inputs were substitutes for each other. Therefore, it was recommended to continue using the existing inputs in order to maintain current production levels. Kavoi et al. (2009), investigated milk production and input demand in small dairy farms in Kenya using the dual cost approach. In their study, elasticity indicated a wide succession of inputs, including substitution of whole foods with protein foods. The results indicated that the scale disadvantages associated with milk production in Kenya. Howitt et al. (2012), described and introduced a separate calibration model of economic models of agricultural production and water management in the state of California.

Due to the importance of potatoes in the economic development process, the need to generate more income for farmers, create employment, and facilitate growth of national capital and GDP, as well as the food needed for the world's growing population, it is inevitable to plan mass production of this item and utilize the inputs used in this field more skillfully. Therefore, the present study seeks to investigate the cost of production of this item, find cost elasticity and economies of scale in order to utilize scarce resources and economize potato production in Ardabil city. The research also seeks to find the relationship between the size of the potato farm and the amount of production and costs spent to increase productivity. The study assumes that production inputs are rationally and economically exploited by potatoes. In addition, it i assumed that there is a constant return to scale in the potato farms. Likewise, it is presumed that there are economies of scale in potato production farms in the research area and the technology of potato production in the research area is hemotetic.

METHODOLOGY

Ardabil province is located in the north of the Iranian plateau between 37° 5′ and 39° 59′ north latitude of the equator and 47° 10′ to 52° 55′ east longitude of the Greenwich Peninsula in northwestern Iran.

with an area of 17867 square kilometers, it occupies 1.09 of the total area of the country. Ardabil plain with an area of about 85,000 hectares is a fertile and potential land located in northwestern Iran (Statistical Yearbook of Ardabil Province, 2015). According to the latest statistics provided in1394, Ardabil province has 805 million $ of GDP without oil and 154 million $ of value added.

These statistics show that the share of value added in the agricultural, industry and mining, construction and service sectors of the province has been 24.2, 19.7, 56.1 percent, respectively, which shows that the province has an advantage in the services and agriculture sector (Statistical Yearbook of Ardabil Province, 2017).

Potato production in the country is estimated at 4.99 million tonnes, which is equivalent to 6.67 percent of crop production and 29.65 percent of total vegetable production, and 99.77 percent of it is irrigated land). Ardabil province with 14.12 percent of the country's potato production is the second largest producer of this product after Hamedan province with 19.68 percent of total production. Isfahan with 7.37 percent , East Azerbaijan with 6.65 percent, southern Kerman province with 6.26 percent, and Kurdistan with 6.19 percent of the country's potato production are ranked third to sixth, respectively. The six provinces have a total of 60.46 percent of the country's potato production (Statistical Yearbook of Ardabil Province, 2016).

Ardabil province with an annual production of more than 700 thousand tonnes of potatoes per year not only meets the needs

Table1
Area under Cultivation (Hectares) and Production (Tonnes) Of Potatoes in 6 Leading Provinces

Rank	Year place	89-90		90-91		91-92		92-93	
	Province	Cultivation level	Produc-tion	Cultivation level	Produc-tion	Cultivation level	Produc-tion	Cultivation level	Production
1	whole country	170290	4478003	181426	5069000	158564	4597631	159079	498865
2	Hamedan	23844	887284	25070	997707	21037	910274	28257	106394
3	Ardabil	22118	698505	22645	690237	26636	620692	23790	779506
4	Esfahan	11867	0257260	14151	315979	12314	304727	16578	461588
5	East Azarbaijan	9568	283638	11629	342513	9267	310663	10645	351845
6	Kurdistan	12279	361509	13404	383991	10777	348285	10419	344349
7	Zanjan	15206	433475	11048	394333	10992	357481	5705	197370

Rank	Year place	93-94		94-95		95-96		96-97	
	Province	Cultivation level	Produc-tion	Cultivation level	Produc-tion	Cultivation level	Produc-tion	Cultivation level	Production
1	whole country	160217	5140623	159061	4995327	146538	5012949	122578	4117462
2	Hamedan	26127	979288	26067	983404	24248	971500	-	-
3	Ardabil	22316	767223	22414	705618	21896	711064	22764	715592
4	Esfahan	12282	379563	13886	396610	15002	458062	-	-
5	East Azarbaijan	10304	341816	10333	336971	9271	314460	-	-
6	Kurdistan	10116	318408	9887	321320	7369	278635	-	-
7	Zanjan	6486	212901	6739	215595	6100	206460	-	-

Sources: Ministry of Jihad Agriculture (Agricultural Statistics, 2010-2020) of the province but also can easily meet the needs of the country and beyond that, it has a good capacity to export this product to other countries. In contrast, provinces with low production offer their product only in the market within the province or eventually neighboring provinces. Statistical data show that Ardabil province on average, during the years 2009 to 2017, with an annual production of about 14 percent of the country's potatoes, has been able to account for 21.2 percent of the annual exports of this product (Statistical Yearbook of Ardabil Province, 2016). Considering the importance of potato crop, in meeting the food needs of humans and household consumption basket, and on the other hand, considering that Ardabil province is one of the major production areas of this crop in the country, Investigating the status and structure of potato production in Ardabil city in recognizing the current situation and potentials in the research area can be of paramount significance.

Examination of the process and production process of an important potato crop in the past in Ardabil province and city shows that the use of production factors and inputs in this region does not follow logical and global standards and principles (HassanPanah, 2016). And this activity is not appropriate and optimal. Therefore, identifying the relationships between factors of production and inputs and in general knowledge of the structure of production, composition and use of inputs can be effective in economizing production of this item. Therefore, the present study was conducted in Ardabil city with the aim of investigating the production structure, explaining the existence of economic efficiency in the production of this product.

Table2

Area under Cultivation and Number of Potato Farmers in Ardabil Province

City name	Area under cultivation	Number of operators
Ardabil	12175	3108
Sarain	356	58
Nir	2375	103
Namin	6990	1789
whole province	21896	5058

Source: Ardabil Agricultural Jihad Organization (2017)

Table 3

Area under Cultivation and Number of Potato Farmers in Ardabil County

Name of the area	Area under cultivation	Number of operators
Suburbs	6595	18261
Fooladlo	3082	677
Somarin	830	155
22Bahman	1668	450
City collection	12175	3108

Source: Ardabil Agricultural Jihad Organization (2017)

Data collection procedure

The present research made employed both documentation and fieldwork to collect the data. Statistics and information were provided by documents from the Agricultural Jihad of Ardabil Province and the Ministry of Agricultural Jihad. Using Cochran's Relationship, 183 potato producing farmers were randomly selected from four regions of Ardabil country and the data were collected through survey and cross-sectional method for the year 1397-1976 using a questionnaire, interviews, and observation.

Data analysis

In order to investigate the presence or absence of economies of scale in potato farms, it is necessary to know the structure of production. Then, the manager of a production unit, with appropriate cost function and its proper interpretation, can select appropriate solutions and allocate inputs in production. In this study, because of the greater flexibility of cost functions, the use of input prices rather than the physical quantities of production factors as independent physical variables, and the first-order homogeneity of input prices, the cost function of potatoes was investigated.

The cost function provides the optimal relationship between firm cost, input price, and production level. It also indicates the minimum cost for each level of output accessible to the consumer (Yazdani & Abedi, 2009). The minimum cost depends on two sets of parameters, the amount of output and the price of inputs. C=C (P, Q) P, represents the price vector of inputs and Q, the level of output. In order to investigate the composition of inputs and how to use them, the cost elasticity and economies of scale were determined by using the Translog cost function. In the Translog Cost function

$$C = C(Q, P_E, P_M, P_L, P_W, P_S, P_f)$$

C= total cost, Pe = land cost (rental cost per hectare), Pm= car cost (car rental cost per hour calculated in hectares), Pl = price per person working day, Pf = fertilizer price per hectare,

Pw = cost of water consumed per hectare, Ps = cost of seed per hectare And Q= Amount of potato production per hectare.

The contribution behavior of inputs and the substitution elasticity of production is expressed both by the production function and by the cost function. The cost share of input i is in the form.

$$S_i = \frac{\partial LnC}{\partial LnP_i} = \frac{\partial C}{\partial P_i} \cdot \frac{P_i}{C} = \frac{P_i X_i}{C}$$

The substitution elasticity between inputs and output factors is as follows.

$$\eta_{ij} = \frac{\partial LnX_i}{\partial LnP_j} \Rightarrow \eta_{ij} = \frac{\alpha_{ij} + S_i S_j}{S_i}$$

$$\eta_{ij} = \frac{\partial LnX_i}{\partial LnP_j} \Rightarrow \eta_{ij} = \frac{\alpha_{ij} + S_i S_j}{S_i}$$

Since the Cog Douglas cost function has a fixed-rate efficiency for all farm sizes and is restricted, the Translog cost function does not impose any substitution between inputs. It also allows to modify output to scale along with the level of production. This makes the U cost of production average. In this study, the cost function of Translog was used. The generalized and summarized form of the Translog cost function is based on the second Taylor series expansion:

$$\ln C = \beta_0 + \sum_{i=1}^{N} \beta_i \ln p_i + \frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} \gamma_{ij} \ln p_i \ln p_j$$
$$+ \alpha_1 \ln q + \frac{1}{2} \alpha_2 (\ln q)^2$$
$$+ \sum_{i=1}^{N} \delta_{iq} \ln p_i \ln q + \varepsilon_k$$

In the cost function of the Translog Pi, the input price is the input i and the output value Q.

The second-order Taylor series expansion of Lnc is obtained around the point Lnp =0

The cost-equity-share equations, obtained by deriving the cost function from the input price, form the, i-form input.

$$S_i = V_i + \gamma_{Qi} LnQ + \sum_{j=1}^{n} \gamma_{ij} LnP_j$$

The scale of the Translog function function is as follows.

$$\frac{dy}{y} = \alpha_1 \frac{dx_1}{x_1} + \beta_1 \frac{dx_2}{x_2} + 2\alpha_2 \log x_1 \frac{dx_1}{x_1} + 2\beta_2 \log x_2 \frac{dx_2}{x_2} + \gamma_1 \log x_1$$

$$\frac{dx_2}{x_2} + \gamma_1 \log x_2 \frac{dx_1}{x_1}$$

The cost-elasticity criterion of production was used to estimate the economies of scale. Which is generally derived from the cost function as a relation,

$$\varepsilon_c = \frac{\delta \ln c}{\delta \ln Q} = \frac{\frac{\delta c}{c}}{\frac{\delta Q}{Q}} = \frac{MC}{AC}$$

or, by taking the differential from the Translog cost function as follows.

$$\frac{dTC}{TC} = \alpha_1 \frac{dPx_1}{Px_1} + \beta_1 \frac{dPx_2}{Px_2} + \alpha_2 \log Px_1 \frac{dPx_1}{Px_1} + \beta_2 \log Px_2 \frac{dPx_2}{Px_2} + \delta_3 \log Px_2 \frac{dPx_1}{Px_1} + \delta_3$$

In this study, six inputs are used because of the homogeneity of the Translog cost function, the total share of input costs is normally equal to one.

$$V_E + V_M + V_L + V_W + V_S + V_f = 1 \quad , \quad \sum_{i=1}^{6} V_i = 1$$

Therefore, estimating the system of equations would normally cause the variance matrix and the covariance of the disruption components to be zero, followed by a linear problem between the inputs and the explanatory variables. In order to solve this problem, the appropriate method for estimating equations, eliminating one of the insignificant inputs compared to other inputs, is the cost-share equations of the simultaneous equation system. In this study, fertilizer input was removed. Based on fertilizer input prices, other functions and cost share of inputs were normalized. Overview of the parameters and estimated coefficients for potato production cost function and cost share of each of the five inputs: including land, machinery, labor, water consumption per hectare and seed consumption were calculated as follows.

$$Ln\left(\frac{C}{P_f}\right) = V_0 + V_Q LnQ + \sum_{i=1}^{5} V_i Ln\left(\frac{P_i}{P_f}\right) + \frac{1}{2}\gamma_{QQ}(LnQ)^2 + \frac{1}{2}\sum_{i=1}^{5}\sum_{j=1}^{5}\gamma_{ij} Ln\left(\frac{P_i}{P_f}\right) Ln\left(\frac{P_j}{P_f}\right) + \sum_{i=1}^{5}\gamma_{Qi} LnQ Ln\left(\frac{P_i}{P_f}\right) + U_C$$

The use of the Translog Cost function is subject to conditions that are called Goodwill. The homogeneity and the symmetry of the Translog cost function are related to the input price. Since the dependent variable is logarithmic, the non-negative property of the Translog cost function can be proved and the following constraints must be applied to satisfy homogeneity and symmetry. Otherwise, the following constraints on cost function parameters are set.

$$\sum_{i}^{n} \gamma_{ij} = \sum_{j}^{n} \gamma_{ji} = 0 \qquad \sum_{i}^{n} V_i = 1 \qquad \sum_{i}^{n} V_i = 1$$

Other features of the cost function after estimation as well as Translog cost function estimation by means of repetitive unrelated regression methods did not impose any restrictions on the possibility of substitution of inputs, nor did they limit the structure of production to be hemotetic and homogeneous. However, features such as technology hemotetic and production function, scaling efficiency, and cobb-Douglas production function were statistically tested on the Translog cost function.

The most important purpose of this study was to estimate the return to scale as a technical feature of the production function. Economies of scale in production mean that larger scale production and larger farms are less costly. The cost elasticity is derived from the derivation of the cost relative to the quantity of production. And by definition it is the “ratio of changes in production cost to one percent change in production quantity” change in production quantity or through change in cultivation level or change in Performance is achieved. Since farmers can control the change in the area under cultivation better than the change in yield, the return to scale is more justified in this study. In the present study, to estimate the model and perform the necessary calculations, information was needed on the price and quantity of inputs used in potato production, which were collected through face-to-face interviews and questionnaires.

RESULTS AND DISCUSSION

The estimation of the Translog cost function in Table 4 was estimated for the costs incurred at the level of one hectare and shows that the highest coefficients were for seed and land inputs. Production quantities in the cost-share equations of land, machinery, seeds, work force, and water have been marked as gQL, gQM, gQS, gQE, and gQW respectively. Apart from water, they were statistically significant. Given that the coefficients of land and machinery, and negative water, and seed and labor coefficients were positive, the findings indicate that increased production rates have a negative effect on the cost share of land and machinery. That is, by the increased production, less inputs and machinery are used, while the use of seed input and labor force are increased. Also, increasing the scale of production has no significant effect on the cost share of water. This situation reinforces the hypothesis that the structure of production is non-hemotetical. That is, scale change (an increase in the production level), according to the results of the study, will lead to more use of seed input and labor force and less use of land and machinery, while the use of water input will remain constant. The R2 obtained (0.995) indicates a good fit to the Translog cost function. In other words, it has been able to explain the total production cost changes by six inputs.

In order to interpret the relationships between inputs, alternating elasticities were investigated between them. In order to test the hypothesis of technology and potato production function in Ardabil city, the chi-square test was performed as follows.

$$\lambda = \left(\frac{\det \Omega_R}{\det \Omega_U}\right)^{-\frac{n}{2}} \Rightarrow X^2 \approx -2\ln\lambda$$

In the above relation, $\det\Omega_R$ the variance-covariance matrix of the disruption components of the model is bound to the hemotetic constraint and $\det\Omega_U$ It is related to the non-binding model, the test result is meaningful.

$$X^2 \approx -2\ln\lambda = -2\times \ln\left(\frac{5.38\times10^{-23}}{4.40\times10^{-23}}\right)^{-\frac{n}{2}} = +36.8$$

Given the two-way hemostatic test and the asymmetric chi-square distribution, the critical value at the 1% error level is equal to $X^2_{a/2} = X^2_{0.005}$ and Degree of freedom 5 (number of hemotetic restraints) is 16.75. Since the calculated statistic is larger than the critical value of the table. Therefore, the hypothesis of production technology being hemototic is rejected with 99% confidence. And the opposite hypothesis is that the technology and function of potato production in the research area are non-hemotetic. Also considering that the cost function is not separable by multiplying the output values and the input prices. Therefore, it can be said that the cost structure of potato crop in the research area is non-hemototico.

That is, this relationship is not established

C=F(Q)*H (P)

Scale change is the change in the amount of a product resulting from a proportional

Table4

ISUR System Estimation Results of Translog Cost Function and Potato Share Equations of Ardabil City

Parameter	Coefficient	Standard deviation	T statistics	Parameter	Coefficien	Standard deviation	T statistics
V.	-4.30	11.53	-0.37	Υ_{MM}	0.08	0.005	17.8***
V_Q	2.54	2.22	1.14	Υ_{LL}	0.059	0./005	11.36***
Υ_{QQ}	-0.22	0.21	-1.02	Υ_{SS}	0.141	0.003	43.5***
Υ_{QE}	-0.016	0.008	-2.03**	Υ_{WW}	0.06	0.002	25.72***
Υ_{QM}	-0.013	0.005	-2.47***	Υ_{EM}	-0.03	0.002	-165.6***
Υ_{QL}	0.004	0.001	4.396***	Υ_{EL}	-0.053	0.003	-19.61***
Υ_{QS}	0.036	0.009	3.75***	Υ_{ES}	-0.08	0.002	-32.1***
Υ_{QW}	-0.001	0.004	-0.32	Υ_{EW}	-0.02	0.001	-15.39***
Υ_{E}	-0.696	0.088	-7.89***	Υ_{ML}	-0.0008	0.004	-0.19
Υ_{M}	0.25	0.059	4.22***	Υ_{MS}	-0.034	0.002	-16.5***
Υ_{L}	0.355	0.022	16.28***	Υ_{MW}	-0.013	0.002	-6.06***
Υ_{S}	0.776	0.108	7.13***	Υ_{LS}	-0.0001	0.00005	-4.65***
Υ_{W}	0.056	0.047	1.199	Υ_{LW}	-0.008	0.0004	-18.3***
Υ_{EE}	0.187	0.001	134.7***	Υ_{SW}	-0.017	0.002	-11.7***
D	0.01	0.003	2.86***				

R^2_E=0.899, R^2_M=0.805 , R^2_L=0.0446, , R^2_S=0.821, R^2_W=0.763
4.40*10^{-23} R^2_S=0.995

***$p<0.01$, ** $p<0.05$, * $p<0.1$

Determinant of the variance – covariance matrix of the system of total equations.
Good estimation of the Translog cost function.

change in the price of all inputs (Nicholson & Snyder, 2012).

So, if there is a change in the scale of production, the share of the cost of production inputs will be skewed. Since the production technology was rejected for the above reasons, the scale change in production would cause the use of inputs to be skewed.

$$N_i = \frac{\gamma_{Qi}}{S_i} \qquad (i = E, M, L, W, S, f)$$

If the (N_i) obtained is smaller than zero, it is related to the scale change in order to store the input (endowment input). That is, the inputs will be less used. Conversely, if (N_i) is greater than zero, the slope will be related to the scale change for input and (input) use. And if (Ni) is equal to zero, there is no oblique to the scale change for the input. The amount of input for the inputs used in potato production in Ardabil city was calculated using the parameters listed below.

As shown in Table 5, the potato production technology in the research area is due to the non-hemotetic production of the product and with respect to the numbers obtained in the production process, for the input of land (-0.063), machinery input (113 (-0.01) and water inputs (-0.016) The slope of the scale has been shifted to store these inputs and with the increase in production scale, these inputs are less used and their cost share will be reduced. Whereas for labor inputs (0.023) and seeds (0.121) the scale shift is due to the consumption of these inputs. And with the increase in the area under cultivation, these inputs will be used more and will increase their cost. In other words, the related bias is due to the scale change to store inputs of land, machinery and water and the greater use of labor and seed inputs in the potato production process in the research area.

Scale Constant Efficiency Test: Since the assumption of the hemotetic of potato production technology in the research area

Table 5

Estimates of Skews Due to Scale Change of Potato Production Inputs in the Research Area

Name of Input	(Antelles value) The amount of skew associated with the scale change
Earth	-0.063
Machinery	-0.113
Labor	0.023
Seed	0.121
Water	-0.016

was rejected for the reasons stated above, it can be said that the product production function in the region does not have a constant yield relative to the scale. Also: If the function and production technology have a constant return condition on the scale, we can write the translog cost function as follows:

C (Q, P) = Q.H (P)

In this case, the following relations must prevail between the parameters of the equations:

$$V_Q=1\ ,\ \gamma_{QQ}=0\ ,\ \gamma_{Qi}=0 \qquad (i=E,M,L,W,S,F)$$

Coefficients are significantly different from zero, as shown in Table 6 above, from the Wald test, so the constant return to scale is also rejected, meaning that the production function does not have a constant return to scale.

Testing the Cobb-Douglas Hypothesis of Potato Cost Function in the Research Area: The transgressive cost function is considered as the general Cobb-Douglas cost function. Therefore, it is also necessary to consider the form of being a *Cobb-Douglas*. The condition for the estimated cost function to be Cobb-Douglas is that the following constraints apply.

$$\gamma_{QQ}=\gamma_{QE}=\gamma_{QM}=\gamma_{QL}=\gamma_{QS}=\gamma_{QW}=\gamma_{EE}=\gamma_{MM}=\gamma_{LL}=\gamma_{SS}=\gamma_{WW}=\gamma_{EM}=\gamma_{EL}=\gamma_{ES}=\gamma_{EW}=\gamma_{ML}=\gamma_{MS}=\gamma_{MW}=\gamma_{LS}=\gamma_{LW}=\gamma_{SW}=\cdot$$

Also, to test the cost function of Cobb Douglas, we first estimate the cost function without (non-bound) constraints and then by applying the constraints to the cost function of Cobb Douglas.

(Bound model). We then test the H_0 hypothesis of the function Cobb Douglas using the F statistic.

$$F=\frac{RSS_R - RSS_{UR}/m}{RSS_{UR}/n-k}$$

RSS_R = Sum of squares of disturbance model constraint statements,

RSS_{UR} = Sum of squares of the non-bound model disturbance statements. m Number of constraints *n* Sample size K is the number of non-bound model parameters.

$$\frac{(0.841-0.253)/21}{0.253/(183-29)}=17.04$$

Given that the critical value of *F* table with 21 degrees of freedom and 154 denominator degrees of freedom at 1 percent confidence level is 1.97, this is smaller than the

Table 6

Wald Test Results (Constant Return to Scale)

Parameter	γ_{QW}	γ_{QS}	γ_{QL}	γ_{QM}	γ_{QE}	γ_{QQ}	V_Q	Chi-square	df	Probability
Coefficient	-0.0356	.0355	0.0026	-0.0080	0.0066	0.4350	2.56	24.35	6	0.0004**

computational statistics of the research. Therefore, the null hypothesis that, the cost function is Cobb Douglas, is rejected and it can be concluded that the cost function does not have the Cobb-Douglas form.

Estimating the Cost Share of Inputs: In order to calculate the elasticities and relationships between inputs, the cost share of the inputs must first be calculated. The cost share of the inputs alone does not have a definite and economically usable interpretation and is used to calculate the drawdowns. The total cost of the inputs was estimated as follows.

$$S_i = V_i + \gamma_{Qi} LnQ + \sum_{j=1}^{5} \gamma_{ij} Ln\left(\frac{P_j}{P_f}\right) + U_i$$

Table 7 shows that the highest share is related to seed input and the lowest share is related to water input. And since the share of inputs is greater than zero and positive for all digital observations, the monotonic condition is also based on the cost function of potatoes in the research area. After estimating the share of input costs, Allen's partial and partial elasticities were estimated according to the following equations.

$$A_{ij} = \frac{1}{S_i} \cdot \frac{1}{S_j} [\gamma_{ij} + S_i S_j] \Rightarrow A_{ij} = \frac{\gamma_{ij}}{S_i S_j} + 1 \; A_{ii} = \frac{1}{S_i} \times E_{ii}$$

And the results showed that all of Allen's Own stretches for all inputs, ie, the original diameter of the negative matrix have the expected sign which shows the inverse relationship between the input price and the quantity demanded for that input. Cross elasticity between inputs of land and machinery (-0.0313), land and labor (-0.2145), land and seed consumption (-0.0875) and water land (-0.3155) were negative and indicated that these inputs complement each other in the potato production process in the research area. Or, better yet, the input of the earth is a non-substitutable variable. Allen's elasticity between machinery and labor (0.9561) and 0 machinery and seed consumed (0.0095), consumed seed and water (0.0453), indicated the succession of these inputs in production.

Estimated Own and Cross-Demand Price Demand for Potato Inputs: Own-source and cross-demand price elasticities of inputs in the potato production process in the research area can be obtained using the share of input costs and the following relationships.

$$E_{ii}=SiA_{ii} \qquad E_{ij}=S_jA_{ij} \qquad E_{ji}=S_iA_{ji}$$

Demand price elasticities measure the percentage of demand changes relative to the percent of self-inflated (own-elastic) and other inputs (cross-price elasticities). The intrinsic price elasticity of inputs is negative and less than zero as expected by the economic theories (Yazdani & Abedi, 2009). Given the numbers obtained from the calculation of the elasticities, the exponential function is concave to the price of the inputs, since they are smaller than one, indicating that the demand for these inputs is elastic. The price elasticity of demand is negative for all inputs. This means that as the price of these inputs increases, their demand decreases. The labor and seed inputs are the most sensitive. Accordingly, by one percent increase in the price of labor, its demand is decreased by 0.082 percent. Self-contained price elasticities for all inputs is as follows; land (-0. 00063), machinery (-0.0136), labor (-0.0282), seeds (-0.0755), water (-0, 00038), i.e. diameter. The origin of the matrix is a

Table7

Average Cost Share of Potato Inputs in the Study Area

Parameter (input)	S_s	S_l	S_m	S_e	S_w
Average	0.297424	0.172511	.0115929	0.251206	0.062363

logically correct, negative sign, which is fully consistent with economic theories.

Investigation of cost elasticity and economies of scale: Cost elasticity is derived from the cost derivative relative to the amount of output and by definition it is "the ratio of production cost changes to one percent change in production value"(Yazdani & Abedi, 2009).

Therefore, for the translog cost function, the cost elasticity is calculated from the following equation.

$$EC = \frac{\partial \ln c}{\partial \ln q}$$

If the calculated number is less than one, it indicates that as production increases, the cost will decrease and the production will be at the downside of the cost curve. Conversely, if the number is greater than one, it means that by increasing production by one percent, the cost will increase by more than one percent. Hence, the production will be on the upward curve of the cost curve. If the number is equal to one, it means that the average cost is at its minimum rate.

Since the cost elasticity (Ec) obtained from the test -1.5044 (≤1), the average cost of production will decrease by an increase in the production. That is, potato production in the research area is located in the downstream part of the cost curve. The economies of scale are also calculated as follows:

Es=1-Ec=[1-(-1/5044)] =2/5044

The number obtained for economies of scale also indicates that potato production in the study area has a significant incremental economies of the scale. In other words, for a 1-percent increase in production costs, 2.5 percent will be added to potato production, which indicates high economies of the scale.

CONCLUSIONS AND SUGGESTIONS

Meeting food needs and its security for human society is of considerable importance. Likewise, the lack of food security seriously threatens human life and society and poses a serious threat. The agricultural sector plays a significant role in providing food and food security for the growing population all over the world. The results of various tests in this regard showed that the cost function of potatoes in the non-hemotetic research area is a non-constant return to scale and also the cost function is not a Cup-Douglas function. The present study finding is in line with the findings of Alemdar and Necat Oren (2006), Bakhshahyesh and Yazdani (2015), Pourmokhtar and Ghaderzadeh (2013), AMJADI et al. (2007) and confirms their findings. But it is in the opposite direction with the findings of (Piri & Heidari, 2018). This result indicates that the proper

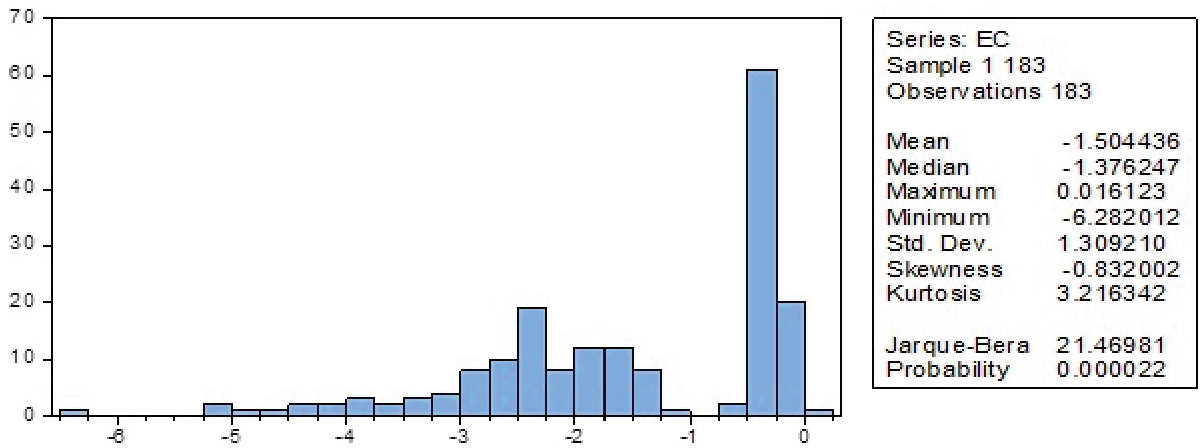

Figure 1. Cost Elasticity Graph

combination of factors of production is influenced by the scale of the field of activity. According to the relationship and research (Antel) scale change (an increase in production level), the results of the present research showed that the number obtained for seed input and labor has an additional oblique, which indicates an increase in the production level. Also, it will lead to more use of seed and labor input and less use of land and machinery, while the use of water input will remain constant. This result was similar to the results of previous studies such as Evolotopoulos (2013), Ray (1982), and Rashid Iqlim et al., Rashidghalam et al. (2012) and (Khalilian, 2010). In the present study, input price elasticity demand for inputs is less than one. This is in line with and confirmed the the findings of (Jahangi and Asghari ,2006), (KHALILIAN & ABEDI SHAPOORABADI, 2002), AMJADI et al. (2007),(Motiko Vedna,2008),Kavoi et al. (2009), Hosseini et al. (2013), and Seifi and Dehghanpoor (2014). This indicates the low flexibility of potato production in the region. Therefore, it can be concluded that farmers can not react highly to changes in input prices. As a result, the unreasonable increase in the price of inputs leads to an increase in costs and losses for producers. It seems that the management of this issue should also be considered in policy making. The highest cost was related to seed input and the lowest was related to water input. Also, the cost elasticity obtained from the research result is less than zero and indicates a decrease in the average cost of production versus an increase in production. There are economies of scale in potato production in Ardabil and according to the number obtained in the research, for a 1-percent increase in production costs, more than two and a half percent is added to the amount of product and output. In other words, the average cost of each production unit decreases with increasing farm size. Therefore, larger crop units are more efficient than smaller crop units. Accordingly, and according to the results obtained, including the non-hemototic cost structure, higher scales of potato production and the use of more cultivated area in the region are suggested. In this regard, due to the low water level of groundwater aquifers due to unreasonable use of water by farmers in the past in the research area, and the results of the Antel relationship, regarding water input, which is skewed by negative scale change, it is recommended that farmers cultivate potatoes on a larger scale in Ardabil so that the consumption of scarce water input can be optimally allocated. Since the research results showed that the oblique result of the change in scale is positive for labor input, the use of large-scale cultivation of this crop will lead to more job development and reduce the unemployment rate in the research area.

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