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As can be seen in Table 2, the hypothesis 'productivity does not Granger-cause the added-value of the agricultural sector' is not refuted at the 10% significance level, so it can accepted that the variable of energy productivity in Iran's agricultural sector has not influenced the added-value of this sector. On the other hand, the hypothesis 'added-value of Iran's agricultural sector is not a factor of productivity improvement' is not refuted at the 10% significance level, implying that the added-value has had no impact on the productivity of energy carriers too. So, it can be claimed that there has been no bidirectional relationship between the added-value of the agricultural sector and the productivity of energy carriers. It is thus recommended to resort to pricing and non-pricing methods for productivity improvement. Price tools only provide adequate incentive for productivity growth via replacement among production factors. If the economic structure and facilities do not exist for efficiency enhancement in these conditions, energy consumption patterns cannot be expected to be improved. Hence, it is imperative to supplement reforms in energy pricing system with the development of efficient technologies, training and skill improvement of human resource, improvement of management and ownership structure, development of infrastructure, and reduction of trade costs of energy saving services.

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on the first-difference of the variables and then, the test can be run. On the other hand, the results of the Granger causality test are very sensitive to the lag length. If the selected lag length is less than the actual lag length, the exclusion of the appropriate lags will create a bias, but if the selected lag length is more than the actual one, the superfluous lags in the VAR model will make the estimations inefficient (Cheng, 1997).

Results and Recommendations

To achieve the research goals, we used the macroeconomic data of Iran for the period 1989-2012. Data on the added-value were solicited from the national accounts of Iran in current and fixed prices, which are published by the Central Bank of Iran. Data on energy use were also collected from the balance sheet of the Ministry of Energy. The model was estimated in the Eviews 8 econometric software package.

First, the stationarity of the variables was checked using the augmented Dickey-Fuller test. As the results in Table 1 show, the variable of energy productivity and the variable of added-value of the agricultural sector were not stationary at the data level, but their first-difference forms were stationary. So, the Granger causality test could be employed to check the stationarity of the residuals of Model (1), or the causal relationship between the two variables.

Table 1

The results of the augmented Dickey-Fuller test

Variable	Data level	First-order difference
Added-value	-2.28	-4.38
Productivity	-1.62	-9.52

Source: Research findings.

Table 2

The results of the Granger causality test

	F-statistic	Probability
Productivity does not Granger-cause added-value.	0.91	0.45
Added-value does not Granger-cause productivity.	0.55	0.65

Source: Research finding.

results show that energy prices have a limited role in the growth of energy productivity growth and technology change is an important factor in its growth.

Yang (2000) tested the Granger causality between energy use and gross domestic product (GDP) using the standard Granger causality test and the data for the period 1954-1997. According to the results, total energy use has a bidirectional Granger-causality relationship with GDP, electricity use, and coal use, but there is a unidirectional Granger causality running from GDP to oil consumption and a unidirectional Granger causality running from gas consumption to GDP.

Methodology

We used the productivity index proposed by Wang (2011) to calculate the energy productivity index. Accordingly, productivity index is calculated by dividing added-value by the amount of a certain input. Energy productivity is thus defined as the ratio of added-value to energy use. This ratio reflects the average added-value created per unit of energy use.

Granger (1969) argues that if the current values (Y_t) can be predicted more precisely when the past values (X_t) are considered than when they are not, then X_t is said to Granger-cause Y_t. In the Granger causality test, to test the hypothesis 'X_t does not Granger-cause Y_t', a vector autoregression (VAR) model is formed as below:

$$Y_t = \sum_{i=1}^{k} \alpha_i . Y_{t-1} + \sum_{i=1}^{k} \beta_i . X_{t-1} + u_i$$

If $\beta_i = 0$, then X_t does not Granger-cause Y_t. However, the lag length of K is arbitrary in this test. Geweke (1984) states that the validity of this test depends on the order of the VAR model and the stationarity or non-stationarity of the variables. If the variables are not stationary, the validity of the test will be impaired. According to Granger (1986), the test is valid when the variables are not cointegrated. So, it is necessary to check the stationarity of the variables in the first place and determine their cointegration relationship in the second place. If the variables are stationary of the first order, but they are not cointegrated, a VAR model can be formed

drawn great attention. This relationship has mostly been explored by the concept of causality.

The study reported here used the Granger causality method to shed light on how these two variables are related. In fact, the paper aims to answer the questions as to whether there is a Granger-causality relationship between energy productivity and added-value of the agricultural sector, and if so, whether the relationship is unidirectional or bidirectional.

Review of Literature

In a study in Turkey, Karkacier et al. (2006) report that along with the increase in energy use by the agricultural sector, its productivity is increased too. Amadeh et al. (2009) reveal that electricity use is the reason for the added-value of the agricultural sector. According to Abbasinexad and Vafinajjari (2004), energy productivity has been descending in the economic sectors including agriculture over the 1971-2000 period, but in spite of the decline of energy productivity, its impact has been positive and significant on the production of the agricultural sector.

Adenikinju and Alumuyiawa (1999) studied the relationship between energy use and productivity improvement in the Nigerian manufacturing sector. According to them, the efficiency of the manufacturing sector is improved in most countries through energy conservation, changes in the industrial structure, and fuel mix in the industries. In addition, if these technological improvements are made in the manufacturing sector, reforms in energy prices will yield more significant results.

Roy et al. (1999) addressed the trend of energy productivity for six energy-intensive industries of India. The results show that after the energy price was doubled in India, the total productivity of the industrial sector was decreased by 0.7 percent, but the productivity of industries in Canada was found to be hardly influenced as compared to India. The increase in energy prices will have a negative impact on productivity in the long run and will reduce welfare.

Miketa and Mulder (2003) explored energy productivity in 56 developed and developing countries in 10 industrial activities. The

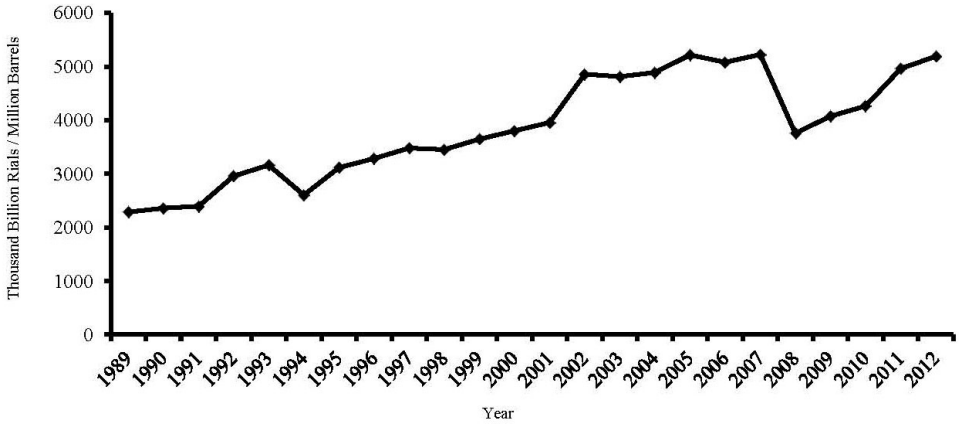

Figure 1

The temporal trend of the added-value in the agricultural sector of Iran

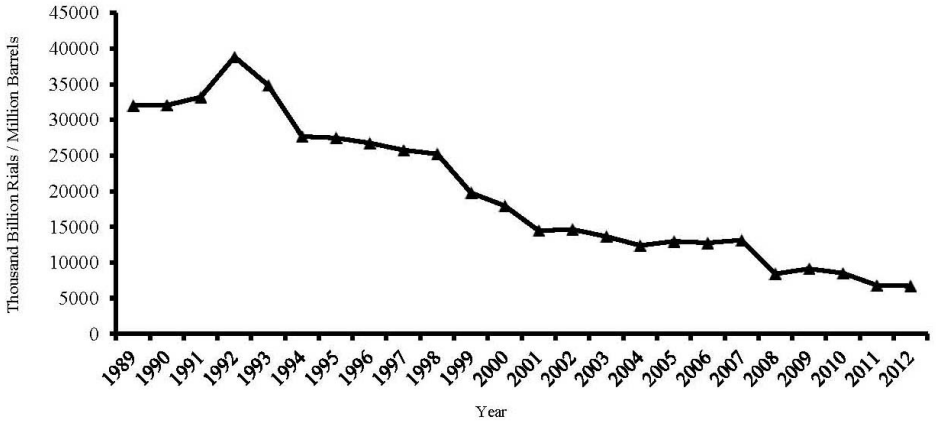

Figure 2

The temporal trend of energy productivity in the agricultural sector of Iran

Given the relationship between productivity and economic growth, exploring the relationship between energy productivity and the added-value of the agricultural sector can be very useful in developing economic policies for this sector. The analysis of the relationship between energy and production in whole economy has

Introduction:-

Attempts to use energy resources more productively have been interested in by the government in recent years and the agricultural sector has been no exception. In addition, it has been tried to reduce the use of off-farm inputs, especially energy, due to environmental considerations (Taheri & Mousavi, 2010).

The improvement of productivity as a major source of economic growth means more optimal, effective and efficient use of all production resources including labor, capital, and energy. The enhancement of the productivity of non-renewable energies is of higher significance in Iran as an energy-rich country. On the other hand, energy is perceived as one of the main factors responsible for the formation and development of industrial societies and the extent of a country's access to different energy sources reflects its development potential and political-economic power. Although higher energy use is usually an indicator of development when countries are compared in terms of per capita energy use, it should be noted that higher consumption rate is an indicator of development if it is accompanied by higher domestic production. Thus, when energy productivity is escalated, economic development and higher social welfare can be achieved with no expense on energy use or even along with the reduction of its use.

The main energy sources consumed by the agricultural sector of Iran are oil products and electricity (Anomymous, 2009). The use of these energy sources has increased by, on average, 35.6 percent over the period 1989-2012, whereas the average annual growth rate of the added-value of the agricultural sector has been 3.31 percent over the same period. So, it can be said that the growth of energy use by the agricultural sector surpasses the growth of the added-value of this sector. The trend of energy productivity including oil products and electricity over this period shows a descending trend so that the average annual growth rate of energy productivity has been -14.33 percent in the agricultural sector of Iran. As is evident in Figure 1, the temporal trend of the agricultural sector's added-value in Iran has been ascending, but Figure 2 displays that energy productivity in this sector has had a descending temporal trend.

الملخص:

المصدر الرئيسي للطاقة المستهلكة في القطاع الزراعي الإيراني هو المنتجات البترولية والكهرباء. في المتوسط ، نما استهلاك عامل الطاقة هذا بمعدل ٣٥.٦ في المائة خلال الفترة ١٩٨٩-١٩٩٨.

ومع ذلك ، فإن القيمة المضافة للقطاع الزراعي خلال هذه الفترة كان متوسط معدل النمو السنوي ٣.٣١ ٪ وكانت كفاءة ناقلات الطاقة دائما في التناقص، بحيث بلغ متوسط معدل النمو السنوي في القطاع الزراعي في إيران -١٤.٣٣ ٪.

تبحث هذه الدراسة تأثير كفاءة استخدام الطاقة على القيمة الزراعية المضافة، وتشير النتائج إلى أن هذين المتغيرين لا يرتبطان ببعضهما البعض، وبالتالي، يمكن القول أن هناك عوامل أخرى تؤثر على القيمة الزراعية المضافة وتؤثر على الإنتاجية. ينبغي أن تنظر شركات الطاقة في القطاع الزراعي في مزيج من سياسات الأسعار وغير السعرية.

الكلمات المفتاحية: شركات الطاقة، القيمة المضافة، الزراعة، سببية جرانجر.

Abstract:-

Oil products and electricity are the main sources of energy for the agricultural sector of Iran. In the period 1989-2012, the use of this energy carrier has increased at an average rate of 35.6%, whereas the average annual growth rate of the value-added of the agricultural sector has been 3.31% over the same period and the productivity trend of energy carriers has always been on a fall so that their average annual growth rate in the agricultural sector of Iran has been -14.33%. The present study aimed to explore the effectiveness of energy productivity on the added-value of the agricultural sector. The results showed that the two variables had no causal relationship. It can thus be said that other factors are influential on the added-value of the agricultural sector and that for the productivity of energy carriers to be influential on the agricultural sector, it is necessary to examine a combination of pricing and non-pricing policies.

Keywords: energy carriers, added-value, agricultural sector, Granger causality

The Granger-causality relationship between energy productivity and added-value of Iran's agricultural sector

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دراسة العلاقة السببية الجرنجرية بين كفاءة الطاقة والقيمة المضافة للقطاع الزراعي الإيراني

الدكتور محمدرضا ساسولي
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سراوان - إيران