European Online Journal of Natural and Social Sciences 2016; www.european-science.com
Vol.5, No.3 Special Issue on Humanities and Social Sciences
ISSN 1805-3602

# Impacts of Efficiency Change on the Productivity Growth of Iran Agriculture

**Mehdi Salarieh[1], Amir Mohammadinezhad[2], Reza Moghaddasi[3]**
[1]PhD Scholar, Department of Agricultural Economics, Science and Research Branch, Islamic Azad University, Tehran, Iran; [2]Associate Professor, Department of Agricultural Economics, Science and Research Branch, Islamic Azad University, Tehran, Iran; [3]Associate Professor, Department of Agricultural Economics, Science and Research Branch, Islamic Azad University, Tehran, Iran

**Abstract**

The aim of this paper is to study the impacts of technological progress and efficiency change on the productivity growth of Iran agriculture separated by Provinces. The period of this study is from 2005-2014. First of all, the impacts of efficiency change and technology change were separated using DEA and Malmquist model. Then, their impacts on productivity growth were studied. It was concluded that the impact of efficiency change on productivity is stronger than that of technology change. Then, the impacts of production inputs change on three variables i.e. efficiency, technology and productivity were assessed. According to results, labor change has a positive impact on productivity growth while capital change has a negligible impact on the factors of production productivity.

**Keywords:** efficiency, capital, factors of production, Malmquist model, productivity, technology

## Introduction

Improved agricultural productivity through promoted technology level and investing on this sector may remarkably influence the overall economy of the countries so that everyone can benefit from obtained advantages. According to the theoretical fundamentals of development, the difference in agricultural productivity between different countries is originated from technological progress of production, returns to scale and improved management (Lu et al., 2008). In addition, studies show that productivity index is the most favorable index for measuring performance from economic point of view so that it is used as a typical measure in all assessments. Economists have tried to discover the actual reasons of the economic growth and development of countries. They have found that those countries which rely on productivity growth more than increased natural and physical resources have experienced rapid growth (Torabi and Bakhshoode, 2008). Productivity growth directly increases agricultural incomes. In addition, increased agricultural production can indirectly reduce foodstuff price through increased supply of foodstuff on the one hand and increase the demand for non-agricultural products and services due to the increased agricultural income on the other hand. This, in turn, increases employment in non-agriculture sector. Therefore, all communities can benefit from the productivity growth of agriculture (Enkamlu, 2004).

On the other side, decreased per capita production of agricultural products and foodstuff can result in economic depression in a region within several years. This depression can create worse condition if it does not receive governmental supports for increasing the production of agricultural products. Achieving sustainable development is a basic fundamental of social welfare. Therefore, productivity has attracted the attentions of policymakers. To find the resources of productivity growth, it is only necessary to find that what is the origination of this growth, or in other words what are the determinants of productivity growth? (Isaksson, 2010) The policies of the Ministry of

Agriculture Jihad have been seriously pursued in some provinces while others have paid less attention to them. Therefore, by studying agricultural efficiency and productivity and its influential factors using province data, it becomes possible to apply different persuasive policies separated by provinces by determining the condition of different provinces. To this end, this paper studied the trend of productivity, technology change and efficiency change and their influential factors in different provinces of Iran and assessed the following objectives:

- The trend of productivity change of total factor production, TFP, in Iran agriculture sector separated by provinces
- Decomposing TFP productivity growth to efficiency change and technology change components
- Comparing the trend of technical and technological changes in Iran provinces
- Assessing the contribution of technological changes and efficiency change to TFP productivity growth in different provinces and comparing the results
- Identifying factors affecting productivity growth, efficiency change and technological change in different provinces

Malmquist index is used to achieve the objectives of this study and to measure the overall productivity of TFP. The index, then, is decomposed to production change and efficiency change components. This study used panel data-based regression methods and their related tests, including panel unit root, cross-sectional correlation tests, selecting between panel data and pool data tests and selecting from constant and random impacts tests, and 2005 to 2015 time series data in order to assess the influential factors of productivity growth, efficiency change and technology change. Data was analyzed by DEAP, Eviews and STATA.

## Theoretical Foundations of the study

### *Productivity*

Productivity is defined as affluence, fertility, and fecundity and production talent. Considering the different definitions of productivity, in theoretical field it is defined as doing a work accurately and continually (Amirtemouri and Khalilian, 2009). From application point of view, it is defined as output to input ratio in every system. In recent years, however, it has been discussed as a concept of efficiency and in the meaning of the improvement of the indices of people life. In economy literature, it is defined as the amount of output derived from one or more inputs. This index states the quality of utilizing resources and production factors in a given period of time. It encapsulates the triple impacts of technology change, scale change and efficiency change of inputs i.e. moving towards frontier production function from inside. Thus, occasional change of productivity or productivity gap between production units in a given time section indicate the change in and difference of technical and performance power of an economic unit or sector in converting inputs to products and services. In other words, it implies the change in the success of a set of inputs in producing outputs (Salami, 1998).

In real world, productivity change is manifested in the change of the amount of products derived from each input consumption unit, among other production units, at a given period of time. On this basis, productivity growth is defined as the difference between output growth and consumed input growth over time. In other words, after deducing the difference of consumed inputs from derived output change, the obtained residual is considered as the rate of productivity growth between two time sections or as the interlocation productivity gap (Salami, 1998).

Economists have proposed two approaches for calculating productivity index. The first one is econometric approach and the second on is non-parametric approach. The former calculates productivity by estimating a production function and a cost function while the latter defines it using math planning or calculating index number procedure.

***Efficiency***

Technical efficiency is defined simply as the ratio of the amount of product produced in a unit to the maximum amount of product deliverable by a given amount of inputs assuming the same technological level. In a given technological level, units which deliver the maximum possible outputs thanks to a correct management will have the highest technical efficiency. The theoretical framework of efficiency is actually based on the optimization of producer behavior or in other words the production theory. In production theory, the optimal behavior of a firm is analyzed based on a set of primary assumptions where different hypotheses about producer's behavior are examined using the same assumptions. Producer's maximum efficiency is one of the assumptions. In other words, it is assumed that there is no difference in adopting production factors between potent and actual producers. Relying on this assumption, neoclassical production theory neglects the inefficiency of production firms. In the analysis of production and cost functions and their related concepts, it is assumed that in a given level of production technology, market structure, production factors and product, producer acts in accordance with its production or cost graphs. Therefore, the maximum profit or the minimum cost of a firm is derived using these assumptions. According to empirical studies, producers have not been always successful in solving their optimization problem and malfunctioned in terms of efficiency. This makes conclusions and arguments of this field a problematic process. This is why the attention of economists was attracted to inefficiency as a part of deviations observed in production or cost frontier (Hakimipour, 2008).

Production efficiency is an important matter and concentrates on the fact that whether or not a firm could produce its products by consuming the least possible input or the least cost. According to Pareto principles, allocating production resources to the production of different products is efficient when it is impossible to increase the production rate of a product without decreasing the production rate of other products. In other words, if in a time section it is possible to increase the production level of at least one product without decreasing the production rate of other products, the allocation of available resources for producing different products will be essentially inefficient (Ebadi, 2007).

***Technology***

Generally, economic growth theories introduce three factors as the sources of economic growth: capital accumulation change, technology change and labor change (Baro, 1997; Hajirahimi, 2005). In other words, economic growth is theoretically originated from the quantitative growth of production inputs, the qualitative growth of the inputs and methods for adopting the inputs which are manifested in technology change. Despite a broad consensus on the importance of the role of technology change in the growth of economic sectors, there are broad disagreement on the method of measuring and developing an empirical index for technology change. This disagreement roots in the fact statistical data which could be used as an empirical index is hardly found the nature of technology change.

Researchers believe that technological progress is a key factor of socio-economic growth and is the secret of the success of economic firms and countries in the global competition on business and economy. Therefore, different authors study different dimensions of technology in economic development at both national level and different economic fields. Technical change is a dimension of technology change resulting in the production of more products using a given amount of input. In other words, technical changes increase the average production of the factors of production.

Technology is referred to the knowledge of using and manufacturing capital machineries and equipment. More comprehensively, it encapsulates all methods developed due to the existence of scientific knowledge (Gharebaghian, 1993; Yavaridashti, 2010).

**Data Envelopment Analysis (DEA)**

DEA is a math-based planning technique measuring the relative efficiency of a group of decision making units, DMUs. In other words, DEA is a math-based planning technique used for measuring the relative performance of those DMUs with different inputs and outputs where it is difficult to measure their performance (Fertona, 2000). DEA is a non-parametric procedure determining efficiency frontier of DMUs with the same inputs and outputs using mathematical planning (Charnes, 1997). It provides a theoretical and practical framework for performance analysis and measurement of DMUs' relative efficiency with the same inputs. It makes it possible to measure firms' efficiency and performance by developing an efficient frontier through a series of points and determining the position of a firm compared with other firms and comparing firms with each other (Ghanimifard et al., 2008). This technique has not a single output variable and there is no limitation for the number of outputs in the model. In this technique the assessment criterion is firms with the same activities at the same conditions so that instead of frontier production function, the performance of firms with the highest output to input ratio is considered as the efficiency frontier )Momeni, 2007]. The first condition for selecting the studied units is input-output homogeneity as this model assumes that all firms produce at the same space (Sajjadi et al., 2008). The efficiency of a DMU is output to input ratio of that unit. If a DMU can produce more outputs with constant inputs or can produce constant outputs with fewer inputs, it will have higher efficiency (Mehrez, 2004). If the units of an organization have only one input and one output, their efficiency will be equal to the ratio of that output to that input. But, if a unit has different inputs and outputs, it will be a difficult, or even an impossible, task to find a common weight for the inputs and outputs. DEA is used in such situations.

**Literature Review**

Alston (2007) studied the influential factors of the overall TFP productivity of underlying agricultural sectors of 51 developing countries. His results showed that the promotion and training of agriculture is an important factor affecting the agricultural productivity of the studied countries.

Using a meta-frontier analysis, Chen and Song (2008) assessed the efficiency and technological gap of agriculture in different regions of China. Different regions of China were classified to four classes in terms of area, economic development and production technology. The study used 1990s data of 3 regions, covering 2159 sections. According to results, eastern regions showed higher efficiency as compared to northern regions and northeastern regions were inclined to the conventional technologies available in China. Luh et al (2008) conducted a study to identify reasons of difference in agricultural growth between studied countries. They used Malmquist productivity index and decomposed it to technology change and efficiency change and employed seemingly unrelated regression methods. They used 1961-2001 time series and studied China, Indonesia, Korea, Japan, Malaysia, Philippine, Taiwan and Thailand. They found that productivity has been promoted over time in Malaysia and Japan implying the existence of efficiency and innovation in the countries compared with others. They observed no distinct pattern for productivity change in China, Korea and Taiwan while it showed a decreasing trend in Philippine, Thailand and Indonesia. They found that Taiwan was on efficiency frontier during the study period and the fluctuations of productivity change were mainly originated from technical change component. The agriculture sector of Taiwan, however, showed no distinct growth. Similar changes were observed in productivity and its components in China and Korea. Seemingly unrelated regression results showed that R&D costs and its interaction with human capital has been the main reason for the technological progress of agriculture.

Linh (2009) used Malmquist index and studied TFP productivity of Vietnam agriculture during 1985-2000. His results showed that in the studied period and from 1985 to 1989 TFP productivity had an increasing trend while from 1990 to 1995 TFP productivity had a decreasing trend and from that time TFP productivity has continued its increasing trend in next years.

Alvarez and Corral (2010) estimated the efficiency of dairy products firms based on technology concentration degree using the production function of latent class stochastic frontiers. The results of this study showed that concentration of technology in a given region results in more efficiency compared with the dispersion of technology in different regions.

Jin et al (2010) conducted a study to investigate the TFP productivity trend in agriculture sector during 1990-2004. They used production cost data of 23 firms dominant in the production of agricultural equipment and estimated the growth rate of FTP productivity for each product. At the end, they decomposed TFP productivity growth to efficiency change and technology change components. Their results showed that mean TFP productivity growth rate was 2% on annual basis while the annual growth rate of gardening and livestock sciences was high ranging from 3% to 5%. According to their results, technology change contributes more to the annual growth of TFP productivity and no tangible changes were seen in the efficiency of China agriculture sector.

Dietrich et al (2014) anticipated technology change in agriculture sector using an endogenous growth model. In their study, an endogenous growth model was introduced for agriculture and R&D investments. Then, the technology change of the sectors was anticipated by different scenarios. The obtained results showed that the elasticity of production to investment ratio was 0.29 in agriculture and per capita production cost per unit increases as production level increases. They anticipated future growth of production based on their own model.

Ndlovu et al (2014) analyzed the productivity and efficiency of corn production in agricultural zones protected by Zimbabwe. They used the panel data of farmer families of 15 rural regions during 3 periods of time from 2008 to 2010.

First of all, corn production function was obtained using fixed impacts of panel data. Then, technology change was extracted and productivity and efficiency changes of protected regions and other regions were compared using stochastic frontier analysis. According to results, production technology was a land saving technology in the studied region and the efficiency of protected regions was 39% higher than that of other regions.

Atici and Podinovski (2015) studied technical efficiency of different units of agriculture sector using DEA. They used data of 36 agricultural products of Turkey. According to results, under constant and variable efficiencies, there was a slight difference between efficiencies due to the large number of products in the studied sample region.

Ahmadishadmehr et al (2014) studied the influential factors of energy productivity in Iran agriculture sector using 1975 to 2008 time series data. They used generalized average productivity, GAP, index to calculate productivity. First of all, production function was estimated in accordance with Engle Grenger method. Then, the impact of different variables on productivity was assessed by this method. The results showed that the variables of labor per energy unit, machineries capital stock per energy unit and time trend had a significant positive impact while the virtual variable of war had a significant negative impact on energy productivity of Iran agriculture.

Parhizkari and Sabouhi (2014) performed an economic analysis on the impacts of technological progress and mechanization on agricultural products of Qazvin Province. They used 1992-2011 time series data and performed regression analysis in positive math plan (PMP). According to their results, mechanization has a significant positive impact on all selected agricultural products of Qazvin. They concluded, however, that applying proposed scenarios (increasing chemical fertilizers by 10%, decreasing pesticides by 15% and increasing machineries work hour by 20%) reduced cultivation area of wheat and barley by 3.5% and 1.6% , respectively compared with the base year while the cultivation area of other products increased by 2.5% to 12.8%.

Kohansal (2014) assessed technology change, breaking it to its main constituents and analyzing economy of scale for the production of irrigated wheat in Razavi Khorasan Province. He used Trans-log cost function and cost contribution equations within equation system framework. In order to estimate the equations, he used seemingly unrelated regression and 1994-2011 time series data. His results showed that the trend of technology change originated from scale development, is the main component of technology change trend. In addition, he found that increasing return to scale is dominant in the production of irrigated wheat in Razavi Khorasan. On this basis, he recommended increased production scale policies for the farms of this province.

Qanbari et al (2014) studied the influential factors of energy productivity in Iran agriculture. This study used 1978-2008 time series data and calculated the partial productivity of energy. Then, influential factors of productivity were assessed using auto-regression distributed lad (ARDL). According to results, mean capital per consuming energy, labor real wage, mean labor per energy unit, real price of oil products and contribution of power to total consumed energy had a significant positive impact on energy productivity in short-term. In addition, they showed that the change of the contribution of power to total consumed energy has a significant positive impact on the energy productivity of agriculture in long-term.

## Data Analysis and Results

This section studies and analyzes the estimations of models used to determine the impacts of technology change and efficiency change on the agricultural productivity change in Iran Provinces. First of all, the employed variables are introduced and then models' results are assessed.

### *Production Inputs*

a) Capital stock: it is considered as price stock considering a constant value for machineries stock of each province. Related data was collected from The Ministry of Agricultural Jihad database.

b) Labor of agriculture sector: it is the product of employment percentage in agriculture sector and adults population in each province per year. Related data was collected from The Ministry of Agricultural Jihad database.

c) Considering the importance of fertilizes in agriculture as an important input, this variable was used as an effective independent variable affecting efficiency change, technology change and productivity and its impacts were studied. Related data was collected from The Ministry of Agricultural Jihad database.

d) Cultivation area of dry and irrigated products )constant price) was derived from The Ministry of Agricultural Jihad database separated by each province. To estimate Malmquist index for cultivation area, the values of garden and agriculture cultivation area were introduced as two separate inputs. Related data was collected from The Ministry of Agricultural Jihad database.

Production output including garden and agricultural products were determined in ton/hectares separated by provinces. This value is multiplied by the cultivation area of each province in order to obtain total garden and agricultural products separately. It should be mentioned that agricultural products include the cultivation of dry and irrigated products where cultivation area is calculated in the same manner. In addition, the amount of livestock products including fish meat, chicken meat and red meat was calculated separated by province. Related data was collected from The Ministry of Agricultural Jihad database.

Independent variables are efficiency change (EFFCH), technology change (TECCH) and total factor productivity change (TFPCH).

**Calculation of Malmquist productivity index by DEA**

In DEA analysis, the structure of Malmquist productivity index is constituted of two Malmquiet productivity indices as geometrical mean, and is shown by separate function D with the assumption of $D^k(x^k, y^k) = 1$. Malmquist productivity index is decomposed to two components. The first component deals with the measurement of efficiency change while the second one deals with the measurement of frontier technology change. Technology frontier is determined by efficiency frontier which is estimated for a set of decision making units using DEA. Malmquist index assumes that at time t+1 there is a production function similar to that of time t. The calculation of Malmquist index demands two mixed and separated periodic scale. These two separated periodic scales can be determined by efficiency frontier which is estimated using DEA. According to the following model, the two scales can be obtained using CRR model of DEA:

$$D_0^i\left(x_0^i, y_0^i\right) = \theta$$

$$st. \sum_{i=1}^{m} \lambda_j \, x_{i0}^t \leq x_{i0}^t \, , i = 1,2, \dots, m$$

$$\lambda_j \geq 0 \, , j = 1,2, \dots \dots, n$$

Where $x_{ij}^t$ is the ith input and $y_{rj}^t$ is the rth output of $DMU_j$ at time t. Efficiency,

$$D_0^i\left(x_0^i, y_0^i\right) = \theta$$

is a value by which it is possible to reduce inputs. Replacing t by t+1 gives the following relation:

$$\min \theta$$

$$st. \sum_{i=1}^{m} \lambda_j \, x_{ij}^{t+1} \leq \theta x_{i0}^{t+1} \, , i = 1,2, \dots, m$$

$$\sum_{r=1}^{s} \lambda_j \, y_{t0}^r \leq y \;\; , r = 1,2, \dots \dots, s$$

$$\lambda_j \geq 0 \, , j = 1,2, \dots \dots, n$$

Similarly, another mixed periodic index $D_0^{t+1}(x_0^{t+1} + y_0^{t+1})$, is necessary to estimate Malmquist productivity index of the core input which is applicable in the following problems:

$$\min \theta$$

$$st. \sum_{i=1}^{m} \lambda_j \, x_{i0}^t \leq \theta x_{i0}^{t+1} \, , i = 1,2, \dots, m$$

$$\sum_{r=1}^{s} \lambda_j \, y_{rj}^{t+1} \leq \; y_{r0}^{t+1} \, , r = 1,2, \dots \dots, s$$

$$\lambda_j \geq 0 \, , j = 1,2, \dots \dots, n$$

The following table shows the geometric mean of EFFCH, TECCH and TFPCH versus Malmquist index from 2004 to 2014 for different provinces. The results indicate that during the studied period 7 provinces out of studied provinces have experienced TFP productivity decline on average. The provinces are: Tehran, Chaharmahal and Bakhtiari, Razavi Khorasan, Khuzestan, Fars, Kerman, Gilan. Among the studied provinces, Golestan and Kerman showed the best and the worst performance with an average increase by 21.4 and an average decrease by 11.15, respectively.

As seen in table 10-4, there was no efficiency change on average in Khuzestan, Gilan, Tehran and Markazi provinces while Hormozgan and Golestan provinces had the best efficiency increase by 11.5% and 12.8%, respectively. The worst condition was seen in Qom province experienced an efficiency decrease by 2%. According to results, except Razavi Khorasan, Kerman, Fars and Qom provinces experienced an efficiency decrease by 0.9%, 1.3%, 0.1% and 0.9%, on average respectively, other provinces experienced efficiency increase on average. Regarding technology change, the best condition was seen in Yazd province with an annual increase by 12.4% on average while the worst condition was seen in Kerman with an annual decrease by 10%. According to the results, 12 provinces )East Azarbaijan, Isfahan, Bushehr, North Khorasan, Semnan, Hamedan, Qom, Golestan, Markazi, Yazd, Mazandaran and Zanjan have experienced an increasing trend in technology while other provinces have experienced a decreasing trend on average.

**Table 1: Geometric mean of efficiency change, technology change and TFP productivity change of the studied provinces in the studied period (Source: software output)**

| Province | Efficiency change | Technology change | Productivity change |
|---|---|---|---|
| East Azarbaijan | 1.020 | 1.052 | 1.073 |
| Isfahan | 1.024 | 1.008 | 1.032 |
| Bushehr | 1.098 | 1.069 | 1.174 |
| Tehran | 1 | 0.990 | 0.990 |
| Chaharmahal and Bakhtiari | 1.002 | 0.956 | 0.959 |
| Razavi Khorasan | 0.991 | 0.968 | 0.959 |
| North Khorasan | 1.016 | 1.006 | 1.022 |
| Khuzestan | 1 | 0.986 | 0.986 |
| Zanjan | 1.038 | 1.082 | 1.124 |
| Semnan | 1.061 | 1.105 | 1.173 |
| Fars | 0.999 | 0.941 | 0.941 |
| Qazvin | 1.034 | 0.985 | 1.018 |
| Qom | 0.981 | 1.091 | 1.070 |
| Kerman | 0.987 | 0.900 | 0.889 |
| Golestan | 1.128 | 1.076 | 1.214 |
| Gilan | 1 | 0.999 | 0.999 |
| Mazandaran | 1.098 | 1.008 | 1.106 |
| Markazi | 1 | 1.021 | 1.021 |
| Hormozgan | 1.115 | 0.993 | 1.107 |
| Hamedan | 1.057 | 0.983 | 1.039 |
| Yazd | 1.022 | 1.124 | 1.148 |
| Geometrical mean | 1.042 | 1.027 | 1.070 |

The influential factors of TFP in the agriculture sector of the studied provinces from 2005 to 2014 are discussed in the following. To this end, the following model will be evaluated:

$$TFPCH_{it} = \gamma_0 + \gamma_1 KCH_{it} + \gamma_2 LCH_{it} + \gamma_3 CHCH_{it} + \gamma_4 NCH_{it} + \varepsilon_{it}$$

TEPCH, KCH, LCH, CHCH and NCH stand for TFP change, capital change, labor change, chemical fertilizer change and cultivation area change, respectively.

To study the reliability of variables, LLC (Lewin, Lin and Chu) panel square root and IPS (Im, Pesaran and Shin) panel square root tests are used. According to both, variables are reliable at CI:… In other words, null hypothesis )there is a unit root for the variables) is rejected. For example, the statistics of TEPCH was derived as -6.343 from IPS test and the probability level of this statistics is 0.000 )P-value=0.000_. Since probability level is below 0.05, it can be concluded that the null hypothesis )there is a unit root for this variable) is rejected and this variable is reliable at this level. According to LLC test, the probability level is 0.000 implying that the null hypothesis is rejected. Again, this test indicates that TEPCH is reliable at CI…. Similar arguments can be practiced for other variables.

**Model Estimation**

The results of cross-sectional correlation test derived from above model imply that there is no cross-sectional correlation in this model. The statistic of IPS test was 1.080 and its probability level is 0.28 implying that the null hypothesis )there is a cross-sectional correlation in the model) is rejected. On the other hand, Fries test showed that there is no cross-sectional correlation in the studied model. Therefore, given no cross-sectional correlation in the model, other tests of the model can be performed.

The following table shows estimations of F-Limer test conducted on the model. According to the table, pool data-based technique should be used for model estimation.

**Table 2: Test results for selection between panel data and pool data**

| Test | Statistic | Probability level |
|---|---|---|
| F-Limer | 0.659 | 0.860 |

Source: study findings

The following table shows model estimation based on pool data. According to the table, the negative impact of capital change on TFP change is not confirmed statistically. On the other hand, the results show that labor change and chemical fertilizers change had a significant positive and a significant negative impact on TFP change, respectively. In addition, cultivation area had not a significant impact on TFP change. As seen in the table, time had a significant positive impact on TFP change. It can be argued that TFP change has been increased over time.

**Table 3: Model estimations based on pool data**

| Descriptive variables | Coefficient | Standard deviation | t-statistic | Probability level |
|---|---|---|---|---|
| Capital change | -3.47E-6 | 2.53E-6 | -1.370 | 0.172 |
| Labor change | 1.23E-6 | 4.89E-7 | 2.515 | 0.013 |
| Chemical fertilizer change | -2.7E-6 | 1.32E-6 | -2.050 | 0.042 |
| Cultivation area change | 1.46E-6 | 1.22E-6 | 1.189 | 0.236 |
| time | 0.041 | 0.017 | 2.405 | 0.017 |
| Intercept | -55.873 | 23.659 | -2.361 | 0.019 |
| F-statistic (probability level) | | | | 5.351 (0.000) |
| Durbin-Watson statistic | | | | 1.986 |
| Coefficient of determination | | | | 0.513 |

Source: Study findings

**Discussion and Conclusion**

The results of this study reveal that 7 provinces out of the studied provinces have experienced FTP decrease on average. The studied provinces are Tehran, Chaharmahal and Bakhtiari, Razavi Khorasan, Khuzestan, Fars, Kerman and Gilan. Among the studied provinces Golestan showed the best performance with an increase by 21.4% and Kerman showed the worst performance with a decrease by 11.1%.

It can be argued that the agricultural efficiency of Iran provinces has been increased on average by 4.2% in the studied period while technology has been increased by almost 2.7% despite its descending slope. This indicates that TFP has been increased by 7%. It can be argued that the increase of efficiency and technology has increased FTP in 21 provinces. However, the increase of efficiency has had a more effective role as compared to that of technology increase.

According to the model estimation for influential factors of FTP, the negative impact of capital change on FTP change is not confirmed. On the other hand, the results show that labor change has had a significant positive impact on FTP while chemical fertilizer change has had a significant negative impact on it.

Based on the obtained results the following recommendations are made:

• Government can equip agriculture sector in different provinces through long-term and low-interest financial facilities and assist them to utilize modern cultivation and irrigation systems in order to enable farmers to promote their productivity by promoting efficiency.

• Training agriculture principles to farmers can assist them to utilize equipment and chemical fertilizers in planting, growing and harvesting procedures which in turn improve the performance of farmers through their better understanding of their region.

• The promotion of efficiency and productivity in agriculture sector is a time-consuming process. Therefore, it is recommended to develop and implement a comprehensive and long-term plan considering available requirements, limitations and social condition.

**References**

Alauddin, M., & Tisdell, C. (1986). Market Analysis, Technical Change and Income Distribution in Semi-Subsistence Agriculture: The Case of Bangladesh, Agricultural Economics, 1, 1-18.

Amirteimouri, S., & Khalilian. S. (2011). TFP productivity growth in important economic sectors of Iran during the 1st, 2nd and 3rd development plans. Agricultural Economy and Development, 71, 141-162.

Balcombe, K., Bailey, A., & Morrison, J. (2002). Stochastic Biases in Technical Change in U.S. Agriculture: A Bootstrap Approach, Published by Agricultural Economics and Business Management, Imperial College of Science.

Dadrasmoghaddam, A., & Zibaei, M. (2008). Labor productivity growth rate in Iran agriculture. Agricultural Economy and Development, 64, 1-18.

Dashti, Gh., Yavari, S., Pishbahar, E., & Haiati, B. (2012). Influential factors of technical efficiency of poultry breeding units, Sanghar and Kaliaei provinces, Journal of Livestock Science research, 3, 83-95.

Fare, R., Grosskope, S., Norris, M., & Zhongyang, Zh. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries, The American Economic Review, 84,66-83.

Gholamrezaei, D., & Shahtahmasbi, E. (2010). Assessment of relative efficiency of Iran provinces in achieving the 3rd development program targets for agriculture filed. Agricultural Economy and Development, 67, 126-149.

Hajirahimi, M. (2004). The trend of technology change and actual growth in Iran agriculture: Latent variable method, PhD Dissertation, Agriculture Faculty, Agricultural Economy, Shiraz University.

Hatziprokopiou, M. (1996). Production Structure, Technical Change, and Productivity Growth in Albanian Agriculture Journal of Comparative Economics, 22, 295-310.

Hayami, Y. & Ruttan, V.W. (1985). Agricultural Development: An International Perspective. The Johns Hopkins University Pres, Baltimore, MD.

Herdt, R.W. & Capule, C. (1983). Adoption, Spread and Production Impact of Modern Rice Varieties in Asia. International Rice Research Institute, Los Banes.

Isaksson, A. (2009). Structural Change and Productivity Growth: A Review with Implications for Developing Countries, WORKING PAPER 08/2009.

Jin, S., Ma, H., Huang, J., Hu, R., & Rozelle, S. (2010). Productivity, efficiency and technical change: Measuring the performance of China's transforming agriculture, Journal of Prod. Anal, 33, 191-207.

Johnston, B. F. (1990). Technical Efficiency on Individual Farms in Northwest India, Southern Economic Journal, 51, 108–16.

Lotfalipour, M.R., & Razmara, A. (20070. Assessment of the technical efficiency and productivity trend in Iran industries; case study: Workshops with 50 employees and more. Journal of Knowledge and Development, 18, 55-78.

Luh, Y. H., Chang, C. C., & Huang, F. M. (2008). Efficiency change and productivity growth in agriculture: A comparative analysis for selected East Asian, Economies Journal of Asian Economics, 19, 312-324.

Mahdavi Esmaeilabadi, M., & Mohammadrezaei, R. (2011). Comparative analysis of technical efficiency studies on Iran agriculture, Business Studies, 40, 99-113.

Mojaverian, M. (2004). Estimation of Malmquist index for strategic products from 1990 to 2000. Agricultural Economy and Development, 43 & 44, 143-162.

Nkamleu, G. B. (2004). Productivity Growth, Technical Progress and Efficiency Change in African Agriculture, African Development Bank, pp. 203-222.

Rezaei, J., Tavakkoli Baghdadabad, M.R., & Faghihnasiri, M. (2009). Assessment of TFP productivity in agriculture sector using non-parametric approaches, Village and Development Quarterly, 3, 97-122.

Seyyedan. S. M. (2008). Technical efficiency of beat farmers and influential factors of its damages: Case study in Hamedan Province, Beet, 21,137-150.

Sha-Sha, L., Yan-Sui, L., Hua-Lou, L., & Xiang-Liang, G. (2013). Agricultural Production Structure Optimization: A Case Study of Major Grain Producing Areas, China, Journal of Integrative Agriculture, 12, 184-197.

Tahamipour, M., & Shahmoradi, M. (2007). Measurement of TFP productivity growth of agriculture sector and its contribution to added-value growth, 6th conference of Iran Agricultural Economy.

Tim, J. C., & Rao, D. S. P. (2003). Total factor productivity growth in agriculture: A Malmquist index analysis of 93 countries, 1980-2000, http://Econpapers.hhs.se

Torabidastgerdouei, S., & Bakhshoude. M. (2007). The trend of productivity change in agriculture sector of Islamic countries. Development and Productivity, 6, 10-16.