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# Economic Analysis of Fertilizer and Pesticides in Wheat Fields of Varamin Plain (Iran)

Akram Neshat [1] , Majid Ahmadian [2] , Mohammad Hasan Vakilpour [1] , Sadegh Khalilian [1]

[1] *Department of Agricultural Economics, Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran*
[2] *Faculty of Economics, University of Tehran, Tehran, Iran*

***ABSTRACT :*** *Quantitative analysis of production by examining the amount of the consumption of inputs is considered as the core principles of agricultural management that follows production increase through efficient use of resources. In this study, with an emphasis on environmental objectives, the efficient production management of chemical inputs, including fertilizers and pesticides for wheat farmers of Varamin plain production in the crop year of 2012-2013 was investigated. After estimating the production function of translog for this product, elasticity of production of nitrogen fertilizer inputs, phosphorus fertilizer, and pesticides was calculated. It was found that nitrogen fertilizer is used in the non-economic stage of production. In addition, the demand function of indicated that nitrogen fertilizer indicated much influence than phosphorus fertilizer and pesticides to price changes. Therefore, by using appropriate policy instruments to reduce consumption of nitrogen fertilizers including price policies and educational and promotional measures and to inform the farmers can help farmers protect the environment.*

**KEYWORDS -** *production function, price demand elasticity, environment, Varamin plain, Iran*

## I. INTRODUCTION

Allocation of production factors among different activities so that it considers appropriate economical, social and environmental aims of agriculture center will be more compatible with sustainable agriculture [1, 2].

Most of the agriculture management procedures are evaluated only based on economical criteria and they do not consider environmental and human healthy [3] while the most effective solution to obtain sustainable development will be introduction of a sustainable view with simultaneous aims of increasing agriculture production and decreasing harmful effects of agriculture [4].

During recent years, excessive use of chemical inputs including fertilizers and pesticides in agriculture has made anxious and unsustainable status in agriculture activities [3]. Excessive use of these inputs in agriculture may cause increasing agricultural production in short-time, but in long-time may cause low quality and productivity of soil, surface and underground water contamination and be a serious threaten for human healthy and prevalence of dangerous illnesses in human like cancers and allergies [5,6,7]. So, managing inputs use in order to obtain aims of environment protection, human and other organisms' healthy and to achieve sustainable development is unavoidable.

According to the importance of this issue, in the present research, we aimed to evaluate suitable production function with emphasize on environmental pollutant inputs and using maximizing exploiter benefit condition, nitrogen fertilizer, phosphorus fertilizers and pesticide inputs demand function was extracted and price sensitivity of these inputs demand was evaluated and optimal economic amount which have the most economical benefit for farmer, was evaluated.

## II. LITERATURE REVIEW

Using estimates of production function of agricultural products, several studies have been conducted to determine the optimum use of production factors inside and outside the country that some of them are discussed here. Nilabja (2004) examined the substitution effects of manure instead of chemical fertilizers in the production of rice and peanuts in India. He believes that excessive use of chemical fertilizers during the Green Revolution has damaged the soil quality [8].

Goni and Baba (2007) analyzed the efficiency of resources in the production of rice crop in Nigeria. By calculating Cobb-Douglas production function, they found that of all inputs except labor have been used less than optimal level[9]. Rashid Ghalam and Khalilian (2012) estimated the sugar beet production function in Iran during the 2000-2007. By calculating the production elasticity, they concluded that two inputs of water and chemical fertilizer were used in the third stage. In addition, they examined the price sensitivity of inputs demand by deriving function of inputs demand from production function and calculating elasticity of demand function[10].

Fallahi et al (2014) calculated the optimum amount of consumption of inputs in the production of wheat in the Seydan-Farough plain of Fars province in Iran in 2010-2011 by using production function estimation. The most important result of their study was that farmers used water and nitrogen fertilizer inputs more than the economic optimum[11]. The results of the study conducted by Hojabr Kiani (1999) represents that excessive consumption of chemical fertilizers by farmers has been in the wheat production[12].

## III. MATERIALS AND METHOD

This study was conducted in the plains of Varamin located in the southeast of Tehran in the crop year of 2012-2013. In order to achieve the objectives of the study, two-stage stratified sampling was used through interviews of beneficiaries, and they completed 113 questionnaires. The method of doing the study was so that the proper production function is firstly estimated by using OLS method and Eviews 8 software package. Then, production elasticity, input demand function, and elasticity of demands of nitrogen fertilizer, phosphorus fertilizer and pesticides inputs would be calculated.

### a. Production function

One product can be produced by different combination of inputs. Production function states the technical relationship between production factors and product and it shows the maximum product that is obtained from different methods and combination of inputs [13]. By estimating the appropriate production function and information obtained from it, actual production power can be determined and appropriate policies on the use of inputs, productivity, inputs pricing, and generally production planning. General form of production function can be shown as follow:

$$Y=f(X_1,X_2,\ldots,X_n) \qquad (1)$$

Where Y is the the amount of produced product and X is the vector of amount of production inputs. To select appropriate production function, different production functions was firstly calculated and based on criteria of superior function selection, including the number of less parameters, simplicity of interpretation, computational simplicity, power of generalization and prediction, match with economic theory [14], the most appropriate function was selected. Due to wide application of translog function and its compatibility with current research data, this function was used that will be explained.

### b. Translog production function

Translog production function is logarithmic transcendental production function that was firstly introduced by Christensen, Jorgenson and Lao(1971)[15]. Translog production function with input n of variable can be written as follows:

$$LnY = \alpha + \sum_{i=1}^{n} \beta_i LnX_i + \frac{1}{2}\sum_{i=1}^{n} \beta_{ii} (LnX_i)^2 + \sum_{i=1}^{n}\sum_{j=2}^{n} \beta_{ij} (LnX_i)(LnX_j) \quad (2)$$

Where y is product, $\alpha$ is the efficiency parameter, $X_i$ and $X_j$ are the amounts of inputs of i and j, and (i=j=1,2,…,n). The final production of ith input is calculated by following equation:

$$MP_i = \frac{\partial Y}{\partial X_i} = (\beta_i + \beta_{ii} LnX_i + \sum_{j=2}^{n} \beta_{ij} \ln x_j)(\frac{Y}{X_i}) \quad (3)$$

The ease of interpretation of the results and the necessary calculations in the derivation of translog cost function are considered as the most important causes of the widespread use of this function by economists[16]. One feature of this function is that it allows that substitution and production elasticity can change, depending on the level of inputs consumption. In addition, the first derivative of this function has no limitation in terms of sign. In other words, translog function shows all three production regions and final production in increasing, decreasing or negative. In the translog function, in addition to main variables parameters, coefficients of mutual relationships of variables are also estimated[15].

**c. Production elasticity**

To calculate production elasticity in the translog production function, equation (4) is used[17].

$$EP_i = \frac{\frac{\partial Y}{Y}}{\frac{\partial X_i}{X_i}} = \beta_i + \beta_{ii} LnX_i + \sum_{j=2}^{n} \beta_{ij} \ln x_j \qquad (4)$$

By using production function approach and determining technical coefficients, in addition to the value of final production, the importance of each input in the increase of wheat product is determined by using inputs production elasticity.

That which of the functions can better reflect the production behavior of considered product is the issue that depends on technology governs on production flow and it is determined by using econometrics and statistical criteria. Gujarati (1995) considers low number of parameters, simplicity of interpretation, computational simplicity, generalization power, and prediction as criteria to select the most appropriate function[14]. In addition to mentioned criteria, Thompson (1998) thinks that experimental studies are good guidelines to select function [18].

**d. Input demand function**

Demand for inputs is the a demand function derived from product and depends on price of produced product, input price, price of substitution and supplement inputs, and production function parameters that represent technical relationship of production. The general explanation of problem is as follows: suppose that production function is Y=f(X,β) in which X is the amount of input and β is the production function parameters. If product price is P and input price is $P_{x,}$ we can write the related demand function as X=g (β, $P_x$, $P_y$). Note that the function g is the that is different from the production function f. To drive demand input function from production input the first-order condition to maximization profit is used. Given the complete competitive market, condition for profit maximization of manufacturer is obtained by this equation:

$$VMP_x = P_x \rightarrow P_y . MP_x = P_x \qquad (5)$$

That this equation shows the curve of input demand for different prices X. if the price of product increases, the curve $VMP_x$ goes upwards and increases the demand for input[13].

The general form of input demand function derived from translog production function is as follows:

$$P_y (\beta_i + \beta_{ii} (\mathrm{LnX}_i) + \sum_{j=2}^{n} (LnX_i)) = \mathrm{P}_{x_i} \qquad (6)$$

Finally, using inputs demand function and having the price of product and price of inputs, price elasticity of inputs demand is calculated by following equation. Price elasticity of inputs demand shows the sensitivity of demand of farmers to changes of production inputs price.

$$E_{ii} = \frac{\partial \log X_i}{\partial \log P_{X_i}} \times 100 \quad (7)$$

Price elasticity of inputs for translog production function can be calculated from this equation:

$$E_{X_i} = \beta_i + \beta_{ii}(\mathrm{LnX}_i) + \sum_{j=2}^{n}(LnX_i) \quad (8)$$

Price elasticity of demand indicated that if the price of considered input changes by one percent, the demand of considered input would change several percent.

## IV. RESULTS

In this study, using data extracted from questionnaire of Cobb - Douglas production function, transcendental and translog and generalized quadratic were estimated to select the most appropriate production function. It should be noted that Divisia index was used to estimate production functions in order to focus on important variables studied in this study and due to co-linearity among variables. After fitting the different types of production functions and considering the parameters of lower number of parameters, consistency with the theory, computational simplicity, ($R^2$), and a significance statistics of total regression (F), translog production function was selected as the best function of wheat production that its results have been represented in the Table (1). ). In this model y is the amount of wheat production per hectare (Kg), X1 is the amount of used N fertilizer per hectare (Kg), X2 is the amount of used P fertilizer per hectare, X3 is the amount of used pesticide per hectare (Kg). DI Divisia Index including other used inputs in wheat production (water, labor, seed) and Ln is the symbol of natural logarithm.

***Table (1): the results of estimation of translog production function for wheat product***

| Row | Variable | Cofficient | t statistic |
|---|---|---|---|
| 1 | constant | 1.60 | 0.14 |
| 2 | Lnx1 | -5.84*** | -3.87 |
| 3 | Lnx2 | -6.12* | -1.89 |
| 4 | Lnx3 | 11.8*** | 9.06 |
| 5 | LnDI | 6.90** | 3.67 |
| 6 | $(Lnx1)^2$ | 0.29** | 2.29 |
| 7 | $(Lnx2)^2$ | 1.76*** | 4.90 |
| 8 | $(Lnx3)^2$ | -0.11 | -1.48 |
| 9 | $(LnDI)^2$ | -0.30*** | -3.07 |
| 10 | Lnx1. Lnx2 | -0.39*** | -3.05 |
| 11 | Lnx1 . Lnx3 | 0.75*** | 6.06 |
| 12 | Lnx1 . LnDI | 0.53*** | 3.69 |
| 13 | Lnx2 . Lnx3 | -1.12*** | -8.66 |
| 14 | Lnx2 . LnDI | -0.75*** | -6.72 |
| 15 | Lnx3 . LnDI | -1.36*** | -10.02 |
| **$R^2$= 0.83** | **F= 36.08** | **DW= 1.84** | |

*,**, *** represent significance at the level of 90%, 95%, and 99%

Based on Table (1), determination coefficient is 0/83 that is proper explanation for estimated model. The significance of statistics F at the level of 99% and significance of majority of coefficients based on statistics t at least at the level of 10% represents goodness of fit of this model. Results have been presented after doing necessary tests to investigate the classic hypotheses in the regression by OLS method and to solve the problems of these hypotheses. The heteroscedasticity of disorder components usually present in the cross-section data and Harvey test revealed the problem White correction was used to solve the problem. Given the obtained results obtained from production function and use of mean of inputs consumption, production elasticity was calculated by equation (4) that its results have been shown in Table (2):

***Table (2): production elasticity of chemical inputs of wheat production***

| | Nitrogen fertilizer | phosphorus fertilizer | pesticide |
|---|---|---|---|
| **production Elasticity** | -0.49 | 0.21 | 0.09 |

Considering the negative elasticity of nitrogen fertilizer, is was revealed that clear that beneficiaries are active in the third stage of production (non-economic stage of production).

From the economic dimension, one of the reasons to excessive consumption of these inputs is related to its price. If we can reduce the consumption of these inputs by means of policy tools so that farmers activates in the second and economic stage of production, the application of this policy will lead to increased production. Demand functions of inputs of nitrogen fertilizer, phosphorus fertilizer, and pesticides are derivable using production function and average values of inputs by following equations, respectively.

$$P_y\left(-5.84+2(0.29)\,\mathrm{LnX_1}-0.39LnX_2+0.75LnX_3+0.53LnDI\right)\left(\frac{y}{X_1}\right)=P_{X_1} \quad (9)$$

$$P_y\left(-6.12+2(1.76)\,\mathrm{LnX_2}-0.39LnX_1-1.12LnX_3-0.75LnDI\right)\left(\frac{y}{X_2}\right)=P_{X_2} \quad (10)$$

$$P_y\left(11.18+2(-0.11)\,\mathrm{LnX_3}+0.75LnX_1-1.12LnX_2-1.36LnDI\right)\left(\frac{y}{X_3}\right)=P_{X_3} \quad (11)$$

Assuming competitive market and assuming that value of all other factors is constant and by providing average value related to each of the inputs, price elasticity of demand is calculated by using input demand functions that its results have been shown in Table (3).

***Table (3): the results of calculation of demand elasticity of chemical inputs of production***

| input | Nitrogen fertilizer | phosphorus fertilizer | Pesticides |
|---|---|---|---|
| Price Elasticity | -0.46 | -0.16 | -0.07 |

Results of Table (3) suggest that all elasticity have correct and logical (negative) sign and shows reverse relationship between price and value of input demand that is consistent with economic theory. Results also indicated that demand amount of wheat farmers shows less sensitivity to price of production inputs.

## V. CONCLUSION

As the excessive use of chemical inputs in modern intensive farming has negative environmental impacts on various sectors of water, soil and human health, the management of these inputs is necessary in order to protect the environment. Therefore, in this study, the effect of the use of pollutant inputs such as chemical fertilizers and pesticides on value of wheat production in the plains of Varamin was determined.Numeric values of production elasticity was calculated negative for of nitrogen fertilizer, while it was calculated positive for phosphorus fertilizer and pesticides that it showed farmers have used input of nitrogen fertilizer in the third stage of production and in a non-economical way in the crop year 2012-2013. The excessive use of this input has reduced the production of the product. If we can reduce the consumption of these inputs by means of appropriate policy tools to help to farmers work in the second and economic stage of production, the production will increase. While, phosphorus fertilizer and pesticide inputs have been used in the economic stage of production. The comparison of price elasticity of inputs demand indicated that price changes have little impact on amount of inputs consumption, and price sensitivity of nitrogen fertilizer is higher than other inputs and pesticide input has the lowest sensitivity to price changes. Therefore, inputs consumption can be relatively reduced by using price tools. In addition, one of the effective actions to reduce the consumption of chemical fertilizers is the estimation of need for fertilizer in various regions and amount of chemical fertilizers consumption based on this estimation.

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