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Research Paper

Factors Affecting Energy Consumption in the Agricultural Sector of Iran: The Application of ARDL-FUZZY

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Abstract

Given the unlimited needs of mankind and the limited resources available, human beings have always been thinking about how to use the available resources and facilities optimally. Energy plays an important role in economic activities and it is of great importance in agriculture. Over the past four decades, energy consumption in the agricultural sector has increased tremendously. In Iran, energy used to be provided with subsidies to various economic sectors like agriculture in order to support the production. In this study, the ARDL- FUZZY method is used to study the effect of various factors on energy consumption in Iran's agricultural sector. The data on energy consumption by the agricultural sector, the share of the agricultural sector in the economy, the ratio of capital to labor, energy intensity, and energy prices were collected for the period 1974-2015. The results indicate that the share of the agricultural sector has a positive and significant effect on energy consumption over the studied period. The capital/labor ratio has a positive effect on energy consumption. Energy intensity in the studied period eventually has an irregular trend and has a positive effect on energy consumption in this sector. Energy prices (fossil fuels and electricity) have a negative effect (a low level of significance) on energy consumption. Therefore, it is suggested to give more consideration to energy consumption and its underlying factors in policymaking due to the importance of energy and the problem of pollution.

Keywords:
Energy consumption, agricultural sector, ARDL-FUZZY, Iran

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INTRODUCTION

Petroleum shocks along with the economic recessions in the West in the 1970s have led to the emergence of an energy role in economic transformations in particular. Nowadays, energy is important both as an input and an output (Zare Mehrjerdi et al., 2012; Ziaabadi et al., 2013). As a developing country with enormous energy resources, extensive oil reserves, and large mineral deposits, Iran can be a model example of growth based on almost over-exploitation of natural resources. Prudent and balanced planning for the production and consumption of energy is, therefore, of utmost importance and must be carried out with extreme care.

The relative abundance of energy resources in Iran is the prime reason for its higher per capita consumption of energy compared with other countries with similar economic structures and more limited energy resources (Armen & Zare, 2009; Ministry of Energy of Iran, 2015). Cheap energy costs and factors like the absence of modern technology in different economic sectors in Iran are responsible for much higher per capita energy consumption than practically most developing or developed countries. This phenomenon is not only detrimental to the environment and sustained economic development, but imposes heavy costs on the national economy. High energy consumption, in addition to environmental degradation and high economic costs, is an obstacle to achieve sustainable development. The first step in this direction was the inclusion of Article 121 in the "Third Cultural and Socio-economic Development Plan" in the Law of the Islamic Republic of Iran, by which the Ministry of Oil was commissioned to set up specialized committees to draw up standards and quotas for energy consumption in various sectors of the economy. Subsequent to the Law's ratification, a new organization named "Optimization of Energy Consumption Organization" was set up jointly by the Ministry of Oil and the Ministry of Power in order to oversee the implementation of the content of Article 121 (Barati Malayeri & Jaffari, 2008; Zare Mehrjerdi et al., 2012; Ziaabadi et al., 2013).

In recent years, making use of energy input has become very important due to changes in technology and applications of energy-consuming equipment and machinery in many agricultural sub-sectors and increasing levels of mechanization. The trend of energy consumption in the agricultural sector shows that energy consumption has increased from about 10.4 million barrels of crude oil in 1974 to 51.3 million barrels in 2015 in the agricultural sector (Ministry of Energy of Iran, 2015). It consists of about 3.80% of the total energy of Iran. Moreover, the level of energy consumption in agriculture has increased drastically since 2001 and has shown a significant increase compared to previous decades (Kohansal & Rafie, 2012). A comparison to the global pattern of energy consumption shows that Iran has low energy efficiency. The average amount of energy consumed per 1,000 dollars of production in Iran is 176 kg of crude oil while in many countries this number is less than 100 (United Nations Conference on Trade and Development, 2011). Emphasizing economic, social and cultural development programs of the Islamic Republic of Iran and budget bill of 2010 on the one hand and subsidy reform plan on the other hand have obliged the government to make specific plans for optimal energy consumption in various economic sectors such as agriculture. So, identifying factors affecting the consumption of energy resources in agriculture can be important for suitable policy-making and optimal energy consumption.

Many studies have already been carried out on energy and energy consumption in the agricultural sector. Kordoni et al. (2018) investigated the energy consumption of crops in Iran and found that crop systems depend on energy. Farajian et al. (2018) showed that energy had heavily been used in the Iranian agricultural sector during the period 1988-2014. However, energy productivity was increased by price liberalization. Energy consumption in Iran was analyzed by Jahangard et al. (2017) for the period 2001-2011. They showed that 73% of the energy consumption was related to the final demand. Fei and Lin (2017) analyzed the energy-saving potentials of China's agricultural sector by using an econometric approach and a scenario analysis. Then, a co-integration analysis and an error correction model were employed to make a long-term analysis for the period 1980-2012. Results showed that agricultural output and mechanical power had positive impacts on energy consumption. Schulte and Heindl (2017) applied a quadratic expenditure system to estimate price and expenditure elasticity of residential energy demand (electricity and heating) in Germany by using data from 1993 to 2008. Increases in energy prices showed a regressive pattern of incidence, implying that the welfare consequences of direct energy taxation were larger for low-income households. The sustainability of agriculture in the European nations was examined by Yan et al. (2017) with an emphasis on the role of energy for the period 1995-2012. Abbasi (2015) forecasted energy consumption in the agricultural sector of Iran and expressed economic and environmental damages. Mousavi (2015) concluded that GDP per capita and capital per capita were effective in energy intensity in Iran. Using the data of Turkey energy markets (gas) and the co-integration model with structural delays, Cetin and Yoksel (2014) showed that energy dependency strongly affected the long-term dynamics of the energy market. Sadeghi et al. (2012) used the Granger causality and Granger Hashyao for the period 1995-2007 in Iran. Their results suggested a causal relationship between the value of industrial production and consumption of energy. Heidari and Saiedpour (2012) analyzed the relationship between GDP, energy consumption, and non-oil exports in Iran and confirmed a long-run relationship using time series data of 1967-2007 and econometric methods. Ghanbari et al. (2012) evaluated the energy consumption function using the ARDL method and concluded that there was a stable long-run relationship between energy consumption, GDP, and energy price during 1971-2008. Kohansal and Rafie (2012) examined changes in energy consumption in agriculture and showed that as rural household expenditures were increased by 10%, energy consumption was increased by 0.92% in agriculture with the data of 2007 in Iran. Malaysian agriculture's energy productivity was analyzed by Ahamed et al. (2011) for the period 1991-2009. It was revealed that energy productivity was lower in Malaysia than in Norway. Azadeh et al., (2009); Chung (2012); Farahi et al (2011); Gholizadeh & Vahidpour (2011); Khashei & Bijari (2010); Moradi et al. (2012); Mousavi et al. (2010); Pourkazemi et al., (2016); Yan-Qun et al (2007), are examples of studies using fuzzy regression.

Therefore, given the importance of energy in the agricultural sector and economic and environmental risks of high energy consumption, this study aims to investigate the factors influencing energy consumption in the agricultural sector of Iran over 1974-2015 by using the ARDL-FUZZY method.

METHODOLOGY

Classical regression and fuzzy regression are based on two different perspectives. The classic regression model considers some assumptions in the field of probable distribution of errors. Although the classic regression model has various applications, in some cases, there are problems in making this model including low or insufficient number of observations, problems in defining suitable distribution function, ambiguity in the relationship between dependent and independent variables, ambiguity in occurrence or occurrence degree of events, and carelessness or error. To solve these problems, the fuzzy regression method can be used (Shayan Nejad et al., 2007; Pourkazemi et al., 2016).

Fuzzy regression

Fuzzy regression is a generalization of classical regression that is used to compute the functional relationship between independent and dependent variables in a fuzzy environment. In the classic linear regression, a specific amount of an output variable is calculated for each set of input variables; however, the fuzzy regression estimates a range of possible amounts for the output variable. In general, there are three types of models for fitting a fuzzy regression: fuzzy possibilistic regression models, least squares regression models, and interval-analysis-based regression models. Fuzzy possibilistic regression models were first presented by Tanaka et al. (1987). These models obtain the best regression equation by minimizing fuzzy amounts. It is done by minimizing the total width of membership functions of fuzzy coefficients of the regression equation. One of the regression models is the possibilistic regression model in which coefficients are fuzzy while inputs and outputs are non-fuzzy. In this study, this model was used based on the nature of data (Eq. 2) (Khashei & Bijari, 2010; Sadatinejad et al., 2011).

$$\tilde{y} = \widetilde{A_0} + \widetilde{A_1}x_1 + \widetilde{A_2}x_2 + \widetilde{A_3}x_3 + \cdots + \widetilde{A_n}x_n \tag{1}$$

in which represent fuzzy numbers and the input variables $(\tilde{A}_0, \tilde{A}_1, \tilde{A}_2, \ldots, \tilde{A}_n)$ are the natural numbers. For every *n* variable, one fuzzy number like is calculated as the output. In linear regression with fuzzy coefficients, it is assumed that the observations and variables are accurate and unambiguous in regression coefficients. The symmetric triangular membership function is used to find the above parameters, which is shown in Figure 1.

Suppose that there are *m* rows of observational data, *n* input variables), and an output variable in every row. Also, suppose that the fuzzy number is in the form of a symmetrical triangle (Figure 1: is number width and is the center of fuzzy number). In this case, the membership function can be written as Eq. 2.

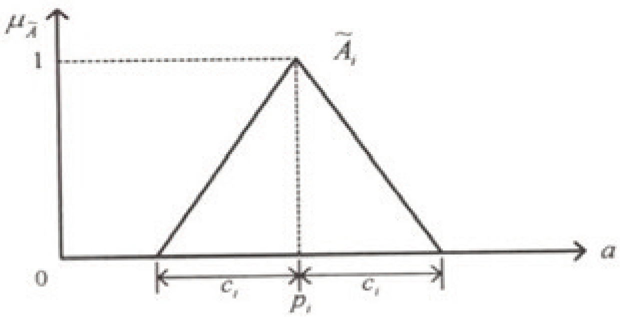

Figure 1. Membership function of fuzzy

Coefficients fuzzy number in Figure 1 shows toughly equal amount of , and shows its fuzzy amount; this can be shown as . Therefore, the fuzzy regression equation is as follows:

$$\mu_{\tilde{A}}(a_i) = \begin{cases} 1 - \dfrac{|P_i - a_i|}{C_i} & P_i - C_i \leq a_i \leq P_i + C_i \\ 0 & \end{cases} \tag{2}$$

$$\tilde{y} = (P_0, C_0) + (P_1, C_1)x_1 + (P_2, C_2)x_2 + \cdots + (P_n, C_n)x_n \tag{3}$$

Membership function of the output fuzzy variable $(\tilde{y})$ is shown as follows:

$$\mu_{\tilde{y}}(y) = \begin{cases} \max(\min[\mu_{\tilde{A}}(a_i)]) \\ 0 \end{cases}$$

$$\{a | y = f(x, a) \neq \emptyset\} \tag{4}$$

Inserting Eq. 2 in Eq. 4 yields Eq. 5 as below:

$$\mu_{\tilde{y}}(y) = \begin{cases} 1 - \dfrac{y - P_0 - \sum_1^n P_i X_i}{C_0 - \sum_1^n C_i |X_i|} & X_i \neq 0 \\ 1 & X_i = 0, y = 0 \\ 0 & X_i = 0, y \neq 0 \end{cases} \quad (5)$$

Different methods have been proposed to solve fuzzy linear regression problem. One of them is to change the fuzzy regression problem to a linear programming problem. The aim of fuzzy regression model is to determine optimal amounts of $\tilde{A}^{\tilde{A}}$ in a way that the membership degree of the fuzzy output variable (for all data) is bigger than a certain amount (such as h) which is determined by the user. In other words, for m rows of data, we have:

(j=1, 2, 3, 4..., m)

The following inequality must hold:

$$\mu_{\tilde{y}}(y) \geq h \quad (6)$$

As the amount of h increases, the fuzzy amounts of the outputs increase too. Eq. 6 shows that the fuzzy output must be between the amounts of A and B shown in Figure 2. According to Eq. 3, the center and width of the output membership function equal

$$c_0 + \sum c_i X_i \text{ و } P_0 + \sum_1^n P_i X_i$$

In a fuzzy possibilistic regression, the coefficients are determined in a way that the width of the fuzzy output is minimized for all datasets. Accordingly, the objective function and constraints of a linear programming problem can be presented as Eq. 7-10.

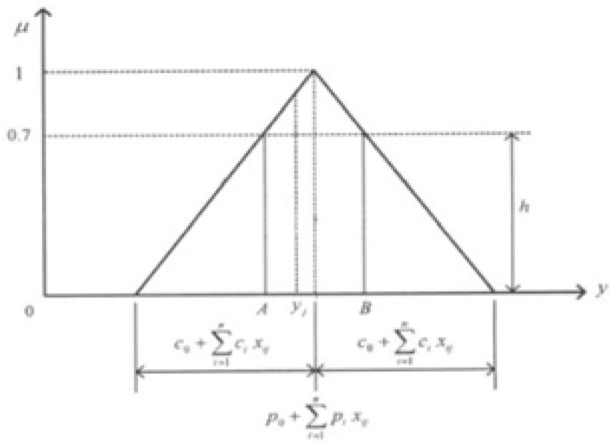

Figure 2. Fuzzy output membership function

Thus, to solve a linear regression problem with fuzzy coefficients and non-fuzzy data, the only thing we must do is to solve the linear programming model based on the above equations. Eq. (9) and (10) are written separately for each pair of observational data. Therefore, the required data enters into the program and the inequalities are formed. The obtained inequalities are, then, solved by the Lingo software and finally the output of the program is the coefficient P (Pourkazemi et al., 2016; Sadatinejad et al., 2011).

$$\tilde{y} = \widetilde{A_0} + \widetilde{A_1}x_1 + \widetilde{A_2}x_2 + \widetilde{A_3}x_3 + \cdots + \widetilde{A_n}x_n \quad (7)$$

Minimize: $mc_0+\sum_{j=1}^{m}\sum_{(i=1)}^{n} C_i |X\_i|$ (8)

$P_0+\sum P_i X_{ij} -(1-h)[C_0+\sum c_i X_{ij}] \leq y_j$ (9)

$P_0+\sum P_i X_{ij} +(1-h)[C_0+\sum c_i X_{ij}] \geq y_j$ (10)

According to Bandaranaike and Munasighe (1983), if production inputs are divided into two groups, the production function is defined as (Amadeh, 2014):

$$Q= f(J,E) \quad (11)$$

in which J represents other production factors and *E* represents energy including fossil energy and electricity.

Therefore, the cost function is defined as:

$$C=P_J.J+P_E.E \quad (12)$$

To optimize, the cost function is minimized as below:

$$\text{Min} \quad P_J.J+P_E.E$$

s.t

$$Q(J,E)=\bar{Q} \quad (13)$$

Thus, the Lagrange function is formed as follows:

$$L=P_J.J+P_E.E+\lambda(\bar{Q}-Q(J,E)) \quad (14)$$

By deriving the Lagrange function, the following equations are derived for the variables: J, E, λ.

$$\frac{\partial L}{\partial J}=P_J-\lambda\frac{\partial Q(J,E)}{\partial J}=0$$

$$\frac{\partial L}{\partial E}=P_E-\lambda\frac{\partial Q(J,E)}{\partial E}=0$$

$$\frac{\partial L}{\partial \lambda}=\bar{Q}-Q(J,E)=0 \quad (15)$$

If the production function of the agricultural sector is assumed as a Cobb-Douglas function, then we have:

$$Q=J^{f_1}E^{f_2} \quad (16)$$

Therefore, the Lagrange function is revised as below:

$$L=P_J.J+P_E.E+\lambda(\bar{Q}-J^{f_1}E^{f_2})$$

$$\frac{\partial L}{\partial J}=P_J-\lambda f_1 J^{f_1-1}E^{f_2}=0$$

$$\frac{\partial L}{\partial E}=P_E-\lambda J^{f_1} f_2 E^{f_2-1}=0$$

$$\frac{\partial L}{\partial \lambda}=\bar{Q}-J^{f_1}E^{f_2}=0 \quad (17)$$

By extracting the quantity of *E*, the energy demand function is obtained as follows:

$$E=\frac{P_J f_1 J^{f_1-f_2+1}}{P_E f_1 J^{f_1-1}} \quad (18)$$

By considering a functional form for Eq. (18), we have:

$$E=\frac{P_J.J}{P_E} \quad (19)$$

$E=AP_E^{\alpha}V^{\beta}$ Finally, the equation will be obtained:

$$E=AP_E^{\alpha}V^{\beta} \quad (20)$$

By taking the logarithm of the two sides, Eq. (20) can be rewritten as:

$$LnE=LnA+\alpha_1 LnP_E+\alpha_2 LnV \quad (21)$$

where *A* is a fixed coefficient, P_E is the energy price, and *V* includes the other variables that affect energy consumption including *I* as the intensity of energy consumption (energy consumption in the agricultural sector to value-added of the agricultural sector), *S* as the share of the agricultural sector in the economy (the value-added of the agricultural sector to GDP) (Heidary, 2005), ratio of capital-labor (K/L ratio), is used as an indicator of the technology level and it is expected with the advancement and improvement of technology (Mousavi, 2015). *P* is the energy price variable which is an important policymaking variable (Amadeh, 2014; Mehrabi Boshrabadi & Naghavi, 2011). Total energy in agriculture is supplied from two energy sources of oil products and electricity. Therefore, to calculate energy price in the agricultural sector, the total product of the share of oil products and electricity in their prices was used. The final equation is as below:

$$LnE=LnA+\alpha_1 LnP_E+\alpha_2 LnS+\alpha_3 LnI+\alpha_4 Ln\frac{K}{L} \quad (22)$$

The goal is to estimate the parameters A and α_i to obtain the best fitting model for the data. Therefore, intercept (A) and α_i coefficients were calculated by the fuzzy coefficients. One of the dynamic patterns corresponding to the stationary long-run relationship is the ARDL model. But, the ARDL econometric model expresses every coefficient as a fixed number, and since the fuzzy models can estimate a confidence interval for each coefficient of variables, the present study used the ARDL-FUZZY model to increase the accuracy of the results. The ARDL-FUZZY method is also used in the study because it is worth mentioning that the advantage of fuzzy estimation systems over the classic methods is that they lack restricting assumptions, especially where the distribution of residuals is not normal (Pourkazemi et al., 2016). In addition, since they estimate a confidence interval for coefficients instead of a fixed number, their results are more reliable. The coefficients are estimated by the Microfit, Stata and Win QSB software package. Data were collected for the period 1974-2015 from the Central Bank of the Islamic Republic of Iran (2017), World Bank (2016) and Ministry of Energy of Iran (2015).

RESULTS AND DISCUSSION

In the econometric literature, making use of conventional evaluation methods such as OLS was not always effective. Given the data type, the augmented Dickey-Fuller test was used to test their unit root.

Table 1

Results of the Augmented Dickey-Fuller Unit Root Test

Variables	ADF statistics	Critical values (α=5%)	Degree of convergence
LE	-4.583	-3.587	I (0)
L(K/L)	-5.628	-2.948	I (1)
LS	-5.902	-2.948	I (1)
LI	-5.146	-2.948	I (1)
LP	-4.113	-2.948	I (1)

Results Table 1 showed that some of the variables used here had a unit root. Thus, ARDL was used to avoid factitious regression and bias error. ARDL dynamic results are shown in Table 2.

Since the stationary of variables are of the order of one and zero, ARDL can be used. Based on the estimated results, co-integration t-test is calculated as follows:

$$\hat{t} = \frac{\sum_i^p a_i - 1}{\sum_i^p \widehat{s_{a_i}}} = -4/61$$

Since Banerjee, Dolado and Mestre critical quantity is significant at the 95% level, the null hypothesis (there is no balance relationship) is rejected and the existence of a balance relationship and a co-integration relationship between variables is confirmed. Therefore, confirming the presence of a long-run relationship between the variables using ARDL-FUZZY, the long-run coefficients were estimated; their results are shown in Table 3 (concerning confidence interval of 70% and 90% (h = 0.3, h=0.1).

The long-run relationship shows a significant positive relationship between energy consumption intensity and energy consumption in the agricultural sector. Considering the results of model estimation, as energy consumption intensity increases by one percent in high and low bounces with a confidence interval of 70% and 90%, energy

Table 2

Results of ARDL (1, 1, 0, 0, 0) Approach

Variable	Coefficient	Variable	Coefficient
E (-1)	0.7121**	P	-0.0152
I	2.5340**	K/L	0.4178E-2*
I (-1)	-1.5177*	C	-1.3289**
S	2.9474*	F=89.201	R^2=0.99

** *P*<0.01 and * *P*<0.05

Table 3

ARDL-FUZZY Long-Run Relationship

Variable	h=0.1		h=0.3	
	Lower bounds	Upper bounds	Lower bounds	Upper bounds
I	0.576**	0.632**	0.448**	0.632**
S	0.069**	0.262**	0.054**	0.262**
P	-0.088*	0.00	-0.113*	0.00
K/L	0.00	0.259**	0.00	0.370**
C	-1.016**	-1.517**	-1.307**	-1.576**
Ecm	-0.267			

** *P*<0.01 and * *P*<0.05

consumption increases by 0.448–0.632 and 0.576-0.632, respectively. Energy consumption intensity shows the level of energy consumption per one production unit. In other words, energy intensity is the energy consumption level (initial or final) for the production of one unit of value-added which is mainly expressed in barrels of crude oil in million IRR in terms of domestic prices. The positive and significant effect of the intensity of energy consumption variable indicates that energy intensity has a significant effect on energy consumption. It means that the higher the energy consumption intensity is, the higher the energy consumption will be.

During 1974-2015, GDP (in constant price of 1997) was increased from 114,776 billion IRR to 623,039.6 billion IRR in 2015 (Central Bank of the Islamic Republic of Iran, 2017). A survey of the trend of energy intensity in the agricultural sector shows this variable has an increasing trend but it has a decreasing recently. This decline has been set to continue to improve energy efficiency policies by the government and Energy Department of Iran. Some of these policies which have been considered by policy-makers since the first development plan are the adjustment of energy prices, continuous increase in energy price during the development plans, non-price policies such as energy audits, energy label, incentive policies, as well as efforts to develop efficient equipment market. If such policies are taken into account in future, energy intensity is expected to decrease continuously in the economic sectors including agricultural sector.

K/L ratio has also a positive significant impact on energy consumption, 0-0.259 and 0-0.370 in lower and upper bounds (90% and 70% levels) in the agricultural sector, respectively. Capital and labor are the most important factors affecting economic growth. The use of labor and capital is dependent on energy. Energy affects labor and capital and thus affects the production of the agricultural sector. Increasing the K/L ratio increases energy consumption by creating an opportunity for increasing the level of cultivation and increasing production in the agricultural sector. This ratio represents the use of technology (machinery and equipment) instead of the labor force in the agricultural sector. The positive coefficient showed that the use of high-energy consumption technology and the technology used in the agricultural sector tend to increase energy consumption. Production process of agricultural crops is a complex process which is changing constantly in parallel with the emergence of new technologies.

Conducting agricultural research and advances in technology not only results in the creation of new inputs required in this sector but also affects the way these inputs are used and combined. This shows that the technical relations between outputs (products) and inputs (production factors) used in the agricultural sector are steadily changing. Production function of the agricultural sector is influenced by several factors whose effects on the performance of the agricultural sector have their roots in mutual technical relationships that these factors have on each other.

The share of the agricultural sector in Iran's economy has a positive significant effect on energy consumption in agriculture. Inequality of this coefficient in high and low bounces reveals uncertainty in estimating this coefficient. According to the results, the variable "share of agriculture" had effects 0.069-0.262 and 0.054-0.262 on energy consumption in agricultural sector at the 70% and 90% levels. Studying energy consumption in agriculture shows that as production was increased in different years, consumption of different energy including oil products and electricity were increased too from 10.4 million barrels in 1974 to 51.3 million barrels in 2015 (Ministry of Energy of Iran, 2015). Therefore, the increased production reflects an increased rate of energy use in the agricultural sector. Over the studied period, the agricultural sector's share in Iran's economy has not increased but unfortunately, energy consumption in this sector has been increased. The low energy efficiency and productivity of the agricultural sector have entailed adverse economic and environmental effects. So, increasing energy consumption will raise environmental concerns.

The variable "energy price" has a negative effect on energy consumption in agriculture. This effect is statistically significant at the level of 88% (-0.088-0 and -0.113-0 at the 90% and 70% levels, respectively). This means that as energy price increases, its consumption decreases. It should be noted that during this period energy price has strongly been supported by the government, while it was increased following the subsidy reform plan. Concerning increased energy prices mentioned by economic policymakers in recent years, it must be noted that the increased energy prices will reduce energy consumption in the agricultural sector; if energy efficiency is not increased, it will lead to a decline in productivity of the agricultural sector. Reducing fuel subsidies and increasing energy prices are a way to prevent energy wastage. Energy subsidization to assist domestic production has traditionally been prevalent in the economy of Iran so that energy consumption has always exceeded the economic growth while overlooking its productivity. On the other hand, energy subsidization in Iran – like all other energy-rich countries – has resulted in a high level of exploitation of energy resources, traditionally accompanied by low energy productivity. As subsidy decreases and energy prices increase, energy demand reduces. Since energy is one of the most important inputs in agricultural production, production is affected by the increased price of energy. However, government expenses paid in the form of subsidies will decrease. Therefore, the production is likely to decline at the macro level and in the entire agricultural sector. But at the same time, reducing government expenses will provide an opportunity to use financial resources. On the other hand, increased price as a means of controlling and optimizing the consumption of this input cannot continue unlimitedly because it will result in negative consequences such as increased inflation. Moreover, as population grows as a factor influencing energy demand, the agricultural sector is required to meet more needs, and since higher prices will reduce energy consumption and finally decrease production, it can have devastating effects on food security.

It is necessary to mention that since fuzzy regression method estimates a confidence interval for coefficients instead of a fixed number therefore it increases the reliability of the results. Error correction models (ECM) have many applications because they connect short-term fluctuations of variables to the long-term equilibrium amounts. Thus, to estimate the equilibrium speed (equilibrium coefficient), an ECM model was used. The equilibrium coefficient was -0.267, suggesting that at each period, the short-term fluctuations were adjusted for -0.267 and got closer to their long-run trend. The results of this study are consistent with the findings of Amadeh (2014), Cetin & Yoksel (2014), Farajian et al. (2018), Fei & Lin (2017), Ghanbari et al (2012) and Sadeghi et al. (2012).

CONCLUSIONS

Agricultural sector plays an important role in the production and processing industries in Iran. In recent years, financial support of farmers, pale role of dealers, natural factors, and transformation of traditional farming into mechanized agriculture have increased productivity, reducing relative energy consumption in the agricultural sector with a little decline in energy intensity. It should be noted that government supports in the past decades have increased gross production of agriculture, but energy consumption of the main fuel (especially electricity) has been increased drastically. The reasons can be sought in the breakdown of technologies used in this sector and low fuel price which diminishes incentives to reduce consumption.

Subsidies paid for production inputs in general and energy in particular are used to enhance economic growth, increase employment, control the general level of prices and finally establish social justice. Since energy intensity shows final energy consumption per unit of activity (output or value-added), the effect of energy net intensity measures consumption changes resulted from changes in energy intensity. Negative value of this effect between two years indicates a decrease in the energy consumption and in energy savings. Energy intensity is strongly influenced by the way resources are utilized and by energy-consuming equipment. Therefore, the effect of energy intensity plays an important role in the research on energy economy in the field of the research on saving behavior. Therefore, it is necessary to pay more attention to increase energy efficiency and reduce energy consumption by reducing the intensity and appropriate pricing policy. The increased productivity results in the decreased consumption intensity in agriculture. Thus, making use of advanced technologies, mechanized cultivation, and modified varieties can reduce energy consumption intensity in this sector.

It is necessary to pay attention to energy efficiency, the ratio of K/L, and the type of machinery to save energy and increase production in policies. To extract water and product in agriculture, a huge amount of energy (gasoline and electricity) is used. Therefore, one way to save energy is to decrease fuel and energy subsidies in this sector. Since agricultural sector is in charge of supplying food, it is suggested that policymakers take it into account in reducing subsidies and in supportive policies. Reducing subsidies and increasing prices should be a gradual process. Rising prices cannot continue indefinitely to optimize energy consumption because inflation will increase and food security will be compromised. So, it is suggested to use pricing, subsidies and non-pricing policies to increase energy-saving technologies, adjusting the production structure in the agricultural sector, educate farmers to manage energy consumption, and expand the use of clean energy to replace fossil fuels.

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