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Managing Farm-Centric Risks in Production at the Flood-Prone Locations of Khyber Pakhtunkhwa, Pakistan

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Abstract

The monsoon floods of 2010, 2011, and 2014 in Pakistan caused severe damage to crops, fisheries, forestry, livestock, and primary infrastructures, such as water channels, tube wells, houses, people, seed stocks, animal shelters, fertilizers and agricultural equipment/machinery. Floods are a major source of risk to agriculture in Pakistan and other countries in South Asia. In response to these risks, management in agriculture is not only crucial for avoiding risk but also has ramifications concerning the optimum combination of risks and returns that can result of a wide range of outcomes. This thesis evaluates farmers' perceptions about various sources of weather-related risks in farming and their attitudes towards these risks. It also explores the simultaneous adoption of risk management strategies. A survey was conducted with 200 farm households. Farmers' perceptions about risk were measured on a Likert scale, and the risk attitude of the farmers was measured through a cubic utility function. In addition, probit and multivariate probit models were used to analyze the influence of socio-economic and demographic factors on the management decisions of farmers. Among the small farmers, the majority perceived floods and heavy rains as a major source of risk. Younger farmers were more risk-loving than older farmers. Inexperienced formers were also more risk-loving. Three informal management strategies were adopted in the study area: assets depletion, consumption reduction, and diversification at the farm level. As age and education increase, the propensity to deplete assets increases. In addition, management strategies were associated with socioeconomic characteristics of farmers to their risk perceptions and risk attitudes.

Abbreviations

CE:	*Certainty Equivalent*
ELCE:	*Equally likely Certainty Equivalent*
GDP:	*Gross Domestic Product*
GOP:	*Government of Pakistan*
K.P.K:	*Khyber Pakhtunkhwa*
MN:	*Multivariate Normality*
NDMA:	*National Disaster Management Authority*
OECD:	*Organization of Economic Cooperation and Development*
PDMA :	*Provincial Disaster Management Authority*

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1 Introduction

1.1 Background

Agriculture throughout the world is confronted with uncertain and variable climatic conditions in the form of temperature and rainfall (Azam-Ali, 2007, Wang et al., 2009). The agriculture sector is highly dependent on the climate, which is affected by natural disasters (Klopper et al., 2006). Due to these considerations, the risk in agriculture should not be considered from the perspective of the individual farmer. Instead, it should be considered from the perspective of the community to see how these factors have societal as well as environmental consequences.

Significant sources of risk in agriculture are weather conditions, crop damage from diseases & pests, the quality of the seeds and genetics, the use of technology that is not designed for the unique management that farm requires, and the inefficiency of farming machinery (Kahan, 2008) . However, among these factors, the weather is still the most dominant factor in agricultural production, where extreme weather patterns such as floods, cyclones, storms, drought, and hailstorms lead to negative consequences for the farm. It means that, unlike other preventable influences, farmers are incapable of mitigating these unpredictable disasters. As the agricultural output is the primary source of revenue for all agricultural organizations; therefore, it is essential for the farmers to identify and manage these risks in production effectively(Drollette, 2009).

The agricultural sector in Pakistan faced three massive floods in rapid succession, shattering the whole economy, particularly the agricultural industry. The Floods in 2010, 2011, and 2014 not only affected crops, fisheries, forestry, and livestock, but also primary infrastructures like water channels, tube wells, seed stocks, houses, animal sheds, fertilizers, and agricultural equipment and machinery. The floods struck just before the harvesting period of primary crops, such as rice, sugarcane, cotton, maize, and vegetables. Total production loss of paddy, sugar cane and cotton were 13.3 million tons. More than two million hectares of standing crops were damaged, and over 1.2 million livestock (excluding poultry) died in flood (WFP, 2010). It is unavoidable to discuss the recent floods in September 2014, from which 367 people died, 2.5 million were impaired by the heavy rains and floods. One hundred twenty-nine thousand eight hundred eighty houses were damaged, and over 1 million acres of cultivated land and 250,000 farmers were affected. The estimated cost for recovery is US$ 439.7 million and 56.2 million for resilience building (NDMA, 2014). According to (Anderson, 2001, Word Bank, 2001) to tackle these risks, farmers need to implement one of two approaches; the formal and informal approaches which are further divided in to ex-anti and ex-post. The informal ex-ante risk management strategies at the farm level are crop diversification, intercropping, diversification in income sources, the liquidation of accumulated assets, the adoption of new and advanced level cropping techniques, and sharing of risk with others such as informal risk pooling and crop sharing. While the informal ex-post risk management approaches at the farm level, include such as the reallocation of labor and the selling of assets, consumption reduction and mutual aid. However, on the other hand, the formal approaches taken by farmers instead include ex-ante market-based risk management strategies. These strategies involve the marketing of future contracts, and the acquisition of insurance alongside ex-post market strategies to manage the risks in capital access (Ullah and Shivakoti, 2014). Among both of these alternative strategies, the publicly provided ex-ante risk-reducing strategies involve agricultural pest management systems, extension services, and the establishment of infrastructure (i.e., roads, irrigation systems, and dams), while the publicly-based ex-post risk management strategies include social assistance, the transfer of capital and provision of access to credit (Saqib et al., 2016a).

1.2 Problem statement

Since 2010, the agricultural sector in Pakistan has faced three massive floods that had devastating impacts on the entire economy, particularly in the agriculture sector. The monsoon floods of 2010, 2011, and 2014 caused massive damage to crops, fisheries, forestry, livestock, and primary infrastructures, such as water channels, tube wells, houses, people, seed stocks, animal shelters, fertilizers and agricultural equipment/machinery. The floods struck just before the harvesting period of the main crops: rice, cotton, sugarcane, maize and vegetables. The total production loss of paddy, sugar cane and cotton were assessed at 13.3 million metric tons. Over two million hectares of standing crops were damaged, and over 1.2 million livestock, excluding poultry, died in the 2010 flood (World Food Programme, 2010). In 2011, another massive flood struck Sindh and Baluchistan provinces, which severely affected these areas. The people suffered from a loss of livelihood, especially relating to agricultural activities. Approximately 80% of Sindh's rural population is dependent upon agricultural activities for their livelihoods; livestock, crops, fisheries and forestry (NDMA, 2011). The flood in 2011, destroyed standing crops of sugar cane, cotton, sorghum, rice, vegetables and pulses; livestock also suffered heavy losses. For instance, approximately 115,500 livestock were killed, and though around 5 million livestock survived, they were also indirectly affected through disease and displacement. The estimated total loss was US$ 1,840.3 million, of which 89% was direct damage and 11% indirect losses. The highest damage (approximately US$ 1.84 billion) occurred in the agriculture sector, particularly to fisheries and livestock. The total damage caused by the 2011 floods has been estimated at US$ 3.7 billion, and the total cost of recovery and reconstruction estimated at US$ 2.7 billion (Pakistan Economic Survey, 2011-12).

The 2010 flood ruthlessly affected Pakistan's agricultural sector, leaving farmers in search of tools to alleviate the impacts of these risks in the future. Many of those farmers have adopted several risk management tools, like precautionary savings, credit, and enterprise diversification (Ullah and Shivakoti, 2014). Risk management is a continuous process for farmers. Decisions in these uncertain situations are based on their perception of the environment, information, attitudes, and preferences (Kitonyoh, 2015). Ullah et al. (2015c) found that in risk-prone areas, farmers addressed production risk proactively by using their precautionary savings, agricultural credit, and diversification as risk management tools at the farm level in Pakistan. Likewise, farmers adopted diversification beyond the farm, such as diversification in crops, scheduling of farming practices, migration, and a variety of other diversification methods such as irrigation and water conservation techniques were used to cope with climatic risks (Below et al., 2010). Similarly, to cope with droughts, farmers practiced income diversification, asset depletion, expenditure adjustment, water shortage coping techniques and migration (Ashraf and Routray, 2013). However, risk management in agriculture is not only crucial for avoiding risk, but also has ramifications concerning the optimum combination of risks and returns that can result in a wide range of outcomes (Hardaker et al., 2004).

1.3 Research Questions

The following questions will guide this research:

- What are the farmers' perceptions about weather-related risks such as floods and heavy rains at the farm level and their attitudes towards these risks?

- What are the strategies adopted by the farmers to manage risks, and what are the determinants of these strategies?

1.4 Aim and Rationale of the Study

The study aims to investigate the farmers' behavior in risk perception and their attitude towards decisions at the farm level. The study also aims to explore the strategies adopted by the farmers' and factors influencing the decisions of adopting risk management strategies.
Production risk is an essential risk that farmers face due to flooding, heavy rains, pests, and diseases, and farmers adopt several risk management strategies to cope with these risks.
The literature argues that limited studies are available in Pakistan to discuss this issue.
Farmers used different strategies to mitigate the risks in agriculture. For instance, diversification of enterprises became the most critical risk management tool adopted by the US corn belt farmers (Ortmann et al., 1992). Liquid asset accumulation, adoption of advanced cropping techniques, and risk sharing (crop insurance) are the essential strategies to assuage production risk in agriculture (Velandia et al., 2009b). Enterprise mix diversification was the most significant risk coping strategy among Australian farmers (Kandulu et al., 2012).
Diversification, precautionary saving, and credit availability are adopted to cope with agricultural risks in Pakistan (Ullah and Shivakoti, 2014).
The study investigates the factors which stimulate the farmers' decisions to adopt risk management tools to mitigate the impacts of unfavorable weather conditions as well as the potential of utilizing these tools simultaneously. The study will highlight the role of farmers' risk perceptions and their attitude towards decision-making for taking risk management tools. The findings of the current study might be useful for government agencies, extension workers, and other researchers in guiding which new strategy will be more suitable along with traditional tools. The extension department and workers can also take advantage of knowing which producers are most important so they can be better educated in the adoption of any specific risk management tool.

1.5 Research Hypotheses

The underlying hypotheses for this research are:

- Risk perception and risk attitude are significantly different among different groups of farmers.

- Farmer's socio-economics characteristics influence the adoption of a risk management strategy.

The 1st Null Hypothesis is that Risk perceptions and Risk attitudes of small, medium and large farmers are similar. The 2nd Null hypothesis is that Farmers' socio-economics characteristics, risk perceptions and attitudes have no influence on the adoption of a Risk management strategy. Farmers' characteristics include socioeconomics and demographic characteristics such as age, education, experience, off-farm income and landholding size etc.

2 Literature Review

This chapter includes the concepts, definitions, sources, and types of risks in agriculture. Different risk management tools that were adopted by the farmers to manage risk, the factors associated with the risk management tools and the literature gaps are integral parts of this chapter.

2.1 The Concept of Risk and Uncertainty in Agriculture

Hardaker et al. (1997), defined risk as imperfect knowledge where the probabilities of the possible outcomes are known, and uncertainty exist when these probabilities are not known. Risk is the probabilistic calculations that are possible (Schneider, 2010). According to Singh (2010), uncertainty refers to an event the outcome of which is not sure, i.e. the outcome may be one of the many probable outcomes. Risk is uncertainty that involves the probability of losing money, potential damage to human health, consequences that upset resources (e.g., irrigation, credit), and other kinds of events that may affect a person's welfare (Harwood et al., 1999).

2.2 The forms of Risks in Agriculture

Musser and Patrick (2002) defined five significant sources of risk in the agriculture sector. Production risk, including livestock production, variability in crop yields, diseases, pests, and weather conditions. financial risk includes the ability to pay bills, to have money to continue farming, and to avoid bankruptcy. Marketing risk is concerned with variations in prices and the amount of the commodity that can be marketed. Human resources risk relates to the availability of agricultural labor, either family members or employees. Institutional and environmental risk includes factors associated with rules and regulation by individuals or businesses and changes in government policies which are linked to farming practices and the environment. According to OECD (2001), risks are divided into risks that are common to all businesses, i.e., personal accidents, family situations, health, macroeconomic risk. The risks that are related to agriculture, more specifically the weather conditions, technological change, pests, and diseases. Market risks are input and output price variability, relationships with the food supply chain concerning safety, quality, and new products. Ecological risks include climate change, production and natural resources management) and institutional risk (food safety, agriculture policies, and environmental regulations).
Hardaker et al. (2004), stated that there are two types of risk in the agriculture sector.one is a business risk that comprises production, institutional, market, and personal risks. Another is financial risks resulting from different financing methods of the farm business.

2.2.1 Production Risk or Risk in Yield

For most of the farmers, Production risk is smaller in the livestock sector than the crop sector, as the weather has a slighter effect on production in livestock. Hardaker et al. (2004) stated that production risk is among the significant risks that farmers face. Weather is generally a considerable source of risk among all sources of production risks related to agriculture. Farmers have little or nothing to do against natural disasters such as floods, cyclones, drought, hail, and storm surge because they are most uncertain and unpredictable. In the least developed countries, mostly having agriculture-based economies have inadequate social safety nets. Such less-developed risk-mitigation infrastructure makes these countries the most vulnerable to climatic variability (Morton, 2007).

2.2.2 Technological Risk

Technological risk is related to changes in machinery and technology, specifically chemical and biological techniques. Farmers are unable to predict these changes. The obsolescence of old machinery depreciates under the introduction of new machines. The old machines become comparatively costly for use (Anaman, 1988). Technological enhancement, processing, transportation, and other non-farm activities can also affect farm incomes (Sonka and Patrick, 1984).

2.2.3 Market or Price-driven Risks

The market or price risk originates from fluctuations and volatility in the prices of inputs and outputs in the production decisions to be made. Most of the farmers are vulnerable to unpredictable and imperfectly competitive markets of inputs and outputs. Market or price risks often have significant effects and may rise over time. Uncertainty regarding the availability of inputs and their prices is a further source of market risk. Output price variability was valued as the most significant source of risk by a sample of commercial vegetable farmers in KwaZulu-Natal (Bullock et al., 1994). Similarly, crops and livestock price variability was the primary source of risk for a sample of commercial farmers in KwaZulu-Natal (Woodburn et al., 1995).

2.2.4 Human or Personal Risks

Human or personal risk means exposure to death, injury, or illness of the farmers or the farmer's labor force. Human or personal risks are a common phenomenon among all businesspeople/operators and employees. Hardaker et al. (1997) concluded that human or personal risk is primarily due to life crises like the death of the farmer, the divorce of a spouse who jointly owns the farm enterprise, an extended illness, or negligence by the farmer or farm laborers.

2.2.5 Institutional and Legal Risks

Institutional and legal risks are linked to government price control, and income programs Institutional policies or legal risks also affect contracts of sale, lease agreements, or political stability due to external and internal factors((Maurer, 2014). Changes in government policies constitute an institutional risk. It includes the policy related to pesticides and insecticides used for crops or the use of drugs for animals will cause a change at the cost of production(Aktar et al., 2009)´

2.3 Risk Management Strategies

Farmers have several options for risk management tools that are suitable to the case and nature of the risk to which they are vulnerable. They can be used to significant effect to mitigate or reduce risks, such as sharing the risk, avoiding risk, transferring risk, taking a risk, preventing risk, and spreading risk (Singh, 2010). Risk management strategies are adopted and developed to ensure some protection in circumstances where the outcomes of a decision are unknown before making decisions (Ullah and Shivakoti, 2014). These strategies cover a variety of responses that may lower the chances of an adverse event happening and reduce the harmful effects if the event does occur (Saqib et al., 2016a). Velandia et al. (2009b)stated that the identification of the management strategy is the first step in risk management to handle the risks. It involves the right choice of methods or the combinations of choices for mitigation, transferring, sharing, and bearing business and financial risks.

Harwood et al. (1999) analyzed different risk management tools in the case of the US agriculture sector, using the utility approach to measure the attitude of the farmers towards risk. They concluded that the primary sources of the risk are the price and yield risks. To cope with them, farmers have adopted several risk management tools, like diversification, a mix of debt and equity, capital insurance, hedging, and futures contracts.

Huirne et al. (2000) conducted a study based on Dutch livestock farmers by distributing a survey questionnaire to 2,700 farmers. Surveys were questioning farmers' socio-economic characteristics and their perceptions about the various risks and risk management tools that farmers are adopting. Perceptions were measured by the Likert scale (Ullah and Shivakoti, 2014), and they identified three different kinds of risks and two risk management tools the farmers were practicing. Saqib et al. (2016a) revealed that in Pakistan, farmers are using agricultural credit as a risk management strategy in floods prone areas. Drollette (2009) divided individuals into three different categories according to their preferences and perception of risk and their attitudes toward risk. These are:

Risk-Averse:

This category includes those individuals who are the most cautious risk-takers. They cannot bear the risk and try to avoid risk as much as possible, accepting only that which is bearable.

Risk Neutral:

Risk neutral encompasses individuals who strive to decrease risk while still actively pursuing profit opportunities. They know that there is some level of risk in nearly every venture but also understand the need to face some degree of risk.

Risk loving:

These individuals are risk lovers and see taking the risk as a challenge. They enjoy the odds and take on risk without ensuring a proper mitigation strategy.

2.4 Risk Management Strategy in Response to Risk in Production

Several production risk management strategies can be adopted by farmers to handle yield variability. Renting the land for crop sharing and hiring labor are effective ways of sharing the production risk and this method of risk reduction was ranked highly by farmers Meuwissen et al. (2001). Enterprise mix diversification was an important risk management strategy for large US and Australian farmers (Kandulu et al., 2012). Other risk management strategies include liquid assets accumulation, adoption of advanced cropping techniques, and sharing risk with others, e.g. crop insurance and forward contracting Velandia et al. (2009b), shared tenancy, production contracts and insurance by Meuwissen et al. (2001), informal pooling and crop sharing (Anderson, 2001), all of which are widely practiced management techniques. These include risk reduction (ex-ante strategies to lower or minimize the risk) and risk coping strategies (ex-post strategies to mitigate risk). (Singla and Sagar, 2012) Furthermore, these are categorized into formal and informal strategies. Informal strategies are practiced at the farm level by farmers, whereas formal strategies are institutional and driven by national governments (Anderson, 2002, World Bank, 2001). Informal strategies at the farm level include income diversification, crop diversification, precautionary savings, selling of assets, etc. whereas formal strategies are government policies, such as agricultural credit, crop insurance schemes, price stabilization, information systems and subsidizing inputs (OECD, 2011). For instance, Below et al. (2010) stated that farmers adopt several risk management strategies to cope with climatic risks, such as diversification outside of farming activities, migration, crop and variety diversification, different timing of farm practices, irrigation, water conservation techniques and agricultural conservation. Similarly, OECD (2011) reported that farmers adopt several risk management strategies to cope with droughts in Pakistan, such as adjustments in input use, water shortage coping techniques, income diversification, asset depletion, expenditure adjustment and migration. Ullah et al. (2015a) also added that in flood prone areas of Pakistan, farmers adopted diversification and precautionary savings strategies.

2.5 Factors Affecting Risk Management Tools

Many factors can influence the adoption of risk management tools from different aspects. Factors, like risk attitude and risk perception, farm household characteristics, and nature of the farm, can also significantly influence farmers' risk-taking decisions. Risk management tools and strategies at the farm level vary with the risk environment and farm characteristics (Aditto et al., 2012) Perception and attitudes can play a significant role in the decision-making process of farmers (V.A. Ogurtsov, 2008). Perception in drought-related risk adaptation depends on the attitude and socio-economic characteristics of individual farmers (Udmale et al., 2014). Factors that affect risk management are essential to consider. In the literature, most of the farmers were examined to be risk-averse, and their attitudes at a personal level were risk-averse, as well.

2.5.1 Impact of Household Characteristics on risk management Tools

Socio-economic and demographic characteristics such as age, income, education, household size, risk attitude, are essential factors in risk management decisions at the farm level (Sherrick et al., 2004, Smith and Baquet, 1996). According to Velandia et al. (2009b), experience and level of education are the most critical factors to affect risk management decisions and different risk attitudes (Sherrick et al., 2004). Farmers who have higher income and are older tend to be riskier, while larger household size lessens the risk-taking tendency and their health status often compels farmers to adopt risk management tools. In different studies, there are different preferences towards risk-taking attitudes, e.g., education and income (Saqib et al., 2016a, Ullah and Shivakoti, 2014), and gender (Gilliam et al., 2010, Naz et al., 2018). Likewise, other studies revealed that socio-economic factors affect the risk management decisions of farmers (Harrison et al., 2007, Lucas and Pabuayon, 2011), income (Dadzie and Acquah, 2012a, Iqbal et al., 2016, Ullah et al., 2015b, Cohen and Einav, 2005) age (Iqbal et al., 2016, Dadzie and Acquah, 2012a, Kisaka-Lwayo and Obi, 2012, Tanaka et al., 2010). Similarly, farm size (Lucas and Pabuayon, 2011, Kisaka-Lwayo and Obi, 2012), land ownership status (Lucas and Pabuayon, 2011, Ullah et al., 2015a), off-farm employment (Kitonyoh, 2015), farm size (Iqbal et al., 2016), and farmers' risk perceptions (Ullah et al., 2015b).

2.6 The Gap in Current Literature

Farmers are using several tools for risk management, as managing risks is common within the agricultural sector (Velandia et al., 2009b). In most of the literature, there is little evidence on the simultaneous adoption of risk management tools and the factors which affect these management decisions. In previous studies, factors influencing the adoption of single risk tools were of prime focus, and the studies which endorsed only tools of risk management were for crop insurance (Makki and Somwaru, 2001, XU and LIAO, 2014)), hedging in future options (Makus et al., 1990), forward contract (Davis et al., 2005), forward pricing (Sherrick et al., 2004), and agricultural credit (Saqib et al., 2016a).

The studies evaluating more than one tool examined, analyzed, alongside their adoption by multivariate probit models and their interrelationship (Ullah and Shivakoti, 2014). These studies revealed the simultaneous adoption of crop insurance, spreading sales, and forward contracting. Multinomial probit and multivariate models were used to investigate simultaneous adoption. They also reported that these risk management adoption decisions were correlated. However, there is limited literature that has incorporated all risk management decisions in West Pakistan and its simultaneous adoption. Therefore, this study utilizes a holistic approach to incorporate these management tools.

3 METHODOLOGY

This chapter discusses the methods used in this study, the purpose and selection of the study area, sampling methods and sample size, data collection, and data analysis techniques.

3.1 Selection of the Study Area

Khyber Pakhtunkhwa (K.P.K), is purposively selected. KPK province has 25 districts; 24 out of 25 districts were hit by floods in 2010, of which ten were profoundly affected and 14 moderately affected (NDMA, 2010). Agriculture is the primary source of livelihood in KPK province, with 48% of the labor force engaged in agriculture. Agriculture contributes 40% to the GDP of KPK (Ullah and Shivakoti, 2014). The flood in 2010 destroyed about 70% of cultivated rice crop. Flooding caused damage to fruit orchards and vegetable crops which are essential sources of food.

3.1.1 Selecting the Districts and Sampling

Mardan and Charsadda districts were selected for the current study because these were among the districts directly affected by the massive floods in 2010. However, no study has been conducted following the floods in Mardan and Charsadda to examine affected farmers, and strategies to cope with the risks of floods and heavy rains. Mardan and Charsadda are among the most vulnerable districts shown in the Monsoon Contingency Plan 2013. Total farm households affected in both the districts were 75,355. The farming households in the study area being estimated from the population and household data provided by PDMA[1], as 70% of the households in rural areas are farm households (Ullah and Shivakoti, 2014). The total households that were vulnerable to floods numbered 50,954. However, the farm vulnerable households were 36,162. After the data on the farming households obtained, the number of sample households was selected using Yamane's formula (Yamane (1967):

$$n = N/(1+Ne^2) \qquad \text{(i)}$$

Where

n = Sample size in each area

N = total numbers of farming households in an area

e = Precision value, set as 7% (0.07)

$$n = 36162/\left[1+36162\times(0.07)^2\right]$$

$$n = 203$$

This formula is adopted because the population is finite and known. In a finite population, when the original sample collected is more than 5% of the population size, the corrected sample size is determined by using the Yamane's formula (Israel, 1992). A total of 203 farm households were selected out of 36162, keeping 7% precisions value by using Yamane's formula. It is pertinent to mention that Saqib et al. (2016a), Saqib et al. (2016c) used ±7% and Ullah et al.

[1]Provincial Disaster Management Authority

(2015a) ±13% margin of error. Many studies have used the sample size is equally distributed between districts. Charsadda and Mardan are at high risk, according to the Provincial disaster management authority. Therefore, 100 farmers from Mardan District and 103 from Charsadda were selected randomly. However, at the end of the data collection, 200 sample size was obtained, 100 from each district.

3.2 Data Collection

The study is based on primary data collected through a standardized questionnaire. The semi-structured questionnaire attached in Appendix (I) was prepared to collect data at the household level. The question for the dependent variable was based on multiple-choice questions. The farmers can express what are the strategies they are adopting to manage risk. The respondents were household heads who knew about all the activities at the farm level. Secondary data was also obtained from the PDMA, NDMA[2], the district agriculture office, and the Pakistan Bureau of Statistics about the history and the losses during these floods. Data about the farm practices and the land information was collected from the land revenue and record office at the district level.

3.3 Data Analysis

After collecting data from the selected areas and households, SPSS and STATA packages are used to process, retrieve, and analyze data. The data analysis is divided into two parts: descriptive statistics to determine percentages, frequency distributions, and regression analysis to assess the correlational relationship between the dependent and independent variables.

3.4 Variables

The dependent variables are the informal management strategies: assets depletion, diversification, and consumption reduction. These questions were open-ended questions with multiple choices. The farmers mentioned that what are the different tools they adopted at the farm level. (Ullah et al., 2015c) stated that farmers have more than one option to adopt the strategies simultaneously at the farm level. The farmers mentioned their strategies that they were adopting at the farm level. Later, those strategies were coded. Based on the data, strategies mentioned below were the most common in the study area which were practiced by more than half of the respondents. The strategies that were practiced by less than 50% of the farmers, were not in the scope of this study.

Assets Depletion

Assets depletion is the management strategy used by the farmers to manage their risk after the floods. They sold their productive assets, such as bicycles, motorcycles, and other home used appliances to get money and start farming activities. This was multiple-choice questions where farmers have mentioned that what they have sold their assets(Ashraf and Routray, 2013). These

[2] National Disaster Management Authority

include the assets of the farmers such as motorcycle, generator their commercial plots, bicycle, etc. If they have sold something productive assets in the market=1, 0= otherwise.

Diversification

This was the strategy that the farmers have practiced in the study area. Farmers stated that after the floods, they needed other sources of income to manage these risks. For this purpose, some of the family members started daily labor in construction, and some sent their children abroad to send remittances etc. If they have adopted diversification=1, 0= otherwise.

Consumption Reduction

The farmers used this strategy to manage risk management strategy. (Jain and Parshad, 2006) stated that in India for risk management after the disaster situation the farmers reduced their consumption expenditures to cope with risks. The farmers stated that they had reduced their consumption of food and non-food expenditures. If they have reduced the expenditures=1, 0= otherwise.

Risk Perception

The study used an 'indirect method' borrowed from Ogurtsov et al. (2008) to assess the risk perception of the farmers. Studies about risk perception started in the 1940s in the United States with the writings of Gilbert White about human adjustment to floods. In the 1960s, risk perception was used to study public Perception of nuclear technologies. Studies of risk perception have gained increasing interest in flood risk management (Kellens et al., 2013) because it leads to increased flood preparedness and response of the people. People from diverse disciplines have diverse views about risk (Qasim et al., 2015). Similarly, the risk perception of experts and the general public differ widely (Cutter et al., 2003) because the risk is the likelihood that an individual experiences (Short, 1984). An individual's risk perception is important as it determines his/her response against a natural hazard (Burn, 1999). The perceived risk determines the factors of one's attitude, cognition and vulnerability (Armaş and Avram, 2008). In some Muslim communities, religion is believed to affect people's risk perception, and they do not take any actions for preparedness and mitigation of flood hazards (Qasim et al., 2015). Religious beliefs have nothing to do with risk perception (Mitchell, 2000). The two well-known approaches for explaining risk perception are the Psychometric and cultural theory approaches. The former is related to psychology and the latter to the fields of sociology and anthropology. The psychometric approach is employed to studies of risk communication, gender, race and demographics and uses questionnaires and factor-analytic methods for risk perception (Armaş and Avram, 2008). The cultural theory approach advocates that perception and acceptance of risk are rooted in social and cultural norms (Shaw et al., 2004). Although, both of these approaches have faced severe criticism by researchers for their qualitative nature and difficulty in operationalization but they are widely used in risk perception studies Questions were asked about the risk perception, mentioned incidence and severity of each source of risk, and they put the subjective weighting or probability on a 5-point Likert scale. A matrix approach (Appendix II) is used to convert their responses into a high and low category (Lansdowne, 1999) (Cooper et al., 2005), earning low categorisation if between 2 and 5 and high if between 6 to 10. The study used an 'indirect method' borrowed from Ogurtsov et al. (2008) and Saqib et al. (2016c) to assess the risk perception of the farmers. This is superior over the other methods, and it incorporated both the incidence and severity of the risks (Ullah et al., 2015a, Saqib et al., 2016c)

Risk Attitude

Literature reveals several approaches for measuring attitudes toward risk. Just and Pope (1979) categorized these approaches into direct and indirect approaches while Young (1979) and Robison et al. (1984) identified three basic methods of measuring the attitudes of farm owners to risk these are;

Observed Economic Behaviour

In this method of calculating and measuring the attitudes, the observed and the predicted behaviors are differenced through empirical models, Likewise, these models relied upon either on production theory and uncertainty (Saha et al., 1994) or econometric models, selection of cropping pattern (mathematical programming) and (Wiens, 1976) presented excellent examples of these methods in, Binici et al. (2003) and Ullah and Shivakoti (2014).

Experimental Methods

This method is like a utility method in additions of the real bets while in the first method, hypothetical gain and losses were sued. This method is used by Lusk and Coble (2005) and Lucas and Pabuayon (2011). Binswanger (Binswanger, 1980) developed an incentivized method to elicit farmers' risk preferences. Today, the multiple price lists developed by Holt and Laury (Holt and Laury, 2002) are the commonly applied to elicit risk preferences in Economics laboratories, but also in the field. An overview of the recent methodical advances in the context of European agriculture is provided by Iyer (Iyer et al.).

Direct Estimation of the Utility Function

In this method, the respondent’s preferences are measured by asking questions, and a set of alternatives is given, and the utility functions are obtained. This method is reported by Lins et al. (1981), Halter and Mason (1978), Bond and Wonder (1980b), (Lins et al., 1981, Halter and Mason, 1978, SriRamaratnam et al., 1987) and (Bond and Wonder, 1980b), SriRamaratnam et al. (1987). For farmers’ Risk attitude ELCE method as being widely used in many studies to elicit the utility function of Von Neumann-Morgenstern (Appendix II). Examples of studies are Hardaker et al. (1997), Smidts and Wageningen (1990a) and (V.A. Ogurtsov, 2008). However, this method has the disadvantages that it is difficult to calculate the utility due to biases (Saqib et al., 2016c).

The Equally Likely Certainty Equivalent Method (ELCEM) is used to calculate the risk attitude of farmers. Several studies have adopted this model (Hardaker et al., 2004, Iqbal et al., 2016, Torkamani, 2005, Smidts and Wageningen, 1990b, Ogurtsov et al., 2008) Certainty equivalence for several risky outcomes was then compared with associated utility values (Ullah, 2014). For example, farmers were asked to mention a monetary value between two risky outcomes that would make them indifferent: the annual income of a sample farmer is PKR 200,000, with an associated probability of 0.5, and in case of loss, 0 income with the same probability of 0.5; the farmer is asked to choose the income in this range. For example, say the farmer was indifferent in PKR 120,000, which was an assured outcome. The farmer then had to choose in the range between PKR 0 and 120,000 and was found indifferent at PKR 60,000. Likewise, in the next step, he is asked to choose in the range between PKR 0 and 60,000 and was found indifferent at PKR 30,000. The experiment was repeated, and the next amount was PKR 20,000 to which the farmer was indifferent. Likewise, the farmer was asked to choose between the higher ranges (PKR 120,000-200,000) and was indifferent at PKR 140,000. Similarly, between PRK 140,000 and 200,000, the farmer was indifferent at PKR 170, 000. Similarly, the experiment was repeated, and several CE points were derived with their associated probabilities. This procedure was repeated for every farmer, and the values were incorporated into the cubic utility function (equation 5).

Utility values for certainty equivalence were put in the cubic utility function that divides the farmers into three categories: risk-lover, averse or neutral. The utility function is:

$$\text{ui}(\text{w}) = \alpha_1 + \alpha_2 \text{w} + \alpha_3 \text{w}^2 + \alpha_4 \text{w}^3 \qquad (5)$$

where α_s are the parameters and w represent the wealth of the farmers and their attitudes toward risk, which are dependent on several factors. However, a significant theoretical argument has been shown that there is a link between risk attitude and wealth. Arrow (1970) and Pratt (1964a) stated that for an individual, absolute risk aversion should be a decreasing function of wealth. Instead of wealth, we have used annual income as a substitute for the household in the cubic utility function (Olarinde et al., 2007, Ullah et al., 2015b).

After estimation of the model, the first and second derivatives of the function are:

$$U' = \alpha_2 + 2\alpha_3 w + 3\alpha_4 w^2 \qquad (6)$$

$$U'' = 2\alpha_3 + 6\alpha_4 w \qquad (7)$$

Then, by using the derivatives, the absolute risk aversion is calculated by the formula:

$$r_a(\text{w}) = -\frac{U''(\text{W})}{U'(\text{W})} \qquad (8)$$

where $U'(\text{w})$ is > 0, and is the first derivative with respect to income.
According to Arrow (1970) and Pratt (1964a), the risk aversion coefficient indicates the nature of risk attitude. In the language of mathematics:

$r_a(\text{w}) < 0$ implies risk aversion
$r_a(\text{w}) = 0$ implies indifference
$r_a(\text{w}) > 0$ implies risk-lover

Example of Elicitation of Certainty Equivalents and Computation of Utility Values has been moved to Appendix.

3.5 Farm Household Characteristics

Socioeconomic factors, such as age, off-farm income, and education, are vital factors in farmer's risk management decisions (Sherrick et al., 2004). The socio-economic and demographic factors used in this study are age, farming experience, education, farm size, monthly off-farm income, and the proportion of owned land (Velandia et al. 2009; (Deressa et al., 2010b) (Mesfin et al., 2011b); and (Rehima, 2013) have used these variables.

3.6 Multivariate Probit Model

A multivariate probit model is used to analyze the simultaneous influence of explanatory variables over a risk management strategy. A multivariate probit model is a correlated binary regression model form that measures the estimate of the impact of independent variables on more than one dependent variable simultaneously. It allows error term to be freely correlated. In this study, the farmers were practicing three informal risk management tools to manage risks. Also, the study aims for the simultaneous adoption of these activities. Therefore, a multivariate model will allow possible simultaneous correlations in the farmer's decision to adopt the risk management tools the study is considering: The specific model is as follows.

$$Y_{ij} = x_{ij}\beta_j + \varepsilon_{ij} \qquad (v)$$

Where Y_{ij} (j =1,...,3) shows the risk management alternatives (in present study m = 3) that are risk management tools used by the i^{th} farmer (i =1,..., n), where n=200, x_{ij} is a 1×3 vector of explanatory variables that will affect the risk management adoption decision, $\beta_j$is a k ×1 vector of unknown coefficient estimated parameters, and ε_{ij} The unobserved error term is normally distributed with zero mean and constant variance. In this specification, each Y_j is a binary variable and, thus, the equation is a system of m equations (m = 3 in this case) to be estimated:

$$Y_1^* = \alpha_1 + X\beta_1 + \varepsilon_1$$

$$Y_2^* = \alpha_2 + X\beta_2 + \varepsilon_2$$

$$Y_3^* = \alpha_3 + X\beta_3 + \varepsilon_3$$

whereY_1^*, andY_2^* and $Y^*{}_3$, are different dependent variables which show each risk management strategy such that yj = 1 if y_j^*> 0 and 0 otherwise.

4 Profile of the area and Respondents Characteristics

This chapter is comprised of two main parts; one is a profile of the study area based on secondary data information which includes geographical location, climate, soil, land use, main crops and vegetable statistics. Second is a profile of the respondents which provides for age-wise distribution, education, experience, family size, farming labor, and land ownership, while the farmers are divided into three categories, small, middle and large.

4.1 Profile of the Study Area

Profile of the study area is based on necessary information about the districts, geographical location, climate, land use management, main crops, fruits and vegetable sown in Mardan and Charsadda districts and approximate annual productivity of crops in both irrigated and unirrigated areas in both seasons the Kharif[3] And Rabi[4] Crops.

4.1.1 Basic Information

Mardan and Charsadda are the fertile Districts of KPK (Khyber Pakhtunkhwa), and 80% of its population directly or indirectly depends on Agriculture. Mardan and Charsadda have agriculture areas mostly. The Mardan district lies from 34 degrees 05 to 34 degrees 32 north latitudes and 71 degrees 48 to 27-degree 25 east longitudes. The total area of the district is1632 square kilometers. The Charsadda district lies between 34-03' and 34-38' north latitudes and 71-28' and 71-53' east longitudes. Charsadda is located in the west of the Khyber Pakhtunkhwa and is surrounded by Malakand District to the north, Mardan to the east, Nowshera and Peshawar districts to the south and the Mohmand Agency of the Federally Administered Tribal Areas to the west. Mardan district covers an area of 996 square kilometers.

4.1.2 Climate

The summer season is sweltering. A steep rise of temperature occurs from May to June, July, August and September record high temperatures. The temperature reaches its maximum in June, i.e., 43.50" C. Due to intensive cultivation and artificial irrigation, the area is humid. The coldest months are December and January. The mean minimum temperature recorded for January the coldest month is 0.5^0 C. Most of the rainfall occurs in July, August, December, and January. The maximum rainfall recorded for August, which is the wettest month is 125.8mm. Towards the end of cold weather, there are occasional thunderstorms and hailstorms. The relative humidity is quite high throughout the year while maximum humidity has been recorded in December, i.e., 73.35%.

[3] Urdu word used for the crops that are cultivated and harvested during the rainy (monsoon) season in the South Asia.
[4] Refers to agricultural crops sown in winter and harvested in the spring.

4.1.3 Soil

The soil of Mardan and Charsadda is very fertile. District Mardan is divided into two parts, the South-Western plain area, and North-Eastern hilly region. The land is very fertile in the southern part of the district has heavy clay loam soil while the northern part, the land ranges from clay to clay loam and loam soil. Due to this variation of soil, every type of crop is grown here. Mardan has an agriculture area mostly, and the major crops are wheat, sugarcane, maize, tobacco, rice, rapeseed, mustard, and various vegetable crops. Important fruits are orange, plum, peach, apricot, pear, rare mango, apple strawberry, watermelon, and honey melon. Lands of Charsadda are very fertile, and farmers are also very hard workers. Major crops of Charsadda are Tobacco, Sugarcane, Sugar beet, Wheat and Maize. Primary vegetables of Charsadda are Potato, Tomato, Cabbage, Brinjals, Okra and Spinach. Major fruits of Charsadda are Citrus Apricot, Plum, Pears Strawberry, watermelon and honey melon.

4.1.4 Irrigation water

The primary sources of irrigation are canals. Upper and lower Swat canals mostly irrigate the Mardan district, while tube wells and local arhat systems are also in use for irrigation. In the district, Charsadda three rivers, The River Jindi, the Kabul River, and the Swat River are the primary source of irrigation. These three rivers then merge and join the Indus River. The area surrounded by River Swat and River Kabul is called Doaaba and has great importance in the District.

4.1.5 Population

The total population of Mardan, according to the 2017 census is 2,373061 persons given in (Table 1). The majority are rural populations.

Table 1:-Detail Population of District Mardan[5] Census 2017

	Rural	Urban	Total
Population	1,933,736	439,325	2,373,061
Male	975,545	225,326	1,200,871
Female	958,179	213,933	1,172,112
Transgender	12	66	78
Household	252,486	59,382	311,868

Source: Population Census, 2017.

Charsadda District has three Tehsils, i.e., Charsadda, Shabqadar, and Tangi. Charsadda district was created in 1998. Before 1998 it was tehsil of Peshawar district. Charsadda has remained the kingdom of Gandhara civilization. According to the census 2017 of Pakistan, the total population of Charsadda district is 1616198. The average annual growth rate is 2.44 from 1998 to 2017.

[5] http://www.pbs.gov.pk/sites/default/files//DISTRICT_WISE_CENSUS_RESULTS_CENSUS_2017.pdf

Table 2:-Detail Population of District Charsadda Census 2017

	Rural	Urban	Total
Population	1346023	270175	1616198
Male	681659	138861	820520
Female	664355	131302	795657
Transgender	9	12	21
Household	183437	37621	221058

Source: Population Census, 2017.

4.1.6 Basic Land use statistics of Area

Table 3 shows the land use statistics of district Mardan and Charsaada. The total cultivated area of district Charsadda is 733319 hectares, and district Mardan is 99977 hectares. The cropped area of Charsadda is 5.27% and 6.65% in Mardan of the whole province.

Table 3:-Land use Statistics (Area in Hectares)

District	Reported Area	Cultivated Area	Cropped Area	Uncultivated-Area	Culturable Waste
Charsadda	98641 (1.17)	73319 (3.90)	96618 (5.27)	25322 (0.83)	6174 (0.49)
Mardan	162100 (1.92)	99977 (5.32)	122036 (6.65)	62123 (0.95)	5188 (0.41)
K.P.K.	8452299	1880985	1834835	6571314	1253568

Source: Agriculture Department K.P.K, 2017. Figures in parenthesis are percentages w.r.t province.

4.2 Profile of the Respondents

This part of the study includes the respondents' characteristics. It encompasses farmer distribution, farmer age, farming experience, education, off-farm annual income, and farm size holding of the respondents.

4.2.1 Distribution of Farmers

A categorization of the sample farmers has been made based on farm size holdings. For this purpose, three categories have been developed that is small farmers, medium farmers, and large farmers. The base for this categorization was the landholding size standard as prescribed by the district agriculture extension department. A sample has been selected on the ration that was provided by the agriculture extension department (Table 5).

Table 4:-Categorization of Sample Respondents

Land holing Size (Acre)	Category of Farmers	Sample in the study area
Below 5	Small farmers	131
5-12.5	Medium farmers	39
Above 12.5	Large farmers	30

Source: Agriculture Extension Office Mardan and Charsadda

4.2.2 Age of Household former

Distribution based on age has been made by dividing the sample respondents' age into three groups shown in table 6. Age is measured as the respondents' age in years. According to the survey, most of the farmers (51.5%) fall in the first group ranging from 21 years to 40 years of age. The lowest number of farmers has been reported for the old age that is 15%, constituting 30 respondents of the age range 61-80 years.

Comparing different landholding farmers, the small and middle farmers that age group 21-40 are in the majority with 56% and 46% respectively. Similarly, both groups consist of the lowest number of farmers for the age group 61-80. In the case of large farmers, age group 21-40 and 61-80 years have the same. The details provided show that most of the farmers are young, resulting in high productivity. The average age is reported 42 years in the overall study. Among the farmer's landholding group, the large farmer's average age is highest that is 49 years while the small farmers' average age was reported to be lowest, i.e., 41 years. As far as the maximum and minimum age is concerned both the small and large farmers' maximum age is 80, while for minimum age, the small farmer has a minimum age of 21 years.

Table 5:- Distribution of Respondents by Farmers Age

Age of farmers	Small Farmers		Middle Famers		Large Farmers		Total	
	f	%	F	%	f	%	f	%
21-40	73	56	18	46	12	40	103	51.5
41-60	46	35	15	39	6	20	67	33.5
61-80	12	9	6	15	12	40	30	15
Total	131	100	39	100	30	100	200	100
Average	41		46		49		42	
Minimum	21		23		68		31	
Maximum	80		70		80		70	

Source: Field Survey, 2018

4.2.3 Education of farmers

Education is an important variable that plays a vital role in agriculture output. Education helps farmers adopting modern technology which results in high yield compared to less or uneducated farmers. Education enabled farmers in risk management decisions, and they will prefer to input usage that requires modern technologies (Rahman and Asadullah, 2005). Education increases innovation in the agriculture sector (Hossain et al. 1990). Sample respondents have been categorized into seven levels from illiterate to master level. The highest level of education reported is a master's degree during the survey.

Table 6:-Distribution of Famers by Education

Education of Farmers	Small Farmers		Middle Famers		Large Farmers		Total	
	f	%	F	%	F	%	F	%
Illiterate	46	35	18	45	12	40	76	38
Primary	18	14	3	8	0	0	21	10.5
Middle[6]	22	17	3	8	6	20	31	15.5
Matric[6]	25	19	9	23	6	20	40	20
[7]Intermediate	10	7	3	8	6	19	19	9.5
Bachelor	5	4	0	0	0	0	5	2.5
Master	5	4	3	8	0	0	8	4
Total	131	100	39	100	30	100	200	100
Average	7		5		4		6	
Minimum	0		0		0		0	
Maximum	16		12		10		16	

Source: Field Survey, 2018

According to this study, the highest level of illiterate was reported in medium farmers, which is 45% (18 out of 39 respondents), followed by large farmers where the ratio is 40%. In small farmers, the matric respondents are 19%. The proportion of bachelor and master respondents among the small farmers is 4%. In the case of middle farmers, matric education is 23%, intermediate is 8%, the bachelor is nil, while respondents with master education are 8%. The middle, matric, and intermediate level of education in large farmers are the same that 20%. Bachelor and master level education in large farmers found nil. On average the education level is highest in the small farmers that is seven years of education, one of the reasons is that small farmers have less income due to smallholdings, this leaves no option to smallholders except schooling to improve their standard living.

4.2.4 Forming Experience of the former

The forming experience has categorized into three groups. Small farm holding farmers have the ratio of experience from 2 to 20 years. 37% of the small farmers having experience of 21 to 40 years and just 3% are in the group of 41 to 60 years of experience. Similarly, in middle farmers, the ratio of experience group 2-20 is highest, which is 61%, followed by the second category constituting 31% of the respondents. In the case of large farmers, the experience ranging from 2-20 and 21-40 both groups have the same number of respondents that are 12, making 40% of total respondents. Farm experience is a vital factor in farming practice and related risks management. Experience enables the individual to learn from past phenomena and will result in an accurate decision regarding production. According to the survey, the large farmers on average have a vast experience as compared to small and medium farmers.

[6]Middle is 8 year of education.

[6]Matric is secondary school education.

[7] Intermediate is a higher secondary education.

Table 7:-Distribution of Respondents by Farmers' Experience

Experience of farmers (years)	Small Farmers		Middle Famers		Large Farmers		Total	
	F	%	F	%	f	%	F	%
2-20	80	61	24	61	12	40	116	58
21-40	47	36	12	31	12	40	71	35.5
41-60	4	3	3	8	6	20	13	6.5
Total	131	100	39	100	30	100	200	100
Average	20		24		29		21	
Minimum	2		4		11		2	
Maximum	60		55		55		60	

Source: Field Survey, 2018

4.2.5 Annual Income and off-farm income

In the past literature, it is evident that income is also an essential factor in farmers' attitude, behavior and decision making. Income is support to farmers, especially the off-farm income, to decide high-risk nature. The table highlights the farm income of small, medium and large farmers. The farmers have been categorized into four categories based on income. The significant of the small farmers (48%) falls in the lowest income group that is less than PKR 200000. 25% falls in the second group, which is PKR 200001-400000. In the small farmer's group, 19% and 8% fall in the third and fourth category that is 400001-600000 and above 600000 respectively. In the case of middle farmers, the highest number of respondents (38%) falls in the second category, which is PKR 200001-400000, followed by less than 200000 groups where the ratio is 24%. In the last group of farmers that is large farmers' majority of the respondents, i.e. 60% are in the highest income group of above Rs 600000. Out of the remaining large farmers, 07% are in the first income group that is less than 200000, and 20% are in the 3rd group (400000-600000). It is evident from the table below that a large farmer has the highest average income of PKR 878000. Similarly, the minimum and maximum levels of income are also high for large farmers.

Table 8:-Distribution of Respondents by Farmers Annual Income

The income of Farmers (PKR/Year) PKR (Pakistani Rupee)	Small Farmers		Medium Famers		Large Farmers		Total	
	f	%	F	%	F	%	F	%
<200000	63	48	9	24	2	7	74	33
200001-400000	33	25	15	38	4	13	52	26
400001-600000	25	19	9	23	6	20	40	20
>600000	10	8	6	15	18	60	34	17
Total	131	100	39	100	30	100	200	100
Average	273485		402077		878000		341540	
Minimum	32000		120000		510000		32000	
Maximum	760000		1160000		1800000		1800000	

Source: Field Survey, 2018

In the Off form income table small former out of 131 formers 43 former lies in the group having off form income 52000 or less .similarly out of 39 formers six formers are in the first group. In a large former group, most of the former have high off form income.

Table 9:-Distribution of Respondents by Farmers off-farm Annual Income

Off-farm Income of Farmers (PKR/Year)	**Small Farmers**		**Medium Famers**		**Large Farmers**		**Total**	
	f	%	f	%	f	%	f	%
<52000	43	33	6	15	1	4	50	25
52001-104000	39	30	11	28	4	13	54	27
104001-156000	27	20	17	44	9	30	53	26
	22	17	5	13	16	53	43	22
Total	131	100	39	100	30	100	200	100
Average	71106		104540		228290		88875	
Minimum	8320		31200		132600		8320	
Maximum	200000		301650		468000		468000	

4.2.6 Land Ownership

Ownership status of the farmers shows that in small farmers, 20% are owners, 67% are tenants while 13% of respondents were owner cum tenants. In middle farmers, that ratio of owners is high than small farmers, and it is 38%. Tenants among the middle farmers are 16%. According to the reported data, the owner cum tenants' ratio is highest in all three farmers categories that are 46%. The owner in large farmers is the highest in proportion and is 80% of total large farmers. In large farmers, no tenants were found. Owner cum tenants were 22% in the large farmers. In the whole sample survey, 32.5% are owners, 47% are tenants, and 20.5% are owner cum tenants.

Table 10:-Distributions of Respondents by Land Ownership

Land Ownership	Small Farmers		Middle Famers		Large Farmers		Total	
	F	%	F	%	f	%	f	%
Owner	26	20	15	38	24	80	65	32.5
Tenant	88	67	6	16	0	0	94	47
Owner cum tenant	17	13	18	46	6	20	41	20.5
Total	131	100	39	100	30	100	200	100

Source: Field Survey, 2018

4.3 Summary

The key finding of the above discussion is that about 80% of the population of the target area, directly or indirectly dependant on agriculture. Landholding in the area is small as the majority of the farmers hold less than 2 acres of land. Mostly young people (more than 50%), age ranging from 21 to 40 years are involved in farming. As far as the experience is concerned, all the farmers in the study area have 21 years of experience on average. Education level is found to be low in the area as the average education level was just the primary level. The average farm income of the farmers was reported to be PKR 341540 annually. The monthly income was PKR 28460, and the minimum wage rate in Pakistan is PKR. 11000 (GoP, 2015 Budget).

5 Determinants of simultaneous Adoption of Risk Management Strategies

5.1 Farmers Risk Perceptions about Floods and Heavy Rains

5.1.1 Risk Perception of Floods

Risk perception of farmers about the climatic risks is a significant factor that affects farmers' decisions about risk management in agriculture. The following table (Table 13) for the total sampled households shows that more than 50% of the farmers perceive a high-risk perception about floods. Out of total formers (i.e.62.5%) consider it a significant risk while 38% of the farmers showed low-risk perception about the floods. Among the small farmers, most of them (75.4%) perceived a high perception of floods while (24.6%) of them feel that floods are not a crucial source of risk to their fields. Among the middle farmers, about one-third of the farmers (35.3%) perceived high risk due to floods. More than half of middle formers (64.7%) perceived low risk. In the case of big farmers group, more than half of them (61.5%) reported for the low-risk perception and more than one third (38.5%) perceived high-risk perception of floods.

Table 11:-Distribution of Respondents on the Basis of Risk Perception of Floods

Risk Perception of Floods	Small Farmers		Middle Famers		Large Farmers		Total	
	f	%	f	%	F	%	f	%
High risk of floods	99	75.4	14	35.3	12	38.5	125	62.5
Low Risk of Floods	32	24.6	25	64.7	18	61.5	75	37.5
Total	131	100.0	39	100.0	30	100.0	200	100.0
Chi-Square	12.581**				P-Value:0.002			

Source: Field Survey, 2018
Note: f = frequency ** means significant at 1% level of significance

The Chi-square test shows that the former's risk perception is not the same in different farmers groups. Based on p-values (p=0.002), it is likely that farmers have differences in risk perception about floods as an exogenous factor. Most of the farmers perceived a high-risk perception of floods but significantly different. Therefore, the null hypothesis is such that, based on landholding size, there is no difference in risk perception of floods of different formers is not true. Therefore, the alternative hypothesis is accepted is that there is a significant difference in risk perceptions of different formers based on landholding size is accepted.

5.1.2 Risk Perception about Heavy Rains

Famers are distributed based on risk perception of heavy rains in Table 14. Among the total sampled respondents, more than half (67.82%) of the farmers have a high-risk perception of heavy rains. One-third of them (32.18%) reported low-risk perception of heavy rain. Within the group of small farmers, most of them showed high-risk perception than middle and large farmers, as they are more vulnerable to disasters. In the case of small farmers, only 19.3% of the farmers have a low-risk perception of heavy rains while most (80.7%) of them reported that they have very high risk from heavy rains. Evidence in the field showed that most of the farmers reported that the current heavy rains devastated their crops. Even average farmers also faced high risk from heavy rains. Around half (53%) of them reported that they have high risk from heavy rains and the rest of them indicated heavy rains as low risk. Out large farmers, more than half (69.23%) of the farmers considered heavy rains are not the primary source of risk, and about one third (30.77%) perceived that heavy rains are the primary source of danger.

Table 12:-Distribution of Respondents based on Risk Perception of Heavy Rains

Risk Perception of Heavy Rains	Small Farmers		Middle Famers		Large Farmers		Total	
	F	%	f	%	f	%	f	%
High Risk of Heavy Rains	106	80.70	21	53.00	9	30.77	136	67.82
Low risk of Heavy Rains	25	19.30	18	47.00	21	69.23	64	32.18
Total	131	100.0	39	100.0	30	100.0	200	100.0
Chi-Square	14.23**				P-Value:0.001			

Source: Field Survey, 2018
** means significant at 1% level of significance

Based on the p-value (0.001), at the 1% level of confidence, it can be concluded, that the risk perceptions of heavy rain of different formers are not similar and accepting alternative Hypothesis that there are differences in farmers' perception about heavy rains as a risky exogenous event. The findings of this study reveal that more than half of the farmers were risk-averse, and their perceptions about floods were found to be high.

In natural disasters, In terms of economic loss, flooding is the most destructive natural disaster (Ali, 2007). In the study area, farmers were the most affected in terms of damages to crops, livestock, irrigation systems, water contamination and other agricultural operations. Further, the impacts of floods on agricultural systems aggravated the problems in terms of losses in farm yields and food security. The same results were obtained by Deen (2015) and Khan et al. (2010), and Qasim et al. (2015). Due to these massive losses and damages to the agriculture sector in the foods of 2010, 2011 and 2014, farmers had a very high-risk perception of floods and heavy rains compared to other natural disasters. The same results were obtained by Saqib et al. (2016c). They revealed that most of the small farmers had a high-risk perception of floods and heavy rains. This high-risk perception of farmers led to the high-risk attitude averse nature of farmers.

5.2 Farmer's Risk Attitude

Different approaches have been adopted by researchers to measure the attitudes of farmers (Dadzie and Acquah, 2012a). Two basic approaches, direct and indirect, are used for measuring risk attitude. The direct method, as suggested by von Neumann and Morgenstern, has complications that result from the fact that the subjects have different levels of tolerance or intolerance for gambling and that the concepts of probability are by no means intuitively obvious, and moreover, it is a time-consuming method (Moscardi and de Janvry, 1977). Risk attitude can be measured through eliciting Certainty Equivalents (CEs) and the experimental method as gambling with real payoffs (Binswanger, 1980). In interviews for farmers' elicitation of preferences, Anderson et al. (1977) have discussed several techniques. These include the von Neumann-Morgenstern (N-M) model, Equally Likely Certainty Equivalent (ELCE) method, a modified version of the N-M model, and the Equally Likely but risky outcome method. Based on the above discussion, we have adopted the interview method of the direct approach with the ELCE, using a Purely Hypothetical Risky model. The farmers are categorized into three groups. First is risk-preferring farmer are those who are willing to take risks, or the expected outcome is preferred over a certain outcome. Second is risk-neutral: those who are indifferent to certain and uncertain outcomes but have the same expected income. The third is risk-averse; where farmers give preference to guaranteed income over income that is uncertain. It is assumed that the selection of expected or sure outcomes is based on utility. Farmers opt for that choice which gives them more utility. Farmers maximize utility. Utility, in our case, is a function of wealth, but we use it as a function of income (Hardaker et al., 2004, Olarinde et al., 2007).

$$U = u(w) \qquad (1)$$

The individual wants to maximize utility with respect to income.

$$U'(w) \ \geq 0 \qquad (2)$$

The first differential is positive and indicates that more is preferred over less (also called convex utility function). Likewise, risk aversion is a state of a utility function that shows a decrease in marginal utility as the payoff increases (also called concave utility function). Risk neutral has a linear utility function (Hardaker et al., 2004). The expected utility theory is defined by Von Neumann and Morgenstern (1944). According to this theory, there are reasons behind individual choices involving risks. The decision-makers compare the expected utility in risky and uncertain prospects. Levy (2006) argued that individuals are reluctant to accept choices with uncertain payoffs, but rather, are willing to accept another choice with a low and sure payoff. Farmers will try to maximize utility within the constraints.

$$\boldsymbol{U = u(y, c)} \qquad (\mathbf{3})$$

Where y is farm income, and c is consumption. The TUF will show the nature of individual behavior based on convexity or concavity of the utility function. This will further lead to risk aversion, which is the central behavioral concept in the expected utility theory (Musser and Patrick, 2002). Risk aversion attitude measures a decision-makers' unwillingness to accept outcomes with uncertain payoffs. Instead, they prefer certain outcomes, although with the probability of lower expected payoffs. A decision-maker's utility function will shape their risk preferences (Hardaker et al., 2004). A decision-maker's utility function will have a positive slope, which means that a higher payoff is always preferred to a lesser one. The nature of risk attitude is further explained by Arrow (1970) and (Pratt, 1964a), which is mentioned in chapter 3.

The method for calculating risks attitude (ELCE)[8] discussed in detail in Appendix II. From each respondent, certainty values were obtained, and then for each value, their corresponding utility values were calculated. Furthermore, the CE[9] values were regressed on utility values, which were in the cubic utility function. After solving for the regression model, the absolute risk Aversion coefficient was calculated by taking the first and second derivatives obtained. Respondents are divided based on landholding size into three categories, small, medium, and large farmers and then are compared with their attitudes. So, in small farmers 62% (Table 15) are risk-averse, and they are going to secure themselves from the risks; therefore, they were likely to adopt some risk management strategy, while 38% of them were risk lovers. Similarly, among medium farmers, 62% are risk-averse, while in the case of large farmers, 83% of farmers are risk-lover.

Table 13:-Distribution of Respondents by Risk Attitude

Risk Attitude of Farmers	Small Farmers		Medium Famers		Large Farmers		Total	
	f	%	f	%	f	%	f	%
Risk lover	50	38	15	38	25	83	73	37
Risk averse	81	62	24	62	05	17	127	63
Total	131	100	39	100	30	100	200	100

Source: Field Survey, 2018

Among the total farmers, 37% of respondents were risk lovers, and 63% are risk-averse. It implies that out of the total, most of the farmers, whether they belong to small or other groups of farmers, are risk-averse. Accepting the alternative Hypothesis that risk Attitudes of different formers are significantly different. Findings of the study for risk aversion are consistent with the findings of Iqbal et al. (2016), Ullah et al. (2015b), Bond and Wonder (1980a) and Kitonyoh (2015). They reported that the majority of farmers in their studies were risk-averse in nature.

5.3 Determinants of Risk Management Tools

5.3.1 Risk Management Tools

In this study, three management decisions, namely asset depletion, consumption reduction, and diversification which were the most commonly used risk management strategies in the field, are discussed. Table 16 shows that 46.97% of the farmers from the Charsadda district and 53.03% from the Mardan District were practicing assets depletion. Regarding consumption reduction, 48.34% of the total farmers in Charsadda district were using this strategy, while 51.66% of farmers from Mardan were practicing consumption reduction. Likewise, in Charsadda district about 45% were involved in diversification, and 55% of formers from Mardan district were engaged in diversification. Looking at the overall result of each strategy number, we conclude that the formers were not just practicing one tool but instead were involved in mix adoption.

[8] equally likely certainty equivalent
[9] certainty equivalent

Table 14:-Adoption of Risk Management Tools (Multiple Choices)

Adoption of Risk Management Tools	Charsadda	Mardan	Overall
Asset Depletion	62 (46.97)	70 (53.03)	132
Consumption Reduction	73 (48.34)	78 (51.66)	151
Diversification	51 (45.13)	62 (54.84)	113

Source: Field Survey, 2018

5.3.2 Correlation among risk management decisions

Table 17 below shows the correlation among the risk management tools which were adopted by the farmers in the study area. The correlation coefficient is the pairwise correlation between the error terms of the equations of the multivariate models. The correlation coefficient is significant at the 99% level implies that these equations are correlated, and simultaneous adoption models fit in this scenario. Therefore, the study has used a multivariate probit model.

Table 15:-Correlation among the Risk Management Decisions

Risk Management Tools	Correlation Coefficients
Assets Depletion and Consumption Reduction	0.355**
Consumption Reduction and Diversification	0.432**
Diversification and Asset Depletion	0.264**

** shows significance level at 99%

The positive sign indicates that at the same time, the farmers also go for the other management tools.

5.3.3 Factors determining assets depletion

Assets depletion was a standard risk management tool used by farmers in the study area. Baas et al. (2008) said that assets accumulation and depletion play a vital role in disaster risk reduction (Table 18). The results for the assets depletion coefficient show that age is positively (0.043) associated and highly significant at a 99% level of confidence. Implies that as the age increases, this is more likely that older farmers adopted asset depletion more than the younger farmers. The results of this study are consistent with the findings of Firas (2011) who found that in Syria, farmers liquidated their productive assets at the time of need as a risk management strategy. Also, education is significant and positively linked with the adoption of assets depletion as a risk management strategy. Educated farmers are more likely to be ready for the disasters and risks to their agriculture. The results are consistent with the study of Naz et al. (2018), revealed that education has positively affected the adoption of management tools in Bangladesh. It implies that educated farmers can make wiser farm management decisions (Deressa et al., 2009). Unlike education, farming experience negatively linked to assets depletion strategy. It implies that as the farmer was more experienced, he was more interested in other adoption strategies. Ullah and Shivakoti (2014) and Saqib et al. (2016a) revealed that experienced farmers could manage climatic risks in a better way than inexperienced farmers. Off-farm income is negatively associated with assets depletion. This result is against *a priori* expectation but may be due to the severity of floods. Given the potentially huge losses associated with more severe floods, most farmers were involved in assets depletion. Lastly, risk attitude is positively related to the adoption of risk management strategies. It implies risk-averse farmers were more involved in asset depletion than those who were risk lovers.

5.3.4 Factors determining consumption reduction

Another common strategy was consumption reduction. Consumption reduction was associated with other socio-economic factors. Among these factors, off-farm income positively associated with a decrease in household consumption. The findings of our study show that income has a positive association with the adoption of agricultural credit. This supports the results of Ullah (2014), who fund a positive relationship of income with precautionary savings, diversification, and agricultural credit adoption. Whereas, these results are in contrast to the findings of (Velandia et al., 2009a), who observed that the relationship of the lower-income category with management strategies adoption was positive, but as income changed to a higher category, the relationship changed from positive to negative.

Households decreased their use to run the household affairs due to the loss of the floods. Risk perception of floods was associated positively with the adoption of consumption reduction in the study area. Positive association implies that because of the high perception of the floods, farmers were more going for Consumption reduction. Likewise, risk perception about the heavy rains had the same relationship with the adoption of this strategy. The adoption of an effective risk coping strategy by farmers depends upon their appropriate risk perception, which is a prerequisite in managing agriculture risk (Sulewski and Kłoczko-Gajewska, 2014, Saqib et al., 2016a). Weather sources such as floods and heavy rains cause crop failure and ultimately have severe, negative impacts on the livelihoods of farmers, particularly for whom agriculture is the primary source of income and employment. Our results indicate that high-risk perception of floods and heavy rains led farmers to adopt consumption reduction as a risk management strategy; these results are in agreement with the findings of (Ullah, 2014, Saqib et al., 2016a). Risk attitude of the farmers was positively associated with the consumption reduction. It implies that as the farmers were risk-averse, they were more involved in practicing this strategy. Risk attitude averseness induces the farmers to take measures and secure themselves from losses caused by disasters. Our results signify the findings of (Ullah et al., 2015a, Saqib et al., 2016c), who reported that farmers' risk perception and risk attitude about floods and heavy rains were essential factors in farm investment, production, and risk management decisions. They further suggested that farmers' risk perception and attitude should be considered main factors when deciding on risk management strategies in the agriculture sector.

5.3.5 Factors determining diversification

Based on the results and significant findings of this study, it is clear that risk and uncertainty are the leading causes of low yields and crop production in the study area. The majority of farmers were risk-averse and had a high perception of floods. The results of diversification show that age, landholding size, risk attitude of floods, and heavy rains were significantly associated with the adoption of diversification. Age had a positive association with diversification. Older farmers had higher adoption than younger farmers. Results for age are similar to previous research (Dadzie and Acquah, 2012b, Deressa et al., 2010a, Rehima et al., 2013), in that old farmers are more risk-averse and adopt more risk management strategies compared to their younger counterparts. However, our findings are in disagreement with other studies (Mesfin et al., 2011a, Ashfaq et al., 2008, Ullah et al., 2015a), where age was found to negatively affect the adoption of risk management strategies. Similarly, Velandia et al. (2009a) observed a negative relationship of age with various risk management strategies: crop insurance, forward contracting and spreading sales. Jensen and Pope (2014) also reported a negative effect of age on farmers' adoption of precautionary savings as a risk management strategy. Landholding size was positively associated with diversification. The result might be because larger landholding farmers were relatively more abundant and had the needed capital to undertake diversification of off-farm activities to mitigate risk. This result contrasts findings of Mesfin et al. (2011b)who found a negative relationship between landholding with decisions of adopting diversification as a strategy but consistent with the findings of Deressa et al. (2010b), Ullah et al. (2015a) and Velandia et al. (2009b). Small farmers are more vulnerable to natural disasters than large farmers. Because they have less land holdings, less income, and fewer savings, they need more funds to mitigate the adverse impacts of disasters, whereas middle and upper subsistence farmers have large landholdings, enormous wealth, more stability in income flow, and a more extensive asset base. This signals their larger capacity for bearing risk and a lesser need for risk management tools. Results indicate that the majority of small farmers adopt diversification as a risk management strategy. Findings confirm (Velandia et al., 2009a), and are in disagreement with (Ullah et al., 2015a), who reported that large farmers are adopting agriculture credit more than small farmers.

Risk assigning from heavy rains in the study area was associated positively with the adoption of diversification. The results imply that farmers with higher risk perception about the heavy rains were more likely to go for diversification for adaptation to these risks. Risk perception is a significant indicator of disaster literature. It demonstrates individual, and community responses to natural disasters (Birkholz et al., 2014) and a positive correlation is found between public response and adaptation/management to natural hazards. This means that when risk perception of farmers is high, they will be more risk-averse and will adopt risk-mitigating activities. For example, farmers had a high-risk perception of floods, so they adopted agricultural credit (Zulfiqar et al., 2016, Saqib et al., 2016b) and off-farm diversification (Zulfiqar et al., 2016) as agricultural flood-risk management tools. Likewise, farmers may use diversification in income, precautionary savings, diversification in crops and several other farm risk management tools in post and pre-disaster situations. Large farmers have more land and greater diversification of income and crops.

Table 16:-Factors Influencing Risk Management Decisions (Individual Probit Models)

Independent Variables	Asset Depletion	Consumption Reduction	Diversification
Age	0.043**	-0.032	0.031**
	(0.021)	(0.001)	(0.012)
Education	0.051**	-0.02	-0.01
	(0.020)	(0.010)	(0.011)
Farming Experience	-0.031**	0.004	-0.021
	(0.011)	(0.012)	(0.010)
Off-farm Income	6.4×10^{-4}**	6.21×10^{-4}**	-6.32×10^{-3}
	(0.000)	(0.000)	(0.000)
Landholding Size	0.034	0.006	0.106**
	(0.054)	(0.039)	(0.046)
Risk Perception of Floods	0.046	0.531**	0.052
	(0.182)	(0.181)	(0.201)
Risk perception of Heavy Rains	0.003	0.441**	0.601**
	(0.211)	(0.182)	(0.212)
Risk Attitude	0.741**	0.550**	0.421
	(0.221)	(0.220)	(0.301)
Log Likelihood-value	-162.301	-178.01	-151.03
LR χ^2 Test (8)	132.02**	98.01**	155.21**
Pseudo R^2	0.348	0.43	0.342
N	200	200	200

Notes: Figures in parenthesis are the standard errors and **, and *** show significant levels at 95% and 99%.

5.3.6 Results of the multivariate probit model

Results in Table 17 show that the correlation among the management tools is significantly correlated with each other and indicates that adoption is to be tested through multivariate models. The estimated parameters of the multivariate probit model show the simultaneous adoption risk management decisions mentioned in table 19.

Table 17:-Factors Influencing Risk Management Decisions (Multivariate Probit Model)

Independent Variables	Asset Depletion	Consumption Reduction	Diversification
Age	0.031**	0.023**	-0.21
	(0.01)	(0.021)	(0.010)
Education	-0.021	0.066**	-0.31
	(0.031)	(0.021)	(0.02)
Farming Experience	-0.021	-0.041**	0.003
	(0.010)	(0.011)	(0.010)
Off-farm Income	-0.000	3.21**	0.000**
	(0.000)	(0.000)	(0.000)
Landholding Size	0.103**	0.031	0.0026
	(0.047)	(0.045)	(0.041)
Risk Perception of Floods	0.038	0.092	0.552***
	(0.211)	(0.201)	(0.211)
Risk perception of Heavy Rains	0.621**	0.043	0.512**
	(0.187)	(0.211)	(0.188)
Risk Attitude	0.331	0.752**	0.578**
	(0.231)	(0.231)	(0.212)
Log likelihood value -482.01	LR $\chi 2$ Test (24) 241.05**		
ρkj 15.023**	N 200		

Notes: Notes: Figures in parenthesis are the standard errors and ** and *** show significant levels at 95% and 99%.

5.4 Conclusion and Recommendations

5.4.1 Conclusion

Risk perception is an essential factor that affects farmers' decisions about their risk management decisions. Most of the small farmers perceived high risks about the floods and heavy rains. Findings of the risk attitude of farmers show that among the small farmers, most of them were risk-averse. Regarding the adoption of the management tools, farmers were practicing assets depletion, consumption reduction, and diversification. Findings for the determinants of risk management tools show that assets depletion age has a positive influence. Education positively linked with the adoption of assets depletion. Farming experience and off-farm income are negatively associated with the depletion of the assets. Risk attitude was positively associated with the adoption of risk management strategies. Another common approach was consumption reduction. Consumption reduction was related to other socio-economic factors. Among these factors, off-farm income positively associated with a decrease in household consumption. Risk perception of floods was associated positively with the adoption of consumption reduction in the study area. Likewise, risk perception about the heavy rains had the same relationship with the adoption of this strategy.

Risk attitude of the farmers was positively associated with the consumption reduction. The results show that age, landholding size, risk attitude of floods and heavy rains, and risk perceptions of farmers, are significantly associated with the adoption of diversification. Age had a positive association with diversification. Landholding size was positively associated with diversification. It implies that with more landholding, the farmers were comparatively more abundant, and they had the capital for the diversification of off-farm activities. Risk assigning from heavy rains in the study area was associated positively with the adoption of diversification. The results imply that as the farmers had a higher risk of risk perception about the heavy rains, they are more ready to go for diversification.

5.4.2 Recommendations

- Most of the farmers in the study area were small. Their risk perceptions were high and risk-averse in nature. The PDMA should help these small farmers at the time of disasters so that the farmers could manage their risk well.
- Framers were practicing informal risk management strategies The government should provide help to these farmers in the form of seeds and land preparation so that they would rely less on traditional management tools.
- Famers' socio-economic characteristics such as landholding, their off-farm income were important in the adoption of risk management at the farm level. Therefore, the local government should play its role to improve their likelihood.

5.5 Future Research

This study has focused on the traditional management tools of risk management in the study area. Future research recommends a survey about the farmers' willingness to pay for crop insurance in the area. The next research may also target to study the farmers' access to credit sources in these floods' prone regions. These are formal risk management strategies and help how the institutional mechanism could help the farmers.

References;

ADITTO, S., GAN, C. & NARTEA, G. V. 2012. Sources of risk and risk management strategies: the case of smallholder farmers in a developing economy. *Risk Management–Current Issues and Challenges*.

AKTAR, W., SENGUPTA, D. & CHOWDHURY, A. 2009. Impact of pesticides use in agriculture: their benefits and hazards. *Interdisciplinary toxicology,* 2**,** 1-12.

ALI, A. M. S. 2007. September 2004 flood event in southwestern Bangladesh: a study of its nature, causes, and human perception and adjustments to a new hazard. *Natural Hazards,* 40**,** 89-111.

ANAMAN, K. 1988. African Farm Management. *Principles and Applications with Examples.'Ghana Universities Press, Accra*.

ANDERSON, J. R. 2001. *Risk management in rural development: A review*, World Bank, Rural Development Department.

ANDERSON, J. R. 2002. Risk Management in Rural Development: A review. World Bank, Rural Development Department.

ANDERSON, J. R., DILLON, J. L. & HARDAKER, J. B. 1977. *Agricultural decision analysis*, Iowa State University Press.

ARMAŞ, I. & AVRAM, E. 2008. Patterns and trends in the perception of seismic risk. Case study: Bucharest Municipality/Romania. *Natural Hazards,* 44**,** 147-161.

ARROW, K. 1970. Essays in The Theory of Risk Bearing North-Holland. *Amsterdam, The Netherlands*.

ASHFAQ, M., HASSAN, S., NASEER, M. Z., BAIG, I. A. & ASMA, J. 2008. Factors Affecting Farm Diversification in Rice-Wheat. *Pakistan Journal of Agricultural Sciences,* 45**,** 91-94.

ASHRAF, M. & ROUTRAY, J. K. 2013. Perception and understanding of drought and coping strategies of farming households in north-west Balochistan. *International Journal of Disaster Risk Reduction,* 5**,** 49-60.

AZAM-ALI, S. Agricultural diversification: The potential for underutilised crops in Africa's changing climates. Rivista di Biologia - Biology Forum, 2007. ANICIA SRL, 27.

BAAS, S., RAMASAMY, S., DEPRYCK, J. D. & BATTISTA, F. 2008. *Disaster risk management systems analysis: A guide book*, Food and Agriculture Organization of the United Nations Rome, Italy.

BELOW, T., ARTNER, A., SIEBERT, R. & SIEBER, S. 2010. Micro-level practices to adapt to climate change for African small-scale farmers:A review of Selected Literature. IFPRI Discussion Paper 00953, International Food Policy Research Research Instirute, Washington D.C.

BINICI, T., KOC, A. A., ZULAUF, C. R. & BAYANER, A. 2003. Risk Attitudes of Farmers in Terms of Risk Aversion: A Case Study of Lower Seyhan Plain Farmers in Adana Province, Turkey. *Turkish Journal of Agriculture & Forestry,* 27.

BINSWANGER, H. P. 1980. Attitudes toward risk: Experimental measurement in rural India. *American Journal of Agricultural Economics,* 62**,** 395-407.

BIRKHOLZ, S., MURO, M., JEFFREY, P. & SMITH, H. 2014. Rethinking the relationship between flood risk perception and flood management. *Science of the Total Environment,* 478**,** 12-20.

BOND, G. E. & WONDER, B. 1980a. Risk attitudes amongst Australian farmers. *Australian Journal of Agricultural Economics,* 24**,** 16-34.

BOND, G. E. & WONDER, B. 1980b. Risk attitudes amongst Australian farmers. *Australian Journal of Agricultural and Resource Economics,* 24**,** 16-34.

BULLOCK, W., ORTMNANN, G. & LEVIN, J. 1994. Farmer characteristics, risk sources and managerial responses to risk in vegetable farming: Evidence from large- and small-scale commercial vegetable farmers in Kwazulu-Natal. *Agrekon,* 33**,** 103-112.
BURN, D. H. 1999. Perceptions of flood risk: a case study of the Red River flood of 1997. *Water Resources Research,* 35**,** 3451-3458.
COHEN, A. & EINAV, L. 2005. Estimating risk preferences from deductible choice. Massachusetts Avenue, Cambridge, MA 02138: National Bureau of Economic Research.
COOPER, D., GREY, S., RAYMOND, G. & WALKER, P. 2005. Project risk management guidelines. *Managing Risk in Large Projects and Complex Procurements, Chippenham: John Wiley & Sons, Ltd*.
CUTTER, S. L., BORUFF, B. J. & SHIRLEY, W. L. 2003. Social vulnerability to environmental hazards. *Social science quarterly,* 84**,** 242-261.
DADZIE, S. K. N. & ACQUAH, H. 2012a. Attitude toward risk and coping responses: The case of food crop farmers at Agona Duakwa in Agona East District of Ghana. *International Journal of Agriculture and Forestry,* 2**,** 29-37.
DADZIE, S. K. N. & ACQUAH, H. D. 2012b. Attitudes Toward Risk and Coping Responses: The Case of Food Crop Farmers at Agona Duakwa in Agona East District of Ghana. *International Journal of Agriculture and Forestry,* 2**,** 29-37.
DAVIS, T., PATRICK, G., COBLE, K., KNIGHT, T. & BAQUET, A. 2005. Forward pricing behavior of corn and soybean producers.
DEEN, S. 2015. Pakistan 2010 floods. Policy gaps in disaster preparedness and response. *International journal of disaster risk reduction,* 12**,** 341-349.
DERESSA, T. T., HASSAN, R. M., RINGLER, C., ALEMU, T. & YESUF, M. 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global environmental change,* 19**,** 248-255.
DERESSA, T. T., RINGLER, C. & HASSAN, R. M. 2010a. Factors Affecting the Choices of Coping Strategies for Climate Extremes. The Case of Farmers in the Nile Basin of Ethiopia.
DERESSA, T. T., RINGLER, C. & HASSAN, R. M. 2010b. Factors Affecting the Choices of Coping Strategies for Climate Extremes. *1032*.
DROLLETTE, S. A. 2009. Managing production risk in agriculture. *Department of Applied Economics Utah State University*.
FIRAS, Y. 2011. Agricultural Risks and Risk Management of Different Farming Systems in Syria.
GILLIAM, J., CHATTERJEE, S. & GRABLE, J. 2010. Measuring the perception of financial risk tolerance: A tale of two measures. *Journal of Financial Counseling and Planning,* 21.
HALTER, A. & MASON, R. 1978. Utility measurement for those who need to know. *Western Journal of Agricultural Economics***,** 99-109.
HARDAKER, J., HUIRNE, R. & ANDERSON, J. 1997. Coping with risk in agriculture. *CAB International, Wallingford, UK*.
HARDAKER, J. B., HUIRNE, R. B., ANDERSON, J. R. & LIEN, G. 2004. *Coping with risk in agriculture*, CABI publishing.
HARRISON, G. W., LAU, M. I. & RUTSTRÖM, E. E. 2007. Estimating risk attitudes in denmark: A field experiment*. *The Scandinavian Journal of Economics,* 109**,** 341-368.
HARWOOD, J. L., HEIFNER, R., COBLE, K., PERRY, J. & SOMWARU, A. 1999. *Managing risk in farming: concepts, research, and analysis,* US Department of Agriculture, Economic Research Service.

HOLT, C. A. & LAURY, S. K. 2002. Risk Aversion and Incentive Effects. *American Economic Review,* 92**,** 1644-1655.
HUIRNE, R., MIRANDA, P., HARDAKER, J. B. & ANDERSON, J. F. 2000. Risk and risk management in agriculture: an overview and empirical results. *Int. J. Risk Assessment and Management,* 1**,** 25.
IQBAL, M. A., PING, Q., ABID, M., KAZMI, S. M. M. & RIZWAN, M. 2016. Assessing risk perceptions and attitude among cotton farmers: A case of Punjab province, Pakistan. *International Journal of Disaster Risk Reduction,* 16**,** 68-74.
ISRAEL, G. D. 1992. *Determining sample size* [Online]. Available: chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/https://www.tarleton.edu/academicassessment/documents/Samplesize.pdf [Accessed].
IYER, P., BOZZOLA, M., HIRSCH, S., MERANER, M. & FINGER, R. Measuring Farmer Risk Preferences in Europe: A Systematic Review. *Journal of Agricultural Economics,* n/a.
JAIN, R. & PARSHAD, M. 2006. Report of the working group on risk management in agriculture for the eleventh five year plan (2007-2012). *New Delhi, India: Government of India Planning Commission*.
JENSEN, F. E. & POPE, R. D. 2014. Agricultural Precautionary Wealth. *Journal of Agricultural and Resource Economics,* 29**,** 17-30.
JUST, R. E. & POPE, R. D. 1979. Production function estimation and related risk considerations. *American Journal of Agricultural Economics,* 61**,** 276-284.
KAHAN, D. 2008. *Managing risk in farming,* Food and Agriculture Organization of the United Nations.
KANDULU, J. M., BRYAN, B. A., KING, D. & CONNOR, J. D. 2012. Mitigating economic risk from climate variability in rain-fed agriculture through enterprise mix diversification. *Ecological Economics,* 79**,** 105-112.
KELLENS, W., TERPSTRA, T. & DE MAEYER, P. 2013. Perception and communication of flood risks: a systematic review of empirical research. *Risk analysis,* 33**,** 24-49.
KHAN, A. N., KHAN, S. N. & ALI, A. 2010. Analysis of Damages Caused by Flood-2010 In District Peshawar. *J. Sc. & Tech, Univ. Peshawar,* 36**,** 11-16.
KISAKA-LWAYO, M. & OBI, A. 2012. Risk perceptions and management strategies by smallholder farmers in KwaZulu-Natal Province, South Africa. *International Journal of Agricultural Management,* 1**,** 28-39.
KITONYOH, C. K. 2015. *A Farm Level Analysis of Risk Attitude, Sources and Risk Measurement Strategies among Farmers in Trans Nzoia County, Kenya.* MSc Thesis, Moi University.
KLOPPER, E., VOGEL, C. H. & LANDMAN, W. A. 2006. Seasonal climate forecasts–potential agricultural-risk management tools? *Climatic Change,* 76**,** 73-90.
LANSDOWNE, Z. F. 1999. Risk matrix: an approach for prioritizing risks and tracking risk mitigation progress. *Proceedings of the 30th Annual Project Management Institute, Philadelphia, PA, October***,** 10-16.
LEVY, H. 2006. *Stochastic dominance: Investment decision making under uncertainty,* Springer.
LINS, D. A., GABRIEL, S. C. & SONKA, S. T. 1981. An analysis of the risk aversion of farm operators: an asset portfolio approach. *Western Journal of Agricultural Economics***,** 15-29.
LUCAS, M. P. & PABUAYON, I. M. 2011. Risk Perceptions, Attitudes, and Influential Factors of Rainfed Lowland Rice Farmers in Ilocos Norte, Philippines. *Asian Journal of Agriculture and Development,* 8**,** 61-77.

LUSK, J. L. & COBLE, K. H. 2005. Risk perceptions, risk preference, and acceptance of risky food. *American Journal of Agricultural Economics,* 87**,** 393-405.
MAKKI, S. S. & SOMWARU, A. 2001. Asymmetric information in the market for yield and revenue insurance products. United States Department of Agriculture, Economic Research Service.
MAKUS, L. D., LIN, B. H., CARLSON, J. & KREBILL-PRATHER, R. 1990. Factors influencing farm level use of futures and options in commodity marketing. *Agribusiness,* 6**,** 621-631.
MAURER, K. 2014. Where is the risk? Is agricultural banking really more difficult than other sectors? *Finance for Food.* Springer, Berlin, Heidelberg.
MESFIN, W., FUFA, B. & HAJI, J. 2011a. Pattern, Trend and Determinants of Crop Diversification: Empirical Evidence from Smallholders in Eastern Ethiopia. *Journal of Economics and Sustainable Development,* 2**,** 78-89.
MESFIN, W., FUFA, B. & HAJI, J. 2011b. Pattern, Trend and Determinants of Crop Diversification: Empirical Evidence from Smallholders in Eastern Ethiopia. *Journal of Economics and Sustainable Development,* 2**,** 78-89.
MEUWISSEN, M. P., HUIRNE, R. & HARDAKER, J. 2001. Risk and risk management: an empirical analysis of Dutch livestock farmers. *Livestock production science,* 69**,** 43-53.
MITCHELL, J. T. 2000. The hazards of one's faith: hazard perceptions of South Carolina Christian clergy. *Global Environmental Change Part B: Environmental Hazards,* 2**,** 25-41.
MORTON, J. F. 2007. The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the national academy of sciences,* 104**,** 19680-19685.
MOSCARDI, E. & DE JANVRY, A. 1977. Attitudes toward risk among peasants: An econometric approach. *American Journal of Agricultural Economics,* 59**,** 710-716.
MUSSER, W. N. & PATRICK, G. F. 2002. How much does risk really matter to farmers? *A comprehensive assessment of the role of risk in US Agriculture.* Springer.
NAZ, F., DONEYS, P. & SAQIB, S. E. 2018. Adaptation strategies to floods: A gender-based analysis of the farming-dependent char community in the Padma floodplain, Bangladesh. *International Journal of Disaster Risk Reduction,* 28**,** 519-530.
NDMA 2010. Annual Report 2010. Islamabad Pakistan.
NDMA 2011. Flood Rapid Response Plan. Islamabad Pakistan.
NDMA 2014. RECOVERY NEEDS ASSESSMENT AND ACTION FRAMEWORK 2014-16 Islamabad Pakistan.
OECD 2001. Agricultural policy monitoring and evaluation.
OECD 2011. Risk Management in Agriculture: What Role for Governments.
OGURTSOV, V., VAN ASSELDONK, M. & HUIRNE, R. 2008. Assessing and modelling catastrophic risk perceptions and attitudes in agriculture: a review. *NJAS-Wageningen Journal of Life Sciences,* 56**,** 39-58.
OLARINDE, L., MANYONG, V. & AKINTOLA, J. 2007. Attitudes towards risk among maize farmers in the dry savanna zone of Nigeria: some prospective policies for improving food production. *African Journal of Agricultural Research,* 2**,** 399-408.
ORTMANN, G. F., PATRICK, G. F., MUSSER, W. N. & DOSTER, D. H. 1992. Information sources, computer use, and risk management: evidence from leading commercial cornbelt farmers. *Station bulletin-Purdue University, Agricultural Experiment Station (USA).*
PAKISTAN ECONOMIC SURVEY 2011-12. Highlights of the Pakistan Economic Survey. Islamabad: Ministry of Finance.
PRATT, J. W. 1964a. Risk aversion in the small and in the large. *Econometrica,* 32**,** 122-136.

PRATT, J. W. 1964b. Risk aversion in the small and in the large. *Econometrica: Journal of the Econometric Society***,** 122-136.
QASIM, S., KHAN, A. N., SHRESTHA, R. P. & QASIM, M. 2015. Risk perception of the people in the flood prone Khyber Pukhthunkhwa province of Pakistan. *International Journal of Disaster Risk Reduction,* 14**,** 373-378.
REHIMA, M., BELAY, K., DAWIT, A. & RASHID, S. 2013. Factors affecting farmers' crops diversification: Evidence from SNNPR, Ethiopia. *International Journal of Agricultural Sciences,* 3**,** 558-565.
REHIMA, M., BELAY, K., DAWIT, A., AND RASHID, S 2013. Factors affecting farmers' crops diversification. *Ethiopia. International Journal of Agricultural Sciences,* 3(6)**,** 558-565.
ROBISON, L. J., BARRY, P. J., KLIEBENSTEIN, J. B. & PATRICK, G. F. 1984. Risk attitudes: concepts and measurement approaches Risk management in Agriculture, Iowa State University Press, Ames, pp. 26-49.
SAHA, A., SHUMWAY, C. R. & TALPAZ, H. 1994. Joint estimation of risk preference structure and technology using expo-power utility. *American Journal of Agricultural Economics,* 76**,** 173-184.
SAQIB, S. E., AHMAD, M. M., PANEZAI, S. & ALI, U. 2016a. Factors influencing farmers' adoption of agricultural credit as a risk management strategy: The case of Pakistan. *International Journal of Disaster Risk Reduction,* 17**,** 67-76.
SAQIB, S. E., AHMAD, M. M., PANEZAI, S. & ALI, U. 2016b. Factors influencing farmers' adoption of agricultural credit as a risk management strategy: The case of Pakistan. *International Journal of Disaster Risk Reduction***,** 67-76.
SAQIB, S. E., AHMAD, M. M., PANEZAI, S. & RANA, I. A. 2016c. An empirical assessment of farmers' risk attitudes in flood-prone areas of Pakistan. *International journal of disaster risk reduction,* 18**,** 107-114.
SCHNEIDER, L. 2010. Risk and Risk Transfer in Agriculture:Facilitating food security and poor farmer participation *In:* OXFAM AMERICA (ed.). Boston.
SHAW, R., SHIWAKU HIROHIDE KOBAYASHI, K. & KOBAYASHI, M. 2004. Linking experience, education, perception and earthquake preparedness. *Disaster Prevention and Management: An International Journal,* 13**,** 39-49.
SHERRICK, B. J., BARRY, P. J., ELLINGER, P. N. & SCHNITKEY, G. D. 2004. Factors influencing farmers' crop insurance decisions. *American Journal of Agricultural Economics,* 86**,** 103-114.
SHORT, J. F. 1984. The social fabric at risk: toward the social transformation of risk analysis. *American sociological review,* 49**,** 711-725.
SINGH, G. 2010. *Crop insurance in India,* Indian Institute of Management Ahmedabad.
SINGLA, S. & SAGAR, M. 2012. Integrated risk management in agriculture: an inductive research. *The Journal of Risk Finance,* 13**,** 199-214.
SMIDTS, A. & WAGENINGEN, L. 1990a. *Decision making under risk: a study of models and measurement procedures with special reference to the farmer's marketing behavior,* Wageningen Agricultural University.
SMIDTS, A. & WAGENINGEN, L. 1990b. *Decision making under risk: a study of models and measurement procedures with special reference to the farmer's marketing behaviour,* Wageningen Agricultural University.
SMITH, V. H. & BAQUET, A. E. 1996. The demand for multiple peril crop insurance: evidence from Montana wheat farms. *American Journal of Agricultural Economics,* 78**,** 189-201.
SONKA, S. T. & PATRICK, G. F. 1984. Risk management and decision making in agricultural firms.

SRIRAMARATNAM, S., BESSLER, D. A., RISTER, M. E., MATOCHA, J. E. & NOVAK, J. 1987. Fertilization under uncertainty: An analysis based on producer yield expectations. *American Journal of Agricultural Economics,* 69**,** 349-357.
SULEWSKI, P. & KŁOCZKO-GAJEWSKA, A. 2014. Farmers' risk perception, risk aversion and strategies to cope with production risk: an empirical study from Poland. *Studies in Agricultural Economics,* 116**,** 140-147.
TANAKA, T., CAMERER, C. F. & NGUYEN, Q. 2010. Risk and time preferences: linking experimental and household survey data from Vietnam. *American Economic Review,* 100**,** 557-571.
TORKAMANI, J. 2005. Using a whole-farm modelling approach to assess prospective technologies under uncertainty. *Agricultural systems,* 85**,** 138-154.
UDMALE, P., ICHIKAWA, Y., MANANDHAR, S., ISHIDAIRA, H. & KIEM, A. S. 2014. Farmers′ perception of drought impacts, local adaptation and administrative mitigation measures in Maharashtra State, India. *International Journal of Disaster Risk Reduction,* 10**,** 250-269.
ULLAH, R. 2014. *Production Risk Management and Its Impacts at the Farm Level: The Case of Paksitan.* Doctor, Ph. D. Thesis, Asian Institute of Technology.
ULLAH, R., JOURDAIN, D., SHIVAKOTI, G. P. & DHAKAL, S. 2015a. Managing catastrophic risks in agriculture: simultaneous adoption of diversification and precautionary savings. *International Journal of Disaster Risk Reduction,* 12**,** 268-277.
ULLAH, R. & SHIVAKOTI, G. P. 2014. Adoption of on-farm and off-farm diversification to manage agricultural risks: Are these decisions correlated? *Outlook on AGRICULTURE,* 43**,** 265-271.
ULLAH, R., SHIVAKOTI, G. P. & ALI, G. 2015b. Factors effecting farmers' risk attitude and risk perceptions: The case of Khyber Pakhtunkhwa, Pakistan. *International Journal of Disaster Risk Reduction,* 13**,** 151-157.
ULLAH, R., SHIVAKOTI, G. P., REHMAN, M. & KAMRAN, M. A. 2015c. Catastrophic Risks Management at Farm: The Use of Diversification, Precautionary Savings and Agricultural Credit. *Pak. J. Agri. Sci,* 52**,** 1139-1147.
V.A. OGURTSOV, M. P. A. M. V. A. A. R. B. M. H. 2008. Assessing and modelling catastrophic risk perceptions and attitudes in agriculture: a review. *NJAS-Wageningen Journal of Life Sciences,* 56-1/2,.
VELANDIA, M., REJESUS, R. M., KNIGHT, T. O. & SHERRICK, B. J. 2009a. Factors affecting farmers' utilization of agricultural risk management tools: the case of crop insurance, forward contracting, and spreading sales. *Journal of Agricultural and Applied Economics,* 41**,** 107-123.
VELANDIA, M., REJESUS, R. M., KNIGHT, T. O. & SHERRICK, B. J. 2009b. Factors affecting farmers' utilization of agricultural risk management tools: the case of crop insurance, forward contracting, and spreading sales. *Journal of Agricultural and Applied Economics,* 41**,** 107-123.
VON NEUMANN, J. & MORGENSTERN, O. 1944. *Theory of games and economic behavior,* Princeton, NJ, Princeton university press.
WANG, E., CRESSWELL, H., BRYAN, B., GLOVER, M. & KING, D. 2009. Modelling farming systems performance at catchment and regional scales to support natural resource management. *NJAS-Wageningen Journal of Life Sciences,* 57**,** 101-108.
WFP. 2010. Pakistan Flood Impact Assessment. Available: https://www.wfp.org/content/pakistan-flood-impact-assessment-september-2010 [Accessed 20th December , 2014].
WIENS, T. B. 1976. Peasant risk aversion and allocative behavior: a quadratic programming experiment. *American Journal of Agricultural Economics,* 58**,** 629-635.

WOODBURN, M., ORTMANN, G. & LEVIN, J. 1995. Sources and management of risk: Evidence from commercial farmers in KwaZulu-Natal. *South African Journal of Economic and Management Sciences,* 17**,** 46-63.
WORD BANK 2001. World development report 2000/2001: attacking poverty. *New York, Oxford University Press), table,* 19**,** 311.
WORLD BANK 2001. World Development Report 2000-2001: Attacking Poverty. Washington, DC.:World Bank.
WORLD FOOD PROGRAMME 2010. Pakistan Flood Impact Assessment. WFP.
XU, J.-F. & LIAO, P. 2014. Crop Insurance, Premium Subsidy and Agricultural Output. *Journal of Integrative Agriculture,* 13**,** 2537-2545.
YAMANE, T. 1967. Elementary sampling theory.
YOUNG, D. L. 1979. Risk preferences of agricultural producers: their use in extension and research. *American Journal of Agricultural Economics,* 61**,** 1063-1070.
ZULFIQAR, F., ULLAH, R., ABID, M. & HUSSAIN, A. 2016. Cotton production under risk: a simultaneous adoption of risk coping tools. *Natural Hazards,* 84**,** 959-974.

Appendix

Appendix-I

Swedish University of Agricultural Sciences, Uppsala Sweden

Environmental Economics and Management

QUESTIONNAIRE

Questionnaire No………… **Date…/…/……**

Managing Farm-Centric Risks in Production at the Flood-Prone locations of Khyber Pakhtunkhwa, Pakistan

Questionnaire for Household Survey

My name is Arifullah Arifullah. I am currently pursuing a master's degree in environmental economics *and Management* from the *Swedish University of Agricultural Sciences, Uppsala Sweden*. My research topic is **"Managing Farm-Centric Risks in Production at the Flood-Prone locations of Khyber Pakhtunkhwa, Pakistan."** All the information collected through this questionnaire are highly confidential and purely for academic purpose. So kindly do not hesitate to express your real situation and personal opinion. I appreciate your cooperation in giving your time and for the success of my research.

Basic details of household:

Respondent's Name:	………………………..	Date:	………………………..
District:	………………………..	Village	………………………..
Union Council:	………………………..	Tehsil	………………………..

Farm Household Characteristics OR Demographic profile of the Respondent

I. Age: ………………………………………………. (Year)

II. Education: ………………………………………………. (Years of Schooling)

III. Farming Experience ………………………………………………. (Years)

IV. Household Farm Size:

- Area Owned ……………………………………………… (Acre)
- The area leased out ……………………………………………… (Acre)
- The area leased in ……………………………………………… (Acre)

V. Farm income & Off-farm Income:

- Total farm income (PKRs/year) ………………………………………………. (PKRs/Month)
- Total Off-farm income: ……………………………………………… (PKRs/Month)
- Total household/monthly income ……………………………………………….. (PKRs/Month)

VI. Land Ownership

- ☐ Owner.
- ☐ Tenant.
- ☐ Owner-Cum-Tenant.

VII. Family Size: _________________ (Head Count of Family Members)

VIII. How many family members are involved in farming? _________ (Number)

Risk Sources and Management Strategies (multiple answers)

IX What are the primary sources of weather-related risk?

- ☐ Heavy Rains.
- ☐ Floods.
- ☐ If others (specify): ………………………………

X What are the primary sources of weather-related risk?

- ○ ………………………………… ○ …………………………………
- ○ ………………………………… ○ …………………………………

XI. What are strategies do you use to minimize the risk in agriculture?

a) --------------------------------
b) --------------------------------
c) --------------------------------
d) --------------------------------
e) --------------------------------
Other------------------------------

XII. Please ask further in which form and how the farmers are using the respective strategies.

Objective

Risk Perception

11. Rank the following risk sources, its incidence, and severity, on a Likert scale from 1 (very low) to 5 (very high).

Ranking	Very low	Low	Normal	High	Very High
Risk of Floods					
Incidence	1	2	3	4	5
Severity	1	2	3	4	5
Risk of Heavy Rains					
Incidence	1	2	3	4	5
Severity	1	2	3	4	5

Objective

Risk Attitude

1. Noted the monetary value of sure outcome, which makes household indifferent between the 2 risky outcomes of Rs. (Total Annual Household Income) and Rs.0 with equal probability: ________________________________ (Amount X2 Rs).
2. Noted the monetary value of Sure outcome which makes household indifferent between the 2 risky outcomes of Rs. (X2) and Rs.0 with equal probability: ________________________________ (Amount X3 Rs).
3. Noted the monetary value of Sure outcome which makes household indifferent between the 2 risky outcomes of Rs. (X3) and Total Annual Household Income with equal probability: ________________________________ (Amount X4 Rs).
4. Noted the monetary value of Sure outcome which makes household indifferent between the 2 risky outcomes of Rs. (X4) and Total Annual Household Income with equal probability: ________________________________ (Amount X5 Rs.).
5. Noted the monetary value of Sure outcome which makes household indifferent between the 2 risky outcomes of Rs. (X5) and Total Annual Household Income with equal probability: ________________________________ (Amount X6 Rs.).
6. Noted the monetary value of Sure outcome which makes household indifferent between the 2 risky outcomes of Rs. (X6) and X1 with equal probability: ________________________________ (Amount X7 Rs.).

S/N	RiskY outcome A probability p= (1/2)	Risk outcome B probability p= (1/2)	Sure outcome /Indifferent Xi

1	Total annual income	0 Income	X1
2	Amount X1	0 Income	X2
3	Amount X2	0 Income	X3
4	Amount X3	Total annual income	X4
5	Amount X4	Total annual income	X5
6	Amount X5	Total annual income	X6
7	Amount X6	X1	X7

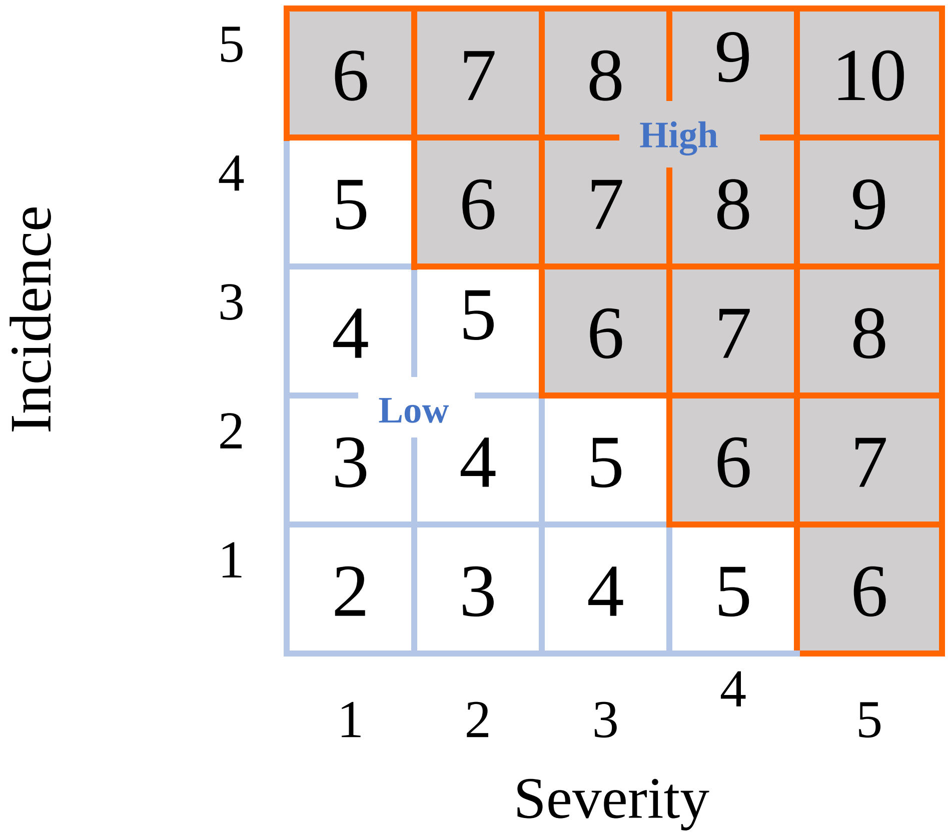
19 What are the strategies you adopted for managing the risk?

- …………………………
- …………………………
- …………………………
- …………………………

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Appendix II

Risk Matrix



Risk Attitudes

The risk attitude of the formers was calculated Equally Likely Certainty Equivalent Method (ELCEM). The certainty equivalent is a sure outcome a former is accepting at the time of offer instead of taking the risk of the high but uncertain outcome in the future. The procedure is that there is a risky outcome with discrete payoffs (x_1,x_2….. x_m …. x_{n-1}, x_n) with particular probabilities (P_1, P_2 ⋯P_m⋯ P_{n-I}, P_n). The summation of all probabilities is equal to 1. In using the ELCE method, the first step is to know the preferences. To find a certainty equivalent (CE) for a hypothetical 50/50 example with the best payoffs x_n having utility(U= I) and worst possible outcome x_1 having utility (U= 0).

The Equally Likely Certainty Equivalent Method (ELCEM) is used to calculate the risk attitude of farmers. Several studies have adopted this model (Hardaker et al., 2004, Iqbal et al., 2016, Torkamani, 2005, Smidts and Wageningen, 1990b, Ogurtsov et al., 2008) Certainty equivalence for several risky outcomes was then compared with associated utility values (Ullah, 2014). For example, farmers were asked to mention a monetary value between two risky outcomes that would make them indifferent. For example, the annual income of a sample farmer is PKR 200,000, with an associated probability of 0.5, and in case of loss, 0 income with the same probability of 0.5; the farmer is asked to choose the income in this range. For example, say the farmer was indifferent in PKR 120,000, which was an assured outcome. The farmer then had to choose in the range between PKR 0 and 120,000, and was found indifferent at PKR 60,000. Likewise, in the next step, he is asked to choose in the range between PKR 0 and 60,000 and was found indifferent at PKR 30,000. The experiment was repeated, and the next amount was PKR 20,000 to which the farmer was indifferent. Likewise, the farmer was asked to choose between the higher ranges (PKR 120,000-200,000) and was indifferent at PKR 140,000.

Similarly, between PRK 140,000 and 200,000, the farmer was indifferent at PKR 170, 000. Similarly, the experiment was repeated, and several CE points were derived from their associated probabilities. This procedure was repeated for every farmer, and the values were incorporated in the cubic utility function.

There are two risky outcomes, and it will be a decision problem. CE is the maximum sure payment, x_m, that the producer is willing to accept instead of facing risk (Hardaker et al., 2004). This value will be higher than x_1 and will be lower than x_n. In the Later stage expected utility for the CE of x_m is calculated; in the next step following the same procedure, the expected utilities for corresponding CEs were determined for other points between x_1 and x_n. After obtaining CEs between the range of points x_1 and x_m, the expected utility for x_1 (U= 0) and x_m (calculated in the first step) with their respective probabilities of 0.5 is calculated by weighted average. Following the same method, the CEs of other points can be calculated until a sufficient number of CEs are elicited to plot the utility function (Smidts, 1990; Hardakeret et al., 2004; (V.A. Ogurtsov, 2008).

The advantage of ELCE is that it is based on ethically neutral probabilities of (.5) (Smidts, 1990; Hardakeret et al., 2004). People find 50/50 risky prospects much easier to conceptualize than with probabilities with ratios Hardakeret et al., 2004. After deriving CEs, place them into the cubic utility function to obtain the utility of each individual, following the model below:

$$u(w) = \alpha_1 + \alpha_2 w + \alpha_3 w^2 + \alpha_4 w^3 \qquad \text{(ii)}$$

Cubic utility function showed risk attitude, risk preference, risk aversion, and risk indifference attitudes (Binici et al., 2003). The utility was converted into a quantitative measurement of risk aversion called absolute risk aversion (Pratt, 1964b, Hardaker et al., 2004). The following formula can derive the absolute risk aversion

$$R_a(W) = -\frac{U''(W)}{U'(W)} \quad \text{(iii)}$$

$$R_a(W) = \text{coeffecient of risk aversion}$$

$$U'^{(W)} = \text{first order differential of a utility function}$$

$$U''^{(W)} = \text{second order differential of a utility function}$$

W is representing wealth in the above equation; the income was substituted for wealth in this model following Olarinde et al. (2007) and Hardakar et al. (2004).

If:

$$R_a(W) > 0 \quad \text{or positive}$$

Positive means that the individual is risk-averse.

$$R_a(W) = 0$$

Then the individual is indifferent or neutral to risk.

$$R_a(W) < 0 \quad \text{or negative}$$

The individual is risk seekers or risk preferred.

The cubic utility function is

$$ui(w) = \alpha_1 + \alpha_2 w + \alpha_3 w^2 + \alpha_4 w^3 \quad where\ i = 1...9$$

Then by taking the derivatives, absolute risk aversion is calculated by the formula.

$$R_a(W) = \frac{U'(W)}{U''(W)}$$

where U'(w) is > 0, and is the first derivative with respect to income.
According to Arrow (1970) and Pratt (1964a), the risk aversion coefficient indicates the nature of risk attitude. In the language of mathematics:

r_a (w) $<$ 0 implies risk aversion
r_a (w) $=$ 0 implies indifference
r_a (w) $>$ 0 implies risk-lover

As an example, one of the regression results obtained for the first respondent is given based on the above methodology, and absolute risk aversion is calculated.

Example of Elicitation of Certainty Equivalents and Computation of Utility Values

Step	Elicited CE	Utility Calculation
	Scale	U(0) = 0 and U(200,000) = 1
1	(120,000; 1.0) ~ (0, 200,000; 0.5, 0.5)	U(120,000) = 0.5u(0) + 0.5u(200,000) = 0.5
2	(60,000; 1.0) ~ (0, 120,000; 0.5, 0.5)	U(60,000) = 0.5u(0) + 0.5u(120,000) = 0.25
3	(30,000; 1.0) ~ (0, 60,000; 0.5, 0.5)	U(30,000) = 0.5u(0) + 0.5u(60,000) = 0.125
4	(20,000; 1.0) ~ (0, 30,000; 0.5, 0.5)	U(20,000) = 0.5u(0) + 0.5u(30,000) = 0.0625
5	(140,000; 1.0) ~ (200,000, 140,000; 0.5, 0.5)	U(140,000) = 0.5u(200,000) + (0.5u(140,000) = 0.75
6	(170,000; 1.0) ~ (200,000, 170,000; 0.5, 0.5)	U(170,000) = 0.5u(200,000) + (0.5u(170,000) = 0.875
7	(180,000; 1.0) ~ (200,000, 180,000; 0.5, 0.5)	U(180,000) = 0.5u(200,000) + (0.5u(180,000) = 0.937

Authors' Calculations

Parameter Estimation from Simple Regression Model from Cubic Utility Function

Parameter	**Value**	**t (ratios)**	**P (Value)**
α_1	36.67821	3.378728	0.043132
α_2	-0.00218	-3.08772	0.05381
α_3	4.22E-08	2.800944	0.0678
α_4	-2.6E-13	-2.49192	0.088334
R^2	0.96		

Source: Author's calculations

Based on the above data, the absolute risk is calculated as under

$$R_a(W) = 0.16336$$

The R_a value is positive here, which means that he is risk-averse.