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Farmers' Willingness to Pay for Index Based Crop Insurance in Pakistan: A Case Study on Food and Cash Crops of Rain-fed Areas

Akhter Ali

International Center for Maize and Wheat Improvement (CIMMYT), Park Road, Islamabad, Pakistan

Abstract

In Pakistan, agriculture is vulnerable to multiple risks, especially in the rain-fed areas. The crop insurance can serve as a useful tool to manage risks in the rain-fed areas of Pakistan. This study has assessed farmers' willingness to pay for insurance in the rain-fed areas of Pakistan by conducting a survey of 531 farmers in the Soon valley and Talagang areas of Pakistan. The farmers' willingness to pay for the index based crop insurance has been studied by employing the different econometric models. It has been found that these rain-fed areas consider indexed based insurance to be an important risk management strategy. The empirical results have indicated that farmers' economic status, household assets and membership of community organization are the important determinants of their willingness to pay a higher insurance premium. The propensity score matching results have revealed that farmers were satisfied with index based insurance and were also willing to increase the area under food as well as cash crops. This study has suggested that to make agricultural insurance scheme more successful, the government should provide subsidy which will help in increasing the area under food and cash crops and shall ensure food security in the region.

Key words: Cash crops, food crops, willingness to pay, index based insurance, rain-fed, Pakistan

JEL Classification: Q22, P32

Introduction

Agriculture continues to be an important sector of Pakistan's economy despite its falling share in the national income. In 2010-11, the sector contributed 21 per cent to the gross domestic product (GDP) of Pakistan. The importance of agriculture goes beyond its income contribution. The sector engaged 43 per cent of the workforce in 2010-11, and is dominated by small-scale producers who have less than 2 ha landholding (80% of the total farmers) and largely depend on agriculture for their livelihood. However, livelihood in agriculture is threatened by frequent crop failures and price volatility (Boehlije and Eidman, 1994; Yesuf and Randy, 2008).

The agriculture in the rain-fed areas is of subsistence nature characterized by low land- as well as labour-productivity, and higher yield gap (GoP, 2009). The vulnerability of rain-fed agriculture to extreme weather conditions results in substantial income loss to farm households. The farm households have little support from the government in the form of insurance cover or subsidy to face the disaster (Khan *et al*., 2004). In the rain-fed areas of Pakistan, there is an urgent need for the effective risk management measures. In Pakistan, the insurance penetration accounts for only 0.7 per cent of the GDP, one of the lowest in the world, and there has been no growth in it during the past 10 years. The initiatives taken by various governments to promote agricultural insurance in the country have had limited success.

This paper has analysed the factors that influence a household's willingness to participate in and pay

* Author for correspondence
Email: akhter.ali@cgiar.org

premium for insurance of food and cash crops. It is probably one of the first studies that have been focused on the farmers' willingness to pay for index based crop insurance in Pakistan. However, the index based insurance is not a panacea for all weather-related hazards. It manages only a limited number of risks. The index based insurance pilot project in Pakistan intends to complement the government's initiative by providing another option suitable to the country's diverse climatic, topographic and cropping systems.

Index insurance and traditional insurance are not by definition mutually exclusive. These can co-exist and complement each other since these are really designed to target different layers of risks and different levels of administrative capabilities. However, advances in technology that lower delivery costs and loss adjustment surveys in the case of traditional crop insurance schemes will be needed to make this type of insurance financially feasible. There are significant advantages of index based insurance. It avoids the problems of moral hazard and adverse selection. Because the payment of indemnity is based on the deviations from the index and not on individual losses, no assessment of losses at the individual level is needed. The indemnity process is quick and inexpensive to administer. Additionally, the design of the product lessens the administrative and operational expenses. Despite these major advantages, acceptance of this product by both insurers and insured parties is still low. This can be explained by considering some of the constraints. From the point of view of the insurer, it can be a costly and time-consuming task to assemble the data and construct the appropriate indexes. Once the indexes are created, operational costs are low and this translates into lower premiums for insured parties. The lower premiums attract small producers who otherwise would not be able to afford insurance. The index based weather insurance products that are properly designed can become a first step to facilitate the broader development of robust rural financial markets that serve the needs of the poor in low-income countries. Only a limited number of studies have been focused on the farmers' willingness to pay for crop insurance products such as of Bardsley *et al*. (1984); Patrick (1988); McCarthy (2003) and Sarris *et al*. (2006).

The main objective of the current paper is to estimate the farmers' perceptions regarding index based insurance and their willingness to pay for the insurance of food and cash crops in Pakistan.

Data and Methodology

Data and Description of Variables

The data were collected from two different locations, Soon Valley and Talagang, which are predominantly rain-fed areas situated in the Punjab province of Pakistan and were piloted for the index based crops insurance schemes. A comprehensive survey was carried out by employing a well-structured questionnaire schedule. Information on a number of socioeconomic variables, household assets, income and production of cash and food crops was collected from randomly selected 531 farm households, the majority of them were small farmers.

Table 1 presents the difference in key characteristics of the households willing to participate and not willing to participate in the index based insurance. Farmers willing to participate in the index based insurance were relatively younger, and had better education. However, size of their landholdings, and family was small. Those willing to participate had less access to non-farm income generating activities, but their agricultural production portfolio was more diversified.

The farmers willing to participate in the index based insurance had higher household income and they had also availed the credit facility. The non-participants had better access to extension services. The participants had higher tractor ownership. However the non-participants had higher tube-well and dug-well ownerships. Similarly, the participants had higher livestock ownership.

Methodology

The willingness to pay for the index based insurance product is the amount of money an individual or a household is willing to pay for purchasing the insurance product given its expenditure levels, risk perception, risk aversion and other background characteristics.

The Gustafsson-Wright (2009) model of willingness to pay (WTP) for the micro insurance is:

$$WTP = \Psi(Q^1, Q^0, L, Z, \zeta, \mu, \varepsilon) \quad \ldots(1)$$

Table 1. Difference in key characteristics of farmers willing to participate and not willing to participate in index based crops insurance in Pakistan

Variable	Farmers willing to participate in index based insurance	Farmers not willing to participate in index based Insurance	Difference	t-values
Age	43.27	47.41	-4.14	-1.25
Education	10.32	6.45	3.87**	2.01
Landholding	1.8	3.2	-1.40*	-1.78
Family type	0.37	0.62	-0.25*	1.66
Household size	6.52	9.48	-2.96	-1.48
Nonfarm	0.36	0.58	-0.22*	-1.73
Crop diversity	0.78	0.55	0.23**	2.25
Household income	15478	20164	-4686*	-1.79
Credit	0.31	0.16	0.15***	3.03
Extension	0.17	0.29	-0.12*	-1.94
Tractor	0.41	0.28	0.13**	2.16
Tube-well	0.07	0.13	-0.06*	-1.71
Dug-well	0.31	0.53	-0.22**	-1.99
Road access	0.71	0.58	0.13	1.45
Food crops	0.74	0.57	0.17	1.55
Cash crops	0.45	0.37	0.08	0.82
Livestock	6.25	3.79	2.46***	3.29
Number of farmers	281	260		

Note: ***, **, * denote significance at 1 per cent , 5 per cent and 10 per cent levels, respectively.

where, Q^1 and Q^0 are the levels of utility associated with and without insurance, respectively; L denotes assets of the household; Z represents the vector of household and farm level characteristics (age, education, farm size, etc.); ζ is the probability of facing the risk; μ is the risk aversion; and ζ represents other unobserved factors. $\Psi(.)$ is the maximum value an individual is willing to forgo to avoid or lessen his exposure to a particular risk. Thus, a farmer will buy the insurance policy only under conditions represented by relation (2);

$$\rho(Q^1, L-WTP, Z, \zeta, \mu) \geq (Q^0, L, Z, \zeta, \mu); \varepsilon \quad \ldots(2)$$

where, $\rho(Q^1, L-WTP, Z, \zeta, \mu, \varepsilon_1)$ and $\rho(Q^0, L, Z, \zeta, \mu, \varepsilon_0)$ are indirect utility functions with and without insurance cover, respectively for an individual. ε_1 and ε_0 are assumed to be normally distributed with zero mean and constant variance.

It is important to note that willingness to pay is different from willingness to join the index based insurance as the willingness to join may be higher. In the present study, the farmers' willingness to join has been estimated by employing the Probit model and the acreage farmers are interested to ensure is estimated by employing the Poison regression estimates.

The likely impact of insurance has been estimated using propensity score matching that corrects the sample selection bias which may arise due to systematic differences between the two groups of farmers. A brief description of the propensity score matching method is presented below.

Propensity Score Matching

The expected treatment effect for the treated population is of primary significance[1] and is given by Equation (3):

$$\tau|_{I=1} = E(\tau \mid I=1) = E(R_1 \mid I=1) - E(R_0 \mid I=1) \quad \ldots(3)$$

where, τ is the average treatment effect for the treated (ATT) population, and R_1 denotes the value of outcome for participants of new technology and R_0 is the value of outcome for non-participants. A major problem is that we do not observe $E(R_0 \mid I = 1)$. Although the difference $[\tau^e = E(R_1 \mid I = 1) - E(R_0 \mid I = 0]$ can be estimated, it is potentially a biased estimation.

In the absence of experimental data, the propensity score-matching model (PSM) can be employed to account for this sample selection bias (Dehejia and Wahba, 2002). The PSM is the conditional probability that a farmer adopts the new product, given the pre-adoption characteristics (Rosenbaum and Rubin, 1983). To create the condition of a randomized experiment, the PSM employs the unconfoundedness assumption, also known as conditional independence assumption (CIA), which implies that once Z is controlled for, product adoption is random and uncorrelated with the outcome variables. The PSM can be expressed as per Equation (4):

$$p(Z) = \Pr\{I = 1 \mid Z\} = E\{I \mid Z\} \qquad \ldots(4)$$

where, $I = \{0, 1\}$ is the indicator for adoption and Z is the vector of pre-adoption characteristics. The conditional distribution of Z, given by $p(Z)$ is similar in both the groups of adopters and non-adopters.

Unlike the parametric methods mentioned above, propensity score matching requires no assumption about the functional form in specifying the relationship between outcomes and predictors of outcome. The drawback of the approach is the strong assumption of unconfoundness. As argued by Smith and Todd (2005), there may be systematic differences between outcomes of adopters and non-adopters even after conditioning because selection is based on unmeasured characteristics. However, Jalan and Ravallion (2003) have pointed out that the assumption is no more restrictive that those of the IV approach employed in cross-sectional data analysis. Michalopoulos *et al.* (2004) have indicated that non-experimental method provides the most accurate estimates in the absence of random assignment. On the other hand, the fixed effects model did not consistently improve the results.

After estimating the propensity scores, the average treatment effect for the treated (ATT) can then be estimated as per Equation (5):

$$\tau = E\{R_1 - R_0 \mid I = 1\} = E\{E\{R_1 - R_0 \mid I = 1, p(Z)\}\} = E\{E\{R_1 \mid I = 1, p(Z)\} - E\{R_0 \mid I = 0, p(Z)\} \mid I = 0\} \qquad \ldots(5)$$

Results

The farmers' perceptions regarding food and cash crops insurance have been presented in Table 2[2]. The dependent variable was binary, i.e. 1 for farmers willing to participate in the index based crop insurance and 0 otherwise. A number of explanatory variables were included in the model. The coefficients for age and education were positive and significant. The results are in line with the previous studies such as of McCarthy (2003) and Sarris *et al.* (2006) regarding willingness to pay for crop insurance in developing countries. The coefficient for landholding had a positive and significant effect suggesting that farmers having larger landholdings were more willing to participate in the food and cash crops insurance. The coefficients for family type, crop diversity and non-farm participation were negative and significant. Household income too

Table 2. Farmers' perceptions about indexed based crop insurance in Pakistan (Probit estimates)

Variable	Coefficient	t-values
Age (years)	0.013*	1.79
Education (years)	0.027***	2.84
Landholding (acres)	0.045***	3.16
Family type (dummy)	-0.012	01.13
Household size (No.)	0.029	0.55
Nonfarm (dummy)	-0.036*	-1.77
Crop diversity (dummy)	-0.028**	2.02
Household income (Pakistani rupees)	0.044***	3.16
Credit (dummy)	0.011***	2.55
Extension (dummy)	0.016***	3.90
Tractor (dummy)	0.009*	1.88
Gender (dummy)	0.032	1.22
Tube-well (dummy)	0.017***	2.55
Soon Valley (dummy)	0.028*	1.77
Road access (dummy)	0.057*	1.88
Food crops (dummy)	0.027**	2.02
Cash crops (dummy)	0.031*	1.83
Livestock number	0.049***	2.67
R^2	0.26	
LR χ^2	135.54	
Prob>χ^2	0.000	
Number of Observations	256	

Note: ***, **, * denote significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

had a positive sign. The credit availability and access to extension services were positive and significant. The tractor ownership was also positive and significant at 10 per cent level of significance. The tube-well ownership was negative and non-significant. The food crop was positive and significant at 5 per cent level of significance. Similarly, the cash crop was positive and significant at 10 per cent level of significance. The livestock ownership was positive and highly significant at 1 per cent level of significance. The regional dummies were also included in the model although the results were not significantly different from zero. The R^2 value was 0.26, indicating that 26 per cent variation in the dependent variable was due to variables included in the model and vice versa. The LR χ^2 was significant at 1 per cent level of significance, indicating the robustness of the variables included in the model.

The Poisson regression was estimated for the number of acres for which the farmers were interested to get insurance and the results have been presented in Table 3[3]. The coefficients for age, education, landholding, family type and household income were positive and significant, indicating their positive role in farmers' willingness to insure the number of acres under food and cash crops. The coefficients for household-size and nonfarm participation were negative and significant. Regarding institutional support and household assets, the credit and extension services, tractor, livestock number and tube-well ownership were positive and significant. The effect of gender was studied by including a dummy variable, i.e. 1 for male and 0 for female and the results were positive, although not significantly different from zero. The road access was also included as dummy variable and the coefficient was positive and significant at 5 per cent level of significance. The R^2 value was 0.23, indicating that 23 per cent variation in the dependent variable was due to independent variables included in the model. The LR χ^2 was significant at 1 per cent level of significance, indicating the robustness of the variables included in the model.

Table 3. Farmers' willingness to insure number of acres (Poisson estimates)

Variable	Coefficient	t-values
Age (years)	0.017*	1.85
Education (years)	0.023**	2.02
Landholding (acres)	0.019***	2.76
Family type (dummy)	0.016*	1.66
Household size (No.)	-0.010***	2.48
Nonfarm (dummy)	-0.014	-1.36
Crop diversity (dummy)	0.011	0.55
Household income (Pak rupees)	0.016***	2.47
Credit (dummy)	0.014***	2.61
Extension (dummy)	0.018*	1.90
Tractor (dummy)	0.021*	1.85
Tube-well (dummy)	0.0215***	3.23
Gender (dummy)	0.031	1.49
Road access (dummy)	0.019**	2.19
Livestock number	0.031***	2.54
Soon Valley (dummy)	0.015**	2.34
	0.225	
LR χ^2	207.41	
Prob $>\chi^2$	0.000	
Number of observations	256	

Note: ***, **, * denote significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

The impact of participation in index based insurance was estimated by employing the propensity score matching and the results have been presented in Table 4. The ATT results indicate the difference in outcomes of the farmers willing to participate and not willing to participate in the index based insurance. The ATT results for farmers' satisfaction level were positive and significant at 1 per cent, indicating that farmers willing to participate in index based insurance were more satisfied as compared to farmers not willing to participate in index based insurance. The ATT results regarding the farmers' willingness to increase area under food crops were positive and significant at 5 per cent level of significance, indicating that the index based insurance can help in increasing the area under food crops which in turn can help in increasing the rural household food security in Pakistan[5]. There also existed a huge yield gap between the irrigated and rain-fed areas of Pakistan[6]. So the increase in acreage under food crops can help in ensuring the household food security levels in the rain-fed areas of Pakistan. The results for cash crops were also positive and significant at 5 per cent level of significance, indicating that farmers willing to participate in index based insurance were also willing to increase the area under cash crops[7]. The increase in the area under cash crops can help in increasing the household income levels. The farmers were of the view that the premium rates were a bit

Table 4. Impact of insurance on farmers satisfaction level and numbers of acres under food and cash crops

Variable	ATT	t-values	Critical level of hidden bias	Number of	
				treated	control
Satisfied (dummy)	0.63***	2.84	1.25-1.30	210	180
Willing to increase food crops acreage (dummy)	0.55**	2.16	1.55-1.60	203	172
Willing to increase cash crops acreage (dummy)	0.47**	2.33	1.60-1.65	155	197
Subsidy needed (dummy)	0.81***	3.41	2.10-2.15	210	195

Note: ***, **, * denote significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

high and there was the need about 50 per cent subsidy. The ATT results regarding the subsidy requirement were positive and significant at 1 per cent level of significance, indicating that the premium rates for the food and cash crops insurances were higher and the farmers were looking for the subsidy[8]. In the study area the Pakistan Poverty Alleviation Fund (PPAF) was willing to provide 50 per cent subsidy to the farmers during the initial stages of the implementation of index based Insurance. The results are in line with the previous studies that higher premium rates resulted in substantially lower levels of participation in crop insurance programs (Gardner and Kramer, 1986; Goodwin, 1992; Barnett *et al*., 1990; Niewoudt *et al*., 1985; Smith and Baquet, 1996; Just *et al*., 1999).

From the empirical results it was concluded that the farmers in the rain-fed areas of Pakistan were willing to pay for the index based insurance to cover weather-related risks. The farmers were also willing to increase the area under food and cash crops. The findings of the current study are in line with the previous studies that agricultural insurance programs are likely to be more successful in environments where yields are more volatile, farmers are better educated, debt is a concern and premium rates are subsidized.

Conclusions

In the rain-fed areas of Pakistan the agricultural sector is vulnerable to multiple risks, especially due to changing climatic conditions. The landholdings are small in these areas, and the farmers are unable to cope-up with the multiple risks, hence the index based insurance can serve as a risk management strategy. The farmers' willingness to participate in the food and cash crops insurance schemes are influenced by a number of factors, especially the social capital. With the introduction of the index based insurance, the farmers' choice for the cash crops should change as the cash crops which used to be profitable, but risky, will now be safer. By reducing the degree of riskiness in agricultural production, farmers will resort less to *ex-ante* risk coping mechanisms. One should therefore expect increased specialization and high profits, as farmers focus on maximizing the output of the insured crop, rather than on diversifying the weather risk through the cropping system. The weather index based insurance will thus not only introduce a more efficient and low-cost insurance but it will also provide a more transparent and actuary fair insurance products to the farmer. The provision of direct risk relief to farmers will enable them to alter their production strategies towards maximizing output, rather than diversifying risk, and to shift their demand for credit from consumption loans to investment loans. This is likely to result in increased specialization and investment, and thus contribute to increased profits and the well-being of the farmers in rain-fed areas of Pakistan.

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Notes

1. The propensity score matching rests on two strong assumptions; first, the CIA (conditional independence assumption) states that once the observable factors are controlled for technology, the adoption is random and uncorrelated with the outcome variables and second, the common

support condition that matching can only be carried out over the common support conditions.

2. The Probit model was estimated.
3. The Poisson regression was based on the assumption that mean of the dependent variable was equal to its variance otherwise negatively binomial logit model could have been estimated.
4. The most important food crop in rain-fed areas of Pakistan is mainly the wheat crop.
5. The wheat yields in the irrigated areas are almost double as compared to rain-fed areas.
6. The most important cash crop in rain-fed area is the groundnut crop.
7. The premium rate for the wheat crop was approximately Pakistani rupees 1000/acre and for the groundnut was Pakistani rupees 1275/ acre.

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