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EXPLORING AGRICULTURAL RISK PERCEPTION AND ATTITUDE IN SINDH, PAKISTAN

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ABSTRACT

Farmers must base their decisions on an informed understanding of risk perception and attitude to navigate the numerous challenges associated with agricultural operations. Nonetheless, there is a lack of sufficient research to be found in countries like Pakistan to cope with such risks pragmatically associated with agriculture. As a result, the purpose of this research is to fill this void by examining how Pakistani farmers perceive and respond to risks associated with agriculture. In the Sindh province, we interviewed 480 agricultural households in eight districts. Multi-stage stratified cluster sampling technique was adopted according to the scope of the study. Risk discernment was surveyed utilizing a risk lattice, while the Similarly Equally Likely Certainty Equivalent (ELCE) strategy was utilized to assess risk mentality. We also looked at the factors that influence farmers' perceptions and attitudes of risk using a probit model. According to our findings, salinity, floods, drought or insufficient rainfall, excessive precipitation, and flooding are the most significant threats to farmers' operations. In addition, we discovered that farmers' risk attitudes and perceptions are significantly influenced, either positively or negatively, by a variety of factors, including age, education level, farm remoteness, off-farm income, and access to market information. These experiences are important for researchers and policymakers, improving comprehension we might interpret risk in the executives' systems among ranchers in agricultural countries. They lay the groundwork for subsequent research and legislative initiatives aimed at improving farmers' resilience to challenges.

Keywords: agriculture, Pakistan, probit, risk attitude, risk perception

INTRODUCTION

The rural area is full of a huge number of dangers, as ranchers work in a climate impacted by different variables and weaknesses (Jha *et al.,* 2024). Naderi *et al.* (2024) say that the natural environment, market failures, and social uncertainty are the sources of these dangers. Farmers must use a variety of adaptive measures to reduce these dangers, putting time and money into developing efficient strategies (Xu *et al.,* 2024). While higher benefits are conceivable from horticultural ventures, there is likewise a more prominent possibility of disappointment (Khatri *et al.,* 2024). When making decisions, farmers tend to avoid risks as they often deal with uncertainties such as unpredictable weather conditions, ever-changing market situations, fluctuations in prices and various unexpected challenges like crop diseases or pests (Alotaibi *et al.,* 2024). The types of hazards encountered depend on the specific crop being cultivated. Studies have classified these dangers into several categories including environmental factors, human actions and management practices; marketing-related issues; financial instabilities and production-based risks (Kurlavičius *et al.,* 2024).

The income generated by agriculture is a crucial source of livelihood for rural households (Mengistu and Belda, 2024). As such, farmers must address any production risks to ensure consistent revenue streams. A farmer's attitude and actions play a vital role in how they navigate the challenges associated with risk management at the farm level (Khaspuria *et al.,* 2024). Being aware of potential threats enables them to

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assess probabilities and consequences more effectively, leading to informed decisions about crop management strategies that include adaptation measures as part of their coping mechanisms for future uncertainties in agricultural activities. Pakistan's economy heavily relies on the agriculture sector, which contributes 19.5% to its GDP and supports more than three-quarters of the rural population directly or indirectly. However, this vital industry is susceptible to various climatic fluctuations that adversely impact its productivity (Waris *et al.,* 2023). In Sindh, where population density is high but cultivated area per hectare is limited, agricultural challenges such as water scarcity due to a shortage of fresh water for irrigation continue posing significant threats (Khondoker *et al., 2*023). Farmers in this region rely excessively on groundwater sources that are often inadequate or insufficient (Abanyie *et al.,* 2023). The coastal districts like Badin and Thatta face additional risks from sea-water intrusion resulting primarily from natural hazards like floods caused by cyclones and droughts (Jamali *et al.,* 2023). Moreover, irrigational expansion has also resulted in severe environmental degradation with issues such as salinity soil depletion prevalent while frequent rainwater flooding frequently disrupts livelihood activities causing uncertainty for farmers within Pakistan's agricultural sector today (Safi *et al.,* 2024).

Pakistan's limited capacity and resources pose challenges for adapting to risks both at the farm and national levels (Nadeem *et al.,* 2024). Our review expects to fill this basic examination hole by researching the gamble insights and reactions of Pakistani ranchers. We conducted interviews with 480 rural families across eight regions in the Sindh territory, utilizing a risk network to survey risk discernment and the Equally Likely Certainty Equivalent (ELCE) technique to assess risk disposition. We also examined the factors that influence farmers' perceptions and attitudes of risk by employing a probit model. The discoveries from our exploration feature the main dangers faced by ranchers and recognize key factors, for example, age, schooling level, ranch distance, off-ranch pay, and admittance to showcase data that essentially influence their gamble discernments and mentalities. These bits of knowledge are priceless for scientists and policymakers, as they improve how we might interpret risk in the executives' procedures among ranchers in agricultural countries. In addition, they serve as a crucial foundation for upcoming research and policy initiatives aimed at increasing farmers' resilience to a variety of obstacles.

The structure of this paper is as follows: The materials and methods used in the study are described in detail in the following section, as is the model specification and analytical approach. In this manner, we present and examine the perceptions exhaustively, lastly, we finish up with the critical discoveries and their suggestions for future examination and strategy advancement.

MATERIALS AND METHODS

Study area

The researchers selected Sindh province for their study due to its extensive irrigation and drainage network, which ultimately led to the Indus Delta. Due to its vulnerability to climatic and natural disasters, Sindh was selected for this study. This region has experienced significant flooding in multiple instances over recent years, including in 2003, 2006, 2007, 2010 and 2011 (Xu *et al.,* 2024). Sindh's climate is predominantly dry and hot, typical of the arid subtropical belt (Qureshi *et al.,* 2024). The alluvial plains are divided into lower, middle, and upper zones (Abbas *et al.,* 2024). In the upper region, summer temperatures can exceed 50°C with frequent dust storms, while winter temperatures can drop to around 6°C (Waheed *et al.,* 2024). The middle region, between Sukkur and Hyderabad, experiences relatively warmer conditions compared to its northern neighbour but cooler than areas closer to sea level (Javed, 2023). The lower region, extending from Hyderabad to the Arabian Sea, is characterized by high humidity, with southwest winds prevailing in summer and northeast winds in winter (Sarfaraz and Faisal, 2023). Sindh faces significant challenges with waterlogging and soil salinity, exacerbated by inadequate artificial and natural drainage systems. Over three-quarters (78%) of Sindh is covered with saline groundwater, unsuitable for irrigation (Soomro *et al.,* 2024). The province has thirteen surface drainage systems covering more than 6.2 million acres, with a combined drain length of approximately 6,100 km. Additionally, two sub-surface drainage networks are extending over roughly 0.40 million hectares (Ahmed *et al.,* 2020). A considerable volume of drainage runoff is retained in the basin or released into drains, canals, and rivers. Sindh was chosen for this research due to these extensive irrigation and drainage systems and the frequent flooding events that have highlighted the need for effective risk management strategies in the region.

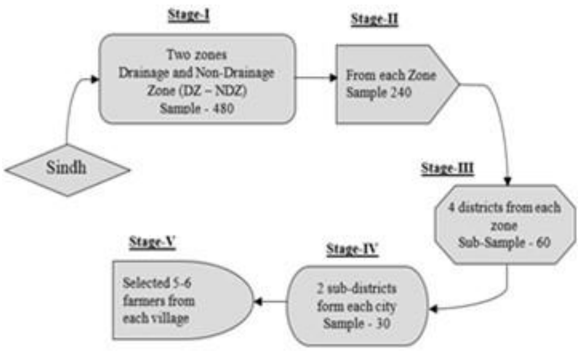

Figure 1. Sampling stages for selecting farmers in the study area

Figure 2. Sample study districts in Sindh province, Pakistan (World map source: ESRI, 2016)

A multi-stage stratified cluster sampling technique was utilized to collect farm-level data from 480 farmers. Such a technique is best suited when the data is gathered in clusters and havings stages Figure 3. Firstly, the study area was determined using the Sindh Irrigation and Drainage Authority's drainage area map of Sindh. Then, two zones were created based on existing and proposed drainage areas: LBOD for the former zone and NDZ for the latter; four districts with diverse attributes within each zone were chosen as well as two sub-districts in every district. In the final stage of the selection process, five or six farmers from each village participated in an interview resulting in a total number of precisely 240 farming households per zone being interviewed. The enumerators received comprehensive training before conducting off-field work which had continuations during fieldwork while engaging participants throughout questionnaire approaches but only after ensuring its clarity by pre-testing it ahead inside that environment itself. Ethical interviewing procedures were implemented, with prior informal arrangements made to ensure clarity on the study's objectives. Through interviews, farmers responded to questions relating to various risk sources and mitigation strategies utilized alongside their households' income streams among other farming-related characteristics. The recorded responses used a dependable 5-point Likert scale anchored by "Strongly Disagree" at one end and "Strongly Agree" on the opposite extreme.

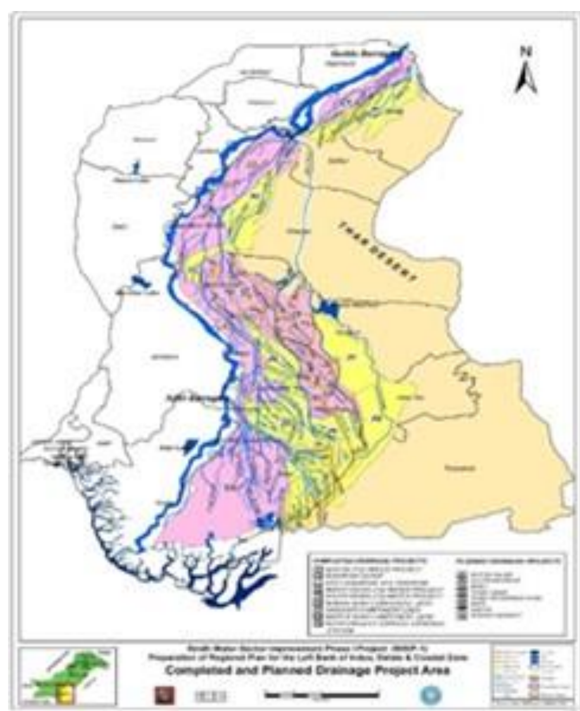

Figure 3. The existing and proposed drainage network indicated on the left bank of the river Indus adapted from the Regional Master Plan for the Left Bank of Indus, Delta and Coastal Zone (SIDA, 2013)

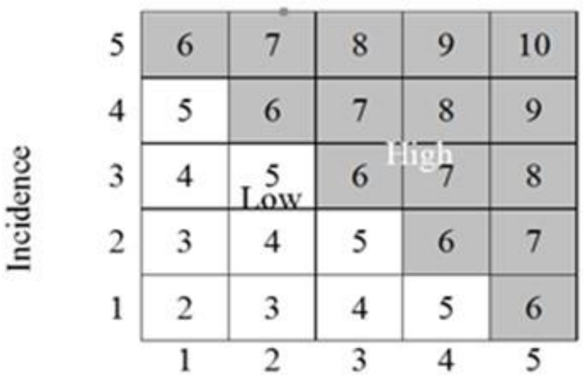

Figure 4. Risk matrix

Farmers' risk perceptions

Our study focuses on four major sources of catastrophic risk, namely: (i) excessive rainfall, (ii) flooding, (iii) insufficient rainfall/ drought and (iv) salinity. We requested farmers to rate the severity and frequency of each hazard using a Likert scale ranging from very low (1)- to very high (5). This rating helped us evaluate how these risks could potentially affect their farms and also determine their effectiveness in dealing with them. After obtaining the scores, they were entered into a risk matrix created by (Pan *et al.,* 2020) and divided into two groups as shown in (Table 2). Scores ranging from 2 to 5 are labeled as low-risk whereas those falling between 6 and 10 are classified as high-risk. The risk matrix results were transformed into binary values for additional assessment. A value of 1 signifies a high-risk score, while zero indicates otherwise.

Farmers' risk attitude

We utilized the Equally Likely Certainty Equivalent (ELCE) method to evaluate farmers' risk attitudes. This involved presenting them with different risky scenarios and determining their Certainty Equivalents (CEs), which were then matched with utility values. As an example, we asked how much money a farmer would need to be indifferent between two outcomes: receiving PKR 100,000 annually from one acre of land with a probability of 0.5 versus suffering total income loss also at a probability of 0.5. If they answered PKR 60,000 as their guaranteed outcome value, this was recorded before asking them for selections within decreasing ranges until reaching another indifference point such as PKR30k- where they became indifferent again. This process continued iteratively allowing us to capture multiple CE points together with associating probabilities for each farmer- these results inform our cubic utility function outlined in Table 1 below.

U(60,000)=0.5u(0)+0.5u(100.000)=0.5(0)+0.5(1)=0.5 ……(1)

The utility values for CE were used in the cubic utility function that splits the farmers into three groups: risk-neutral, averse and seeker. The utility function is:

$$U(w) = \alpha_1 + \alpha_2 w + \alpha_3 w^2 + \alpha_4 w^3 \ldots\ldots\ldots\ldots \quad (1)$$

Therefore, µ(w) represents the wealth utility, and the annual household income is utilized as a proxy for wealth in the cubic utility function. Subsequently, the model's first and second derivatives are calculated as follows:

$$U' = \alpha_2 + 2\alpha_3 w + 3\alpha_4 w^2 \ldots\ldots\ldots\ldots \quad (2)$$

$$U'' = 2\alpha_3 w + 6\alpha_4 w \ldots\ldots\ldots\ldots \quad (3)$$

Where U^' (w) > 0, and the first derivative is taken concerning income. According to Arrow (Arrow, 1970) and Pratt (Pratt, 1964), the coefficient of risk aversion reflects an individual's attitude towards risk. Non-parametrically, it can be explained as follows: r_a (w) < 0 indicates risk aversion, r_a (w) = 0 indicates risk neutrality and r_a (w) > 0 indicates risk preference (Mehmood *et al.,* 2021). The coefficient of risk aversion is negative if the farmer prefers risk, zero if the farmer is indifferent to risk, and positive if the farmer is risk-averse (Peng *et al.,* 2021). Following Rizwan *et al.* (2020), the risk aversion variable is included as a binary variable in the model, indicating whether the farmer is risk-averse (1) or not (0).

$$r_a(W) = {U'(W)}/{U''(W)} \ldots\ldots\ldots\ldots \quad (4)$$

Table 1. Reducing the calculation of utility values and certainty equivalents

ELCE	**Calculations of utility**
	Scale *U*(0) = 0 and U(100,000) = 1
1 (60,000; 1.0) ~ (0, 100,000; 0.5, 0.5)	*U*(60,000) = 0.5u(0) + 0.5u(100,000) = 0.5
2 (30,000; 1.0) ~ (0, 60,000; 0.5, 0.5)	*U*(30,000) = 0.5u(0) + 0.5u(60,000) = 0.25
3 (15000; 1.0) ~ (0, 30,000; 0.5, 0.5)	*U*(15,000) = 0.5u(0) + 0.5u(30,000) = 0.125
4 (8,000; 1.0) ~ (0, 15000; 0.5, 0.5)	*U*(8,000) = 0.5u(0) + 0.5u(15,000) = 0.0625
5 (70,000; 1.0) ~ (100,000, 70,000; 0.5, 0.5)	*U*(70,000) = 0.5u(100,000) + (0.5u(70,000) = 0.75
6 (80,000; 1.0) ~ (100,000, 80,000; 0.5, 0.5)	*U*(80,000) = 0.5u(100,000) + (0.5u(80,000) = 0.875
7 (90,000; 1.0) ~ (100,000, 90,000; 0.5, 0.5)	*U*(90,000) = 0.5u(100,000) + (0.5u(90,000) = 0.937

Access to drainage

When irrigation in rainfed agriculture, salinity levels can worsen in agricultural fields (Roy and Singh, 2024). Addressing this global issue requires effective land drainage due to multiple contributing factors such as insufficient knowledge and poor management decisions (Thatcher *et al.,* 2024). Other causes include inadequate drainage systems or unregulated practices like heavy rainfall and flooding alongside the unchecked proliferation of harmful irrigation systems (Nasreen and Ashraf, 2020). Agricultural regions with proper access to drains tend towards higher productivity while facing fewer problems related to salinity incidents or risks posed by floods or other extreme events. Drainage additionally helps regulate stormwater flow making it a valuable asset for regional farming locations that vary considerably- denoted numerically through whether they possess draining infrastructure indicated via value one versus those without represented by zero (Addas, 2024).

Determinants of risk perceptions and risk attitude

A probit model was used to determine the primary factors that influence farmers' risk attitudes and their choice-making concerning drought/ insufficient precipitation, heavy rainfall, flooding, and salinity.

Model specification

To evaluate the impact of farmers' demographic and farm-level characteristics on their perspectives towards risk and attitudes, a probit model was utilized. Given that the study's dependent variables have binary outcomes, ordinary least squares (OLS) regression is unsuitable for this scenario; therefore, opting for a suitable solution such as employing a probit model was essential. Additionally, since the dependent variable is structured in latent formality- specifically about unobservable constructs - representing it using a probit approach proves beneficial.

$$Y^* = \dot{X}\beta + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Y* is a dependent variable that indicates risk perceptions and attitude. X, on the other hand, represents an independent vector of variables influencing output variables. βi consists of unidentified parameters requiring evaluation while εi denotes the error term. As we are unable to directly observe the latent variable, certain limitations exist in our ability to interpret its impact fully, what we can observe is:

$$Y_{ij} = \alpha + \sum X_i \beta + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Meanwhile, Yij represents the binary dependent variable (where j=5 in this case), indicating the risk attitude and perceptions concerning four types of risks faced by the ith farmer.

$$Yi = \begin{cases} 1 & if\ Y^* > 0 \\ 0 & otherwise \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Variables independent and dependent

This study analyzed the dependence of farmers' attitudes and risk perceptions on four distinct types of risks, namely floods, excessive rainfall, insufficiency, or drought in rainfalls as well as salinity. The assessment utilized various independent variables to evaluate attributes such as age range, level of education attainment among farmers, family size working alongside farm area size, farming experience accumulated over time access to credit facilities, off-farm income generation opportunities available via other sources aside from agriculture-related endeavours with proper market information accessibility along favourable farm characteristics trends for their respective farms.

Significance of model Hypothesis testing

To assess the significance of the model, a global null hypothesis method was employed. In this study, a null hypothesis was formulated assuming that all coefficients in the probit model are equal to 0, as opposed to at least one coefficient being non-zero.

$H_0: \beta_i = 0$

$H_1:$ at least one $\beta_i \neq 0$

Similar to the F-test utilized in Ordinary Least Squares (OLS) regression, this method examines four models linked to risk attitudes and perceptions, with corresponding $\chi 2$ values between 50-200 (Table 3). Each of these values is positive. Additionally, all associated p-values are below 0.001 signifying that each model shows significant correspondence results. Furthermore, pseudo-R^2s ranging from 0.09-0.30 indicate an adequate goodness-of-fit for every model tested which demonstrates how effectively our approach can explain farmers' behaviour concerning risks and their perceptions regarding them.

RESULTS AND DISCUSSION

This part of the study is additionally segregated into various subcategories to interpret and define the study results.

Summary statistics

Table 2 presents the summary statistics for both discrete choice and continuous variables included in this study. Results indicate that farmers had an average age of approximately 43 years, with a mean formal education level of 8.5 years and about 28 years of farming experience on average. Farms were situated around 11 kilometres from urban areas, with an average family size of nine individuals per household. Additionally, farms averaged roughly 43 acres in size while housing up to 6.4 livestock heads on property. The findings suggest that most farmers (79%) exhibited risk-averse behaviour by avoiding any risky opportunities. Girma *et al.* (2023) also found that the majority of the farmers exhibit risk-averse behaviour.

Table 2. Illustration of used variables

Variables	Mean	SD	Max	Min
***Socio*-Economic Attributes**				
Age (years)	42.64	12.83	80	17
Education (years)	8.50	3.31	16	0
Family size	9.00	1.43	15	5
Farm size (Acre)	43.09	85.21	900	2
Farming Experience (years)	28.35	13.05	65	2
Remoteness (distance from in kilometre urban area)	11.44	4.77	50	3
Off-farm income	0.39	0.49	1	0
Accessed credit	0.72	0.45	1	0
Number of livestock	6.41	4.31	22	0
Access to market info	0.85	0.36	1	0
Access to drainage	0.50	0.50	1	0
Risk attitude				
Risk aversion behavior	0.79	0.41	1	0
Risk perceptions				
Risk of Drought/ Inadequate precipitation	0.65	0.48	1	0
Risk of extreme precipitation	0.74	0.44	1	0
Risk of flood	0.67	0.47	1	0
Risk of salinity	0.73	0.44	1	0

Determinants of risk attitude

Table 3 presents the findings from the probit analysis, shedding light on the various factors that shape farmers' attitudes towards risk. Remarkably, several highly relevant indicators that have a major impact on farmers' behaviour have been identified, including education level, proximity to metropolitan areas, availability of finance, and other sources of income outside farming. More interestingly, ageing seems to be positively correlated with a higher propensity to take risks in older agricultural communities as compared to younger ones; prior studies in this area have also confirmed this pattern (Spicka, 2020). It is also noted that those with higher educational degrees tend to be less risk-taking. This tendency might arise from a broader perspective and increased awareness brought about by advanced learning experiences, which influence farm-level decision-making on possible risks or ways to mitigate losses (Sulewski *et al.,* 2020).

Moreover, farmers who live in cities have a higher propensity to be risk-averse than farmers who live in rural areas. This could be attributed to disparities in the information's accessibility. Farmers in rural areas have less exposure to and interaction with modern farming techniques and skilled farmers; as a result, their knowledge is insufficient, which makes them more cautious when taking risks (Rizwan *et al.,* 2020). Furthermore, farmers who make their living off of resources other than farming generally exhibit less risk aversion. On the other hand, people whose only source of income is from non-agricultural sources are more likely to be cautious when it comes to possible hazards (Ahmad *et al.,* 2020). Additional sources of income, such as owning a side business or working for another employer, might improve a farmer's ability to weather unpredictable circumstances and stabilize their household's finances. Therefore, these elements might be crucial in determining how farmers view financial opportunities generally (Pan *et al.,* 2020). Farmers' behaviour when it comes to accepting risks is also greatly influenced by the availability of market information. For this reason, farmers must have sufficient knowledge about crop diseases and communicate regularly with agricultural organizations. By facilitating the effective implementation strategies required to manage any potential threat, this conduit for data sharing and exchange between parties involved empowers farming practitioners and shapes future perceptions and outlooks regarding investment-related insecurity.

Factors of risk perceptions

Table 3 presents the views of dangers that farmers face on their farms, along with the factors that impact these beliefs. Previous research has also highlighted a relationship between risk behaviour and the demographic traits of farmers.

Risk of drought/ insufficient rainfall

Farming households face substantial risks due to the unpredictable nature of agricultural revenues in underdeveloped countries (Li *et al.,* 2020). The primary cause of this is weather variability, which can result in income swings and unstable consumption. This can have disastrous consequences, particularly for disadvantaged families that lack access to credit markets or insurance (Talanow *et al.,* 2021). As a result, agricultural households create different risk-management plans. The study's findings indicate that farmers viewed drought or insufficient rainfall as a very small concern. Nonetheless, a probit model analysis revealed that several variables, such as age, educational attainment, degree of geographic isolation, availability of credit, number of livestock, and accessibility to market information and drainage facilities, significantly influenced farmers' perceptions of this environmental hazard. While there are negative associations with both formal and informal financial products, it is possible that these mechanisms can be effectively used for crisis management during unfavourable weather events. The observed positive association between education attainment and knowledge about drought/ insufficient rainfall implies that higher-educated farmers have a better understanding of how to mitigate such risks. Furthermore, farmers' perceptions of drought were significantly influenced by their livestock holdings, which may help to mitigate financial and consumption shocks. Furthermore, the importance of access to market information is highlighted by its negative coefficient with the availability of crops that are tolerant to drought conditions nearby. Accessing surface drainage systems had a notable beneficial effect on agriculture since it was associated with decreased agricultural losses due to flooding or excess waterlogging; this relationship remained significant even when controlling for other relevant variables. The results are in line with the results of (Mahmood *et al.,* 2021).

Risk of extreme precipitation

Farmers identified extreme precipitation as the primary risk, similar to the results of (Elahi *et al.,* 2022). The probit model findings showed that age, education, family size, farm size, agricultural experience, off-farm income and access to market information were significant factors influencing farmers' perception of extreme precipitation as a risk factor, also associated with (Asefa Bogale, 2024). From this study's results, it can be inferred that older individuals had a negative but significant coefficient indicating they perceived extreme rainfall more frequently than younger people did. Also, the negative coefficient for education level signifies that highly educated farmers perceive minimal crop damage from heavy rain compared to uneducated ones who are prone to risks associated with strong rains affecting their yields negatively over time. A similar pattern was witnessed by (Schmitt *et al.,* 2022). Moreover, farmers who had larger families and income from non-farm sources considered heavy rainfall to be a major risk to their crops. The coefficient for agricultural experience was also positive and significant which indicates that recent occurrences of excessive rain in the last decade may have directly affected their opinions. Additionally, with access to current market information being positively related and significant, it suggests that farmers possess up-to-date data on markets enhancing management skills while enabling them to connect better through advanced communication resources such as weather forecasts allowing more effective task management over time.

Risk of flood

The outcomes of using the probit model exhibit that different factors considerably influence farmers' attitudes towards flood risk. These consist of their level of education, remoteness in terms of farm location, access to credit facilities, count of livestock held by them, availability and accessibility to market information as well as drainage resources. An affirmative coefficient for education implies that those who are educated perceive flooding as a significant danger relevant to their agricultural farms primarily due to previous encounters with floods over the last two decades coupled with an insight into its consequences.

In addition, the farm's remoteness coefficient indicates a significant and positive value. This suggests that farmers residing in rural areas possess greater awareness of flood risks as opposed to their urban counterparts. Residents living in cities may benefit from flood protection measures implemented by local authorities leading to less concern about potential flooding hazards among them. Additionally, the availability of credit facilities increases farmers' knowledge about flood hazards compared to those who do not have access. This outcome also follows a study conducted by Shahzad and Abdulai (2020).

Table 3. Parameter estimates of the probit model

Independent Variables	Risk Attitude	Risk perceptions			
		Drought	Excessive Rainfall	Flood	Salinity
Age (years)	0.0031 (0.0060)	-0.0071* (0.0050)	-0.0092** (0.0050)	-0.007 4(0.0050)	-0.0097** (0.0050)
Education (years)	0.1531*** (0.0250)	0.0512***(0.0190)	-0.0525*** (0.0220)	0.0471*** (0.0190)	-0.0558***(0.0220)
Family size	-0.0271 (0.0530)	-0.0582 (0.0450)	-0.0916** (0.0490)	-0.0495 (0.0450)	-0.1028***(0.0480)
Farm size (Acre)	0.0000 (0.0010)	0.0010 (0.0010)	-0.0010** (0.0010)	0.0010(0.0010)	-0.0010**(0.0010)
Farming Experience (years)	-0.0060 (0.0090)	0.0050 (0.0070)	0.0480*** (0.0080)	0.0050(0.0070)	0.0500***(0.0080)
Remoteness	-0.0500*** (0.0160)	0.0220* (0.0140)	0.0060(0.0150)	0.0240** (0.0140)	0.0040(0.0150)
Off-farm income	-1.1381*** (0.1680)	-0.0721 (0.1370)	0.3892*** (0.1520)	-0.0905 (0.1370)	0.4447***(0.1520)
Accessed credit	0.3585*** (0.1830)	-0.3824*** (0.1540)	0.1188(0.1590)	-0.3259*** (0.1540)	0.0823(0.1590)
Number of livestock	0.0212 (0.0190)	-0.0512*** (0.0160)	-0.0152(0.0170)	-0.0491*** (0.0160)	-0.0171(0.0170)
Access to market info	-0.3521 (0.2650)	-0.6371*** (0.1990)	0.8210*** (0.1780)	-0.5940*** (0.1990)	0.7900***(0.1780)
Access to drainage	-0.1390 (0.1550)	-0.4100*** (0.1270)	0.0720(0.1370)	-0.3850*** (0.1271)	0.0690(0.1361)
N	480	480	480	480	480
Log-likelihood	-173.9590	-275.4880	-231.3320	-275.5981	-233.2180
F-stat significance	0.000	0.000	0.000	0.000	0.000
Pseudo R^2	0.2920	0.1120	0.1631	0.0981	0.1651

*, **, *** indicate the significance level at 15%, 10% and 5% respectively and figures in parenthesis indicate standard errors

Risk of salinity

The implementation of drainage systems has been proven to effectively tackle salinity issues. As per the research, farmers rank salinity as their second-highest risk factor. The results generated by the probit model suggest that several factors including age, educational background, family size and farming experience are influential in shaping farm owners' perceptions about key risks like salinity. Access to market information and off-farm income were also deemed significant influencing factors for this particular matter.

According to the study's findings, older individuals are likely to view salinity as a higher risk due to the negative and significant coefficient for age. On the other hand, more educated farmers may not consider salinity a notable threat as suggested by their negative coefficient in contrast with less educated farmers. This difference could stem from insufficient knowledge about salinity among growers residing farther away from coastal areas compared to those living nearby who have better familiarity with its severity.

In addition, the sizable and detrimental farm size coefficient implies that small-scale farmers are more likely to view salinity as a risk compared to their larger counterparts. Also worth noting is the pessimistic family size coefficient which suggests that those with more members in their household may have a reduced perception of salinity risks.

Conversely, farmers with greater experience hold a positive and noteworthy coefficient for farming practice. This suggests that they consider salinity as a crucial hazard at the farm level compared to those who possess less experience. Similarly, having supplementary sources of income beyond agriculture correlates positively and significantly with perceiving salinity as an important risk thus indicating how farmers perceive its impact on their off-farm livelihoods too. Furthermore, access to market information is indicated by a weighty and optimistic coefficient. This implies that farmers can acquire current data from the marketplace which may improve their abilities in management and provide them with more advanced communication channels. Thus, they can receive timely updates about upcoming weather conditions and manage their activities accordingly.

CONCLUSION AND RECOMMENDATIONS

The objective of this research was to explore how factors related to socio-economic and environment impact farmers' attitudes towards risk perception at the farm level. The study utilized cross-sectional data collected from 480 farmers situated in Sindh province, Pakistan. Findings indicated that a majority of participants possessed knowledge about risks associated with farming based on their personal experience. Generally, respondents showed aversion toward taking chances for a monetary benefit; instead practising behaviours typical of individuals who avoid uncertainties (risk-averse).

The primary risks recognized by farmers include extreme precipitation, salinity, flooding and drought/insufficient precipitation. Through the use of a probit model technique, it was determined that farmer attitudes and perceptions are greatly influenced by factors such as age, education level, remoteness of their farm location from urban centres or markets they have access to off-farm income opportunities in addition to accessibility of drainage facilities. These findings underscore the importance of incorporating all these elements when creating policies intended for individualized approaches towards implementation efforts designed specifically tailored solutions depending on circumstances faced by different farmers within each locale.

By investing in farmer education, and granting them greater access to agricultural advisory services, there is potential for farmers' capability of managing risks at the farm level to be enhanced. In particular, disadvantaged farmers must address saline soil mitigation by implementing effective drainage infrastructure. The government should prioritize investment into proper drainage structures and revisit rehabilitation systems as a means of removing excess rainwater from farms while also providing an outlet for any additional salts which may arise from existing or future projects resulting in negative impacts on crop yield. Providing financial assistance through formal institutions and subsidizing the inputs used in agricultural practices is also one the major solutions to the existing problem. The use of information technology is also critical and educating the farmers regarding the use of advanced techniques is needed to increase farm production. The findings of this research provide essential insights for scientists and policymakers seeking to grasp the intricate interplay between socio-economic and demographic factors in moulding farmers' decision-making, attitudes towards risk-taking, and strategies.

The limitation of this study includes: (a) a single-point investigation of risk perception and attitude as it relates to the cross-sectional design of research, it is not possible to track how risk perceptions may change over specific period of time. (b) this study is specified to the Sindh province and according to the diversified nature across the provinces in Pakistan it may not be generalized to other provinces. (c) there could be other factors such as socio-economic indicators that are not investigated in this research and may have any relationship with risk attitude and perceptions of the farmers. (d) the study focused on risk aversion however, risk tolerance is also critical to examine to study the matter deeply.

AUTHOR’S CONTRIBUTION

A. K. Khajjak: Initiated research idea, paper write up.
A. Nazir: Data analysis.
I. Rodini: Results interpretation.
H. Kashani: Data handling.
A. Ali: Write up and grammer checking.

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