



# Analysis of wheat farmers' risk perceptions and attitudes: evidence from Punjab, Pakistan

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## Abstract

Agriculture involves multiple risks of which environmental and production threats are major ones. Farmers' risk attitudes and risk perceptions have a significant role in dealing with their decisions, farm-relevant practices and management exposure to risk. Developing countries have carried out limited research work on the variety of risk management issues. This research work quantifies farmers' attitudes and perceptions of different types of risks, such as which wheat crop is grown. The study relies on a survey of six wheat-producing districts containing household farms with 402 wheat-producing farmers in Punjab, Pakistan. To discover farmer' attitudes toward risks, the Equally Likely Certainty Equivalent approach has been employed, with the ranking of farmers' perceptions of four disastrous risk sources, storm rainfall and hail, drought, high input prices and wheat diseases, using a risk matrix. A probit model was employed to analyze the empirical estimation of factors affecting farmers' attitudes and perceptions. The findings of the study indicate that the majority of the farmers have a risk-averse nature and consider storm rainfall and hail, drought, high input prices and wheat diseases as major threats to their wheat crops. Empirical findings of the study show that gender, religion, age, farming experience, education, credit, farming area, livestock numbers and off-farm income have significant (positive or negative) effects on farmers' attitudes toward risk and risk perceptions. The study provides a convenient analysis for farmers, researchers, extension services, the agricultural insurance sector, and agriculture policy makers. Policy makers and researchers need to understand farmers' risk attitudes and risks, providing them with precise knowledge regarding risks and refined risk management tools, and ensuring the provision of agricultural financing and contemporary agricultural extension services.

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## 1 Introduction

Farming is considered a risky enterprise, owing to the unpredictable meteorological environment, namely temperature and rainfall, so that agriculture worldwide incites uncertain risks, as shown by Hardaker et al. (1997), Ali (2007) and Wang et al. (2009). The agriculture sector is confronted with major risks, characterized as production, marketing, financial, legal, and environmental, and a risk for human resources (Musser and Patrick 2001). Crop yield and livestock variations, referred to as production risk, have been determined as the major threat faced by the majority of farmers (Sarwar and Saeed 2013). Agriculture depends on the natural ecological environment, including temperature, rainfall, pollution, diseases of crops and price variations because of market imperfections, as the foremost basis for the greatest threats (Singla and Sagar 2012). Farmers must adopt strategies to enhance their adaptive capacity to handle climatic risks, which have a major effect on their well-being. Uncertain natural hazards reduce farm income through reducing production yield, and farmers remain helpless against these natural calamities, so it is prerequisite for farmers to detect these threats and manage the production risks (Drollette 2009). Risk management in agriculture is imperative, reducing farm as well as farmers' welfare (Harwood et al. 1999). Vigilant and timely evaluations of agricultural risks have been formulated and govern the creation of proper strategies. Farmers' decisions of behavior in the circumstances of uncertain situations provide farmer feedback on their perceptions. Observing how farmers perceive risk and how they behave against various risks is considered the proper way to analyze their decisions in risky and uncertain conditions.

Wheat is a major food crop among the cereals grown in Pakistan and the staple diet for the population of the country. Pakistan is the 9th largest producer of wheat in the world (USDA 2015). The wheat crop shares 2% of the gross domestic product and 9.9% value-added in the agriculture sector. The wheat area under cultivation during 2015–2016 was 9,260,000 ha, with the production of 25,482,000 tonnes (Economic Survey of Pakistan 2015–2016). Wheat yield was estimated at 2752 kg/ha, which is relatively lower than the potential yield as compared to other agrarian countries (Agriculture Organization 2014). Wheat is produced throughout the country, though the Punjab province produces more than 75%, so a major share of the total wheat production in the country. Agriculture growth, specifically major crop production in Pakistan, has faced major threats regarding storm rainfall and hail, drought, and crop diseases, as well as economical (high input prices, low output prices) and institutional threats during the last decade (Abid et al. 2015a, b; Gorst et al. 2015). Pakistan has seen numerous extreme weather and environmental changes during 1995–2014 shown by the global climate risk index, and is ranked 8th among the most affected countries for climate change (Kreft et al. 2016). Consecutive environmental changes in Pakistan during the last decade include excessive rainfall in summer with sequential floods, drought in winter and crop diseases, resulting in major losses to agriculture production and in particular to the major crops. Thus, the wheat crop has faced major threats to growth from drought in winter and major losses of production in the harvesting season from storm rainfall and hail (Abid et al. 2011, 2015a, b).

Financial constraints and scarce resources at national and farm levels are major factors in failures to overcome the capacity to adjust to visible risks (Abid et al. 2015a, b). Public institutions located at the local level have no significant ability to cope with these

threats due to the limited and scarce resources. The immaturity of cropping insurance in the agriculture sector means that it fails to play a significant role in Pakistan, having only been functional from 2008, and with the majority of farmers still failing to access the credit availability service, and even managing risks in conventional procedures Ullah et al. (2015b).

In the current era of technical and research-based advances, the dynamics of the weather and climate has a significant role regarding crop yield (Kukul and Irmak 2018). Increases in greenhouse gas emissions have caused a global increase in temperature of 0.74 °C in the last century, with the warmest 30 years (1983–2012) over the last 800 years in the northern hemisphere (IPCC 2014).

In the global scenario, cereal cropping regions have experienced increasing temperatures with a maximum of 0.3 °C and minimum of 0.2 °C per decade over a number of decades, and they are anticipated to rise further during the twenty-first century (Lobell and Gourdjji 2012). It is also estimated that, for each increase of 1 °C, wheat production will decline by almost 6% (Asseng et al. 2015). Rapid climate change has made food security and the availability of water significantly vulnerable (Ali et al. 2017). The sequential increasing episodes of extreme weather will produce a globally declining trend regarding the cereal crops of wheat, maize, rice and soybean (Teixeira et al. 2013). Some specific studies have predicted a declining trend in wheat crop production of 15–45% globally and 20–75% in South Asian countries due to the climate (Bhatta et al. 2016; Fischer et al. 2005). In the continuing climate change of the current era in South Asia, it is anticipated that there will be a 50% decline in wheat production by 2050, which is almost 7% of total world production (Turrall et al. 2011; Fraiture et al. 2007).

It is vital to anticipate environmental changes with predictions, and to be aware of in what way the climate varies and how its threats are recognized, practised and unrestrained by the community (Manandhar et al. (2015; Ono et al. 2010). Local people have become familiar with the perception of natural hazards with environmental variations and the impact on their lives (Manandhar et al. 2015). The findings of numerous studies in the literature have shown the farmers' socio-economic and demographic factors of risk attitude and risk perception, which are affected by the farm and farmers' household characteristics.

A significant divergence of risk preferences has been shown in the findings of a number of studies regarding farmer age, education, off-farm income, experience of farming and the size of their farming area (Ullah et al. 2015b; Saqib et al. 2016a, b; Iqbal et al. 2016). It is a prerequisite that overcoming the production threats in agriculture crops arising from climate erraticism is possible with proper and accurate climatic variation information and risk perceptions (Chaudhary and Aryal 2009). The understanding and managing of farming risk by taking up efficient risk management strategies is possible through the accessing of information sources on environmental variability.

It is important for researchers and policymakers to deliver a significant risk management approach for farmers to overcome the deficient expertise in their attitude toward risk and risk perceptions (Flaten et al. 2005; Nicol et al. 2007). Multiples losses in agriculture through various types of risks can be overcome by implementing better and refined risk management tools and strategies, so that farmers can have an enriched and sympathetic risk perceptions and risk attitudes. It has been stated that proper policy measures are a prerequisite, and should not only focus on farm production but also on the enhancement in farmers' expertise in risk management capacity regarding their risk perceptions and attitudes toward risk (Lucas and Pabuayon 2011). Hazard (facilities or environment) evaluation and the judgments of people who might be exposed are indicated as the risk perception (French et al. 2006). The intentions of people toward risk evaluation situations regarding

unfavorable or favorable actions are accordingly denoted as the risk attitude (Gattig and Hendrickx 2007). Numerous studies have focused on the assessment of sources of farmers' risk perceptions and attitudes toward risk, having regard to farmers' risk management decisions. Globally, there has been plenty of research to quantify farmers' risk perceptions and risk attitudes, while in Pakistan only a few studies have contributed specifically to the perspective of farm-level risk management. This study is an attempt to gain a view of this research gap by focusing on examining wheat farmers' risk attitudes and perceptions concerning their wheat crop and the factors affecting their risk perceptions. The specific objectives of this study are (1) examining wheat farmers' attitudes toward a variety of risks to their wheat crop, (2) investigating the farmers' perceptions of risks to the wheat crop in the study area, and (3) analyzing the factors affecting the farmers' risk attitudes and perceptions. This study is classified into five sections with the introduction in the first section. The materials and methods are described in Sect. 2, while Sect. 3 consists of the determinants of risk attitudes and risk perceptions. The results and discussion of the study are elaborated in Sect. 4, and the conclusion and suggestions are described in the last section.

## 2 Materials and methods

### 2.1 Study area

Punjab is the most populated province of the country with more than 54% of the population and is enriched by the fertile lands of five rivers (PBS 2015–2016). Punjab province was selected for this study of wheat crops because of some significant reasons. Firstly, Punjab province shares 53% in agriculture of the major share of the country's gross domestic product, and secondly Punjab produces more than 75% of total wheat production of Pakistan (PBS 2015–2016). Lastly, the environmental variation has caused significant threats to wheat production, with drought in winter in the wheat-growing season and storm rainfall and hail in the wheat-harvesting season, which demonstrates the hazard to wheat production during recent years.

The study selected six districts of Punjab based on the wheat production share of the province (BOS 2014). Bahawalnagar and Rahim Yar Khan are among the high wheat-producing districts, Vehari and Muzaffargarh form medium wheat-producing districts, while Layyah and Dera Ghazi Khan were selected from low wheat-producing districts. The socio-economic structure, geographical and climatic characteristics, and the experience of risk variations have been recorded in all six districts of the study. Climatic variation has been found in the environment of the province according to a seasonal basis, hot in summer and cold in winter (Abid et al. 2015a). Punjab province averages minimum and maximum temperatures from 1970 to 2001 of 16.3–18.2 °C and 29.3–31.9 °C, respectively. A dispersed pattern of rainfall is found in the Punjab monsoon (June–September) which is considered the rainy season with more than 70% of the annual rainfall (Abid et al. 2015b). Wheat, sugarcane, cotton, rice and maize are the major crops, and the major share of the total production of these crops produced in Pakistan occurs in Punjab province (Economic Survey of Pakistan 2015–2016).

## 2.2 Sampling framework

To sample the wheat farmers in the selected areas of the study, a multistage sampling technique was employed. Various procedural steps were followed for the sampling process after the initial selection of the main study area of Punjab province. Six districts were selected from the main study area regarding high, medium and low wheat-producing areas. A stratified random sampling technique was used in the study area, viewing the distance from the main city for the selection of union councils from selected districts as the third stage. A random sampling technique was employed in the fourth stage for the selection of villages from the selected union councils. In the final stage, farmers were selected from each village according to the list of the revenue department. Sixty-seven farmers were selected from each district for interviewing, as shown in the sampling framework in Table 1.

The data collection procedure from the sampled farm households was performed through a semi-structured questionnaire. Demographic characteristics of the farmers, their age, education, off-farm income, risk attitude to their wheat crop and risk perception to storm rain and hail, drought, input prices and wheat diseases were the priority focus of the questionnaire. Pre-testing of the questionnaire was practised to avoid any missing information relevant to the study; the enumerators were students of COMSATS Vehari trained for sampling the data. The farmers were informed of the objective of the sampling and motivated to cooperate in the study objectives. Farmers participated warmly in providing information regarding the questionnaire with only 5% refusing to participate; these were replaced by other farmers, 20 in total.

## 2.3 Risk perception

Wang and Roush (2000) analyzed assessing risks with an insight into how likely something is to go wrong and what will be its consequences. Cooper et al. (2005) discussed risk factor ranking based on the product of likelihood and consequences. Risks of storm rainfall and hail, drought, high input prices and wheat disease were categorized as the major risks in the study. A Likert scale of 1–5 was selected for farmers to choose regarding the incidence and severity of risks on the farm potential. Cooper et al. (2005) scores were classified in a risk matrix, scoring high if it was 3–5, while it was taken as low if the score was 1–2.

**Table 1** Sample framework of study

Wheat production zones	Production range	Sample districts	Numbers of farmers selected
High production zone	More than 900,000 tonnes	Bahawalnagar	67
		Rahim Yar Khan	67
Medium production zone	Between 600 and 900,000 tonnes	Vehari	67
		Muzaffargarh	67
Low production zone	Below 600,000 tonnes	Layyah	67
		Dera Ghazi Khan	67
Total			402

## 2.4 Risk attitude

Farmers' attitudes have been measured by various approaches in many studies, while direct and indirect are two basic approaches to measure the risk attitude of farmers (Dadzie and Acquah 2012). The direct method was a farmer's interview as suggested by von Neumann and Morgenstern, and has several techniques for the farmer's elicitation of preferences (Anderson et al. 1977). The Neumann–Morgenstern (N–M) model and the Equally Likely Certainty Equivalent Method (ELCEM) as a modified version of the N–M model are two of several techniques employed for currently infrequent studies (Saqib et al. 2016a, b; Hardaker et al. 2004; Iqbal et al. 2016; Ogurtsov et al. 2008; Smidts 1990; Torkamani 2005). A frequently used model, Elicit Utility, comes from the economic proxy of ELCEM whereas Certainty Equivalents (CE) stem from the chain of risky results and contest them with utility values (Binici et al. 2003). Household income has been taken as the utility function to symbolize wealth and used in the study followed by Binici et al. (2003). The sequential and direct proportion of monetary risk has been considered as the more monetary value equals more risk. For the case in point, the respondents (the farmers) were asked to specify the monetary value of a definite outcome which makes them neutral between two risky outcomes in monetary terms, with PKR 200,000 as the sample farmer annual income with a 0.5 associated probability. The status of loss with 0 income has the same 0.5 probability farmer income and was chosen in this range. In the status of the assured outcome of PKR 120,000, the farmer remained indifferent. The range of outcome was indicated between PKR 0 and 120,000 and the farmer remains indifferent at PKR 60,000. In a further procedure, the farmer with the chosen range between PKR 60,000 had equal possibilities with PKR 0 and denoted the indifference at PKR 30,000. For the next amount of PKR 20,000 with the indifferent status of the farmer, the experiment was repeated. In the higher range of PKR 120,000–200,000, the farmers had to choose and remain indifferent at PKR 140,000. In another range, PKR 140,000–200,000, farmers remained indifferent at PKR 170,000. The repetition of the experiment with the association of probabilities allowed several CE points to be derived.

For example, the utility value for the instance of PKR 30,000 was considered as:

$$U(30,000) = 0.5u(0) + 0.5u(60,000) = 0.5(0) + 0.5(1) = 0.5 \quad (1)$$

Subsequently, obtaining various CE and matching them with utility values, a cubic utility function has been applied for estimation of the utility of each individual respondent. The cubic utility function has the given equation (Eq. 2):

$$Uw = a1 + a2w + a3w^2 + a4w^3 \quad (2)$$

Risk aversion, risk preferring and risk indifferent attitudes are all interconnected with this cubic utility function (Binic et al. 2003). Ordinary scale procedures generally assess the utility, and the form of the utility function on an ordinary scale can be mutated into a quantitative degree of risk aversion, known as the absolute risk aversion (Arrow 1964; Pratt 1964; Raskin and Cochran 1986). Arithmetically, the absolute risk aversion can be written as:

$$ra(W) = -U'(W)/U''(W) \quad (3)$$

In Eq. (3), the coefficient of absolute risk aversion is  $ra(W)$ , whereas the first-order and second-order derivatives of wealth ( $W$ ) are mentioned as  $U'$  and  $U''$ . Income is a super-numerary for wealth as given by Olarinde et al. (2007). The sign of the coefficient values justifies the risk behavior of the respondent: the positive sign of the coefficient of absolute

risk aversion clarifies the respondent as risk-averse, and the negative sign of the coefficient of absolute risk aversion enlightens the respondent's likely risk, while being unresponsive to risk has a zero coefficient sign. The analysis comprised the respondent risk attitude and respondent risk aversion behavior as 1, or if not as 0.

### 3 Determinants of the risk attitude and risk perception

In this study, the farmers' demographic characteristics including socioeconomic (age, education, etc.) and farm-level risk attitude and risk perception of storm rainfall and hail, drought, high input prices and risk of wheat disease effects are appraised through probit regression.

#### 3.1 Model specification

The probit model is also commonly known as probit regression, analyzing a dependent variable with only two values. Observation with specific characteristics will fall into a specific one of the categories as the main objective of the probability estimation. Ordinary Least Square regression was not applicable due to binary outcomes of the dependent variable, so the probit model has been considered appropriate for this study (Girard and Matte 2005; Ullah 2015a, b, c). Equation 4 gives the probit model as:

$$Y = X' \beta + \varepsilon \quad (4)$$

In Eq. (4),  $Y$  is the dependent variable for the risk attitude and risk perception, while  $X$  explanatory variables analyze the effect of outcome variables. The  $\beta_i$  points out the vector of estimated unknown parameters with error term  $\varepsilon_i$ . We can observe in Eq. 5:

$$Y_{ij} = \sum X_i \beta + \varepsilon \quad (5)$$

The binary outcome variables are denoted by  $Y_{ij}$  as ( $j=5$ ) and the farmers' risk attitude and risk perception of four kinds as  $i$ th farmers.  $Y$  as 1 is taken as the value greater than 0, while it is taken as 0 if less than 0, as given in Eq. 6:

$$Y_i = \begin{cases} 1 & \text{if } Y_* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

#### 3.2 Dependent and independent variables

In this study, the dependent variable is risk attitude and four-risk perception, namely the risks of storm rainfall and hail, drought, high input prices and cotton disease. In the literature, the studies of Liu (2012), Cardenas and Carpenter (2013), Ward and Singh (2015) Yapici et al. (2017), Ayinde (2008), Cohen and Einav (2007), Harrison et al. (2007), Lucas and Pabuayon (2011) and Kisaka-Lwayo and Obi (2012) have demonstrated the significant role of socio-economic and demographic factors regarding the critical decisions of risk perception and risk attitude. The socio-economic and demographic factors, such as gender, religion, age, farming experience, education, credit access, farming area, market information access, farmer livestock, family size, distance from the main city and off-farm income, were all taken as the independent variables in the study.

### 3.3 Hypothesis testing for model significance

The null hypothesis approach has been employed in this study with method significance of the model. The null hypothesis was established taking the assumption of all coefficients of the probit model being equal to zero versus one of the coefficients is not equal to zero for this study Peng et al. (2002).

$$H_0 : \beta_i = 0$$

$$H_1 : \beta_i \neq 0 \text{ at least one}$$

The Ordinary Least Square method and probit methodology were the same as probit, in the  $F$  test. The  $\chi^2$  value, value for risk attitude and four-risk perception models are positive and range from 99 to 162, as shown in Table 3. All the models'  $p$  values were less than 0.000, verifying all models as fitting significantly. Another measure of goodness of fit is the model Pseudo  $R^2$ , which ranges from 0.2 to 0.339 and has a better fit of our model clarifying the behavior and perception of farmers toward risk.

## 4 Results and discussion

The findings of the study have been classified into descriptive statistics, determining risk attitude and risk perceptions, while risk perceptions have been further subcategorized into the risk of storm rainfall and hail, risk of drought, risk of high input price and risk of wheat diseases.

### 4.1 Descriptive statistics

Descriptive statistics of continuous and discrete choice dummy variables used this study are set out in Table 2. The farmer mean gender was 79% male and 21% female with religion an average 64% for risk as one's own act. Average farmer age was 43 years, with a mean value of farming experience of 18 years and the mean educational status of farmers being 4 years. Average farmer access to formal credit was 48% with the mean of the farming size an area of 25 acres. On average, 56% of farmers had access to market information relevant to their crops. In the study, the average family size consisted of eight persons with a mean number of seven animals for each farmer household family. The mean distance of farms from the main city was 10 km and on average only 27%, farmers had an off-farm income while 73% farmers were totally dependent on farm income. The results of the study elaborated that 68% farmers had no type of risk involvement and showed risk aversion behavior against any uncertainty. Those having risk perceptions concerned wheat crop diseases with the lowest percentage, 56%, while the highest was of storm rainfall and hail, 73%. Farmers rated the risk of drought at 71% and the risk of input prices at 65%, as elaborated in Table 2.



**Table 2** Descriptive statistics of the variables

Variables	Mean	SD	Description
<b>Demographic characteristics</b>			
Gender	0.79	0.67	Dummy value if male 1 otherwise 0 for female
Religion	0.64	0.19	Dummy value if yes 1 otherwise 0
Age (years)	42.95	11.28	Continuous
Farming experience (years)	17.95	9.65	Continuous
Education (years)	3.84	3.12	Continuous
Credit access	0.48	0.50	Dummy value 1 if have credit access otherwise 0
Farming area (acres)	24.63	27.26	Continuous
Market information access (tv, radio, internet)	0.56	0.49	Dummy value 1 if have market information otherwise 0
Farmers livestock (no)	7.28	3.54	Continuous
Family size (no)	7.52	1.29	Continuous
Distance (from main city km (location))	10.27	5.24	Continuous
Off farm income	0.27	0.44	Dummy value 1 if income from other sources access otherwise 0
Risk attitude			
Risk aversion behaviour	0.68	0.46	Dummy value 1 if risk score above 3 otherwise 0
<b>Risk perceptions</b>			
Risk of storm rain and hail	0.73	0.44	Dummy value 1 if risk score above 3 otherwise 0
Risk of drought	0.71	0.45	Dummy value 1 if risk score above 3 otherwise 0
Risk of high input prices	0.65	0.47	Dummy value 1 if risk score above 3 otherwise 0
Risk of wheat diseases	0.56	0.49	Dummy value 1 if risk score above 3 otherwise 0

**Table 3** Parameters estimates of the probit model

Independent variables	Risk attitude (base risk taking)				Risk perception		Wheat diseases
	Storm rainfall and hail	Drought	High input prices				
Gender	-0.304** (0.017)	0.114* (0.089)	0.395* (0.162)	0.345 (0.068)	0.114* (0.089)	0.395* (0.162)	0.017 (0.190)
religion	-0.169** (0.074)	0.074* (0.054)	0.030 (0.035)	0.165** (0.078)	0.074* (0.054)	0.030 (0.035)	0.076** (0.046)
Age	0.024* (0.012)	-0.004 (0.013)	0.006 (0.012)	0.071*** (0.014)	-0.004 (0.013)	0.006 (0.012)	-0.018 (0.011)
Farming experience	-0.027* (0.015)	0.127*** (0.018)	-0.020 (0.014)	-0.011 (0.016)	0.127*** (0.018)	-0.020 (0.014)	0.019 (0.013)
Education	0.189*** (0.028)	0.056** (0.027)	0.061** (0.028)	0.056** (0.027)	0.120*** (0.031)	0.061** (0.028)	0.049* (0.026)
Credit	-0.283 (0.190)	-0.025 (0.202)	0.079 (0.211)	-0.025 (0.202)	0.401* (0.229)	0.079 (0.211)	-1.524*** (0.200)
Farming area	0.034*** (0.008)	-0.006** (0.003)	-0.008** (0.004)	-0.006** (0.003)	0.017** (0.008)	-0.008** (0.004)	-0.007* (0.003)
Market information	-0.404** (0.174)	-0.245 (0.168)	0.295* (0.172)	-0.245 (0.168)	0.214 (0.189)	0.295* (0.172)	0.117 (0.160)
Farmer livestock	-0.069** (0.034)	0.065** (0.028)	0.020 (0.025)	0.065** (0.028)	-0.064* (0.034)	0.020 (0.025)	0.066** (0.026)
Family size	0.010 (0.057)	-0.081 (0.055)	-0.038 (0.058)	-0.081 (0.055)	0.003 (0.063)	-0.038 (0.058)	0.096* (0.056)
Distance from city	-0.021 (0.014)	0.012 (0.015)	-0.149*** (0.014)	0.012 (0.015)	-0.026 (0.015)	-0.149*** (0.014)	0.0005 (0.013)
Off farm income	0.979*** (0.260)	0.186 (0.243)	-0.498** (0.247)	0.186 (0.243)	-0.643** (0.279)	-0.498** (0.247)	0.260 (0.222)
Numbers of farmers	400	400	400	400	400	400	400
Log-likelihood	-183.783	-182.792	-188.393	-182.792	-157.838	-188.393	-218.784
F-stat significance	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R <sup>2</sup>	0.260	0.213	0.269	0.213	0.339	0.269	0.200

Values in parenthesis are the standard errors

\*10 percent, \*\*5 percent and \*\*\*1 percent significance levels

## 4.2 Determinants of risk attitude

Factors affecting the risk attitude of farmers were determined by employing a probit model. The significant factors which play the major role in determining the risk attitude behavior of the farmers were gender, religion, age, farming experience, education, farming area, market information, farmers livestock and off-farm income, as given in Table 3.

The estimates of gender with negative and significant coefficients indicates that male farmers are less risk-averse compared with females; these findings are inconsistent with the studies of Cardenas and Carpenter (2013) and Liu (2012). The negative and significant coefficients of religion indicate a risk aversion attitude and taking the risk on one's own behalf; these findings are similar to the study of Liu (2012). The positive and significant coefficients of age show that aged farmers are more risk-averse as compared to young farmers, so as the age increases farmers become more risk-averse, findings that are indirectly similar to the studies of Dadzie and Acquah (2012), Deressa et al. (2010), Rahim et al. (2013) and Saqib et al. (2016a, b). These findings are in contrast to the studies of Ashfaq et al. (2008), Mesfin et al. (2011), Ullah et al. (2015a) and Iqbal et al. (2016). The coefficient of farming experience is negative and significant, indicating that experienced farmers are less risk-averse as compared to farmers who have less or no experience in farming. These findings are indirectly similar to the studies of Mesfin et al. (2011) and Ullah et al. (2015a), while in contrast to the studies of Ashfaq et al. (2008), Saqib et al. (2016a, b) and Iqbal et al. (2016). Findings of risk-aversion behavior of farmers regarding education is positive and significant, which indicates that educated farmers are more risk-averse compared to less educated or illiterate farmers. Education results are indirectly similar to the studies of Ashfaq et al. (2008), Tavernier and Onyango (2008), Kouamé (2010), Ullah et al. (2015a, b, c), Saqib et al. (2016a, b) and Iqbal et al. (2016), and in contrast to the findings of Mesfin et al. (2011) and Rehima et al. (2013).

The risk-aversion coefficient of farm size is positive and significant, indicating that farmers with large farm sizes have a higher risk-aversion behavior compared with farmers with small farms; these findings are consistent with the studies of Ullah et al. (2015b, c) and Iqbal et al. (2016), but inconsistent with the study of Ullah et al. (2015a). The market information variable with a negative and significant coefficient shows that farmers have less risk-aversion behavior as compared to those farmers which have less or no market information. While such findings are similar to the studies of Ayinde (2008) and Iqbal et al. (2016), they are not consistent with the studies of Mesfin et al. (2011), Rehima et al. (2013), and Ullah et al. (2015b).

The negative and significant coefficient of livestock indicates that farmers with large numbers of livestock have less risk-aversion behavior as compared to farmers which have smaller numbers of livestock and are more risk-averse. These findings are not consistent with the study of Iqbal et al. (2016). Off-farm income's negative and significant coefficient indicates that farmers with no or less off-farm income have more risk-aversion behavior in contrast to farmers who have higher off-farm income. These results are indirectly supported by the studies of Mosley and Verschoor (2005), Ullah et al. (2015b) and Iqbal et al. (2016), while they are not similar to the study of Ullah et al. (2015c).

## 4.3 Determinants of risk perception

We now consider what influences the perception of wheat farmers regarding various types of threats faced by them at the farm level, as mentioned in Table 3. Their socio-economic

characteristics and risk consciousness rapport have been reported by previous research work.

#### 4.3.1 Risk of storm rainfall and hail

Wheat farmers consider heavy rainfall and hail a major risk to their wheat crop. Gender, religion, age, education, farming area and livestock do have a significant impact on the farmer's perception of storm rainfall and hail according to estimates of the probit model. The positive and significant coefficients of gender, religion and age shows that aged farmers perceived the storm rainfall and hail the major risk to their wheat crop as compared to young farmers; findings which are similar to the studies of Saqib et al. (2016a, b), Liu (2012) and Yapici et al. (2017). The variable of the education coefficient, positive and significant, indicate that educated farmers consider storm rainfall and hail the major risk, while the less educated and illiterate wheat farmers do not determine it as the major risk. These findings are in contrast to the studies of Ullah et al. (2015b) and Iqbal et al. (2016). Farming area coefficient, negative and significant, shows that farmers with large farm areas do not determine storm rainfall and hail as a major risk as compared to farmers with small farm areas due to their managerial competencies regarding (weather) information concerning wheat crops; these findings are similar to the study of Ullah et al. (2015b). The positive and significant coefficient of livestock indicate that wheat farmers having livestock consider storm rainfall and hail as the major threat to their wheat crops as compared to those farmers having fewer or no livestock; these findings are similar to the study of Iqbal et al. (2016).

#### 4.3.2 Risk of drought

The findings of the probit model indicate that gender, religion, farming experience, education of farmer, credit, farming area, farmers livestock and off-farm income are major variables forming wheat farmers' perception of drought. The positive and significant coefficients of gender and religion indicate that male farmers and non-religious farmers were less risk-averse of drought as compared to female farmers and religion-minded farmers, findings that are similar to those of Liu (2012) and Yapici et al. (2017). According to the probit model results, the positive and significant coefficient of experienced and educated farmers show they determine drought to be a major risk to wheat crops while less or inexperienced farmers and less or uneducated farmers not consider it a major threat to their wheat crop. These findings are similar to those of Ullah et al. (2015b) while the results of education are in contrast to that study. Farm size and access to credit with positive and significant coefficients indicate that farmers with large farm holdings and access to credit consider drought to be a major threat to their wheat crop while farmers with smaller land holdings and no access to credit determine drought to be less risky. These findings are in contrast to the study of Ullah et al. (2015b). The negative and significant coefficient of livestock and off-farm income indicate that large livestock and high off-farm income reduces farmer concerns of risk toward drought with these farmers considering drought not to be a major threat to their wheat crop as compared to those farmers which have less or no livestock and having less or no off-farm income. These findings concerning livestock and off-farm income are in contrast to the study of Ullah et al. (2015b).

### 4.3.3 Risk of high input prices

Inflation and input shortages remain a hot issue in developing countries due to economic uncertainties. Agrarian input prices do not remain constant and timely input availability is mostly considered a major threat to farmers. In the probit model, the results show that education, farming area, distance from the main city and off-farm income are important and significant factors determining the risk of high input prices for wheat farmers. The positive and significant estimates of gender and religion indicate that male and religion-minded farmers are more conscious of the rise in prices, findings which are inconsistent with the studies of Lin (2012) and Yapici et al. (2017). The findings of education and market information having positive and significant coefficients indicate that higher educated farmers and those having proper information of the market determine that high input prices are major risk to wheat crop production, while less or uneducated farmers and farmers having no access to market information consider it not to be a major threat. The results for education and market information are in contrast with the study of Iqbal et al. (2016). The negative and significant coefficients of farming area and family size shows that farmers holding large farm areas and having a large family size determine high input prices not to be major threat to wheat production, while small area farmers with a small family size consider it an important risk to wheat production, findings which are in contrast to the study of Iqbal et al. (2016). Likewise, wheat farmers being at a greater distance from the main city and with off-farm income consider input prices not to be major threat to wheat production, while farmers close to the main city and having no off-farm income regard it as an important risk to wheat production, results which are contradict the study of Iqbal et al. (2016).

### 4.3.4 Risk of wheat diseases

The results of the probit model indicate that education, credit, farming area, farmer livestock and family size to be important variables in shaping the wheat farmers risk perceptions concerning wheat crop diseases. The findings of gender and religion are positive and significant meaning that male and religious farmers consider disease a major risk to their wheat crop; these findings are similar to the studies of Ward and Singh (2015), Liu (2013), and Cardenas and Carpenter (2013). The positive and significant coefficients of education, livestock and family size show that educated farmers, those having large numbers of livestock and large family size determine that wheat diseases are a major threat to wheat production as compared to less or uneducated farmers, those having few or no livestock and small family size. The findings of education are similar while the results of livestock number and family size are in contrast indirectly related to the study of Iqbal et al. (2016). Farmers holding large farm areas and with access to credit regard the risk of wheat disease not to be important for wheat production while small area farmers and farmers without access to credit regard wheat diseases as a high threat to wheat production. These findings are indirectly similar to the study of Iqbal et al. (2016).

## 5 Conclusion and suggestions

This study has specifically focused on wheat crop farmers' risk perceptions and risk attitudes in the Punjab province of Pakistan with sample data of 402 wheat farmers. Socio-economic and institutional factors affecting these farmers were determined regarding their perceptions and attitudes toward various threats. Probit model estimation indicates fruitful findings relevant to wheat farmers' farming activities. The farmers' knowledge and observations regarding wheat crop risks ranked these threats according to their severity. Farmers were found reluctant to regard any threat to higher income while the majority of farmers show risk-aversion behavior concerning wheat crop production. Numerous risks to the wheat crop distracted most farmers to grow wheat crops due to their facing a loss of productivity and income during the last decade. Farmers ranked risks regarding the loss of wheat production, with the risk of storm rainfall and hail a severe one compared to the risks of drought and input prices, with the least severe one being the risk of wheat diseases affecting production.

Farmers' gender, religion, age, farming experience, education, access to credit, farming area, market information, number of livestock and off-farm income were significant factors affecting their risk perceptions and risk attitudes, as described in the findings of the probit regression estimation. Almost a 7–15% increase in major cereal crop, wheat and rice, is possible through focusing on adaptation measures regarding climate change (Challinor et al. 2014). Ensuring food security and wheat production sustainability, adaptation strategies such as long duration varieties and sowing late have significant roles (Attri and Rathore 2003; Boomiraj et al. 2010). Farmers are facing multiple constraints because of a lack of adequate information regarding climate dynamics, the inadequate availability of finance and a lack of risk management tools, and such factors must be given priority importance to maturing and implementing risk management policies at the initial level. Policy makers and research institutes having priority understanding of farmers' risk perceptions and risk attitudes, can facilitate classy risk management tools, precise information regarding climate and crops, access to adequate credit, access to market information and more off-farm income opportunities which are needed for farmers to overcome farming management deficiencies regarding risks at the farm level.

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