INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 14, No. 5, p. 497-506, 2019

RESEARCH PAPER OPEN ACCESS

Climate change threat to horticulture crops and performance of agricultural extension in Balochistan

Rahmatullah[1], Katsuhito Fuyuki[2], Khalid Nawab[1]

[1]*Department of Agricultural Extension Education and Communication, The University of Agriculture Peshawar, Pakistan.*

[2]*Department of International Development Studies, Graduate School of Agricultural Sciences, Tohoku University, Japan.*

Key words: Horticulture crops, Climate change, Agricultural Extension, Balochistan.

http://dx.doi.org/10.12692/ijb/14.5.497-506 Article published on May 26, 2019

Abstract

Environmental changes today are an inevitable reality for Pakistan and is starting to show its effect through extreme heat stress at basic vegetative stages and expanded water prerequisites of crops. The Aim of this study was to explore the effect of climate change on horticulture crops and the role of agricultural extension workers in Balochistan. A total of 384 farmers were selected through single stage sampling technique for the study, data were collected thorough well-structured interview schedule and analyzed by using Statistical Package for social sciences (SPSS), Paired sample t-test and one sample t-test was applied on the data. The results reveals that majority 82% of the farmers don't know the agricultural extension worker of their area and 95% of the farmers reported that the agricultural extension worker never visited them while, 84% of the farmers reported that fellow farmers were the major source of agricultural information. Majority 93% of the farmers perceived that rainfall is decreased and 97% of the farmers' perceived temperature is increased. Results further reveals that highly significant ($P \leq 0.00$) decrease was observed in the area and yield of all major horticulture crops over the last 10-15 years. Climate change has severe effects on declining crops yield, increasing cost of production, crop infestation with insects and diseases and frequent occurrences of droughts. It is suggested that training should be arranged on climate change and its adaptation for agricultural extension works which will enable them to perform in a batter way in the field.

* **Corresponding Author:** Rahmatullah ✉ rahmatullah364@gmail.com

Introduction

Beginning of 20th century the annual mean temperature has raised from 0.6-1.0 °C in Pakistan (Farooqi *et al.*, 2005). Increased in temperature affected the crop and livestock production. High temperature might have negative effect on crops such as early leafing, flowering and fruiting or follower shading due to high temperature and moisture stress which ultimately affect the livelihood of farmers (Brown, 2006; Tschakert, 2007; Dieye and Roy, 2012).

Environmental changes today are an inevitable reality for Pakistan and is starting to show its effect through extreme heat stress at basic vegetative stages and expanded water prerequisites of crops. Climate has its undesirable impact on agriculture and livestock. Variation in climate directly or indirectly affect the agriculture and farming production (Schmidhuber and Tubiello, 2007).

Despite technological advances, such as improved varieties, genetically modified organisms, and irrigation systems; weather is still a key factor in agricultural productivity, as well as soil properties and natural communities. The effect of climate on agriculture is related to variability in local climates rather than in global climate patterns. Climate change induced by increasing greenhouse gases is likely to affect crops differently from region to region which can affect the agricultural productivity. Global warming could lead to an increase in insect pest populations, damaging yields of staple crops like wheat, soybeans, and corn (*Live Science, 2017)*. Moreover, climate change can affect the growth stages of pathogens and can dramatically hit the agriculture sector. The change in rainfall patterns, increase or decrease in temperature all has a combined effect over the productivity of agriculture.

In climate change adaptation agricultural extension department can play a significant role by creating awareness about planting of trees to stop further deforestation, educate the farming community through starting of campaign about negative effects of climate change and to build their capacity to cope with adverse effect of climate change (Safdar *et al.,* 2014).

The role of agricultural extension workers should be further clarified to the farming community. It includes to promote and encourage the farming community to adopt advanced methods of farming, use of modern technologies, through different methods e.g. arranging group study for farming community, demonstration, field visit, lecture, field days, as well as informing the media regarding the challenges of farming community. Developing policies that improved the role of agricultural extension workers in farming community have a great potential to improve farmers' adaptation strategies for climate change. Government should impart the trainings to agricultural extension works on climate change and its adaptation so that they can provide relevant and timely information on climate change to the farming community (Maponya and Mpandeli, 2013).

Effective agricultural extension system of any country play an important role in the developmental process. Agricultural extension system of Pakistan is strongly criticized for not having significant impact on crop yield and not to get the desired positive changes in rural livelihood. To improve the effectiveness and efficiency of the service, new initiatives have been taken in the form of decentralization and devaluation. There is dire need of an agricultural extension system which is capable to promote sustainable agricultural development and addressing the problems of rural people (Baig *et al.*, 2009).Objectives of the study were first, to check the effect of climate change on Horticulture Crops in the study area; second, to analyze the role of agriculture extension worker about climate change threat; third, to study the farmers perception about climate change effect in the study area.

Materials and methods

Universe of the Study

Universe of the Study was Balochistan province of Pakistan. The province have diversified climate ranges from semi-arid to hyper-arid. The province has been divided into four agro-climatic zones i.e. Desert, Costal, Upland and Plains.

The province temperature vary widely from cool temperate to tropical with mild summers and cold winter in the uplands (PARC, 1980).

Sampling techniques

For the selection of sample multistage sampling (Cochran, 1977) was used. In first stage one division Zhob was selected out of total six division of the province, in second stage three District Musakhail, Zhob, Loralai were randomly selected from the selected Division. To draw the required sample size single stage sampling technique (Casley and Kumar, 1988) was used. The single stage sampling techniques is expressed in equation (1.1).

$$n = \frac{z^2 v^2}{d^2} \quad \text{............} (1.1)$$

Where:

Z^2= reliability coefficient (Constant) = (1.96)

V^2= 50% as no similar studies were found in study area and there is 50% chance of respondents being aware of climate change and its adaptation strategies.

n = required sample size

d^2= assumed marginal error (5%) $n = \frac{1.96^2 50^2}{5^2} = 384$

Data collection and analysis

The data was collected through well-structured interview schedule, three point likert scale was used to check the farmers perception about climate change effect and the weights were assigned such as 1=Uncertain, 2= Disagree and 3= Agree for analysisof data Statistical Package for Social Science (SPSS) was used. To check the effect of climate change on horticulture crops production Paired Sample t-test (1.2) and one sample t-test (1.3) was applied on the data.

Paired Sample t-test

$$t = \frac{\bar{d}}{Sd\sqrt{n}} \quad \text{............} (1.2)$$

Where:

D= difference between two sample observations (before and after effect)

N= number of pairs

Sd= standard deviation

$$Sd = \sqrt{\frac{\sum (d_i - \bar{d})^2}{n-1}} \text{ and } \bar{d} = \frac{\sum d_i}{n}$$, the mean of d-

Values.

One Sample t–test

$$t = \frac{\bar{X} - \mu}{s/\sqrt{n}} \quad \text{............} (1.3)$$

Which under the null hypothesis follow a t-distribution with $(n-1)$ degrees of freedom. In equation (1.3),

Where,

$\bar{X}$ And μ = the sample and population means

S= is the sample standard deviation

N=is the sample size.

Results and discussion

Farmers' knowledge about agriculture extension worker and its visit

Data in Fig. 1. Illustrates that a vast majority of the respondents 82% did not know the agricultural extension worker of their area while, only 18% of the respondents just know the name or by face agricultural extension worker of their area. Moreover, 95% of total respondents reported that extension workers never visited them, whereas, only 5% of the respondents reported that extension workers visited them once a season. These results concluded that visit of the extension workers in the study area was discouraging which might be due to the shortage of facilities with the extension workers and as a result they face problem in covering all the farmers of their area of jurisdiction. The result are in conformity by Baloch and Thapa (2014) and Ahmad *et al.* (2007) who reported that overwhelming majority of farmers were never visited by the agricultural extension workers.

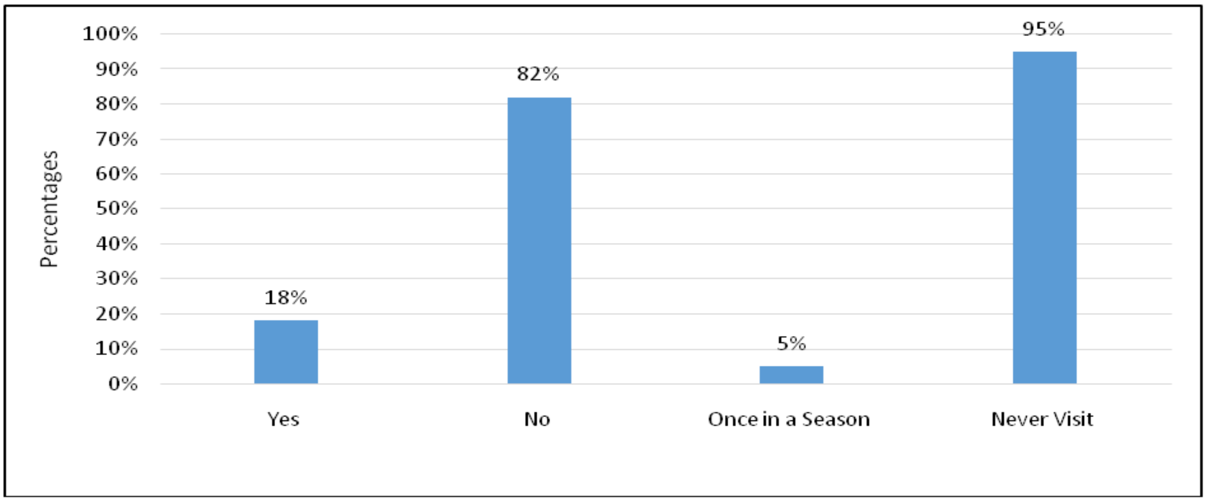

Fig. 1. Farmers Knowledge about Agriculture Extension Worker and its visit.

Source of agricultural information

Data in Fig.2 shows that majority 84% of the respondents reported fellow farmers as their source of agricultural information followed by 7% who reported electronic media and 5% who used agricultural extension workers as the source of agricultural information. Moreover, the results also show that 5% of the respondents also used print media as the source of agricultural information. Unfortunately the role of agricultural extension services was negligible which might be due to low political interest allocating little amount of budget for agricultural at both provincial and federal level. The results are similar with those of Akanda and Roknizzamanu (2012) and Bachhav (2012). The results are also confirmed by Ahmad *et al.* (2007) who reported that majority of farmers did not get the information from extension worker.

Farmer's perception about temperature and rainfall

Data presented in Fig 3 shows that majority93% of the respondents reported that rainfall is decreased in the study area in last 10-15 yeas while only 2% of the respondents reported that rainfall is increased. Furthermore 97% of the respondents in the study area reported that they had observe increased in temperature. While, only 3% of the respondents reported that they did not observed any change in the temperature over the last 10-15 years. These results confirmed by the data of metrological department of Balochistan Fig 4, 5 and 6 which shows the trend of minimum and maximum temperature is increased and rainfall is decreased in that last four decades (1975-2014). These results are also confirmed in other studies of (Raghuvanshi*et al.* 2017; Gbetibouo. 2009; Ajuanget *al.* 2016; Uddin *et al.* 2014) who reported that majority of the respondents observed that temperature is increasing and rainfall is decreasing.

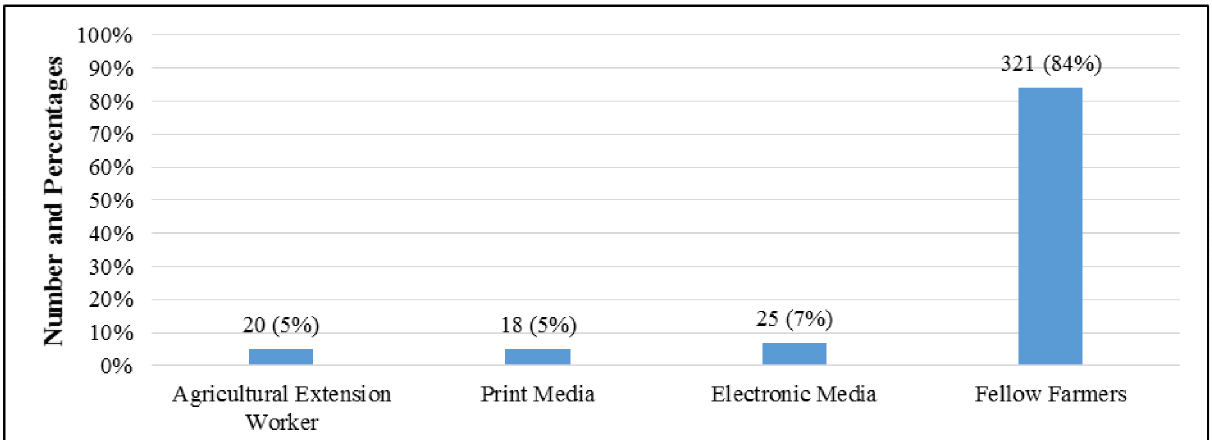

Fig. 2. Source of agricultral information.

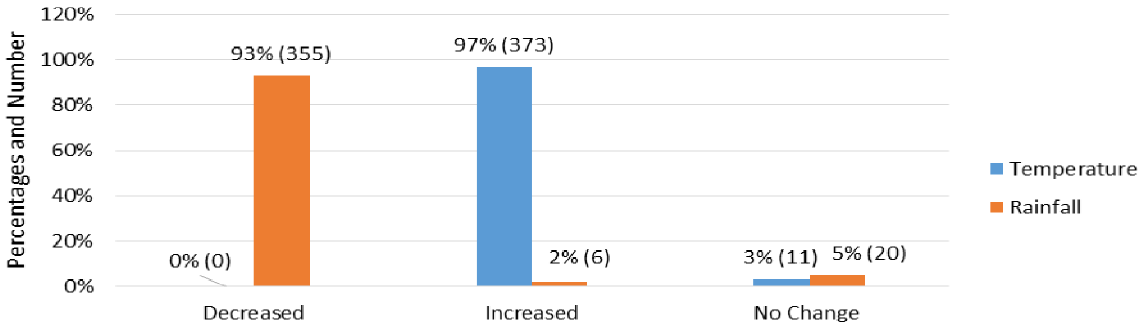

Fig. 3. Farmer's perception about temperature and rainfall.

Trend of the minimum, maximum temperature and rainfall in the study area

The data regarding minimum, maximum temperature and rain fall of about four decades (1975-2014) were obtained from the metrological department of Balochistan. The data were analyzed using Microsoft excel and the results are illustrated in Fig.4, Fig. 5 and Fig. 6. The data show the trend of the minimum, maximum temperature and rainfall over the last four decades has been increased in study area. Majority of the respondents reported that temperature has increased and rain fall decreased over the last 15 year, which is also clear from the trend of rain fall, maximum and minimum temperatures are showing significant increase.

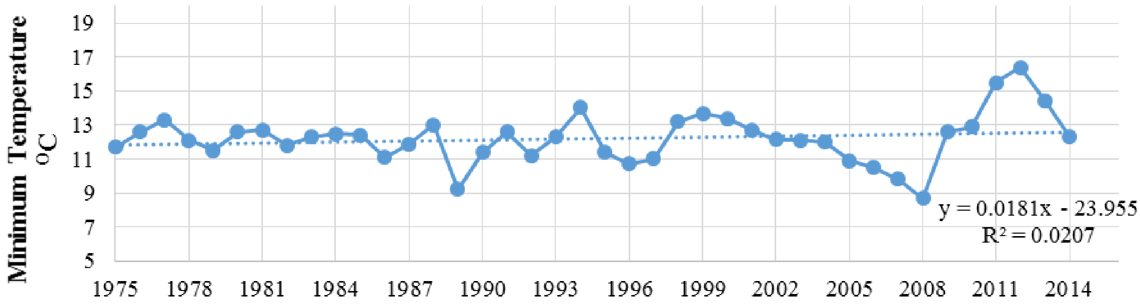

Fig. 4. Minimum Temperature in the study area in last four decades (1975-2014).

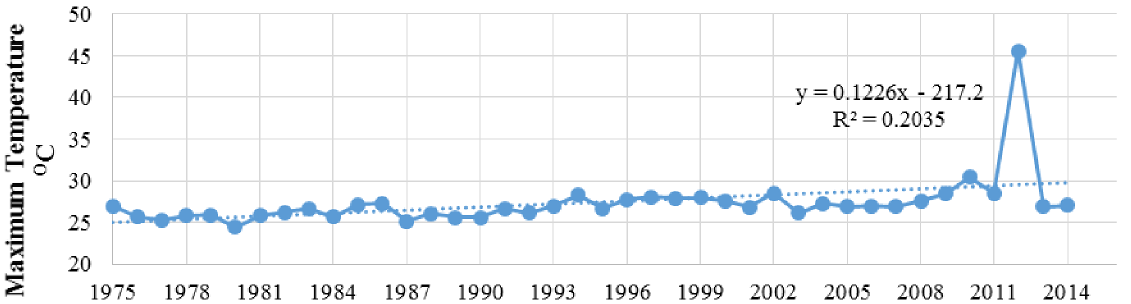

Fig. 5. Maximum Temperature in the study area in last four decades (1975-2014).

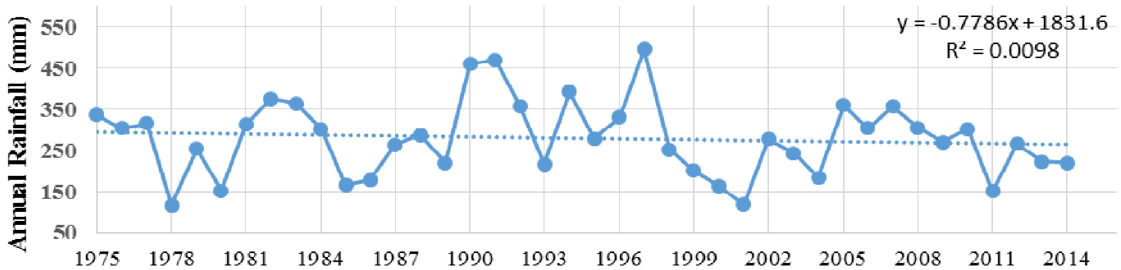

Fig. 6. Rainfall in the study area in last four decades 1975-2014.

Effect of climate change on the area and yield of major fruits

Results in Table 1 depict that there was decrease in the area of various fruits orchards in the last 10-15 years. The area of almond was decreased from 339.68 ha to the 283.40 ha with the 16.57% decrease. Similarly, area under apple orchards was decreased by 448.18 ha to 124.70 ha with 72.17% decrease, apricot area before 10-15 years was 70.45 ha which is reduced to 21.86 ha with 68.91% decrease. Whereas, peach area was decreased from 44.13 ha to 18.62 ha with the 57.80% decreased in the last 10-15 years. Moreover, the effect of climate change was also observed on overall production (192.57 tons) of almond, apple (516.23 tons), apricot (149.22 tons) and peach (44.46 tons) has been decreased to 146.42 tons, 249.18 tons, 64.39 tons and 18.62 tons respectively. The results showed that there was significant effect of climate change over the fruit orchards. To find out mean significant difference of area and yield under fruits before 10-15 years and present, Paired sample t-test was used and the computations were given in the Table 2. The results showed that there was highly significant ($P \leq 0.01$) difference in the mean area of almond before 10-15 years and present i.e. -0.55 acres. Similarly, the mean significant difference area of apple, apricot and peach was -3.56, -0.81 and -0.87 respectively. Furthermore, there was also highly significant ($P \leq 0.01$) difference was observed in the yield of almond, apple, apricot and peach i.e. -227.46, -348.26, -504.44 and -323.47 respectively before 10-15 years and present. These results indicate the scarcity of irrigation water severely affected the most important fruit crops, apple, almond, apricot and peach which are the main source of income in study area. Study area has now become a timber market for the sale of wood from uprooted dead trees. UNDP (2015) reported that apple orchards are undergoing a decline due to continuous drought and depleting water table. About one third of the orchard areas have dried up, a third under great stress, while the remaining one third is alive due to spring water in the upland of Balochistan. The apple crop area has been reducing significantly in the uplands of Balochistan (Government of Balochistan, 2013-2014). The continued stress also affects the fruit quality, especially apple, which is very sensitive to water stress and thus highly requiring irrigation water (Naor, 2006; Girona *et al.*, 2010).

Table 1. Total reported area and production of major fruits before 10-15 years and present of the respondents in the study area.

Sl. No.	Major fruits	Total reported area (ha)		% Area change	Non-bearing area (ha)	Overall production (tons)		
		Before 10-15 years	Present			Before	Present	Percent </>
1	Almond	339.68	283.40	<16.57%	30.36	192.57	146.42	<24%
2	Apple	448.18	124.70	<72.17%	0	516.23	249.18	<51.73%
3	Apricot	70.45	21.86	<68.97	0	149.22	64.39	<56.84%
4	Peach	44.13	18.62	<57.80	0	44.46	18.62	<58.11%

Source: Author Survey results, 2018.

Table 2. Comparison of area and yield under major fruits before 10-15 years and present of the respondents in the study area.

Major Fruits	Present		Before 10-15 years		Mean Difference		t-value	P-value
	Mean	S.E	Mean	S.E	Mean	S.E		
Almond Area in Acre	4.52	0.15	5.07	0.17	-0.55	0.09	-6.11	.000
Almond Yield (Kg per Acre)	946.23	12.56	1173.70	13.91	-227.46	8.68	-26.18	.000
Apple area in acre	3.14	0.15	6.70	0.32	-3.56	0.29	-12.06	.000
Apple yield (Kg per acre)	2542.65	27.98	2890.91	30.03	-348.26	17.71	-19.65	.000
Apricot Area in Acre	2.00	0.18	2.81	0.26	-0.81	0.23	-3.41	.002
Apricot yield (Kg per acre)	2384.81	114.69	2889.25	115.66	-504.44	56.62	-8.90	.000
Peach Area in Acre	2.08	0.22	2.95	0.29	-0.87	0.23	-3.65	.001
Peach yield (Kg per acre)	1190	116.01	1513.47	140.18	-323.47	43.42	-7.44	.000

Source: Author Survey results, 2018.

Effect of climate change on the area and yield of major vegetables

Paired sample t-test was used to find out the mean significant difference of area and yield of major vegetable of the study area and the results are presented in Table 3. The data shows that there is highly significant (P≤0.001) difference observed in the area of Cauliflower, Spinach and Tomato with the mean difference was 0.76, 0.42, and 0.48 respectively. While no significant difference was observed in the area of onion before 10-15 years and present. Furthermore, highly significant (P≤0.001) difference was observed in the yield of major vegetables of study area with the mean difference was -154.28, -190.47 and -170.00 kg/acre of Cauliflower, Spinach, and Onion. Whereas, no significant difference was observed in the yield/acre of Tomato before 10-15 years and present in the study area. Slightly decreases are found in the vegetables yield which might be due to agronomic practices and climatic extremes. These results are in line with (Fosu-Mensah, 2012).

Table 3. Comparison of area and yield under major vegetables before 10-15 years and present of the respondents in the study area.

Major vegetables	Present		Before 10-15 years		Mean difference		t- Value	P-Value
	Mean	S.E	Mean	S.E	Mean	S.E		
Cauliflower Area in Acre	3.04	0.18	2.28	0.14	0.76	0.20	3.70	.001
Cauliflower Yield (Kg per Acre)	5623.33	37.93	5777.61	39.90	-154.28	39.72	-3.88	.001
Spinach Area in Acre	2.14	.14	1.71	.10	.42	.13	3.28	.004
Spinach Yield (Kg per Acre)	6210.95	26.08	6401.42	21.27	-190.47	24.95	-7.63	.000
Tomato Area in Acre	2.44	0.20	1.96	0.11	0.48	0.15	3.11	.004
Tomato Yield (Kg per Acre)	3406.48	100.85	3447.40	58.73	-40.92	111.22	-0.36	.716
Onion Area in Acre	1.78	0.11	1.87	0.12	-0.090	0.07	-1.13	.263
Onion Yield (Kg per Acre)	5750.30	115.57	5920.30	153.33	-170	70.89	-2.39	.022

Source: Author Survey results, 2018.

Farmers' perception regarding effect of climate change

Results in Table 4 depicts that majority (91%) of the respondents were of the view that climate change had significantly decreased the crop yield with over all mean value of 2.88 representing that they agreed on the statement. Similarly, majority (96.9%) of the respondents also agreed with the fact that yearly rainfall is not supporting crop production followed by the 83% of total respondents who reported that climate change leads to crop infestation by insects and diseases. Moreover, about 72% of the respondents reported that with the climate change the cost of production of crops also got increased. These results are similar to Ishaya and Abaje (2008) who reported that 81% of the respondents expressed that climate change increased their cost of crop production.

About 53% of the respondents reported that due to climate change and its effect on local agriculture, the agriculture seems a non-profit occupation to the local community and thus to earn income, people try to migrate themselves to the urban areas for other opportunities. Similarly, decline in the forest resources were reported by the overwhelming majority (97.9%) who agreed with the effect of climate change over the decline of the forest resources, whereas, occurrence of floods were reported by 95.2%. Similarly, 99% of the respondents agreed with the fact regarding frequent occurrence of droughts during the rainy seasons. These results are also in line with Ogalleh*et al.* (2012) who found that 96% of respondents reported the occurrence of drought in rainy season. Furthermore, majority (96.1%) of the respondents reported that drying of water resources is also one of the effects of climate change, followed by the 61.2% who reported that it also brought change in livelihood system. These results are similar to the results of Ishaya and Abaje (2008)Decrease in soil fertility was reported by majority 59.4% of the respondents as disagree i.e. the climate change does not have any effect over the soil fertility with non-significant difference and t-value of 0.523. Decrease in pasture land was also reported by overwhelming majority i.e. 97.9% whereas, deforestation due to the climate change was reported by 99.2% of the total respondents.

Table 4. Perceptions of respondents regarding effects of climate change.

S. No	Effect of climate change	Disagree	Undecided	Agree	Mean average	t-value	P-value
1	Climate change has resulted to decline in crops yield	9 (2.3)	25 (6.5)	350 (91.1)	2.88	45.43	.000
2	The yearly rains are not supporting crop production as before	5 (1.3)	7 (1.8)	372 (96.9)	2.95	64.37	.000
3	Climate change has led to crop infestation with insects and diseases.	11 (2.9)	52 (13.5)	321 (83.6)	2.70	19.77	.000
4	Cost of production of crops is increasing because of climate change.	43 (11.2)	66 (17.2)	275 (71.6)	2.54	13.84	.000
5	Climate change has led to rural-urban migration of youths.	101 (26.3)	79 (20.6)	204 (53.1)	2.32	8.02	.000
6	Climate change has led to decline in forest resources.	3 (0.8)	5 (1.3)	376 (97.9)	2.96	78.00	.000
7	Frequent occurrences of floods during the raining season.	9 (2.3)	9 (2.3)	366 (95.3)	2.92	54.30	.000
8	Frequent occurrences of droughts during the raining season.	1 (0.3)	2 (0.5)	381 (99.2)	2.98	126.68	.000
9	Climate change has led to decreasing/drying of water sources	9 (2.3)	6 (1.6)	369 (96.1)	2.94	64.23	.000
10	Climate change has led to changes in livelihood system	86 (22.4)	63 (16.4)	235 (61.2)	2.44	11.55	.000
11	Decrease in soil fertility	228 (59.4)	74 (19.3)	82 (21.4)	2.02	0.64	.523
12	Decreased Pasture land	4 (1.0)	4 (1.0)	376 (97.9)	2.96	83.86	.000
13	Deforestation	2 (0.5)	1 (0.3)	381 (99.2)	2.98	155.47	.000

Source: Author Survey results, 2018. Values in parenthesis () are Percentages.

Conclusion

It is concluded that most of the area under different major fruits and vegetables has been decreased in last 10-15 years due to decreased rainfall, increased temperature and extreme weather events. Agriculture extension department in the study area is insufficient and inactive. Agriculture extension department was unable to support the farmers regarding climate change. Respondents in the study area perceived of increased temperature and decreased rainfall. Declining crops yield, increasing cost of production, crop infestation with insects and diseases and frequent occurrences of droughts was the major effect of climate change. Campaign should be started for the capacity building of farmers and to cope with the adverse effects of climate change. Government should provide gas pipelines in the study area to stop further deforestation. Agricultural research department of Balochistan should develop climate and drought resistant varieties of fruits and vegetables for the study area. Training should be arranged for agricultural extension works on climate change and its related issues which will enable them to perform in better way in the field with farmers.

Acknowledgement

I am really thankful to my supervisors Prof. Dr. Khalid Nawab and Katsuhito FUYUKI for continues help and support to complete this research. This study is a part of My PhD dissertation that will be submitted to the University of Agriculture Peshawar, Pakistan, by the major author.

.References

Adesina AA, Baidu-Forson J. 1995. Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural economics **13(1),** p 1-9. https://doi.org/10.1016/0169-5150(95)01142-8

Ahmad M, Akram M, Rauf R, Khan IA, Pervez, U. 2007. Interaction of extension worker with farmers and role of radio and television as sources of information in technology transfer: a case study of four villages of district Peshawar and Charsadda. Sarhad Journal of Agriculture **23(2),** 515.

Ajuang CO, Abuom PO, Bosire EK, Dida GO, Anyona DN. 2016. Determinants of climate change awareness level in upper Nyakach Division, Kisumu County, Kenya. Springer Plus **5(1),** p 1015.-1020. https://doi.org/10.1186/s40064-016-2699-y

Akanda AKM, Roknuzzaman MD. 2012. Agricultural information literacy of farmers in the Northern Region of Bangladesh. In Information and Knowledge Management **2(6),** 1-11.

Bachhav NB. 2012. Information Needs of the Rural Farmers: A Study from Maharashtra, India: A Survey. Library Philosophy & Practice. E-journal: p1-12.

Baig MB, Al-Subaiee FS, Straquadine GS. 2009. Role of agricultural extension in sustainable rural development in Pakistan. Agricultural Management/Lucrari Stiintifice Seria I. Management Agricol **11(1),** 10-28. http://www.worldcat.org/oclc/860108645

Baloch AM, Thapa BG. 2014. Agricultural extension in Balochistan, Pakistan: Date palm farmers' access and satisfaction. Journal of Mountain Science **11(4),** p 1035-1048. https://doi.org/10.1007/s11629-013-2837-8

Brown ME. 2006. Assessing natural resource management challenges in Senegal using data from participatory rural appraisals and remote sensing. World Development **34(4),** 751–767.

Casley DJ, Kumar K. 1988. The collection, analysis and use of monitoring and evaluation data. The World Bank.

Cochran WG. 1977. Sampling Techniques. 3rd Edition, John Wiley & Sons, New York.

Dieye AM, Roy DP. 2012. A study of rural Senegalese attitudes and perceptions of their behavior to changes in the climate. Environmental management **50(5),** 929-941. https://doi.org/10.1007/s00267-012-9932-4

Farooqi AB, Khan AH, Mir H. 2005. Climate change perspective in Pakistan. Pakistan Journal of Meteorology **2(3),** 11-21.

Fosu-Mensah BY, Vlek PL, Mac Carthy DS, 2012. Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. Environment, Development and Sustainability, **14(4),** p 495-505. https://doi.org/10.1007/s10668-012-9339-7

Gbetibouo AG. 2009. Understanding farmers' perceptions and adaptations to climate change and variability. The case of the Limpopo Basin, South Africa. IFPRI Discussion Paper 00849. February 2009.

Girona J, Behboudian MH, Mata M, Del Campo J, Marsal J. 2010. Exploring six reduced irrigation options under water shortage for 'Golden Smoothee 'apple: responses of yield components over three years. Agricultural Water Management **98(2),** p 370-375. https://doi.org/10.1016/j.agwat.2010.09.011

Go B. 2014. Government of Balochistan. 2013-2014. Agriculture Statistics of Balochistan. Quetta, Department of Agriculture Extension, Balochistan, Pakistan.

https://doi.org/10.1016/j.worlddev.2005.10.002

Ishaya S, Abaje IB. 2008. Indigenous people's perception on climate change and adaptation strategies in Jema'a local government area of Kaduna State, Nigeria. Journal of geography and regional planning **1(8),** 138. http://dx.doi.org/10.4236/ajcc.2016.52016

Live Science. 2017. Global warming could trigger insect population boom. html. Retrieved August 2, 2018. https://www.livescience.com/4296-global-warming-trigger-insect-population-boom.

Maponya P, Mpandeli S. 2013. The role of extension services in climate change adaptation in Limpopo province, South Africa. Journal of Agricultural Extension and Rural Development **5(7),** p 137-142. https://doi.org/10.5897/JAERD12.117

Naor A. 2006. Irrigation Scheduling and Evaluation of Tree Water Status in Deciduous Orchards. Horticultural Reviews. **32,** 111-166.

Ogalleh S, Vogl C, Eitzinger J, Hauser M. 2012. Local perceptions and responses to climate change and variability: The case of Laikipia District, Kenya. Sustainability **4(12),** 3302-3325. https://doi.org/10.3390/su4123302

PARC. 1980. Pakistan Agriculture Research Council. Agro-ecological regions of Pakistan. Islamabad, PARC (Pakistan Agricultural Research Council), Islamabad.

PDMA. 2018. Balochistan Profile. Retrieved in August 28, 2018. http://pdma.gob.pk/?cat=23. Retrieval Date. August 28, 2018.

Raghuvanshi R, Ansari M, Amardeep A. 2017. A Study of Farmers' Awareness about Climate Change and Adaptation Practices in India, International Journal of Applied Agricultural Sciences **3(6),** 154-160. https://doi: 10.11648/j.ijaas.20170306.13

Safdar U, Shahbaz B, Ali T, Khan IA, Luqman, M, Ali S. 2014. Role of agricultural extension services in adaptation to climate change in Highlands of Kaghan Valley, Pakistan. Pakistan Journal of Agricultural Sciences **51,** 1193-1198.

Schmidhuber J, Tubiello FN. 2007. Global food security under climate change. Proceedings of the National Academy of Sciences, **104(50),** p 19703-19708. https://doi.org/10.1073/pnas.0701976104

Tschakert P. 2007. Views from the vulnerable: understanding climate and other stressors in the Sahel. Global Environmental Change. **17(3–4),** 381–396. https://doi.org/10.1016/j.gloenvcha.2006.11.008

Uddin M, Bokelmann W, Entsminger J. 2014. Factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: A farm level study in Bangladesh. Climate, **2(4),** p 223-241. https://doi.org/10.3390/cli2040223

UNDP. 2015. United Nations Development Program. Request for Proposals (RFP): Drought Risk Assessment in Selected Districts of Balochistan. Islamabad, p 103-104.