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An examination of the impact of agricultural crop insurance on crop production and gross margin of rural farms

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ABSTRACT

Because of the agricultural sector's importance in the national economy, and because it accounts for 17 percent of GDP and 22 percent of job labor, it is critical to support it as much as possible. Agricultural product insurance is one of the most important governmental support levers in the agricultural sector. It not only compensates farmers for the losses caused by the small savings of a large number of farmers, but it also provides more security for agricultural producers, lowering production risks significantly. So, in this study, we attempted to use positive mathematical programming (PMP) to examine the effects of introducing wheat insurance on wheat cultivation and farmer gross margins in the Sistan region. These farmers were divided into three groups based on the size of their cultivated farms: (1) small group (less than 3 hectares), (2) average-sized group (4-10 hectares), and (3) large group (more than 10 hectares). The results showed that after introducing wheat insurance, the farmer accepted it, and the cultivated area of wheat increased from 2 hectares to 2.01 hectares, while the farm's gross return increased from 18423290 Rials to 18511721 Rials, i.e., 0.479 percent more than those farmers who did not participate in the insurance scheme. On average-sized farms, implementing this insurance increased wheat cultivated area from 4.8 hectares to 4.858 hectares, and farm gross return increased from 48803550 Rials to 49291580 Rials, i.e., about 1% more than farmers who did not participate in the scheme. Following this plan, the cultivated area of wheat increased from 16 hectares to 16.445 hectares, and the farm's gross return increased from 139151140 Rials to 142421200 Rials, a 2.35 percent increase over those who did not participate in the scheme.

1. Introduction

In most developing countries, agriculture has gained special importance. Since it includes various activities for providing a part of the national income in foreign currency and food security, it has a remarkable role in developing the economic-social growth of these countries. On the other hand, increased reliance on natural and environmental factors, as well as market volatility in agricultural activities, pose their own risks. Hence, the survival and durability of the agricultural sector require the serious support of its own producers and investors. Meanwhile, numerous risks, such as production, price, or financial market risks, arising from uncertainty about the agricultural policies and activities of the government, as well as human risks, affect the income and welfare levels of these farmers (Shokri and Samadi, 2010). The presence of various risks makes farmers rethink their investments. One of the most important challenges for agricultural planners and policy-makers is to make deliberate and accurate decisions and policies to reduce the income fluctuations of agricultural producers, especially those producers of strategic products (Faraji and Mirdamadi, 2007). There are different approaches titled "the risk management tools," which can decrease the destructive effects of the risks involved in agricultural activities. Risk management is the hazardous management of implementing different methods, tools, and policies to lower the negative impacts of various risks (Tomek and Peterson, 2000).

Insurance of agricultural products is a supporting tool for controlling and managing risk and increasing the security margin of investment in the agricultural sector, which has attracted the attention of policymakers, especially during recent decades. Agricultural insurance is

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a unique financial solution that protects the farmers against possible damage and low income, so it can be considered as an accurate and precise source for the farmers to accept innovations and revisions in their production methods (Forohideh and Tarazkar, 2009).

1.1. The definition of the problem

Agriculture is always accompanied by risk. The presence of risk and the producers' reaction to it affect the form and content of policies made by the agricultural sector. In fact, variety, instability, and risk are three main factors that play a significant role in the motivation and programming of policy-making processes in this sector (Hosseini and Gholizdeh, 2008).

Instability in agricultural incomes and damages incurred to the producers that are the results of the uncontrollable above-mentioned risks had forced many developing countries to program for a more stable agricultural income. Among different economic sectors, agriculture is more subjected to risk. So, due to its numerous effects, insurance can lead to satisfactory rural development, either at a micro or macro level, and it can achieve simultaneous progress for all sectors (Vedenov and Power, 2008).

Insurance policies for agricultural products can achieve this goal by taking possible risks and eliminating the rest of these uncertainties, so that there will be a balance between the demand and supply of the insurance, and the insurance programs will be more efficient and financially, they will rely on their own (Shokri and Samadi, 2010).

1.2. Significance

One of the supporting levers of the government is the insurance of agricultural products. Using this strategy, it can collect the little savings of numerous farmers paid as insurance and use them as compensation for possible agricultural damage. On the other hand, it can increase agricultural producers' security and reduce production risks. Therefore, the insurance of agricultural products can be considered as one of the most essential and effective solutions (Hayati et al., 2010).

However insurance is still an unknown phenomenon for many farmers, mainly because of a low culture of using insurance. Most farmers have no information about the positive, supportive effects of using insurance, and they consider it a waste of money (Iravani et al. 2006). %80 of these farmers are illiterate and less educated, whereas this figure has risen to %85 in Sistan and Baluchistan. Furthermore, only 4.2% of Sistani farmers have a university degree, and only 0.6% have an agricultural degree.

Hence, in spite of various publicities about agricultural products, farmers are not so willing to use this supportive lever (Shokri and Samadi, 2010). In this study, we have used the positive mathematical method for modeling the Sistani farmers' Wheat insurance. The aim of the study was to examine the impact of wheat insurance on wheat farm management and gross margins in Sistan.

2. Methodology

The main idea in PMP is to use the information available in the dual variables of the calibration limits. These dual figures are used to clarify the nonlinear objective function that rebuilds the observed levels of activities into the optimal solution for the new programming problem with no calibration limit (Salami and Einollahi Ahmadabadi, 2001). The PMP has three stages:

Stage 1: calculating shadow prices with supplementary linear programming

Mathematically, it is possible to show the first stage of PMP with a simple linear programming model for maximizing the planned gross margin:

$$\mathrm{Max}\ Z = GM'X \qquad \text{Eq. 1}$$

s.t:

$$AX \leq b \qquad [\pi]$$
$$X \leq (X^0 + e) \qquad [\lambda]$$
$$X \geq 0$$

Where Z is the objective function that must be maximized, X is the activities' vector, A is the matrix of technical coefficients, and b and π are the available resource vector and dual variables, respectively (or shadow prices). In these resources, e and λ are the vector of small positive numbers, and the dual variable of calibration limits, x^0 is the activity level observed in the base year. GM is the product gross margin vector that for each activity is as follows:

$$GM = (YP) - C \qquad \text{Eq. 2}$$

Where P is the cost of the crop, Y is the performance of the crop, and C is the total variable cost.

Stage 2: calculating the nonlinear calibrated cost function

In the second stage, the amount λ is used to calculate a nonlinear variable cost function. Sometimes, for simplicity and lack of strong reasons for choosing other variables, we use the following quadratic variable cost function:

$$C^V = d'x + \frac{1}{2}x'Qx \qquad \text{Eq. 3}$$

Where C represents variable costs, d represents an axis $(n \times 1)$ of parameters related to the linear part of the cost function, and Q represents a symmetric positive definite matrix $(n \times n)$ of parameters related to the quadratic variable cost function. This nonlinear variable cist function is obtained if and only if the final variable cost of the activities is equal to the sum of the accounting expenses of the activities and the dual variable of calibration limit. So, the parameters of the cost function should be as follows:

$$MC = \frac{\partial C^V(X^0)}{\partial x} = d + QX^0 = C + \lambda \qquad \text{Eq. 4}$$

Stage 3: Development of the final programming model in the third stage of PMP, we use a nonlinear calibrated cost function and the limitation of the resources to build a nonlinear programming model, as below:

$$\text{Max } Z = GM'X - d'X - \frac{X'QX}{2} \qquad \text{Eq. 5}$$

s.t:

$AX \leq b$

$X \geq 0$

The solution for this final model in the base year's condition is the same as the activity level of the base year. It is possible to use the changes in the conditions and define different scenarios for analyzing the policies.

1. Positive mathematical programming models are widely used for analyzing and evaluating the adoptability of farmers to changes in the market and policies. In this research, this model is used for assessing its potential and its ability to actualize crop insurance plans. The model of participation possibility in the crop insurance plan is considered for every single crop. Here, the farmer participates in the program and pays his crop insurance fee. If the amount of his harvest is less than the expected rate, he will receive the calculated compensation based on the subtraction of the expected amount of the product from the real amount of the product (Forohideh and Tarazkar, 2009). In this case, the vector of expected gross returns and the covariance matrix of the gross return are recalculated, which is different from the insurance-less case. Therefore, the model is extended and the possibility is created to choose with or without a participation option in the suggested plan through the quadratic mixed-integer formulation. Therefore, based on the above-mentioned points, the final model of calibration used in this research will be as follows:

$$Z = GM'_{un}x_{un} - \frac{1}{2}\phi x'_{un}\sum\nolimits_{un} x_{un} + GM'_{in}x_{in} - \frac{1}{2}\phi x'_{in}\sum\nolimits_{in} x_{in} - d'x - \frac{x'Qx}{2} \qquad \text{Eq. 6}$$

s.t:

$Ax \leq b$

$$x = x_{un} + x_{in} \qquad \text{Eq. 7}$$

Limits:

$$x_{in} \leq b \times \delta \qquad \text{Eq. 8}$$

$$x_{un} \leq b \times (1 - \delta)$$

2. Where x is the area under cultivation of wheat, barley, onion, watermelon, and melon in the field, and d and Q are the parameters of the quadratic cost function. ϕ is the coefficient of risk aversion for the field. In this research, the coefficient of risk aversion from previous studies has been used. GM'_{in} and GM'_{um} are the expected gross return for wheat with and without insurance. The variable x is divided into two variables: x_{in} and x_{un} These variables refer to the area of the field for cultivating wheat with or without insurance. $\sum_{in} x_{in}$ and $\sum_{un} x_{un}$ are the variance matrices of the gross return covariance of cultivating wheat with or without insurance. Sistan's limited resources are land, irrigated water, workforce, and investment. δ is a special dual variable field that has two values, 0 and 1 (Vaderveer, 2001).

Calculated for the participation mode, the objective-oriented part is determined by the second and third lines of Equation 6. Based on the role of the insurance plan, the second line is calculated to determine the expected value and the covariance matrix of the gross margin. Equation 7 is limited if and only if the x variable series for wheat is equal to the variable x (with or without insurance). These limits provide the chance to select individual participants. In fact, when the variable δ for a field equals 1, the farmer has to participate in the program with all other available fields, and vice versa. Therefore, for a field that participates in the program, $(\delta = 1)$, the objective function of equation 6 is eliminated, and the objective function just refers to the insurance mode. The opposite mode happens in a situation without insurance $(\delta = 0)$ (Schmid and Sinabell, 2005).

3. Results and Discussion

The population in the present study consisted of Sistani farmers who are classified into three subgroups:

- Small field with a cultivated area of less than 4 hectares.
- Average-sized fields with a cultivated area of between 4 and 10 hectares.
- Large fields, a cultivated area of more than 10 hectares.

The effect of accepting wheat insurance on the cultivation pattern and the gross return of the farmers

In this section, the impact of accepting insurance on the cultivation pattern of the farmers is analyzed (Table 1). First, the wheat insurance was introduced to all participants, and then its effects were processed by the PMP model. Table 2 shows the results of introducing this insurance to these three groups. As it can be inferred, in a small field, the cultivation areas of wheat, barley, onion, watermelon, and melon are 2, 0.5, 0.1, 0.3, and 0.2 hectares, respectively, and the total cultivated area is 3.1 hectares. Based on this table, after informing the farmer about the crop insurance and his acceptance of the program, his wheat cultivated area increased from 2 hectares to 2.01 hectares. In addition, his watermelon cultivated area increased from 0.3 hectare to 0.314 hectare, whereas the barley cultivated area decreased from 0.5 hectare to 0.492 hectare, the onion cultivated area decreased from 0.1 hectare to 0.0.095 hectare, and the melon cultivated area decreased from 0.2 hectare to 0.186 hectare. After participating in the wheat insurance program, his gross return increased from 18423290 Rials to 18511721 Rials, which is 0.479% more than his nonparticipation in the program. In an average-sized field, the cultivation areas of wheat, barley, onion, watermelon, and melon are 4.8, 1.5, 0.25, 1.2, and 0.5 hectares, respectively, and the total cultivated area is 8.25 hectares. Based on this table, after informing the farmer about the crop insurance and his acceptance of the program, his cultivated area of wheat increased from 4.8 hectares to 4.858 hectares, of onion increased from 0.25 hectares to 0.254 hectares, and of watermelon from 1.2 hectares to 1.227 hectares. Whereas the cultivated area of barley decreased from 1.5 hectares to 1.406 hectares, the cultivated area of melon decreased from 0.5 hectares to 0.45 hectares. After participating in the wheat insurance program, his gross return increased from 48803550 Rials to 49291580 Rials, which is 1% more than his nonparticipation in the program.

Table 1. Number and percentage of sample farmers available for each group

	The farmers of the area based on the cultivated farms		
	Small farm	**Average-sized farm**	**Large farm**
Total percentage of sample farmers	28.1	12.5	4.7
No. of samples	36	16	6
Size of sample farms	3.1	8.25	21.2

Source: research findings

In a large field, the cultivation areas of wheat, barley, onion, watermelon, and melon are 16, 1.5, 0.5, 2.2, and 1 hectares, respectively, and the total cultivated area is 21.2 hectares. Based on this table, after informing the farmer about the crop insurance and his acceptance of the program, his cultivated area of wheat increased from 16 hectares to 16.445 hectares, and of watermelon increased from 2.2 hectares to 2.266 hectares, whereas the barley cultivated area decreased from 1.5 hectares to 1.128 hectares, of melon decreased from 0.5 hectares to 0.429 hectares, and of onion decreased from 1 hectare to 0.827 hectare. After participating in the wheat insurance program, his gross return increased from 139151140 Rials to 142421200 Rials, which is 2.35% more than his nonparticipation in the program.

Table 2. The effect of accepting wheat insurance on the cultivation pattern and the gross return of the farmers

crops	Small fam		Average-sized farm		Large farm	
	Current	**Accepting insurance**	**current**	**Accepting insurance**	**Current**	**Accepting insurance**
Wheat(not insured)	2	-	4.8	-	16	-
Wheat(insured)	0	20.1	-	4.858	-	16.445
Barley	0.5	0.492	1.5	1.406	1.5	1.128
Onion	0.1	0.095	0.25	0.254	0.5	0.579
Watermelon	0.3	0.314	1.2	1.227	2.2	2.226
Melon	0.2	0.186	0.5	0.45	1	0.827
Sum	3.1	3.097	8.25	8.25	21.2	21.195
Gross return	18423	18511	48803	49291	139151	142421

Source: research findings

As it can be observed, introducing the wheat insurance program to Sistani farmers has led to their total participation.

The reason for this comprehensive participation is the low rate of insurance fees paid for every hectare of this crop. This participation was accompanied by an increase in the wheat cultivation area, so their wheat cultivated area increased by 0.513 hectares more than the total under -cultivated area of wheat, i.e., a 2.25% increase. Moreover, after their participation in the insurance program, the gross return of the total farms increased by 3846517 Rials, which is 1.86 percent higher than the period before their participation.

When this program was introduced to the large farms of Sistan, the farmers accepted the insurance, and consequently, their wheat cultivated area and their gross return increased by 2.78% and 2.35%, respectively. The result of introducing the insurance program to the sample fields' participation was that they all attended the program and paid 64480 Rials/ hectare as the insurance fee. This participation was followed by an increase in the wheat cultivated area as well as the gross return of the fields so that the wheat cultivated areas of the small, average-sized, and large fields in Sistan were 0.56%, 1.2%, and 2.78% and their gross returns were 0.48%, 1%, and 2.35%, respectively. However, based on these findings, the following suggestions are presented:

The participation rate of farmers depends on the size of their fields. Smaller farms have a higher sensitivity to the supporting rates, so, in order to insure the crops, it is suggested to divide farmers into homogeneous subgroups and their supporting rates be determined accordingly.

References

Faraji, V., Mirdamadi, M., 2007. Promotion of acceptance of insurance productbyapplegrowers in city of Damavand. Journal of Medical Sciences, 3, 489-500.

Forohideh, M., Tarazkar, M.J., 2009. Performance evaluation of agricultural insurance in iran, farmed fish, with emphasis on insurance. Sixth Conference of Iranian Agricultural Economics. Ferdowsi University of Mashhad, Department of Agriculture.

Hosseini, R., Gholizdeh, B., 2008. Factors affecting crop insurance policies on the economy and stabilizing the income of farmers, Economy and Agriculture, 2(3), 27-45.

Hayati, B., Ghahremizadeh, M., Khodavardizadeh, M., Najafi, N., 2010. Determinants of rural lives tock insurance of Salamas. Journal of Animal Science, 4(2), 27-38.

Salami, H.V., Einollahi Ahmadabadi, M., 2001. Factors affecting sugar beet farmers' tendency to buy insurance for crops, Proceedings of the Conference on Agricultural Insurance, Development and Investment Security, Tehran, 37-50.

Schmid, E. Sinabell, F., 2005. using the positive mathematical programming method to calibrate linear programming models, discussion paper, Nr. DP, Institute for Sustainable Economic Development, University of Natural Resources and Applied Life

Sciences, Vienna. Selected paper presented at AAEA Annual Meetings, Providence, Rhde Island, 24-37.

Shokri, H., Samadi, A., 2010. The effect of organizational indifference on organizational maturity with the mediating role of organizational identity in the Social Insurance Fund of Farmers, Villagers and Nomads, Third International Conference on New Developments in Management, Economics and Accounting, Tehran, https : //civilica.com/doc/949162

Tomek, W.G., Peterson, H.H., 2000. Risk management in agricultural markets: a review. Journal of Futures markets, 21 953-958.

Vaderveer, M.L., 2001 Demand for area crop insurance among litchi producers in northern Vietnam, Journal of Mathematics and Economics, 45, 520-530.

Vedenov, N.V., Power G.J., 2008. Risk-reducing effectiveness of revenue versus yield insurance in the presence of government payments. Journal of Agricultural and Applied Economics, 40(2) 443-445.