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The Analysis of Total Factor Productivity Growth of Oilseed Production in Iran

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Abstract

Despite Iranian's government efforts to increase production of oilseed, Iran's vegetable oil still depends on imports and production of oilseeds covers only a part of domestic consumption. There is a gap between real and expected performance in the main staples which shows the landscape only by increasing productivity. The present study was conducted to examine the productivity growth of oilseeds growing in Iran as a whole. Econometrics approach was used to estimate total factor productivity. The study period was divided into Period 1(1983-1992), Period 2(1993-2002), Period 3 (2003-2012) and Overall period from 1983-2012. Secondary data survey was done. The results of the analysis revealed that the total productivity growth for oilseeds was positive and the average total factor productivity growth in whole period was 1.3%. Although some change has been taken place, there is a potential to achieve higher growth rates in production in the future if resources to be used efficiently.

Keywords: total factor productivity, productivity growth rate, econometric approach, oilseed crop

Introduction

Food demand is increasing, while the resources (land and water) are going to be scarce and face with low quality every day. Farmers need to increase production over the next decade substantially and this increase should occur in the lands where are already under cultivation. The long gap between real and expected performance in the main staples shows that achieving the outlook just occurs by increasing productivity. To produce more with increased use of inputs, production cannot resolve the challenge of global food security and it needs to achieve productivity growth (FAO, 2014).

Unlike developed countries, there is still concentration on promoting production through increased use of inputs and increased demand in domestic markets. Today, all developed and developing countries emphasize on the importance of productivity as essential factor to economic development and the acquisition of competitive advantages in the world. There are various criteria to measure productivity and how to apply it. There are usual and unusual factors affecting the productivity growth that show how to increase productivity in agriculture and why productivity growth in developing countries is essential.

Providing food for the world population is one of the major challenges. Many believe that food availability is the partial right of mankind while almost a billion people particularly in less developed countries with low income face food deficiency (IEG, 2011).

Food security is based on the sustainability in producing with efficient use of traditional inputs and needs optimum combination of them to increase efficiency and also needs technology change to prevalent on restriction of increasing arable land and water and protection of

environmental issues. Due to population growth and per capita consumption of oil in Iran (16-19 kg), in order to maintain food security and put this sub- sector in developing path we need to increase the production potential.

The objectives of this research include examining the structure of oilseeds production, estimating annual growth of oilseed crops, and calculating the growth rate of technology changes in oilseeds. Therefore, the Cobb-Douglas production function and Solow residual method were used. Measuring changes in technology or total factor productivity is done for two reasons. For the comparison between the productivity of oilseeds with other countries, production areas, other products or comparing different time periods together and the statistical evaluation of productivity changes in relation to inputs used in the production process. In both cases, determining changes in technology at every level (product, group of products, a particular region production, country or in global level) will be useful for policy making.

Oil seeds are the most essential products in agriculture that play an important role in food diet and consumer preferences. Oil seeds constitute the world's second largest food supplies after the cereal crops. According to FAO (2015) in the last decade (2000-2010), vegetable oilseeds' production is the most volatile agricultural activity in the world. In this decade, oilseeds sector with annual growth of 5% has been facing food consumption growth in developing countries.

Literature Review

There are numerous researches in the literature of productivity, the factors affecting it, and the methods of measurement and improvement in the agriculture of developing and developed countries. As clear, very few researches have examined the productivity at the regional level or subdivision in some countries that one of the reasons can be the lack of information.

Kiani Herchegani et al. (2014) by using data envelopment analysis, computed and compared total factor productivity, technical efficiency, and technology changes in crops through Malmquist productivity index in the period of 1999-2000 and 2008-2009. They indicated that total factor productivity for most crops including oilseeds increase and productivity changes has been greater than technical changes

Bagherzadeh and Kamijani (2011) analyzed the relationship between internal -external research and development and the agricultural sector's total factor productivity by using econometric approach in the thirty-year period from 1979 to 2008. The results suggested that the effect of internal research and development expenditures in the total factor productivity of this sector was estimated to be 0.15.

Bagherzadeh (2010) analyzed the growth of total factor productivity through division index and Solo residual by using autoregressive distributed lag model in agricultural sector from 1979 to 2008. He estimated the average total factor productivity growth to be 0.8% for the thirty year period.

Islam (2002) studied the productivity growth for the agricultural crop sub-sector by using Ternekovist index from 1980 to 2000 in West Australia. He compared west Australia's productivity with other regions and concluded that crop productivity growth average is 4.2% in west Australia which has more growth compared to other regions.

Kiani et al (2008) measured total factor productivity in agricultural sub-sector products from 1970 to 2004 in Pakistan. They analyzed the relationship between total factor productivity and the expenditure spent on agricultural research and concluded that total factor productivity improved and the average growth was 2.2% over 25 years. They found that investment in agricultural research was an important contribution to productivity growth. Mechanization and infrastructure development in road also had positive and significant effect on productivity growth.

Kibaara et al (2008) analyzed the trends in total factor productivity growth in Kenya by using the Cobb-Douglas production function. The results showed that productivity growth occurred substantially in the production of corn and in dairy products and the main factor in productivity growth in corn production was utilizing chemical fertilizer, productive seeds and the availability of chemical fertilizer in the retail market. Increasing investment in production systems and production plants to feed was the main factor for productivity growth in diary production.

Alston (2007) investigated the factors influencing the increase in total factor productivity in the agricultural sub-sectors such as horticulture and crop and the results for 51 developing countries showed that agricultural training and education were the key elements of improving the agricultural productivity especially in crop sub-sector.

Methodology and Materials

Agricultural productivity is the measurement of the quantity of agricultural output produced for a given quantity of input or a set of inputs. There are different ways of defining and measuring productivity like the amount of output per unit of input (such as tons of wheat per acre of land) or an index of numerous outputs divided by an index of numerous inputs (Wiebe, 2003). The quantities of output relative to the quantity of inputs are the conventional measures of productivity. If output increases at the same rate as inputs, then productivity is unchanged. On the other hand, if the output growth rate exceeds the growth rate in the use of inputs, then productivity is positive.

Two measures are often used. First, partial factor productivity measure which states the amount of output per unit of a particular input like land or labor, and second, the total factor productivity measure. Most commonly used partial measures are land productivity, i.e., yield or output per unit of land, and labor productivity i.e., output per economically active person or per agricultural person-hour (Zepeda, 2001).

Sometimes the indication from partial measures of productivity is not clear enough to show why production is changing. This is because different factors are responsible for changing the productivity, for example, land or labor productivity can be increased due to better and more use of fertilizer, power tillers, the use of high yielding variety (HYV) and etc.

To avoid such kinds of problems, it is better to measure total factor productivity (TFP) to account for the accurate agricultural productivity. Hence, the measure of multifactor or total factor productivity indicates total output relative to a more comprehensive metric of all measurable inputs including land, labor, capital, livestock, chemical fertilizers, pesticides and other purchased inputs (Alston et al., 2009).

It is worthwhile to note that different productivity measures are used for different purposes. For example, yield or land productivity is usually used to evaluate the success of new technology. It is also useful to determine what amount of land is required to meet the future demands of world food (Wiebe, 2003).

Labor productivity is usually used for comparing productivity among sectors within or across economies (Block, 1994).

Different types of economic models such as index number or growth accounting technique, econometric estimation of production relationships and nonparametric approaches are generally used to measure TFP or aggregate agricultural output.

The growth accounting model assembles detailed financial records of inputs and outputs by combining them into input and output indices to calculate TFP index (Diewert, 1980).

The econometric approach is based on an econometric estimation of the production technology (Antle and Capalbo, 1988). It quantifies the marginal contribution of each type of inputs to aggregate the production (Chavas, 2001). For example, it can be found that the effect of 1%

changes in using fertilizer on overall agricultural output with all other inputs remains constant. Linear programming techniques are used to calculate TFP in non-parametric methods (Chavas and Cox, 1992).

Among the three methods, every method is appropriate in addressing different questions and requires different datasets and has some strengths and weaknesses.

Econometrics method is appropriate for academic and case studies and has the advantage that it can be tested and can reveal all effects captured by variables over time as estimated parameters. Production function represents technical relation between the output level and each input and shows that the maximum output can be produced by any particular set of inputs with other constant conditions. The limitation of using this method is the necessity of having enough observations to estimate model.

Technical change is a shift in the production function over time (Chambers, 1994). Following Chambers (1994), the relationship between output, input and technical change can be specified as:

$$Y = f(X_1, X_2, X_3, \dots, X_n, t) \quad (1)$$

According to this functional form, technical change can be measured by how output change as time passed with a constant input.

Chambers expressed disembodied technical change in Cobb-Douglas production function as follow:

$$Y = f(X_i\,, t) = AX_i^{\alpha}t \quad (2)$$

Where Y is total output produced, X_i is total inputs used in producing processes and t is the effect of technical change.

Divisia index is used in this study due to its suitability to Solow residual method. In Divisia index method, the role of each factor in the production process should be determined by giving different weight to the factors. This index allows us to aggregate the heterogeneous factors such as labor, capital, etc. (Bagherzadeh, 2010)

$$TFP = \frac{Y_t}{\pi_{nX_i^{\alpha i}}} \quad (3)$$

By having the logarithm, from the equation (3), the following can be achieved:

$$\log TFP = \log\left[\frac{Y_t}{\pi_{nX_i^{\alpha i}}}\right] \quad (4)$$

$$\log TFP = \log Y_t - [\alpha_1 \log X_1 + \alpha_2 \log\ X_2 + \cdots + \alpha_n \log X_n] \quad (5)$$

Taking the total differentiation of equation (5), rewriting in growth rate, having the logarithms and rearranging terms according to the technical change, the equation (6) is:

$$\dot{TFP} = \dot{y} - [\alpha_1\dot{x_1} + \alpha_2\dot{x_2} + \cdots + \alpha_n\dot{x_n}] \quad (6)$$

Hereby, total factor productivity growth corresponds to output value growth minus input growth used in the production process. Equation (6) is Solow residual. As mentioned in the Divisia index, the weight of production factors should be calculated through estimating output elasticity and production function. Divisia index for oilseeds production with four inputs in the logarithms form is as follows:

$$\log TFP = \log production - [\alpha \log Labour + \beta \log Capital + \gamma \log Energy + \delta \log Expenditure] \quad (7)$$

Where, production is dependent variable in the output value of the all oilseeds (Cotton, soybean, sunflower and canola and safflower) expressed at billion Rials and there are four independent variables as Labor, Capital, Energy and Expenditure. Capital is measured in term of net fixed capital stock and expenditure is measured in term of total cost in producing processes

including expenditure of operation such as preparing land, planting to harvesting expressed at billion Rials. Energy is expressed at equal crude oil

According to the use of time series data, at first, static data should be examined. Therefore, there are various tests including Dickey Fuller, generalized Dickey Fuller, Philips and Peron and KPSS which can be used. In fact, for static data, the estimation of production function by using ordinary least squares coefficients is biased and invalid.

Results and Discussion

In this study, we used secondary data. According to the methodology of this study, the results of generalized Dickey Fuller test to estimate production function coefficients of oilseeds in logarithmic level are shown in Table (1). Stationary tests on each of the series precede with co-integration tests.

Table (1) shows the results of the unit root test levels of the selected variables. By using ADF, the null hypothesis (presence of unit root) was not rejected in all cases which means that LnProduction, LnLabor, LnCapita, LnEnergy and LnExpenditure are not stationary series. Thus, we need to test the first differences of the series to determine the integration order. For further confirmation, we test KPSS for series.

Table 1: Unit root test results for the selected variables

Series	Max. Lag	ADF Test Statistic	Mackinnon Value			Result
			%1	5%	10%	
D(LnProdction)	7	-5.789835	-2.6501*	-1.9533	-1.6097	I(1)
D(LnLabor)	7	-4.920604	-2.6471*	-1.9529	-1.6100	I(1)
D(LnCapital)	7	-5.260656	-2.6501*	-1.9533	-1.6097	I(1)
D(LnEnergy)	7	-2.136639	-2.6471*	-1.9529	-1.6100	I(1)
D(LnExpenditure)	7	-3.456236	-2.6534*	-1.9538	-1.6097	I(1)

Source: Author's calculation

After determination of being static for all variables through first differencing, Johansen co-integration method was used to estimate coefficients. The method simultaneously estimated the long-run and short-run relations between dependent and explanatory variables. According to the trace test compared to critical value in 5% level, there is at most one long-run relation for production function. All the production function coefficients are significant at 5% level except expenditure which is significant at 10% level shown in Table (2)

Table 2: Normalized cointegration coefficients Log likelihood estimation method

Variable	Coefficient	Std. Error	t-Statistic
Labor	1.149772	0.20835	5.5184
Capital	0.303499	0.15179	1.9994
Energy	-0.032241	0.01290	2.4993
Expenditure	0.149116	0.10263	1.4529
Intercept	-18.34332	3.38929	5.4121

Source: Author's calculation

Regarding the results of Table (2), the positive coefficient of labor, capital and expenditure showed the positive effect of these variables on production. Negative sign of energy coefficient and insistence to use indicated that it was likely not to pay attention to marginal efficiency. Labor and net fixed capital stock variable had the highest share in the production of oilseeds.

Table 3: The output and input rate of growth

Variable	1983-1992	1993-2002	2003-2012	1983-2012
Production	0.005	0.027	-0.048	-0.006
Labor	0.034	0.031	-0.060	-0.001
Capital	-0.042	0.051	-0.004	0.003
Energy	0.160	0.596	0.389	0.389
Expenditure	0.118	-0.005	-0.008	0.032

Source: Author's calculation

The evaluation of the inputs growth rate in three decades is shown in Table (3). As observed, production growth rate has decreasing trend despite positive growth rate of capital, energy and expenditure and labor has negative growth rate. The production growth rate is 0.5% in the first decade which has continued its increasing trend in the second decade and reached the highest mean level of 2.7% in the past 30 years but faced negative growth in the third decade. The issue of energy growth in oilseeds production is considerable. The growth rate of energy in the first decade was 11.8% and intensified to the highest growth of 59.6% during thirty years and then reduced in the third decade but still has height rate among the other inputs.

Table 4: Productivity growth of inputs and total factor productivity

Variable	1983-1992	1993-2002	2003-2012	1983-2012
Labor	-0.018	0.031	0.054	0.024
Capital	0.052	-0.033	-0.047	-0.008
Energy	-0.110	-0.293	-0.289	-0.235
Expenditure	-0.031	0.046	-0.031	-0.005
TFP	-0.027	0.010	0.053	0.013

Source: Author's calculation

Table (4) shows the average effect of different resources on productivity growth. The labor variable has had the largest share in the growth of total factor productivity. As observed, capital partial productivity growth rate has decreasing trend. The issue of energy partial productivity growth rate in oilseeds production is noticeable. The partial productivity growth rate of energy in the first and second decade is decreasing with increasing growth of -0.110 and -0.293 to -0.289 respectively. The total factor productivity has increasing trend. The most rate of growth belongs to third decade with 5.3%.

Conclusion

Agricultural outputs are necessary for population growth. There is a gap between real and expected output in the main staples which shows that the landscape only by increasing productivity. As the results shown, the total factor productivity growth rate in oilseeds production had positive trend and was increasing in three decades with average growth equal to -2.7%, 1% and 5.3% respectively and by Solow residual method the average growth was 1.3% for whole period of investigation. According to the partial and total factor productivity growth rates, it can be concluded that when labor productivity is negative / positive growth rate , the total factor productivity is negative / positive growth rate and expressed the same direction. Despite that when capital partial productivity was negative / positive growth rate , the total factor productivity was positive/ negative growth rate and expressed the counter direction. The return to scale is increasing because the total elasticity is greater than one. As shown, the high coefficients of labor and capital variables represent the importance of these variables in oilseeds production. The current research shows that there is a need to reduce expected output gap between the real and expected production to promote it through

productivity growth. Accordingly, it can be concluded that increasing the quality of labor can be effective step on productivity growth and production in order to high amount of share and the positive effect of partial productivity growth rate. Despite the insist on the use of capital and energy as increasing the growth rate of utilizing them in two first decades, the partial productivity growth rate of them were decreasing and still have negative partial productivity growth rate. It needs to have considerable management. Finally, it can be concluded that increased oilseed production may be possible by improving the quality of non-conventional production factor such a farmer education and better management of applying inputs, especially capital and energy to increase oilseed production capacity through productivity growth and thereby the food security. However, intensive oilseed production system may also have some environmental degradation.

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