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The Effect of Crop Insurance on Technical Efficiency of Wheat Farmers in Kermanshah Province: A Corrected Ordinary Least Square Approach

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Abstract: The purpose of this study was to describe the effect of crop insurance on agricultural production among dry wheat farmers in Kermanshah province. The population of this study consisted of dry wheat farmers. Data used in this study was collected using stratified multi-stage cluster sampling method and face to face interview with 251 farmers in three different climate regions: tropical, temperate and cold during 2003-2004 crop years. The procedures used for determining farmers' technical efficiency was Corrected Ordinary Least Square (COLS). Findings revealed that crop insurance has positive effect on temperate and tropical regions. However, the production difference between insured and uninsured farmers in cold region was non-significant. It is therefore concluded that technical efficiency of agricultural production in Kermanshah province is a function of crop insurance as well as other variables such as crop management practices, personal characteristics and fair distribution of agricultural inputs.

Key words: Crop insurance, technical efficiency, production function, dry wheat farming

INTRODUCTION

Iran is situated in the Middle East region of the South Western Asia and is located between 25 and 40° in the North, 44 and 63° in the East. According to the United Nations (1997) Office for the Coordination of Humanitarian Affairs, Iran is the sixth most disaster-prone country in the world. For the past 10 years, an average of 4000 people has been killed and 55,000 affected annually by national disasters. Natural perils include earthquakes, drought, flood, landslides and windstorm.

Among natural disasters, drought has been a recurring phenomenon in Iran and farmers must continually cope with high rainfall variability. The climatic conditions are arid and semi-arid and about two-thirds of the country receives less than 250 mm of precipitation per year (Heydarian, 2007). This implies that optimized use of water resources is very important in this country. A severe drought in 1998 followed by extreme drought years of 1991/2000 and 2000/2001 has proved a disastrous combination for Iran. According to the United Nations (1997), 62, 000,000 people were affected by drought in the year 2000-2001.

Agricultural production is therefore a risky business and Iranian farmers face a variety of weather, pest, disease, input supply and market related risks. Given an uncertain income each year, Iranian farmers must worry about their ability to repay debt, to meet overhead costs (e.g., land rents and taxes) and in many cases, their ability to meet essential living costs for their families.

Economic research perspectives have given a great deal of attention in recent years to crop yield insurance and revenue insurance. However, very little attention has been given to technical efficiency on crop insurance across diverse climatic regions. Production risk derives from the uncertain natural growth process of crops. Weather, disease, pests and other factors affect both the quantity and quality of commodities produced. The first step in developing a crop risk management program is to provide crop insurance. Although technical efficiency was not reported but Donoghue *et al.* (2005) revealed that farmers living in tropical and temperate regions were more inclined to buy insurance coverage for their crops than those living in cold regions. Moreover, in a recent study by Torkamani and Nikoui (2006) in Fars province of Iran, revealed that profitability was the biggest motivating factor in using crop insurance coverage. Furthermore, McCarthy and Sun (2004) indicated that crop insurance has a profound effect on intention to utilize organic farming systems and more indigenous approach to farming practices. Crop insurance is one tool that can assist Iranian crop producers in managing the risk of yield

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or income loss associated with crop disasters. Unfortunately crop insurance coverage is not mandatory in this country and farmers are often reluctant to buy insurance coverage for their crops considering the arid and semi-arid nature of climate and being one of the disaster prone regions of the world.

The role of agriculture in economic development has been recognized for years. Expected increase in agricultural demand associated with population growth and rising per-capita incomes will require continuing increase in agricultural productivity. Agriculture productivity of a production unit, defined as the ratio of its output to its input, varies due to differences in production technology, differences in the setting in which production occurs and differences in the efficiency of the production process.

Efficiency of a production unit may be defined as how effectively it uses variable resources for the purpose of profit maximization, given the best production technology available. The concept of efficiency is further decomposed into two components: technical and allocative efficiency. Technical efficiency refers to the maximum attainable level of output for a given level of production inputs, given the range of alternative technologies available to farmer. Allocative efficiency refers only to the adjustment of inputs and outputs and to reflect relative prices having chosen the production technology (Jaforullah, 2003).

Although agricultural extension agents encourage dry farmers to buy insurance coverage for their crops, only a few farmers have come to believe that crop insurance is essential if they are to produce at their maximum efficiency. The purpose of this study was to determine the effect of crop insurance on technical efficiency among insured and uninsured dry wheat farmers in Kermanshah province.

MATERIALS AND METHODS

The population in this study consisted of insured and uninsured dry wheat farmers of Kermanshah province. Using stratified multi-stage cluster sampling method 251 farmers were interviewed across three different regions: Tropical, temperate and cold during 2003-2004 crop years.

In specifying the model in this study, it is assumed that dry wheat farming produce output (Y) using seven output criteria: machinery (X_1), labor (X_2), seed (X_3), nitrogen fertilizer (X_4), phosphate fertilizer (X_5), pesticide (X_6), land (X_7). We used the statistical deterministic production function such as Cobb-Douglas Production Function to represent the production technology used by Kermanshah dry wheat farmers. The reason for selecting Cobb-Douglas Production Function was its popularity in specification and estimation of production frontiers in empirical studies. Moreover, it is simple to use and it has the potential to make econometric estimation of parameters because of its logarithmic nature of production function.

It is true, as Yin (2000) points out, that this function may be criticized for its restrictive assumptions such as unitary elasticity of substitution and constant returns to scale and input elasticities, but alternatives such as translog production functions also have their own limitations such as being susceptible to multicollinearity and problems in degrees of freedom. A study conducted by Kopp and Smith (1980) suggests that functional specification has only a small impact on measured efficiency.

The statistical deterministic production frontier (Afriat, 1972) representing Cobb-Douglas production technology characterized by variable return to scale is specified as:

$$L_n y_i = \beta_o + \sum_{k=1}^{7} \beta_k L_n X_{ki} - \varepsilon_i \qquad i = 1.2, n \tag{1}$$

In Eq. 1, Y_i represents i^{th} dry wheat farmers output and X_{ki} is the amount of the input used by the K^{th} farm. Constant returns to scale in production is imposed via the following restriction on the parameters:

$$\sum_{u=1}^{7} \beta_k = 1 \tag{2}$$

The production frontier in Eq. 1 is deterministic because it includes a one-side non-negative error term, which is assumed to be independently and identically distributed and has a non-negative mean and constant variance. There are problems in using Ordinary Least Squares (OLS) to estimate this production frontier. According to Greene (1980), while OLS provides best linear unbiased estimates of the slope parameters and appropriately computed standard errors, it dos not provide an unbiased estimate of the intercept parameter β_0. This further causes the OLS residuals of the model to have the incorrect signs. Since the calculation of technical efficiency relies on these residuals being non-negative, Greene (1980) suggest a correction for this biasedness by shifting β_0, The OLS estimator of β_0, upward by the largest positive OLS residual(e*). This two-step procedure is known as the Corrected Ordinary Least Squares (COLS) method. The unbiased estimator of the intercept parameter is given by:

Table 1: Descriptive statistics for the sample of 251 dry wheat farmers in Kermanshah province

Variables	Minimum	Maximum	Mean	SD
Output (t ha^{-1})	0.3	5	1.55	0.79
Machinery (h ha^{-1})	1.0	17	6.56	2.62
Labor (manhour/ha)	5.0	34	16.40	5.42
Seed (k ha^{-1})	120.0	300	180.21	31.97
Nitrogen fertilizer (k ha^{-1})	3.0	400	112.50	50.55
Phosphate fertilizer (k ha^{-1})	2.0	2100	115.73	137.16
Pesticide (L ha^{-1})	0.5	4	1.52	0.60
Land (ha)	1.0	84	7.90	8.11

$$\hat{\beta}^*_o = \hat{\beta}_o + e^* \quad (3)$$

This correction works all OLS residuals non-positive, implying that the estimates of ε_i are non-negative and none of the forms is more than 100 percent efficient. Technical Efficiency (TE) of the i^{th} farms is calculated by using the following equation:

$$TE_i = \exp(-E_i) = \exp(e_i - e^*) \quad (4)$$

Where:
e_i = OLS residual for the i^{th} farm
e^* = Defined above

The inputs that are important in the production of dry wheat farming are: taken machinery, labor, seed, nitrogen fertilizer, phosphate fertilizer, pesticide and land. Machinery is measured by total hours operated per hectare. Labor is measured by total hours that men/women worked per hectare. Seed is the amount of consumption per hectare in kilogram. Nitrogen and phosphate fertilizer is the amount of consumption per hectare in kilogram. Pesticide is the amount of consumption per hectare in liter. Land is the total fragments that used for dry wheat farming during a crop year per hectare. Summery statistics is shown in Table 1.

RESULTS

The Corrected Ordinary Least Squares (COLS) method, as explained earlier, was used to obtain estimates of parameters of the statistical deterministic production models in each climatical region separately.

As shown in Table 2 (cold region) parameters intercept, seed, nitrogen fertilizer and pesticide are statistically significant at 1% level of significance.

In temperate region (Table 3) all parameters have meaningful signs except labor, phosphate fertilizer and land that were not statistically significant.

In tropical region (Table 4) only land, nitrogen and phosphate fertilizers were statistically significant. The distributions of individual technical efficiency estimates for each climatical regions are presented in Table 5.

Table 2: Estimated corrected ordinary least square for dry wheat farmers in cold region

Independent variable Y

Variables	Coeff.	Sd. Err	t-stat	Prob	R^2
Intercept	-1.989540**	0.0021	-3.178880	0.0021	0.829139
X_1	0.175648	0.2114	1.259086	0.2114	Adj.R^2
X_2	-0.173300	0.2729	-1.103390	0.2729	0.815231
X_3	0.755496**	0.0097	2.646563	0.0097	
X_4	0.241162*	0.0427	2.057317	0.0427	
X_5	-0.014600	0.8559	-0.182090	0.8559	
X_6	0.237574**	0.0039	2.967829	0.0039	
X_7	-0.185800	0.4911	-0.691510	0.4911	N = 94

**: Significant at 1%, *: Significant at 5%

Table 3: Estimated corrected ordinary least square for dry wheat farmers in temperate region

Independent variable Y

Variables	Coeff.	Sd.Err	t-stat	Prob	R^2
Intercept	-1.560650**	0.705252	-2.212900	0.0294	0.711672
X_1	0.259744*	0.138979	1.868940	0.0648	Adj.R^2
X_2	-0.290180	0.207150	-1.400800	0.1647	0.689493
X_3	0.588231*	0.309328	1.901641	0.0604	
X_4	0.276348*	0.155741	1.774403	0.0793	
X_5	0.012886	0.171682	0.075058	0.9403	
X_6	0.254040*	0.144392	1.759375	0.0819	
X_7	-0.186550	0.384997	-0.484540	0.6292	N = 99

**: Significant at 5%, *: Significant at 10%

Table 4: Estimated corrected ordinary least square for dry wheat farmers in tropical region

Independent variable Y

Variables	Coeff.	Sd.Err	t-stat	Prob	R^2
Intercept	0.552847	1.055966	0.523546	0.6035	0.782027
X_1	-0.080850	0.258049	-0.313320	0.7557	Adj.R^2
X_2	-0.194630	0.241493	-0.805940	0.4250	0.743881
X_3	-0.239960	0.481642	-0.498220	0.6211	
X_4	0.474158*	0.254402	1.863814	0.0697	
X_5	-0.348250*	0.230108	-1.634210	0.0724	
X_6	-0.109700	0.295209	-0.371590	0.7122	
X_7	1.482800**	0.547628	2.707677	0.0099	N = 58

**: Significant at 1%, *: Significant at 5%

Table 5: Frequency of distributions of technical efficiency estimate from COLS in each region

	Region		
Technical efficiency	Cold	Temperate	Tropical
0<TE = 0.1	1	2	2
0.1<TE = 0.2	0	8	3
0.2<TE = 0.3	0	13	8
0.3<TE = 0.4	3	20	19
0.4<TE = 0.5	9	32	17
0.5<TE = 0.6	23	16	8
0.6<TE = 0.7	32	8	1
0.7<TE = 0.8	22	0	0
0.8<TE = 0.9	4	0	0
0.9<TE = 1	0	0	0
Total	94	99	58
Mean	61.8	40	37.7

We used independent sample t-test to determine the effect of crop insurance among insured and uninsured dry wheat farmers in three climatical regions in Kermanshah province. There is a significant difference between

Table 6: Hypothesis test regarding the mean technical efficiencies between insured and uninsured dry wheat farmers in each region

Hypothesis	Cold	Temperate	Tropical
H_0:	$\mu_{TEin} = \mu_{TEun}$	$\mu_{TEin} = \mu_{TEun}$	$\mu_{TEin} = \mu_{TEun}$
H_1:	$\mu_{TEun} \neq \mu TEin$	$\mu_{TEun} \neq \mu_{TEin}$	$\mu_{TEun} \neq \mu_{TEin}$
Calculated t-test	0.779	4.488	2.450
Decision	Do not reject H_0 at the 5% level of significance	Reject H_0 at the 1% level of significance	Reject H_0 at the 1% level of significance

Un = Uninsured, In = Insured

insured and uninsured dry wheat farmers in temperate and tropical regions (Table 6). However, there were no significant differences across cold regions.

DISCUSSION

In this study, we estimated both insured and uninsured dry wheat farmers' technical efficiencies using COLS method. Results revealed a positive effect of crop insurance in tropical and temperate regions. However, crop insurance coverage did not affect technical efficiency among farmers in cold regions. This might be due to higher rainfall in the cold regions in Kermanshah province. The mean annual precipitation in the province of Kermanshah is 320 mm and most of this precipitation occurs in the cold region. Thus farmers living in these regions may not feel the need to purchase insurance policy for their crops. Results of this study have implications for agricultural extension agents as well as agricultural policy-makers in Iran. First, county extension agents should conduct educational programs for farmers in temperate, tropical and cold regions in order to emphasize the importance of crop insurance in farming practices. One effective way to do this would be to invite insured farmers to extension classes as guest speakers to share their experience with uninsured farmers. Second, extension agents should target farmers in cold regions about the benefits of crop insurance. One effective method would be to distribute extension pamphlets showing drought patterns that have shown to occur every two to three years in Iran. These awareness programs would alert farmers about a possible drought season in the region which in turn would encourage farmers to consider crop insurance. Third, agricultural policy-makers can provide incentives for those farmers who purchase crop insurance. These incentives could be in the form of free fertilizer or free soil sample analysis to those who buy insurance coverage. This may take a while before crop insurance policies are institutionalized in the country but a pre-requisite to that would be to mandate crop insurance across the country. Fourth, agricultural policy-makers in Iran should use mass media as a means of diffusing crop insurance benefits and recognize those who adopt crop insurance across the country. These recognitions can take place in the annual Agricultural Week in Iran where high yielding farmers are recognized and praised for their production. During this annual occasion, insured farmers should be given the opportunity to speak up and tell about the advantages of buying insurance policies for crops. Finally, during drought years, government should provide enough incentives (free fertilizer, free soil analysis etc.) in order to encourage farmers to cover the risk of dry season through crop insurance policies.

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