Research Article

Risk and Coping Strategies of Vegetable Smallholder Farmers in Khyber Pakhtunkhwa of Pakistan

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Abstract | This study focused on farmers' perceptions regarding climate and non-climate risk, their coping strategies and association to socioeconomic attributes. The study was carried out in two districts Nowshera and Charsadda of Khyber Pakhtunkhwa, Pakistan using principal component analysis approach and regression analysis. The data were collected randomly from 130 sampled vegetable growers comprised of 65 respondents each from Nowshera and Charsadda districts through pre-tested interview schedule during financial year 2020-21. Principal Component Analysis was used for determining the risk and coping strategies of the farmers. Moreover, Ordinary Least Square regression model was applied for determining the relationship among perceived risk source elements obtained from factor analysis and farmers' socioeconomic characteristics. Land use for other than agriculture, lack of new knowledge according to climate, supplying inappropriate seed, fear to adopt improved practices that are not applied in village and land price changes had loading in production risk factors. Government programs and inadequate extension services had loadings in institutional risk factors while financial risk factors were no financial support by input dealers and no capacity to provide inputs. Fluctuation in input prices and market competition in- or sells-off had loadings in market risk factor while factors of human risk had loadings on facing difficulties in finding labor and migration of family members. Production strategies factor were weather forecast for adjusting production practices, adopt new technology and production diversity. Leasing inputs, market monitoring and switching to other markets had loadings in market strategy while maintaining good relationship with friends/relatives and maintaining good relationship with market actors in institutional strategy. Human strategy was related to engaging on off-farm employment for income generation and reducing hiring of labor for farm activities while financial strategy was related to sale of perennial crops and sale of livestock. The study suggested for sustainable smallholder agricultural development programs along with farmers' facilitation by giving interest free loan and digitalization to update timely information regarding weather and markets for improving rural livelihood.

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Introduction

Agricultural farms are exposed to climate and non-climate risks. These risks posture severe threat to smallholder farmers, reliant for their livelihood on agriculture (Silici *et al*., 2021). Risks like personal, market or price, production, financial and institutional are identified in developed world (Table 1) are also true for developing countries. Their impacts have severe effects on security of food, livelihood of rural people, wellbeing of farm households' and primarily on motives to alter these changes in the long-term (Iqbal *et al*., 2020). Farm's potential exposure to risk, indicated that risk like increased competition for rural land resources, increasing input costs, declining output prices, more sophisticated technology, increased urban pressures, changing conditions and increased regulations of environment, and inconsistent government support, are prompted by farmers in order to adjust their operations. Tools and resources (capital, land and labour capital, along with income from farm, credit accessibility, equipment, technology and capabilities of farmer in terms of their skills, age and risk perception) available at farm and external factors (government support programs availability, biotechnology development, crops market demand suited to climate change and availability and accuracy of weather forecasts) shaped the farm's adaptive capacity (Bradshaw and Smit, 1997; Marsden, 1998; Winter, 2000; Smithers and Johnson, 2004; Belliveau *et al*., 2006). Farmers' vulnerability to climate change was affected by farmer's poverty level, technology access, literacy and institutions (Fatoki *et al*., 2020).

Farmers' behavior and adopted coping strategies to mitigate risk is an important first step to understand within the environment they operate (Dadzie and Acquah, 2012). The scientific knowledge of adopted coping strategies helped policy makers to develop interventions at farm level (Padhan and Madheswaran, 2022). The attitude to risk of farmers are major determinants of the diffusion rate of new technologies among the farmers and of the out-come of rural development programmes (Shahabuddn *et al*., 1986; MANR, 1997; Adejoro, 2000; Dadzie and Acquah, 2012). Several choices are available for managing risks; however, subject to farmer's own perceptions and attitude towards risks, certain adopted their own coping strategies (Ullah *et al*., 2016; Nazir *et al*., 2018).

Agriculture has a central role in food security, economic growth, generation of employment and poverty alleviation mainly in rural Pakistan. The sector contribution to GDP is 19.2 % and provides employment tto labour force of about 38.5 %. More than three-fifth (65-70 %) of country's population hanged to agriculture for their livelihood (GoP, 2021). The growth of agricultural sector has been constrained by large-scale population, shifting of labour from rural to urban areas, climate change, shrinking arable land and water shortages. Agricultural productivity requires adoption of new approaches. Its strong forward and backward linkages with the secondary and tertiary sectors can spur economic growth of the country (GoP, 2021).

Vegetable as a subsector is one of the most important sectors of Pakistan's agriculture. This subsector posted growth of 4.2 % during 2020-21 (GoP, 2021). It is known as an essence for food and nutrition security and truly most cheap source of vitamins and minerals required for good health. The production of vegetables has promising economic opportunity for reducing

Table 1: *Types of risk in agriculture.*

Production or yield risk	chance of losses in output or yield as a result of events that are beyond the farmer's control, often related to weather, and/or related to technology.
Price or market risk	risk associated with changes in prices of outputs or inputs, which are seldom known when producers make choices about products and inputs; may include market access.
Institutional risk	risk related to changes in government policies and regulations; may impose unanticipated constraints on production practices, or new costs or taxes.
Financial risk	risk resulting from the way in which the farm's capital is obtained and financed; related to borrowing, uncertainty about future interest rates, the ability to meet debt payments, and lender's willingness to continue lending.
Human or personal risk	risk associated with the people who operate the farm, as when death, divorce, illness or injury, may result in disruption of farm production and profitability.

From: (Harwood et al., 1999; Kay et al., 2004). Source: Adopted from Belliveau *et al.* (2006).

poverty in rural areas (Schreinemachers *et al.*, 2018). Vegetables have an intensive agriculture production system that can be grown in any available space. These have a substantial mass within agrifood industry. Vegetables have a wide variety of crops, hence; have a significant different agricultural method that applies to vegetable production (Fundación Global Nature, 2018). Vegetables accounts about one quarter (23 %) nutritious weight and 12% expenditure weight in typical food basket of the country (Dizon and Herforth, 2018).

Khyber Pakhtunkhwa is dominated by smallholder farmers. Vegetables are produced in both the Rabi and kharif seasons (Miller *et al.*, 2021). The consumption of vegetables in the society of the province is both fresh and cooked and the daily meal is not complete without having vegetables. Its production is likely to be exposed to local productivity trends, seasonal factors, transportation issues and perishability. This province is vulnerable to a range of slow and rapid onset hazards, such as landslides, droughts, floods, heat stress, avalanches, pest and disease outbreaks, earthquakes and glacial lake outbursts (Miller *et al.*, 2021). The vegetable growers faced numerous risks like pest attack, crop failure, unfavorable weather conditions and lack of market access. In order to tackle these risks, farmers practiced different risk management strategies like pesticides, crop rotation and forward contracts, enterprise diversification, off-farm employment or crop insurance (Mokhaukhau *et al.*, 2020).

In Pakistan, Ullah *et al.* (2015) studied the farmers' risks perceptions, their risk attitude and the effect of farm and farm household characteristics in Khyber Pakhtunkhwa, Pakistan. Nazir *et al.* (2018) examined the farmers behavior of risk and coping strategies related to risks, the relationship to socioeconomic attributes, risk perceived sources and coping strategies in Sindh province. Similarly, Rizwan *et al.* (2019) and Iqbal *et al.* (2020) investigated the farmers' perceptions, their levels of awareness and dynamics of socioeconomic that influencing their perceptions in Punjab province. However, no study has been conducted to study the smallholder vegetable growers in Khyber Pakhtunkhwa. This study assesses the perception of smallholder vegetable famers in Khyber Pakhtunkhwa province of Pakistan regarding the risk that vegetable growers faced, adjusted farming strategies to cope up possible related risk and factors affecting the levels of perception of farmers regarding risk sources and coping strategies.

Materials and Methods

Selection of the sites

Khyber Pakhtunkhwa with merged district comprised of 17 % (35.53 million) of Pakistan's population, according to Population Census 2017. Majority 83 % of the population are living in rural areas (www.pbs.gov.pk) mostly engaged in agriculture sector for their livelihood. The province comprised of 10.53 % (5.57 million acres) of the total farm area of Pakistan (GoKP, 2017). The province is located on the planet's mid-latitude region. Khyber Pakhtunkhwa has most prone to climate change impacts. Central valley plain is one of the zones of Khyber Pakhtunkhwa that serves as the main food basket of the province (Nizami *et al.*, 2020). The province is famous mainly for its horticultural produce i.e., fruits and vegetables that are supplied to the rest of the country including some exports of vegetables to gulf countries. It has diversified conditions of agro-climate that make possible the production of a variety of fruits and vegetables. This zone is located in the northern half and with few extensions in the southern half of the province, based on large agricultural valley extending east to west. The climate is semi-arid sub-tropical continental and will be more severely affected in the upcoming years due to rising temperature and decrease of rainfall magnitude. Variations in climate affect soil moisture, growth duration, nutrient levels, and water availability for crops. These variations in climate increase the chance of reduced yields or even crop failure (GoKP, 2016; Nizami *et al.*, 2020). Keeping in view the above fact about climate change effects on agriculture especially in valley plain of Khyber Pakhtunkhwa, this study was conducted in two districts of valleys plains of Khyber Pakhtunkhwa namely Nowshera and Charsadda. These two districts were purposively selected from valley plain zone due to agriculturally rich districts. These two districts were purposively selected from valleys plains zone due to agriculturally rich districts.

Samples, data collection tools and procedures

The study in hand was carried out in two districts Nowshera and Charsadda of valley plain during financial year 2020-21. Primary data was directly collected from sampled farmers in the research area through well-structured interview schedule. The study results might be more accurate, if the whole

population of the study area were interviewed. However, keeping in view the financial constraints and lack of manpower, the sample size was restricted to one hundred and thirty (130) vegetable growers. Of the total 130 sampled vegetable growers, 65 each were selected from both district of Nowshera and Charsadda. According to Tabachnick and Fidell (2014, 2019), factor analysis is grounded on coefficients of correlation that tend to be less reliable if computed for small samples. Samples size in the range of hundred to two hundred (100-200) is suitable with well-determined factors and communalities in the range of 0.5 or greater. At least three hundred (300) cases are required with low communalities, a small number of factors, and just three or four indicators for each factor. Sample sizes well over five hundred (500) are needed under the worst conditions of low communalities and a larger number of weakly determined factors. Impact of sample size is reduced with consistently high communalities (all greater than 0.6) and well-determined factors. In such cases, samples well below hundred (100) are suitable, though such small samples run the computational risk of failure of the solution to converge (MacCallum *et al*., 1999). The sampled vegetable growers were randomly interviewed at their fields and homes. Secondary data was collected from research articles/studies and internet sources.

Definition of variables and estimation procedure

Different statements were asked from the farmers of risk and coping strategies and were probed to rate themselves on 5-point predefined likert scale (1–strongly disagree; over 2–disagree, 3–neither agree neither disagree, 4–agree to 5–strongly agree). From review of literature (Wallace, 2002; McGuire and Sperling, 2008; Dadzie and Acquah, 2012; Shuaibu *et al*., 2014; Dessalegn, 2018; Nazir *et al*., 2018; Rizwan *et al*., 2019; Fontaine and Schlumbohm, 2000; Iqbal *et al*., 2020) and preliminary discussion with farmers and experts, 31 specific statements (variables) of risk and 32 specific statements (variables) of coping strategies were identified. The collected data was analyzed using SPSS and MS Excel for calculation of averages, percentages, cross-tabulation and factor analysis.

Principal Component Analysis (PCA) was used in this study that extracted the maximum variance from the set of data with each component. It is ordered with the first component extracting the most variance and the last component the least variance. PCA is choice solution of researcher with prime interest in the reduction of a large variables numbers down to a smaller number of components (Tabachnick and Fidell, 2019).

Sources of risk and coping strategies were separated into different factors according to a rotated component matrix table or orthogonal varimax rotation. Varimax rotation is a maximizing variance of factor loadings by making high loadings higher and low ones lower for each factor (Tabachnick and Fidell, 2019). After identifying the different statements that explain a specific latent variable, Cronbach's alpha, Kaiser-Meyer-Olkin or KMO statistics and Bartlett test of Sphericity was calculated. Cronbach's alpha measured the internal consistency of a test or scale. It is an index (number between 0 and 1) and test of reliability (Tavakol and Dennick, 2011). KMO statistics determines the appropriateness of running a factor analysis to compute a measure of sampling adequacy. It is based on index that compares correlation and partial correlation coefficients. The value below 0.50 is unacceptable, in the 0.50's is miserable, in the 0.60's is mediocre, in the 0.70's is middling, in the 0.80's meritorious and in the 0.90's is marvelous (Hutcheson and Sofroniou, 1999). Bartlett test of Sphericity is a measure of a multivariate normality of set of distribution. It also checks the null hypothesis that the original correlation matrix is an identity matrix. The significant value less than 0.05 indicates that these data do not produce an identity matrix and are thus approximately multivariate normal and acceptable for further analysis (Pallant, 2013; Field, 2000). Lastly, total sum of each factor scores for each farmer of likert scale were used in regression. Ordinary Least Square (OLS) regression model was applied among farmers' characteristics, and risk sources as well as risk coping strategies.

Results and Discussion

Demographic characteristics of sampled vegetable growers

According to Pakistan Demographic Survey, a family or household can be defined as all those persons who live together and share their meal. On average, a household comprised of 13 members that were living on an average area of 16.14 marlas (1 marla= 0.00625 acre). The vegetable growers had on average 6.32 years of schooling with average farming experience of 27.33 years. About three-forth (73 %) of the sampled families had no health issues while remaining 27 %

of the sampled families had health issues (i.e., family members with chronic diseases). More than three-fifth (64 %) of the sampled vegetable growers had the ability to hire labour for their farm activities while 36 % have not afforded to hire labour for farm activities. Literally rural masses laboring poor had several occupations, shifting from one to another activity in a seasonal pattern, or according to upswing and downturn periods or over the course of the life cycle. The household members of a single family were involved in a variety of fields to contribute in family economy (Fontaine and Schlumbohm, 2000). The vegetable growers in the study area had combine income sources i.e., agriculture, wages, jobs, remittances and others. Agriculture was the main income source for majority (83 %) of the sampled vegetable growers where income from vegetable contributed 68 % in the total household income. Vegetable growers in the study area had own cultivated land, rented-in, shared-in land and or their combination. The results revealed that majority (76 %) of the vegetable growers were tenants (growers having more rented-in and shared-in land were considered tenants in this study) while 24 % were owners. The average operational cultivated land of the vegetable growers in the study area was 3.37 acres (Table 2). The vegetable grown by sampled vegetable growers in the study area were round gourd (tinda), tomato, smooth gourd (toori), potato, brinjal, chilli, colocasia/arvi (kachaloo), bottle gourd (kado), onion, green peas, bitter gourd (kareela), garlic, bell pepper (shimla mirch), turnip, cucumber, cauliflower and leaf vegetable (saag).

Farmer's perception of various risk sources

Cronbach's alpha test showed that the data reliability was 0.597. Factor analysis gives five factors for these 14 risk sources using principal component extraction. Table 3 showed five factors and their respective loading items (values of > 0.50). The eigenvalues of five factors had greater than 1 with a total variance of 73.17 %. The Bartlett's test value of Sphericity was also highly significant. Factors 1 to 5 were: I. Production Risk Sources (PRS), II. Institutional Risk Sources (IRS), III. Financial Risk Sources (FRS), IV. Market Risk Sources (MRS) and V. Human Risk Sources (HRS). The PRS had high loadings on land use for other than agriculture followed by lack of new knowledge of vegetable production according to the climate, supplying inappropriate seed, fear to adopt improved practices of farming that are not applied in the village, and changes in land prices. IRS consisted with access to government programs and inadequate extension services. FRS had an association of no financial support by input dealers and no capacity to provide inputs. MRS belonged to fluctuation in input prices and market competition in or sells off. The last factor, HRS had loadings on face difficulties in finding labor and migration of family members.

Table 2: *Socioeconomic characteristics of vegetable growers.*

Characteristics	Unit	Average/percent
Family size	Number	12.67 (6.95)
Household area	Marla	16.14 (15.08)
Education	Years	6.32 (5.33)
Farming experience	Years	27.33 (11.54)
Family health status	No	73
	Yes	27
Farm labor hiring ability	No	36
	Yes	64
Main income source	Agriculture	83
	Non-agriculture	17
Percent contribution of income by source	Vegetables	67.66
	Crops and livestock	7.67
	Wages and jobs	15.20
	Remittances and others	9.47
Tenancy status	Owner	24.39
	Tenant	75.61
Land operational	Acres	3.37 (2.95)

The values in parenthesis are standard Deviations. Source: survey data 2020-2021.

The study results rightly pointed that the build area is engulfing the agriculture land that creates threat to food security and also to increase the prices of land. Availability of quality seed according to climate conditions is a long recognized demand of the farmers. Adopting improved practices by farmers without trial-based practices will not inspire them to adopt, because they cannot take chance to lose crop. The farmers are required to give them access to government programs and sufficient extension services that fulfills their demands. Multiple measures are required as the area farmers are poor, therefore, credit facility according to their socioeconomic conditions, formal market system and stopping migration of the people from agriculture by motivating them through taking attractive measures might lead to the sustainability of farmers' livelihood.

Table 3: *Descriptive statistics and factor loading for risk sources.*

Descriptive Statistics			Rotated component matrix				
	Mean	Std. Deviation	PRS	IRS	FRS	MRS	HRS
Land use for other than agriculture	3.09	1.660	.913	-.074	-.056	-.058	.138
Lack of new knowledge of climate	2.66	1.200	.896	.125	-.023	-.162	-.066
Supplying inappropriate seed	2.95	1.453	.809	-.086	-.104	.009	-.004
Fear regarding to adopt improved farming practices	3.11	1.511	.710	.280	.182	.201	-.227
Changes in land prices	3.12	1.441	.608	-.389	.084	-.182	.267
Access to government programs	4.29	1.054	-.070	.887	.083	.139	-.036
Inadequate extension services	4.11	1.165	.092	.864	-.106	.094	.060
No financial support by input dealers	2.28	1.345	-.053	-.056	.884	-.126	-.037
No capacity to provide inputs	2.71	1.371	.076	.009	.836	.275	-.104
Fluctuation in input prices	4.16	1.011	-.195	.168	-.074	.771	.193
Market competition in- or sell-off	3.88	1.446	.250	.053	-.023	.676	-.248
High market price in previous growing season	4.59	.663	-.216	.103	.293	.638	-.116
Face difficulties in finding labor	4.24	.950	.268	-.193	-.354	.112	.722
Migration of family members	3.37	1.657	-.117	.123	.035	-.161	.804
Eigenvalues			3.512	2.475	1.875	1.253	1.129
Percent of variance			25.084	17.678	13.390	8.949	8.065
Cumulative percentage			25.084	42.762	56.152	65.101	73.166

N= 123; Minimum = 1. Maximum = 5; Cronbach's Alpha 0.597; Kaiser-Meyer-Olkin 0.618; Bartlett's Test of Sphericity df 91 Sig. 0.000; Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Source: Survey data 2021.

Table 4: *Descriptive statistics and factor loading for risk management strategies.*

Descriptive statistics			Rotated component matrix				
	Mean	Std. Deviation	PCS	MCS	ICS	HCS	FCS
Weather forecast for adjusting production practices	4.11	1.158	.933	.078	-.116	-.009	-.075
Adopt new technology	3.96	1.357	.840	.166	-.252	-.011	.306
Production diversity	4.56	.860	.823	.119	.243	.225	-.104
Leasing inputs	4.37	1.058	.019	.903	.067	.076	-.137
Market monitoring	4.48	.843	.126	.841	-.016	-.042	.250
Switching to other markets	4.03	1.145	.287	.638	.248	.346	.014
Maintaining good relationship with friends/relatives	3.33	1.424	-.130	-.035	.941	.011	.015
Maintaining good relationship with market actors	3.52	1.310	.074	.225	.672	-.147	.209
Engaging on off-farm employment for income generation	4.11	1.080	.012	.103	.086	.805	.000
Reducing hiring of labor for farm activities	3.37	1.264	.110	.034	-.369	.638	.019
Sale of perennial crops	2.50	1.468	-.075	-.022	.495	-.055	.813
Sale of livestock	3.51	1.462	.245	.477	-.292	.407	.558
Eigenvalues			3.477	2.279	1.537	1.069	1.005
Percent of variance			28.974	18.994	12.805	8.905	8.374
Cumulative percentage			28.974	47.968	60.773	69.678	78.051

N= 123; Minimum = 1. Maximum = 5; Cronbach's Alpha 0.687; Kaiser-Meyer-Olkin 0.560; Bartlett's Test of Sphericity df 66 Sig. 0.000; Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Source: Survey data 2021.

Perceived/ implemented risk management strategies

Cronbach's alpha test showed that the reliability of data was 0.687. Five factors were obtained with an eigenvalue above 1 and a total variance of 78.05%. This means that these five factors explain 78.05% of the variance. Iqbal *et al*. (2020) calculated a total variance of 74.43% for risk management strategies of Punjab's farmer in Pakistan. These factors also had

significant Bartlett's test value of sphericity. These strategies were: I. Production Coping Strategies (PCS), II. Market Coping Strategies (MCS), III. Institutional Coping Strategies (ICS), IV. Human Coping Strategies (HCS) and V. Financial Coping Strategies (FCS). PCS had higher loadings on weather forecast for adjusting production practices, adopt new technology and production diversity. MCS had high loadings on leasing inputs, market monitoring and switching to other markets for higher prices. ICS was determined as maintaining good relationship with friends/relatives and maintaining good relationship with market actors. HCS was related to engaging on off-farm employment for income generation and reducing hiring of labor for farm activities. Lastly, FCS was related to sale of perennial crops and sale of Livestock (Table 4).

The study results imply that increased awareness regarding weather forecast, diversification and adoption of improved technologies sheds light on the role of government agencies. The farmers are aware of the risk for which they are taking all the available and affordable measures like inputs leasing, market monitoring, maintaining good relationship, off-farm employment sale of available perennial or livestock. Informed policy interventions with new frameworks fulfilling the needs of new era of agriculture might lead to the sustainability of farmers' livelihood.

Factors affecting perceived risk sources

Ordinary Least Square (OLS) multiple regression model was used for determining the relationship among perceived risk source elements obtained from factor analysis and farmers socioeconomic characteristics. Overall, all models were highly significant as f-value. Similarly, most of the independent variables go into the models were significant with corresponding dependent variable. The R-square value was low in the models (Table 5). Iqbal *et al.* (2020) citing Flaten *et al.* (2005); Patrick and Musser (1997), stated that the reason behind was owing to different perceptions from respondent to respondent of risk sources and risk management strategies. Regarding each model, production risk sources was significantly influenced positive by education, farming experience, farm labor hiring ability, main income source, vegetable share in household income while land operational, family health status, household area and tenancy status had negative relationship with production risk factor. The results of relationship of education and income source with perceived production risk sources are similar to the study findings of Iqbal *et al.* (2020). However, the results of relationship of family size, farming experience and operational land with perceived production risk sources were contradictory with the findings of Iqbal *et al.* (2020). Similarly, farming experience, main income source and vegetables share in total household income had positive relationship with institutional risk sources while education, family health status, farm labor hiring ability and tenancy status had negative relationship with institutional risk sources. The study findings contradict the results obtained by Iqbal *et al.* (2020). Similarly, education and main income source had positive relationship with financial risk sources. The results of relationship of education, family size, farming experience and income source with perceived financial risk sources are

Table 5: *Regression results among farm and farmer characteristics and risk source factors.*

Independent variables	Production	Institutional	Financial	Market	Human
Education (years)	***.279	**-.264	***.444	.060	***-.293
Family size (number)	.176	.125	.023	**-.294	***.684
Farming experience (years)	***.475	**.207	.063	-.014	.050
Land operational (acres)	*-.237	.204	-.058	***.320	**-.303
Family health status (0=no, 1=yes)	***-.439	***-.469	.156	***-.458	.076
Household area (marla)	***-.436	.183	-.217	*.239	***-.497
Farm labor hiring ability (0=no, 1=yes)	***.345	***-.285	.017	***-.527	.021
Main income source (0=agriculture, 1=non-agriculture)	***.251	***.295	***.354	*.170	***.328
Vegetables (% share in household income)	***.307	***.300	.158	-.102	**-.194
Tenancy status (0=owner, 1=tenant)	***-.295	*-.169	.058	***-.227	-.124
R square	.434	.265	.255	.426	.388
F	8.577	4.033	3.839	8.301	7.107

*Variables are significant at *** $p < 0.01$, ** $p < 0.05$, and* $p < 0.10$; F is significant at 0.01.*

Table 6: *Regression results among farm and farmer characteristics and coping strategies factors.*

Independent variables	Production	Market	Institutional	Human	Financial
Education (years)	***-.279	.051	***.418	***-.436	-.039
Family size (number)	.171	*.254	-.096	.066	*-.227
Farming experience (years)	**.184	.143	***-.546	**.185	.028
Land operational (acres)	.176	.066	-.057	.015	.004
Family health status (0=no, 1=yes)	***-.505	**-.274	***.347	***-.583	*-.194
Household area (marla)	-.138	***-.466	.010	**.332	-.135
Farm labor hiring ability (0=no, 1=yes)	-.045	.104	.127	***-.292	.127
Main income source (0=agriculture, 1=non-agriculture)	**-.200	***-.320	.074	-.011	***-.228
Vegetables (percent share in agriculture)	***-.405	**-.225	***.385	***-.284	.027
Tenancy status (0=owner, 1=tenant)	***-.323	.004	-.037	.040	***-.468
R square	.370	.321	.427	.392	.426
F	6.572	5.287	8.351	7.224	8.318

*Variables are significant at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$ and; F is significant at 0.01.*

similar to the study findings of Iqbal *et al.* (2020). However, the results of relationship of operational land with perceived financial risk sources was contradictory with the findings of Iqbal *et al.* (2020). Iqbal *et al.* (2020) found positive significant relationship of education and agriculture as primary source of income with perceived financial risk sources. Of the independent variables affecting market risk sources; land operational, household area and main income source had positive relationship with market risk sources while family size, family health status and tenancy status had negative relationship with market risk sources. The results of relationship of farming experience and operational land with perceived market risk sources are similar to the study findings of Iqbal *et al.* (2020). However, the results of relationship of education, family size and income source with perceived market risk sources are contradictory with the findings of Iqbal *et al.* (2020). Moreover, family size and main income source had positive relationship with human risk sources while education, land operational and household area had negative relationship with human risk sources.

Factors affecting perceived coping strategies

Ordinary Least Square (OLS) multiple regression model was also used for determining the relationship among perceived coping strategies elements obtained from factor analysis and farmers' socioeconomic characteristics. Overall, all models were highly significant as f-value. Similarly, most of the independent variables go into the models were significant with corresponding dependent variable. The R-square value was low in the models (Table 6). Regarding each model, production coping strategies was significant positively influenced by farming experience while education, family health status, main income source, vegetables share in total household income and tenancy status had negative relationship with production coping strategies. Family size had positive relationship with market coping strategies while family health status, household area, main income source and vegetables share in total household income had negative relationship with market coping strategies. Of the independent variables affecting institutional coping strategies, education, family health status and vegetables share in total household income had positive relationship with institutional coping strategies while farming experience had negative relationship with institutional coping strategies. Moreover, farming experience and household area had positive relationship with human coping strategies while education, family health status, farm labor hiring ability and vegetables share in total household income had negative relationship with human coping strategies. Moreover, family size, family health status, main income source and tenancy status had negative relationship with financial coping strategies (Table 6).

Conclusions and Recommendations

Khyber Pakhtunkhwa has diversified condition of agro-climate that makes possible the production of a variety of horticultural crops. These crops are exposed to climate and non-climate risks i.e., production risk, human risk, market risk, financial risk and institutional risk. The available resources at farm and external factors shaped the farm's adaptive capacity.

The findings of this study indicated that land use for other than agriculture, lack of new knowledge of climate change, supplying inappropriate seed, fear regarding to adopt improved farming practices that were not applied in village and changes in land prices were the key risk factors of production. Similarly, access to government programs and inadequate extension services were the key factors of intuitional risk. Moreover, no financial support by input dealers and no capacity to provide inputs were the key factors of financial risk. Likewise, fluctuation in input prices, market competition in- or sell-off and high market price in the previous growing season were the key factors of market risk. Additionally, migration of family members and face difficulties in finding labor were the key factors of human risk sources in the study area of Khyber Pakhtunkhwa. The coping strategies adopted/adopting by the sampled farmers were weather forecast for adjusting production practices, adopt new technology and production diversity of production coping strategies. Similarly, leasing inputs, market monitoring and switching to other markets for higher prices were market coping strategies. s. Moreover, maintaining good relationship with friends/relatives and maintaining good relationship with market actors were institutional coping strategies. Likewise, engaging on off-farm employment for income generation and reducing hiring of labor for farm activities of human coping strategies. Additionally, sale of perennial crops and sale of livestock were financial coping strategies. This study suggested that government institutions and non-government institutions related to agriculture should make easy access to farmers. The institutions have to facilitate farmers' by giving them interest free loan. Digitalization is required to update farmers timely for giving them information of weather and markets. There is a need for identification of new business opportunities for absorbing additional youth for improving rural livelihood. Moreover, agricultural and other allied departments of Khyber Pakhtunkhwa are required to make awareness campaign regarding climate change and new technologies along with introduction of trial-based technologies applicable according to socioeconomic and climatic conditions of vegetable growers in the area. Sustainable smallholder agricultural development programs need to be developed focusing on tenants and implemented in a way that the trust deficit among the stakeholders should be reduced. Future research on risk and coping strategies along with vulnerability and risk aversion may also be studied in other parts of the province for vegetables, cereals and fruits also.

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Novelty Statement

This research is adding new knowledge of risk-coping strategies and influencing factors. This knowledge of farm's risk and adapted strategies to cope with based on scientific evidence will help policy makers to be utilized for the betterment of small farmers to develop interventions at farm level.

Author's Contribution

Abdul Hassan: Conducted the research, collected and analysed data, wrote and reviewed the manuscript.
Arshad Farooq: Helped in area analysis and write-up, collected data
Muhammad Ishaq: Helped in data analysis and review.
Ghulam Sadiq: Technical guidelines during the whole process.
Asif Nawaz: Helped in data collection, research review and write-up.

Conflict of interest
The authors have declared no conflict of interest.

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