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CLIMATE CHANGE IMPACTS ON HORTICULTURAL CROPS PRODUCTIVITY AND FARMERS' ADAPTIVE STRATEGIES IN DISTRICT PISHIN, BALOCHISTAN

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ABSTRACT:

Pakistan demography, geography and diverse climatic situation has increased the climate change vulnerability manifold. Balochistan is situated in arid and semi-arid region and has been affected severely due to climate change over the last two decades. The aim of this research is to examine the climate change induced impacts on horticultural crops productivity and farmers' coping and adaptive strategies have also been studied. A comprehensive field survey has been conducted in district Pishin from 200 through face-to-face interviews. Data relevant to area, production and yield (1988 – 2018) of major fruits crops and that of rainfall, maximum and minimum temperature has also been analyzed to understand the variation in area and yield of selected fruits. Findings of the study revealed that temperature has increased whereas rainfall has decreased in the district for the last two decades. These results are in line with the farmers' perception about these climatic indicators. Annual growth rate (in percentage) of area indicates that significant increase has been observed in grapes cultivation (18.63 hectares per year) while least increased in area (0.83 hectares per year) is observed in apricot cultivation during 1988 – 2018. However, a significant decrease in yield of all major fruit crops has been observed during the study period. Field survey further revealed that farmers have adopted varieties of coping and adaptive strategies that includes crop management/diversification, inputs adjustment, and efficient use of water, depletion of household assets, consumption smoothing and migration. To reduce the impact of climate change and to protect the farmers, policy recommendations are proffered for the research area.

KEY WORDS: climate change, Horticulture crops, Water management, coping, adaptation, Balochistan

1. Introduction

Climate change has emerged as a great challenge for Pakistan. Pakistan demography, geography & diverse climatic situation have increased this vulnerability manifold. "Vulnerability is the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards" (Aitsi-Selmi et al., 2015). Location of Pakistan in arid to semi-arid makes it prone to climate change due to its dependence on ground water resources for irrigation such as bore holes or isolated reservoirs. Pakistan economy is agro based. Most of its population is affiliated with

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agriculture sector. This sector contributes 22.7% of Gross Domestic Product and 37.4% of the masses are employed in this sector. According to the Global Climate Risk Index (2020), Pakistan stands 8th (high risk) in terms of vulnerability to climate change. This vulnerability to climate risks has amply been demonstrated to severe drought in recent years (1998-2002) and devastating flood of 2010 (Asad, 2016). Pakistan is considered as one of the most vulnerable countries with the term of climate change aspect, unprecedented flood, water scarcity, energy crisis, food security (BUITEMS & UNDP, 2015). One of the threats identified by the National Climate Change Policy is rising temperatures resulting in enhanced heat and water stressed conditions, particularly in arid and semi-arid regions, leading to reduced agricultural productivity. The economy of Pakistan also faced multivariate natural hazards vulnerabilities like earthquake, unexpected floods, land sliding, torrential rain, climate changes and persistent droughts at country level.

According to the IPCC special report 2016, the threat of climate change especially global warming of 1.5 C^o above pre-industrial levels and related global greenhouse gas emission are challenges for sustainable development, and efforts to eradicate poverty. There is a significant relationship between climate change and water resources given that the globe's temperature is continually rising due to climatic changes. Evaporation rate has been increased due to rise in temperature resulting in persistent droughts spell. Drought is a normal feature of climate change and it looks an inevitable phenomenon (Ashraf & Routray, 2013) as it affects the landscape slowly over a period of time and may remain for years even after the end of the event and therefore is different from other natural disaster such as flood, tropical cyclones, tornadoes and earthquakes. That is why; drought is often referred to as a "Creeping Phenomena" (NDMC & PMD, 2016). Balochistan and Sindh were exposed as most vulnerable places in droughts spell in 1998-2004 and 2014-2015.

Very little rainfall ranging from 20 to 200 mm in lower half portion of Balochistan province was a major cause of drought in major regions of Balochistan (NDMC, 2015). Various research studies confirm this statement for instance, a study on drought risk assessment in Balochistan revealed that out of fifty years (1965-2014); twenty years experienced mild drought, seventeen years near normal and three years were moderate drought conditions in the region (Ainuddin & Kakar, 2015). (Khan, A.N. and Ali, 2015) found that seasonal droughts are positively correlated with variations in the seasonal rainfall in Balochistan. Lack of irrigation water caused by uncontrolled tube-wells installation and continuous drought (Halcrow, 2007); hostile terrain, erratic climatic conditions, scarce water resources (Bhatti, 2008); scanty rainfall, poor governance and resource management (Ahmad, 2007 and Khair et al, 2015) which has affected the horticulture sector especially fruits of the provincial economy. Irrigated crop production reduced considerably during the drought period (1998-2002) at around 33% (Ahmad, 2007) and ranged 20-40% during 2013-2015 (Khair et al., 2015). This has affected overall provincial growth by reducing it from 4.4 % to 2.5 % per annum as compared to at the national growth from 1999-2000 and 2014-2015.

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Agriculture (including livestock) in Balochistan, contributes one-third of the provincial GDP, employs nearly two-thirds of its labor force (GoB & IFPRI, 2021). Balochistan agriculture economy is mainly dependent on groundwater irrigation system. The important horticultural crops such as apple, apricot, grapes, tomato and vegetables accounted for some 45 % share in agriculture value added in the province and some 12 % shares at country level (GoB & IFPRI, 2021). These horticultural crops are highly vulnerable to climate change and their production was reduced by 33% during the drought i.e. 1998-2002 (Ahmed, 2007) and 20% to 40% during 2013-2015 (Khair et al., 2015). Its' main reason was its location in arid and semi-arid regions and dependence on water resources from single-point systems such as bore holes or isolated reservoirs. Inefficient use of groundwater can impact food security and socio-economy negatively for rural communities as they rely on groundwater. A study in Pishin Lora revealed income decline of 73% of households surveyed due to groundwater depletion while also affecting their daily lives (Nasrullah et al., 2011). Resultantly, the economic indicators of the Balochistan are far below the national level and in some areas poverty is increasing contrary to decline at national level.

Therefore, it is very important to examine the climate change induced impacts on horticultural crops productivity and other related factors that include tube-wells installation, trend in rainfall and temperature in the study area. Furthermore, it is also equally important that how they cope or adapted to mitigate the negative effects of climate change on their orchards.

2. Material and methods

2.1 Study area

Balochistan which is the largest and least developed province of Pakistan had witnessed different dry spells due to climate change and caused a great threat to the livelihood of its population. Balochistan has 12.34 million population and majority (85 percent) of this population lives in rural area and their livelihood mainly depends on agriculture and livestock. Figures indicates that majority of the districts (26 out of 33) depends on rain, Karezes, tube-wells and flood water for irrigating their fields. To achieve the desire research objectives, districts Pishin which was severely affected by recent dry spells because of climate change have been selected from the main horticultural crops growing districts of upland Balochistan for extensive field survey

District Pishin is located at 30.7383° N, 67.2848° E in the north west of Balochistan province of Pakistan covering an area of 7,819 sq km and scant population of about 0.74 million. The district of Pishin lies in the north of Quetta and adjoins boundaries with Afghanistan and District Qilla Abdullah in the west, Qilla Saifullah and Harnai in the east. The district is administratively distributed into four Tehsils and one Sub-Tehsils as Pishin, Karbala, Barshore, Karezat, Huramzai and Saranan respectively (**Error! Reference source not found.**).

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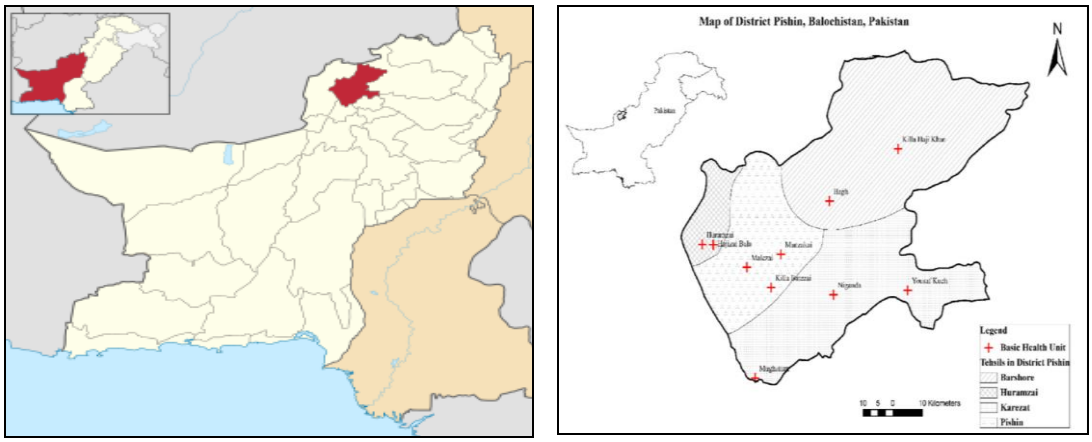

Figure 1: Study area Pishin, Balochistan and its administrative distribution

Main crops in the area are wheat, barley, corn (maize), potatoes, grapes, apples, apricots, and peaches which are grown in the valleys. Sheep and goats are also herded. Main tribes comprise Tareen, Kakar and Syed. District Pishin comprises dry and arid climatic conditions with moderate summers and cold winters.

2.2 Research design

In order to achieve the desire research objectives, an in-depth field survey is conducted in district Pishin. Farm household head who is defined as main person in a family and responsible for all major socio-economic and households' decisions is the sampling unit of this study. By employing a statistical method developed by (Arkin & Colton, 1963), a total of 200 orchard farmers have been be selected and interviewed personally from selected district.

In order to select a farmer, a multistage sampling technique is employed in the selected district. First stage of sampling was comprised on Union Councils selection and these Union Councils were purposively selected with the prior consultation of Key Informants (like *Patwari*) and District Agriculture Officer. Second stage of sampling was consisted on village selection. These villages were selected randomly from the selected Union Councils and finally farmers from the selected villages were randomly chosen for extensive field survey.

In order to collect the data from farm households, a semi-structured questionnaire is developed and used in this study. The first part of this questionnaire mainly focuses on the socio-economic profile of the selected farmers. The second part of this data collection tool comprised on questions that highlighted farmers' perception about climate change, perceived impacts on their agro-based livelihood and finally questionnaire addresses their coping/adaptive strategies to mitigate the negative effects of climate change on their livelihood. Furthermore, data relevant to area, production and yield (1988 – 2018) of major fruits crops such as Apple, Grapes, Apricot, Peach, and Plum is collected from Agricultural Department, Government of Balochistan in order to see the trend and variation in area and yield of selected fruits due to climate change.

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From meteorological office data for the time period 1985 – 2018 related to rainfall, maximum and minimum temperature is also been collected for trend analysis.

To achieve the desired objectives of this research, mostly descriptive statistics such as frequency, percentage is used. In addition for trend analysis, graphs and charts have also been generated to point out the climate change induced impacts on crops productivity and to link it with variation observed in climatic indicators. For the said purpose, SPSS software is employed for data processing and analysis.

2.3 Profile of the respondents

Filed survey results indicate that average age of the respondents in the study area is almost 45 years. The minimum and maximum age of the respondents ranges from 20 years to 75 years respectively, which indicates that mostly farmers are living in the area since their birth or from the time of their forefathers. Average household size is 23 persons per house and it is important to point out that mostly farmers are living in joint family system in the study area. As far farming experience is concerned, it ranges from 4 years to 54 years. Both young and old farmers are engaged in agricultural activities for their livelihood. Average farming experience in district Pishin is about 33 years. Furthermore, a significant portion of family are in active age group (14 – 60 years) and could play an important role in on-farm and off-farm activities in the whole study area.

As it is evident that sampled respondents have large family size and majority of the sampled respondents in the study area lives in a joint family or extended family system. The educational attainment of the sampled respondents indicates that majority of the farmers (30.5 %) in district Pishin are illiterate whereas similar portion of sampled respondents are well educated and have attained Bachelor or higher degree. Survey data also reports that land ownership of the sampled respondents is unevenly distributed and it has been observed that majority of the respondents were small farmers. Average land holding size in district Pishin is 2.37 acres whereas majority of the farmers (94 percent) have less than 5 acres of farm land. Average monthly income of the respondents in district Pishin is PKR 21,595. Survey data revealed that majority of the farmers (78.5 percent) have less than 25,000 rupees monthly income and farmers' income is directly proportional to their landholding size in the study area. Secondary source of income always play a significant role in mitigating the negative impacts of any hazard. It has been evident during the field survey that majority of the respondents (87.5 percent) are engaged in livestock apart from their main source of income of horticulture farming. It is important to point out that about 14 percent of the respondents are also doing government/semi-government jobs, which indicates their higher educational attainment. In addition, a significant portion of the respondents (54.5 %) in the study area also engaged in business activities in order to sustain their livelihood.

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3. Results and discussion

In this section, firstly climate change impacts on temperature and precipitation is investigated. Furthermore, time period data is used to determine the impact of climate change on main horticultural crops in term area, yield and productivity.

3.1 Temperature and Precipitation Trends in Districts Pishin (1985-2018)

3.1.1 Temperature Trends in District Pishin

The 33 years of temperature record shows that the district Psihin experiences subzero temperatures in winters (up to –1.07 C^{o}) and high temperatures in summers (up to 36.75 C^{o}). The Figure 2 below shows that Dec and Jan are the coldest months with average minimum temperatures recorded. Similarly, June, July and August have been recorded as hottest months with average maximum temperatures recorded in the last 33 years. Moderate temperatures are experienced during Feb to May and Sep to Nov ranging between 32.24 to 12.43 C^{o} and 14.09 to 0.56 C^{o} (see Figure 2).

Over the period of last 33 years, basing on the highest recorded temperature during the month of July, the hottest years were measured as 2016 and 2018 (38.3 C^{o}) whereas the years with lowest temperature were recorded as 34.9 C^{o} during year 1989 and . The overall average temperature was recorded as 36.8 C^{o} for the month of July over the period of 33 years.

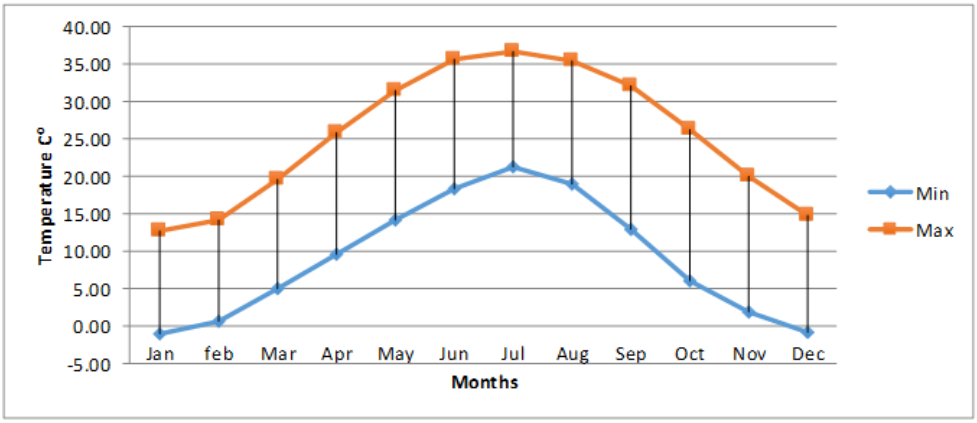

Figure 1: Average Monthly Temperature (Max and Min) in District Pishin from 1985-2018

3.1.2 Precipitation Trends in District Pishin

In 33 years average rainfall in District Pishin has been measured as 14.6 mm. This area has experienced maximum rainfall during year 1991 (41.70 mm) and minimum rainfall during year 2016 (2.39 mm). Spells of lowest recorded rainfall were recorded in years 1998-2002 and 2012-2017 probably characterized by drought periods in the area (see Figure3).

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By analyzing annual rainfall pattern of the district Psihin, it can be noticed that the months from Dec-Apr receive a considerable amount of precipitation in the form of winter snow and spring rainfalls up to 40 mm. However, the time period from May-Nov remains less exposed to precipitation and receives lowest up to 0.9 mm. This shows that the area does not fall under the summer monsoon rains zone and is dependent on the winter rains and snowfall only.

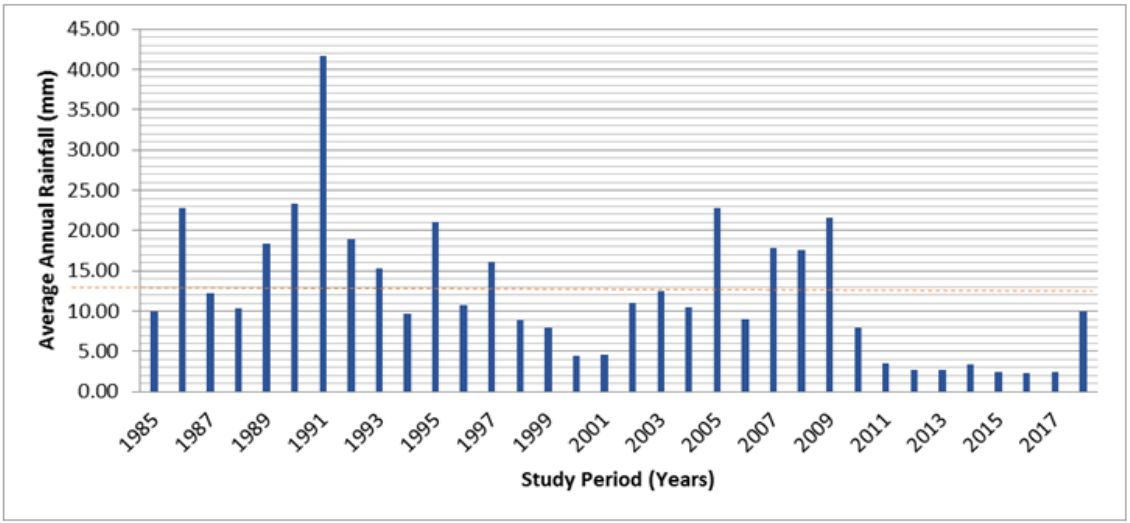

Figure 3. Average Annual Rainfall in District Pishin from 1985-2018

3.2 Trend of Area and Yield of Major Fruits in District Pishin

Temporal trend in area and yield of major fruit crops has been analyzed using 31 years data (1988-2018). The results indicate that remarkable increase in cultivation area of almost all major fruit crops has been observed during the study period. Annual growth rate (in percentage) of area indicates that significant increase has been observed in grapes cultivation (18.63 hectares per year) while least increased in area (0.83 hectares per year) is observed in apricot cultivation during the last 31 years in district Pishin (see **Error! Reference source not found.**1). As far yield of these fruits is concerned, results indicate that significant decrease in yield on annual basis of all major fruit crops has been decreased during the study period. It is important to point out here that increase in grapes cultivation indicate that farmers shifted towards grapes cultivation due to consistent decline in rainfall from 1998 onwards and decline in underground water tables. Since grapes requires less water as compare to other fruits especially apple which is the main cash crop in the district. In addition, productivity of apricot, plum and apple showed significant decline on annual basis during the study period with the figures 2.53, 2.26 and 1.64 tonnes per hectares respectively.

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Table 1: Area and Yield Decadal Change in Percentage and Annual Growth Rate of Major Fruits (1988-2018)

Fruits	Average Area in (Hectares)			Percentage Change		Annual Growth Rate (%)
	1988-97 (I)	1998-07 (II)	2008-18 (III)	I to II	II to III	
Apple	5717	7210	6550	26.1	-9.2	4.18
Apricot	1363	1173	1037	-13.9	-11.6	0.83
Grapes	3594	7943	8400	121.0	5.7	18.63
Peach	221	430	294	94.7	-31.6	4.07
Plum	317	509	500	60.5	-1.7	4.34
Fruits	Average Yield in (Tonnes/Hectares)			Percentage Change		Annual Growth Rate (%)
	1988-97 (I)	1998-07 (II)	2008-18 (III)	I to II	II to III	
Apple	11.6	6.7	5.3	-42.3	-20.5	-1.64
Apricot	15.3	8.4	3.4	-45.5	-59.4	-2.53
Grapes	8.0	4.6	5.1	-42.0	10.5	-1.61
Peach	11.5	7.9	9.7	-31.5	23.3	-0.72
Plum	14.5	6.5	5.2	-55.1	-19.9	-2.26

3.3 Coping and adaptive strategies of the farm household towards climate change

Comprehensive field survey revealed that farmers in the study area adopted varieties of ex-ante and ex-post strategies in order to mitigate the negative effects of climate change (i.e. drought) and to sustain their agro-based livelihood. Amongst them, crop management/diversification, inputs adjustment, efficient use of water, depletion of household assets, consumption smoothing and migration were notable.

3.4 Farm level Diversification strategies

3.4.1 Crop management/diversification

Farmers mostly diversify their crops in order to diffuse the risk and this strategy is well accepted in existing literature. Adger et al., (2003) indicated that farming community go for crop diversification option in their field to minimize the losses and spread the risk that is resulted due to climatic events. Results in Table 6 indicates that a small portion of the farm household opted mixed cropping and planted drought tolerant crops in their field due to recurrent drought situation in the study area. About 15.5% of the farm household cultivated drought tolerant fruit varieties in their field in district Pishin. They further revealed that farmers who had extensive resources, cultivated Kadja and Black Amberi apple varieties. Farmers mentioned that cropping pattern has changed due to long dry conditions and they further explained that apart from dominant fruit varieties such as Shin Coloo and Tor Coloo, farmers in the area cultivated above two varieties because they require less watering time and mature quickly. In addition, famers cultivated grapes as well and pointed out that they are more resilient to dry conditions and at the same time requires less water.

Apart from drought resistance fruits varieties, cultivation of different vegetables is also getting momentum in the area. Farmers pointed out that they are growing different

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vegetables such as potato, tomato, onion etc. along with their orchards. There are several advantages highlighted by the farmers of cultivating vegetables such as short time activity as well as market demand.

3.4.2 Agricultural input adjustment

In addition to crop management, adjustment of agricultural inputs such as use of fertilizers, pesticides, and manure is also an important adaptive strategy practiced by the farming community in district Pishin. Majority of the farmers (66 %) in the study area increased the use of fertilizer in their field. They mentioned that due to long dry condition and water scarcity, trees become weak and production declined, therefore they increased the amount of the fertilizer to control the situation.

Apart from the fertilizer adjustment, majority of the farmers (69 %) in district Pishin, used more pesticides because dry conditions not only make the trees more vulnerable to pest attacks but also affects the production quality. Farmers pointed out that they increase the use of pesticides in order to tackle the pest attacks on trees, which become more prominent in dry conditions. Apart from fertilizer and pesticides, use of manure is also very important since it gives the strength to the trees and improve the soil fertility. Similar to pesticides, majority of the farmers in district Pishin increase the use of manure in their field. They mentioned that manure give power to the trees as well as keep the soil moisture for a long time. However, few farmers decrease the use of manure by mentioning the significant decline in manure production in the area due to drought.

3.4.3 Efficient use of water

In order to minimize the impact of climate change (i.e. drought in our case), farmers have employed numbers of techniques to utilize available water in an efficient way in their fields. Among them, extra cutting of trees, digging of more wells/tube wells, use of pipe for watering, giving water during night time, construction of cemented ponds for water storage, division of garden in to small plots, and construction of more water channels etc. were notable (see Table 6).

Majority of the farmers in the study area did their bests to save their orchards during the long dry spell in the area. In order to save the already scare water resources, they have constructed cemented water ponds and water channels, use pipe for watering instead of flood irrigation in their fields.

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Table 6: Farm level coping/adaptive strategies due to climate change by the farmers

Farm level strategies	N	%
Crop Diversification		
Grow more than one crop and variety in the same piece of land	25	12.5
Grow drought tolerant crops	31	15.5
Planted high-yielding varieties of crop	0	0.0
Planted short duration varieties	10	5.0
Input Adjustment		
Use less	68	34.0
No change	0	0.0
Pesticides		
Use more	138	69.0
Use less	62	31.0
No change	0	0.0
Manure		
Use more	138	69.0
Use less	62	31.0
No change	0	0.0
Water Management		
Use of pipe for watering	20	10.0
Dug more wells/tube wells	167	83.5
Extra cutting of trees	47	23.5
Buy water from tanker	165	82.5
Use drip/sprinkle system	18	9.0
Give water during night time	15	7.5
Constructed ponds for storing water	26	13.0
Remove more water consuming crop	11	5.5
Divide the garden in to small plots	170	85.0
Divide and constructed more water channels	165	82.5
Water harvesting (rain water storage)	15	7.5

Source. Survey data, 2020-21

Most importantly, a significant number of farmers in the area try to save their orchards by giving sacrifice of some part of the orchards, since it was difficult to give water to whole orchard it seems easier for them to give water to some portion and avoid complete failure of the whole orchard. A small portion of the farmers in both the districts used latest technology of drip/sprinkle irrigation in their field to cater the water shortage in an efficient way. Majority of the farmers are small farmers, therefore they can't afford such technology in their fields

3.5 Off-farm strategies

3.5.1 Depletion of assets

Apart from consumption smoothing, field survey further revealed that farmers have also opted asset depletion strategy in order to save their orchards and to fulfill the needs of

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their children in the study area. Paul, (1998) found that assets depletion particularly in underdeveloped world is strongly interlinked with intensity and onset of the drought period. Figures in Table 7 indicate that farmers try to cope with the drought event by selling their agricultural and non-agricultural land, selling of livestock, selling of agricultural equipment etc. in the study area. Majority of the farm household (56.5 %) of the farmers sold their livestock in order to sustain their livelihood or in some instances starting new business. Whereas, about 36 % of the farmers sold their farmland and agricultural equipment in district Pishin to save their orchard from complete failure. In addition, a significant portion of the farming community sold their household utensils in the study area to sustain their livelihood.

3.5.2 Consumption smoothing

Consumption smoothing is one of the well-known off-form level strategy practiced by the farming community whenever they experienced a significant decline in their income. Studies conducted in developing countries, for example, Bhandari et al., (2007) conducted a research study in Eastern India and found that farmers with low income have minimized their expenditure on food, children's education, health care, social events etc. during the drought.

Majority of the respondents in district Pishin economize their expenditures on food, education, clothes, construction, and social events during the stress conditions. Farmers revealed that they have curtail their self to a less expensive food due to decline in their income. In addition, poor farmers particularly in district Pishin could not able to continue education of their children during the drought. Figures in the Table 7 indicate that situation on the mentioned items were miserable in the study area since majority of the farmers belongs marginal landholding category.

3.5.3 Migration

Since orchard, farming in both the districts is the primary source of income of rural household and it has been evidenced that in most of the instance orchards got completely dried up due long dry spells in the study area. Figures indicate that majority of the farmers or their family members in district Pishin migrated to nearby cities and towns to seek alternative source of income in order to sustain the livelihood of their families (see Table 7).

During the field survey, it has been evidenced that family system in Pishin is extended that is why these households have enough manpower which they have utilized during the stress situations. Similar findings have been obtained from other studies (Kuhl, 2002; Lazo & Tapay, 1999; Shah & Shah, 2005) which report that short-term or permanent migration is another coping strategy practiced by the farm household living in rural areas.

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Table 7: Off-farm level coping/adaptive strategies in the context of climate change

Off-farm level strategies	N	%
Asset depletion		
farm land	7	3.5
Cattle	113	56.5
Poultry	75	37.5
Household utensils	43	21.5
Agricultural equipment	65	32.5
Consumption smoothing/economization expenditure		
Reduced number of meals/ate less expensive food	176	88.0
Children's education	194	97.0
Clothes	191	95.5
Health	165	82.5
House construction	180	90.0
Social/family events	200	100.0
Migration		
Family members of the farmers migrated to other cities for alternative sources of income	175	87.5

Source. Survey data, 2020-21

4 Conclusion and policy implications

Climate change has emerged as a great challenge for Pakistan. Pakistan demography, geography and diverse climatic situation have increased this vulnerability manifold. Balochistan is the least developed province of the country and about 85% of the rural communities are engaged in agricultural activities for their livelihood. Furthermore, the economic indicators of the Balochistan are far below the national level and in some areas, poverty is increasing contrary to decline at national level. This study has examined the climate change induced impacts on horticultural crops productivity and other related factors that include trend in rainfall and temperature. In addition, farmers' perception about the climate change and their perceived impacts on their agro-based livelihood and most importantly how they cope or adapted to mitigate the negative effects of climate change on their orchards have also been investigated. Findings of the study revealed that temperature has increased whereas rainfall has decreased in the study over the last two decades. These results are in line with the farmers' perception about these climatic indicators. Annual growth rate (in percentage) of area indicates that significant increase has been observed in grapes cultivation (18.63 hectares per year) while least increased in area (0.83 hectares per year) is observed in apricot cultivation during 1988 – 2018. However, a significant decrease in yield on annual basis of all major fruit crops has been observed during the study period Field survey further revealed that farmers have adopted varieties of ex-ante and ex-post strategies in order to mitigate the negative effects of climate change (i.e. drought) and to sustain their agro-based livelihood. Amongst them, crop management/diversification, inputs adjustment,

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efficient use of water, depletion of household assets, consumption smoothing and migration were notable. The existing agriculture and drought related policies are in favor of the marginal farmers to mitigate the impacts of climatic events and to sustain their livelihood in a stress conditions. To reduce the impact of climate change and to protect the farmers, following policy recommendations are proffered for the research area.

- An accurate and timely weather forecasting system, drought early warning system, and timely communication with farming communities would enabled them to adjust in input use, selection of crops resistant to stress conditions etc. This can be achieved with the proper help and continuous support of government extension services.
- An effective disaster management and awareness campaigns on natural resource management seem to be emergent needs of the communities.
- Emphasis on adoption of new crops and resistant varieties suited to agro-climatic conditions and diversification of farm and livelihoods is needed.
- Since the study area is prone to frequent droughts and also there is high variability in rainfall in the province, there is great need of adjustment in the existing water resource management strategies in the context of changing climate.

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References

Adger, W. N., Huq, S., Brown, K., Conway, D., & Hulme, M. (2003). Adaptation to climate change in the developing world . Progress in Development Studies, 3, 179–195. https://doi.org/10.1191/1464993403ps060oa

Ainuddin, S., & Kakar, K. M. (2015). Status of Community Resilience in Disaster Prone Districts of Baluchistan , Pakistan. November, 126–135.

Arkin, H., & Colton, R. (1963). Tables for Statisticians. Barnes & Noble.

Bhandari, H., Pandey, S., Sharan, R., Naik, D., Hirway, I., S.K. Taunk, S. K., & Sastri, A. S. R. A. S. (2007). Economic costs of drought and rice farmers' drought-coping mechanisms in eastern India . In B. H. Pandey S Hardy B, (Ed.), Economic costs of drought and rice farmers' coping mechanisms: a cross-country comparative analysis (pp. 43–112). International Rice Research Institute (IRRI).

Khair, S. M., Maqsood, A., Rasheed, A., Razique, A., and, S., & Ihsan. (2015). Drought risk assessment in the Province of Balochistan, Pakistan. Carried out by BUITEMS and UNDP. .

Khan, A.N. and Ali, A. (2015). Disaster Risk Reduction Approaches in Pakistan Disaster Risk Reduction Methods, Approaches and Practices.

Kuhl, J. J. (2002). Risk-coping strategies by agricultural households in developing countries: a taxonomy. Manuscript. Institute of Economics, University of Copenhagen and UNEP Collaborating Center on Energy and Environment, Denmark. Roskilde (Denmark): The University of Cop.

Lazo, J. A., & Tapay, N. E. (1999). Social correlates of rainfed rice farmers' mechanisms to cope with

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DOI 10.17605/OSF.IO/U6VX7

drought. Philipp. Agric. Sci., 82(2), 190–199.

Nasrullah, M. A., Khan, Mahmood, A., Malghani, M. G. K. &, & Kakar, E. (2011). Socio-economic effects of water scarcity in Tehsil Karazat district Pishin, Balochistan. Journal of Applied and Emerging Sciences, Balochistan University of Information Technology Engineering and Management Sciences, Quetta, 2(2), 116–123.

NDMC, P. (2015). Drought watch bulletin, 2015. National Drought Monitoring Centre, Pakistan Metrological Department, Islamabade. www.ndmc.pmd.gov.pk/index.htm

Paul, B. K. (1998). Coping mechanisms practised by drought victims (1994/5) in North Bengal, Bangladesh. Applied Geography, 18(4), 355–373. https://doi.org/http://dx.doi.org/10.1016/S0143-6228(98)00026-5

Shah, D. C., & Shah, A. (2005). Migration in remote tribal areas: evidence from southwestern Madhya Pradesh. Indian J. Agric. Econ., 60(2), 184–204.