Pakistan J. Agric. Res. Vol 24 No. 1-4, 2011.

VULNERABILITY TO CLIMATE CHANGE: ADAPTATION STRATEGIES AND LAYERS OF RESILIENCE IN SEMI ARID ZONES OF PAKISTAN

Muhammad Azeem Khan*, Abid Hussain, Irfan Mehmood and Sonila Hassan **

ABSTRACT:- This study aims to identify the effects of climate change on the socioeconomic characteristic and livelihoods of farmers in semi arid zones of Punjab and Khyber Pukhtunkhwa provinces of Pakistan. Data for the study has been taken from various issues of Crop Area Production (by districts) MINFA (Economic Wing), district agricultural departments and meteorological department, Islamabad. Primary data for the study was collected in 2010 by conducting farm level surveys in Kohat and Attock districts. Clusters of six villages were selected from each district for field surveys. Six community representatives and 36 farmers were interviewed by using a set of well-designed questionnaires from each site. Results showed that over last three decades, number of small and tenant farmers increased in the semi-arid zones of Pakistan due to environmental harshness in general and law of inheritance in particular. Due to increase in mean annual temperatures and irregular rain patterns, area under major crops at Kohat and productivity of major crop at Attock decreased. Bivariate correlations between mean seasonal rainfall, area and production of major crops were moderately positive and statistically significant (except for wheat crop at Attock). This means that an increase in rainfall contribute positively towards area under major crops and their production and vice-versa. Farmers perceived a major change in climate at Kohat and a minor change at Attock over time. They reported unsustainability in production practices at Kohat and water management practices at both sites. Main strategies adopted by the farmers to mitigate the effects of climate change were occasional sale of livestock, reduction in consumption expenditures, and migration to nearby cities for non-farm employment.

Key Words: Farmers; Livelihood; Socioeconomics; Climate Change; Vulnerability; Bivariate Correlation; Pakistan.

INTRODUCTION

Pakistan lies in the temperate zone (between latitdes 24° and 37° N), it has a continental type of climate characterized by extreme variations of temperature, both seasonally and daily. The climate is generally varied throughout the country, characterized by hot summers and cool or cold winters mean temperature during June is 38 °C (100 °F) in the plains, the highest temperatures can exceed 47 °C (117 °F). Winters are cold, with minimum mean temperatures in Punjab of about 4 °C (39 °F) in January, and sub-zero temperatures in the far north and Balochistan (Wikipedia, 2011).

In Pakistan, most of the rainfall is associated with the monsoon winds, the western disturbances and the thunderstorms (Kureshy, 1998). The distribution of rainfall in Pakistan varies on wide ranges. The summer monsoon rainfall in Pakistan may vary from 17% to 59% (Luo and Lin, 1999). Land, forests and pastures have been degraded by prolonged misuse in the country. The rich soils of the Indus basin are experiencing water logging and salinity, wind and water erosion and rapidly spreading desertification. Forests are near extinction. Rangelands are being denuded (FAO, 1995). Pakistan faces many environmental challenges which need to be addressed since the economy is dependent on its natural resources. These challenges are grouped in two broad categories with

*Social Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan.
**Social Sciences Division , Pakistan Agricultural Research Council, Islamabad, Pakistan.

varying degrees of impact. The first, arises from a combination of poverty and population growth, leading to the over-exploitation of natural resources, and the second, emanates from the largely unplanned increase in industrialization and urbanization, leading to the pollution of water, air and land. The poor are disproportionately affected by this environmental degradation and lack of access to clean, affordable energy services (UNDP, 2010).

These changes are exposing farmers to new and in many cases unfamiliar conditions . While some farmers may be in a position to take advantage of these changes; many more are facing increased vulnerability. Farmers will have to adapt to both climate change and economic changes at the same time, and thus vulnerability must be considered from a comprehensive rather than restricted perspective. Vulnerability of farmers to climate conditions as a measure influenced by the capacity to take anticipatory actions–such as planting drought resistant seeds, changing the crop-mix, or seeking off-farm income–as well as to recover from losses or damages (Watts and Goodman, 1997). Vulnerability can be assessed at many different levels, including household, community, region, and nation–although most studies emphasize either the micro-level (household) or the macro-level (nation). The micro-level studies typically focus on household vulnerability to either natural events such as droughts or floods (Sivakumar, 2005).

Therefore, the study was designed to assess vulnerability of farming community to climate change in semi-arid zones of Pakistan with the objectives to (i) assess change in average annual rainfall and daily temperature patterns over time and to determine their impact on the area and production of major crops; (ii) assess the impact of climate change on demographic characteristics at research sites; (iii) evaluate the perception of farmers about livestock population, water resources, access to different social and public institutions, labour availability, livelihoods and income generating activities; and (iv) find out main coping strategies adopted by people to mitigate effects of climate change.

MATERIALS AND METHODS

Keeping in view the socioeconomic factors (poverty, food security, population, unemployment, and income and population density) and environmental attributes (average rainfall, precipitation, humidity and cropping pattern) two semi arid tropics; district Kohat (from Khyber Pakhtunkhwa province) and district Attock from (Punjab province) were selected. To assess the changes in climate, data regarding average annual rainfall and mean temperature were collected from Pakistan Metrological Department, Islamabad and district agricultural departments. Bivariate correlation between mean seasonal (*rabi* and *kharif*) temperature, area and production of major crops (wheat and groundnut) and mean seasonal rainfall, area and production of major crops from 1969-70 to 1999-2000 was determined to find out relationship between environmental factors and these variables. As bivariate correlation is a statistical test that measures the association or relationship between two continuous/interval/ordinal level variables (Lani, 2008). Pearson Correlation (r) was determined, as it is the most commonly used bivariate correlation technique which measures the association between two quantitative variables without distinction between the independent and dependent variables. A value of Pearson Correlation from zero to 0.30 indicates a weak, 0.31 to 0.70 a moderate and 0.71 to 1.00 a strong relationship between two quantitative variables (Mertler and Vannatta, 2005).

Primary information was collected by conducting field surveys in tehsil Pindigheb of Attock district and tehsil Lachi of Kohat district during July-September, 2010. One union council from each tehsil and then a cluster of six villages from each union council were selected for data collection purpose. A set of well designed and pre-tested questionnaires was used to gather information. One community representative and one

each of small, medium and large farmers were interviewed from each village. Thus in total, 12 community representatives and 72 farmers were interviewed. Community representatives were asked about demographic features, their perception about primary occupations of the people and livestock population. While, farmers were asked to report their perception about irrigation sources, access to different institutions, labor availability, information flow, farm characteristics, livelihood, impact of climate change, effect of climate change on income activities and copping strategies adopted by the people to mitigate adverse impact of environmental change.

RESULTS AND DISCUSSION

Rainfall Distribution and Temperature Trends in Semi Arid Zones

Before 1984, there are alternate years of low and high rainfalls at Kohat (Figure-1). Thereafter, generally a year of high rainfall follows a 4-5 years of low rainfalls at Kohat. Thus there is a obvious change in rainfall pattern at this site over last five

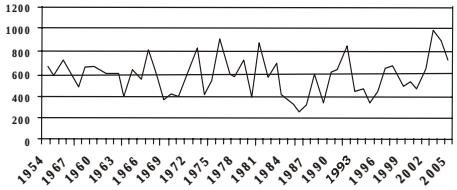

Figure 1. Mean annual rainfall (mm) at Kohat site (1954-2005)

decades. Mean annual rainfall was 575 mm, with a minimum of 233 mm in 1987 and a maximum of 1000 mm in 2004. The average annual rainfall at Attock over last five

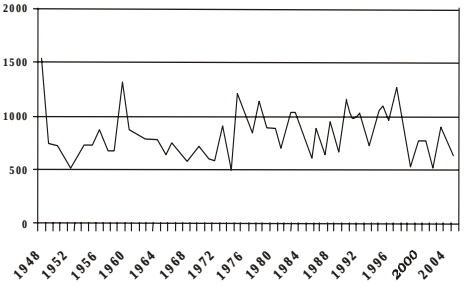

Figure 2. Mean annual rainfall (mm) at Attock site (1948-2005)

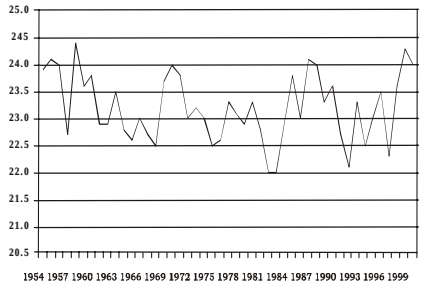

Figure 3. Mean annual temperature (^{o}C) at Kohat site (1954-2000)

to six decades (1948 - 2005) shows that alternate dry and wet periods were generally longer than at Kohat (Figure 2). The minimum rainfall was 492mm in 1975 and maximum was 1542 mm in 1948 with a mean annual rainfall of 832 mm.

Temperature plays vital role in the growth and development of crops. Below normal rainfall associated with above normal heat in crop atmosphere caused increased evapo-transpiration and moisture stress to crops especially in semi arid areas. Mean annual temperature at Kohat shows great variation over last four to five decades (1954-2000).

Average daily temperature at this site reached a maximum of 24.4°C in 1999 and touched a minimum of 22.5°C in 1983 (Figure 3). Variations in daily temperature at this site were comparatively smaller before 1964 and quite larger thereafter. Average daily temperature at Attock shows smaller variations in mean annual temperature than Kohat (Figure 4) Mean daily temperature at this site reached a minimum of 21.6°C in 1992 and reached a maximum of 24.8°C in 1998.

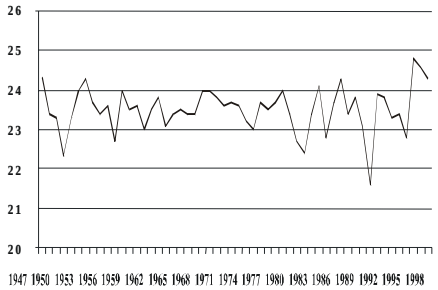

Figure 4. Mean annual temperature (°C) at Attock site (1947-2000)

Area, Production and Yield of Major Crops

Data of mean area, production and yield of major crops of selected districts over last three decades revealed that negative changes have occurred in area and production of wheat crop in Kohat district; however, an improvement in yield has taken place. This scenario is opposite in Attock district, where an increase in wheat area and production has occurred with a decrease in wheat yield of 13.2% during 1991-2000 (Table 1). The area under groundnut crop, in Kohat district, showed a decrease of 23.5% if we compare average area of 2001-2008 with that of 1981-90. However, changes in production (increase of 14.3%) and yield (increase of 49.3%) were positive during the same period. While in Attock district, increase in area under groundnut crop was 59.0% with increase in production of 11.9% and a decline in yield of 29.6%.

Bivariate correlations between area, production and yield of major crops, and mean seasonal temperature were weak and statistically insignificant at both sites (Table 2). Rainfall was a significant factor of crop production, as for Kohat district correlations between mean seasonal rainfall and area, as well as rainfall and production of major crops was moderately positive and significant. Similarly for Attock district, correlation between mean seasonal rainfall and production of wheat crop was moderately positive and statistically significant. Moreover, correlations between seasonal rainfall and area as well as production of groundnut were moderately positive and statistically significant. This means that an increase in rainfall contributes positively towards area under major crops and their production and vice-versa.

General Features of the Study Sites

The demographic characteristics of the study area and community representatives' perceptions about these characteristics revealed that total area of Kohat site, including residential areas, farm lands, forest lands, grazing lands and

Table 1. Area, production and yield of wheat and groundnut

Year	Kohat			Attock		
	Area (000ha)	Production (000t)	Yield ($t ha^{-1}$)	Area (000ha)	Production (000t)	Yield ($t ha^{-1}$)
Wheat						
1981-90	54.2	43.8	0.8	0.9	1.4	1.4
1991-2000	51.0(-59)	40.9(0.69)	0.8(0.0)	1.5(60.0)	1.9(38.8)	1.3(-13.2)
2001-2008	28.5(-47.4)	28.5(-34.9)	1.0(23.6)	1.2 (23.0)	1.5(6.8)	1.3(-13.2)
Groundnut						
1981-90	190.6	196.8	1.0	17.5	17.4	1.0
1991-2000	174.3 (-836)	199.5(1.4)	1.1(10.9)	21.4(22.7)	20.9(20.4)	1.0(-1.9)
2001-2008	145.9(-23.5)	225.0(14.3)	1.5(49.3)	27.8(59.0)	19.4(11.9)	0.7(-29.6)

Table 2. Bivariate correlation

	Kohat	Association	Attock	Association
Wheat				
Area and temperature	-0.12 (0.532)	Weak	-0.10 (0.584)	Weak
Production and temperature	-0.27 (0.149)	Weak	-0.17 (0.371)	Weak
Area and rainfall	0.50 (0.004)**	Moderate	0.16 (0.401)	Weak
production and rainfall	0.66 (0.000)**	Moderate	0.50 (0.005)**	Moderate
Groundnut				
Area and temperature	-0.25 (0.165)	Weak	-0.25 (0.165)	Weak
Production and temperature	-0.28 (0.122)	Weak	-0.28 (0.122)	Weak
area and rainfall	0.36 (0.044)*	Moderate	0.36 (0.044)*	Moderate
Production and rainfall	0.41 (0.018)*	Moderate	0.42 (0.018)*	Moderate

Figures in parenthesis are two tailed significance
*** and * = significant at 1% and 5% levels, respectively.*

shamlats (government owned lands) was 17940.3 acres and of Attock was 38176.3 acres (Table 3). According to farmers' perception minor increases in geographic areas, numbers of landless households and small farmers have occurred over last 30 years (1980 onwards) at both sites. However, at Kohat number of both medium and large farmers decreased while at Attock number of medium farmers remained constant and that of large farmers decreased over time. These results indicate that law of inheritance in particular and environmental harshness in general has resulted in to a decrease number of medium and large farmers and an increase in number of small and tenant farmers over time.

At Kohat, 77% and at Attock 80% of the households are engaged in farming. At Kohat, respondents perceived no change in number of households having farming as primary occupation. However, a minor increase in number of labourers and major increases in number of businessmen and people in public/ private services were reported. At Attock, minor increases in number of farming and business households and major increases in number of labourers and servicemen were observed (Table 3).

Livestock Population

Farmers perceived no change in the population of cattle at both sites, while a minor increase in number of buffalo population at Attock was reported (Table 4). An increase in number of goats at both sites and number of sheep at Kohat was perceived over last three decades. Farmers perceived a minor increase in number of poultry birds at Attock, while no change at Kohat. As described earlier (Table 1) that due to increase in mean annual temperatures and irregular rains patterns, a decrease in area under major crops at Kohat site and in productivity of major crop at Attock have occurred. Thus, people's dependence on livestock farming has increased, as increase in number of small ruminants at Kohat site and number of buffaloes, goats and poultry birds at Attock was perceived.

Sources of Irrigation

At Kohat, wells and ponds were the main sources of irrigation at all farm types. Small farmers at Kohat had access to two wells and two ponds and reported that their access to wells had decreased to some extent over last 30 years (Table 5). Medium farmers had access to two wells, one tubewell, one pond and two mini dams. They reported that their access to wells had improved to some extent while remained

Table 3. Demographic features of the study sites and community representatives' perception about primary occupations

	Kohat		Attock	
Categories	#	Perception	#	Perception
Tenant/ landless HH	128 (23%)	1	93 (20%)	1
Small farmers (0-2 ha)	170 (31%)	1	140 (30%)	1
Medium farmers (2-4 ha)	110 (20%)	-1	170 (37%)	0
Large farmers (>4 ha)	146 (26%)	-1	60 (13%)	-1
Primary occupations of people				
Agriculture	-	0	-	1
Labor	-	1	-	2
Business	-	2	-	1
Service	-	2	-	2

-2=major decrease, -1=minor decrease, 0= no change, +1 = minor increase, +2=major increase

unchanged to other sources of irrigation. At this location, large farmers had access to four wells, two ponds and one mini dam. They reported no change in their access to these sources of irrigation over time.

At Attock, farmers' access to irrigation sources was quite better than at the Kohat. Small farmers had access to 12 wells, 6 ponds and one mini dam. They reported a minor improvement in their access to wells and ponds over time. Medium farmers had access to 30 wells and 6 ponds at this site and they reported a minor improvement in their access to these irrigation sources. Large farmers had access to 39 wells, one tubewell and one mini dam. They perceived a minor increase in number of accessible wells and ponds and major increase in number of accessible tube wells over time.

Farmers' Access to Different Institutions

One each of farmer cooperatives, self help groups, *panchayats*, secondary schools and health centres were accessible to the farmers at Kohat site (Table 6). They perceived a minor increase in number of farmer cooperatives and secondary schools over time. However, veterinary hospitals and banks were non accessible to farmers here.

At Attock, one each of farmer cooperative, self help groups, *panchayats*, health centres, veterinary hospitals and banks were accessible to the farmers. However, secondary schools were non accessible to the farm families at this site. There were nine milk collection centres at this site. Farmers perceived a minor increase in number of milk collection centers, *panchayats*, secondary schools health centres, veterinary hospitals and banks at Attock over last 30 years.

Agricultural extension department is the institution that can create awareness among farmers and train them regarding the environmental issues. So this department should play a very active role in teaching farmers about adoption strategies to cope environmental changes. Moreover, farmer cooperatives and self help groups are the institutions which can be used by agricultural extension department for speedy transfer of knowledge to the farming communities.

Labor Availability, Information Flow and Farm Characteristics

At Kohat most of the farmers (63%) while at Attock site majority of them (42%) reported easy availability of farm labour. Majority of small farmers and most of the medium & large farmers reported ease in

Table 4. Livestock holding of the surveyed household

Livestock	Kohat			Attock		
population	Population	No. per HH	Perception	Population	No. per HH	Perception
Cattle	583	1.1	0	2233	4.8	0
Buffaloes	0	0.0	0	1485	3.2	1
Goats	1800	3.2	1	5483	11.8	1
Sheep	842	1.5	1	3000	6.5	0
Poultry	3088	5.6	0	17220	37.2	1

2 = major decrease, -1= minor decrease, 0 = no change, +1 = minor increase, +2 = major increase

Table 5. Sources of irrigations

Source	Kohat						Attock					
	Small farmers		Medium farmers		Large farmers		Small farmers		Medium farmers		Large farmers	
	#	Percep.	#	Percep.	#	Percep.	#	Percep.	#	Percep.	#	Percep.
Wells	2	-1	2	1	4	0	12	1	30	1	39	1
Tubewells	0	0	1	0	0	0	0	0	0	0	1	2
Ponds	2	0	1	0	2	0	6	1	6	1	6	1
Mini dams	0	0	2	0	1	0	1	0	0	0	1	0

-2= major decrease, 1= indicate decrease, 0= no change, +1= minor increase,+2= major increase

labour availability. Farmers at both sites reported minor improvement in the availablity of both farm and non-farm labour (Table 7). At both study sites, majority of the farmers reported minor improvement in information flow over time. Majority of the small farmers at Kohat reported minor increase in cultivable area; however, at Attock small farmers reported no change in cultivable area. Some of the medium farmers at both sites reported minor increase in cultivable area. Large farmers at Kohat reported no change in cultivable area over time while at Attock they reported major increase in cultivable area. At Kohat, majority of small and medium farmers reported minor, while large farmers reported major increase in farm mechanization. At Attock, most of the all types of farmers reported major increase in farm mechanization over time. None of the farmers at Kohat and some (3%) perceived minor increase in the availability of irrigation water over time (Table 7).

Livelihood Impact of Climate Change

Most of the farmers at both study sites reported change in climate over time. Farmers at Kohat reported a major change in climate; while at Attock, they reported moderate change in climate (Table 8). Due to climate change, a great un-sustainability in production practices was reported by farmers at Kohat. While at Attock, farmers reported that it has not affected production practices. Small farmers at both site and large farmers at Attock reported that climate change has not affected water management practices as these remain sustainable over time. While medium farmers at both sites and large farmers at Kohat reported that change in climate had resulted into un-sustainability in water management practices. Farmers did not report any change in their investments in water harvesting at both sites.

Farmers reported a moderate increase in deforestation at Kohat, while a minor

Table 6. Farm families' access to different institutions

Institutional involment	Kohat		Attock	
	Number	Perception	Number	Perception
Farmer cooperatives	1	1	1	0
Self help groups	1	0	1	0
Panchayat	1	0	1	1
Secondary school	0	1	1	0
Health centres	1	0	1	1
Veterinary hospitals	0	0	1	1
Banks (Regional, rural, privates)	0	0	1	1
Milk collection centres	0	0	9	1

2 = major decrease, -1= minor indicate decrease, 0= no change, +1= minor increase,+2= major increase

Table 7. Labor availability, information flow and farm characteristics (% farmers)

Farm and other attributes	Kohat			Attock		
	Small	Medium	Large	Small	Medium	Large
Availability of farm labor	63 (1)	66 (1)	61 (1)	36 (1)	48 (1)	42 (1)
Availability of off-farm labor	43 (1)	55 (1)	55 (2)	48 (1)	50 (2)	50 (1)
Information flow	34 (1)	34 (1)	50 (1)	48 (1)	37 (1)	45 (1)
Increase in cultivable area	39 (1)	23 (1)	26 (0)	28 (0)	8 (1)	19 (2)
Farm mechanization	31 (1)	41 (1)	41 (2)	58 (2)	55 (2)	61 (2)
Availability of irrigation water	0 (0)	16 (0)	0 (0)	0 (0)	3 (1)	5 (0)

2= major

Figures in parenthesis are farmers perceptions

decrease, -1 = minor indicate decrease, 0= no change, +1= minor increase,+2 = major increase

Table 8. Livelihood impact of climate change (% farmers)

Variable	Kohat			Attock		
	Small	Medium	Large	Small	Medium	Large
Climate change	92 (2)	93 (2)	93 (2)	71 (2)	82 (1)	80 (0)
Unsustainable production practices	36 (1)	21(1)	20 (1)	38 (0)	28 (0)	26 (0)
Unsustainable water management	12 (0)	36 (1)	23 (1)	15 (0)	23 (1)	8 (0)
Deforestation	25 (0)	20 (1)	15 (2)	47 (1)	51 (1)	35 (1)
Change in land use	18 (1)	41 (2)	27 (2)	33 (1)	40 (1)	50 (0)
Demographic pressure	43 (1)	46 (2)	17 (2)	40 (1)	50 (1)	48 (1)
Poverty	62 (0)	43 (2)	9 (2)	56 (0)	35 (0)	20 (1)
Government intervention	21(1)	25 (2)	15 (0)	11 (0)	10 (1)	15 (0)

Figures in parenthesis are farmers perceptions

-2 = major decrease, -1= minor decrease, 0= no change, +1= minor increase ,+2= major increase

increase in deforestation at Attock. The reasons of deforestation was long spell of dry periods and decrease in productivity of major crops at Kohat, and start of poultry farming by the people at Attock. Because, in poultry farming wood is not only used for construction of sheds but also as fuel to keep sheds warm in winter.

Farmers reported minor decrease in the area of wheat, groundnut, millet and sorghum crops at Kohat and millet and mustard crops at Attock over time. While a minor increase in fallow area was reported at both sites. Small farmer at both sites reported a minor change in land use pattern. While medium farmers at Kohat reported a major change and at Attock a minor change in land use pattern. Large farmers reported a major change in land use pattern at Kohat and no change at Attock. Incidence of poverty was highest among the small farmers and there was an inverse relationship between farm size and poverty at both sites.

Effect of Climate Change on Income Activities

One fifth to one third of the farmers reported increase in migration of people to earn livelihood due to climatic variation (Table 9). Small and large farmers at Kohat reported a major increase in migration over time. While medium farmers at Kohat and all types of farmers at Attock reported minor increase in migration of people to other areas in search of jobs due to climatic effects. Some of the farmers also reported changes in their occupations due to climatic variations at both sites. However, they perceived a minor type of change in occupations of people. At Kohat about 10% farmers and at Attock one third to one half of the farmers reported an increase in operational land at their farms over time to meet their subsistence (Table 9). However, they perceived this increase in operational area as a minor change. At Kohat about one-third of the small and medium farmers and two-third of the large farmers re-

Table 9. Change in income activities (% farmers)

Attribute	Kohat			Attock		
	Small	Medium	Large	Small	Medium	Large
Change in migration	22 (2)	23 (1)	17 (2)	33 (1)	26 (1)	13 (1)
Change in occupation	15 (1)	11 (1)	26 (1)	27 (1)	31 (1)	21(1)
Change in operational Size	10 (1)	12 (1)	9 (1)	43 (1)	35 (1)	33 (1)
Change in livestock population	30 (0)	30 (0)	60 (0)	48 (1)	50 (1)	34 (1)

Figures in parenthesis are farmers perceptions

-2 = major decrease, -1= minor decrease, 0= no change, +1 = minor increase,+2= major increase

ported a decrease in livestock population at their farms. However, they perceived that change in livestock population was of minor type. While, at Attock about half of the small and medium farmers and one-third of the large farmers reported an increase in livestock population at their farms. Farmers perceived this increase in livestock population as a minor change.

Coping Strategies

Adoption of coping strategies to mitigate effects of climate changes mainly depends on the socioeconomic characteristics of the farmers. Different copping strategies were adopted by farmers (Table 10). As the incidence of poverty was more at Kohat, thus small farmers here reported reduction in consumption expenditures, migration for employment in non-farm activities and sale of livestock as main coping strategies. Main strategies reported by medium farmers at this site were reduction in consumption expenditures, occasional sale of livestock and change in choice of crops and time of farm operations e.g. land preparation and fertilizer application. Large farmers at Kohat reported occasional sale of livestock, borrowing and use of cash saving as the main coping strategies to face the vagaries of environment.

At Attock, small farmers reported sale of livestock followed by migration for non farm activities and reduction in consumption expenditures as the main coping mechanisms. Medium farmers at this site reported occasional sale of livestock, reduction in consumption expenditures and use of previous cash saving as main coping strategies. Large farmers reported borrowing, change in date of farm operations (sowing date and input application) and occasional sale of livestock as main mechanisms to cope environmental hostilities.

It is therefore concluded that in the semi-arid tropics of the country, farmers are well aware of the environmental changes happening around and have their own strategies to cope up with the challenges brought by these environmental disturbances. Farming is the major occupation at the study sites and most of the families depend on it for their subsistence. The environmental disturbances viz., changes in the temperature and rainfall patterns have essential role in the development and growth of the crops. Change in the rainfall patterns during the last few decades has adversely affected the area and productivity of major crops (wheat and groundnut) in the semi-arid areas of Kohat and Attock. The food security situation is alarming and vulnerability of farm families has increased. Dependency of farm families on livestock and off-farm sources of income is increasing as the crop sector is unable to

Table 10. Coping strategies (% farmers)

Mechanism	Kohat			Attock		
	Small	Medium	Large	Small	Medium	Large
Borrowing	4 (0)	10 (0)	47 (1)	7 (1)	18 (1)	35 (1)
Migration for non farm activity	25 (1)	21 (2)	32 (1)	38 (1)	22 (1)	20 (1)
Shift to new crop suitable for new climate patterns	8 (0)	2 (0)	16 (0)	2 (0)	2 (0)	15 (1)
Partial sale of assets	11 (1)	9 (1)	27 (1)	22 (1)	21 (1)	28 (1)
Increase of mixed crops	6 (0)	6 (0)	27 (1)	9 (1)	8 (1)	17 (1)
Change in date of operation	14 (0)	28 (1)	31 (1)	13 (1)	21 (2)	34 (1)
Use previous cash saving	8 (1)	11 (0)	45 (1)	5 (0)	25 (1)	20 (1)
Reduce consumption expenditure	26 (0)	40 (0)	21 (0)	36 (0)	29 (0)	8 (0)
Sale of livestock	20 (0)	32 (0)	50 (1)	46 (1)	35 (1)	30 (1)

Figures in parenthesis are farmers perceptions

**-2 major decrease, -1= minor decrease, 0 no change, +1= minor increase,+2= major increase*

fulfill the livelihood needs of increasing population. People have opted to adopt off-farm employment opportunities to retain their livelihood mostly away from their native areas. Pressure on community forests for fuel wood and forages is mounting day by day. One of the reasons is increase in number of poultry farmers in the semi-arid areas. Although, people are well aware of the climate change and its impacts on the productivity of crops and their livelihood; however, agricultural extension department should train them about strategies to mitigate environmental harshness. Farmer cooperatives and self help groups are the institutions which can be used by agricultural extension department for speedy transfer of knowledge to the farming communities. Research institutes should produce new drought resistant varieties of the crops. Forest department should create awareness in the rural communities of semiarid tropics of Pakistan about the importance of forest resources. District governments should endeavor to provide alternate sources of energy to reduce the pressure on forest reserves. Community lands should be identified and forest trees should be planted. To increase the productivity of livestock, farmers should also be taught to plant palatable shrubs and forage trees in rain catchments. Awareness about bee keeping, mushroom farming should also be generated in people, as these could be very good income generating activities for them.

LITERATURE CITED

FAO, 1995. Asia's women in agriculture, environment and rural production: Pakistan.(http://www.fao.org/sd/WPdirect/WPre0111.htm)

GoP, 2010. Pakistan Meteorological Department, Sector H-8/2, Islamabad.

GoP, 2009. Agricultural Statistics of Pakistan (Various Issues), Ministry of Food and Agriculture (Economic Wing), Islamabad

GoP, 2001. Crop Area and Production by Districts (Various Issues). Ministry of Food, Livestock and Agriculture. Economic Wing, Islamabad.

Kureshy, K. U. 1998. Geography of Pakistan, National Book Service Lahore, Pakistan.

Lani, J. 2008. Bivariate Correlations. http://statisticssolutions.blogspot.com/2008/12/bivariate-correlations-continued.html

Luo, Q. and Lin, E. 1999. Agricultural vulnerability and adaptation in developing countries: the Asia-Pacific region. Climatic Change 43: 729-743.

Merttler, C. A. and Vannatta, R. A. 2005. Advanced and multivariate statistical methods: Practical application and interpretation (3rd edn.). Los Angelets, CA: Pyrczak.

Sivakumar, M.V.K. 1998. Climate varibility and food vulnertability: Global Change News. (IGBP) 35:14-17.

UNDP, 2010. Environment and Energy. United Nations Development Programme, Pakistan. http://un.org.pk/undpnew//index.php?option=com_content&task=view&id =18&Itemid =36.

Wikipedia, 2011. Climate of Pakistan. http://en.wikipedia.org/wiki/Climate_of_Pakistan.

Watts, M. and Goodman (eds.), 1997.Globalizing food: agrarian questions and global restructuring, London, Rutledge.