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The influence of climatic change on major agricultural crops: a case study of Sindh, Pakistan

Naveed Wahid[1], Ahmed, Raza[1], Zahid H. Channa[2], Arshad Saleem[3], Wazir Ali Metlo[4], Muhammad Hafeez[5], Farzana Altaf[6], Zaid Altaf[7], Arman Khan[8], Masood Wahid Awan[9]

[1]*Department of Economics, Shaheed Benazir Bhutto University, Shaheed Benaziabad, Pakistan*

[2]*Department of Economics, Shaheed Benazir Bhutto University, Shaheed Benazirabad, Pakistan*

[3]*Department of Economics, Shaheed Benazir Bhutto University, Shaheed Benaziabad, Pakistan*

[4]*Department of Business Management, Shaheed Benazir Bhutto University, Shaheed Benazirabad, Pakistan*

[5]*Department of Molecular Biology & Genetics, Shaheed Benazir Bhutto University, Shaheed Benazirabad, Pakistan*

[6]*Putra Business School, University of Putra Malaysia, Malaysia*

[7]*Department of Business Management, Greenwich University, Karachi. Pakistan*

[8]*Putra Business School, University of Putra Malaysia, Malaysia*

[9]*Department of Business Management, Shaheed Benazir Bhutto University, Shaheed Benaziabad, Pakistan.*

[10]*Department Business Mangement, Keynesian Institute Management Sciences, Lahore. Pakistan*

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Abstract

This study has tried to capture the influence of climate change on the major agricultural crops in the Sindh province, Pakistan. Different crops are cultivated in Sindh but the major ones are Wheat, Cotton, Sugarcane, Maze and Rice. This study conducted an empirical analysis to justify the impact of climate change on these crops and to distinguish between weather variability and climate change. Data is gathered from the Agricultural department of Sindh, Pakistan. Agricultural Research Council (PARC), and the Pakistan Meteorological Department. Panel data approach is employed to diagnose the results. Ordinary Least Square, Fixed or Random effect model is used on the bases of Housman test. The results showed the impact of rising temperature on Wheat, Cotton, Sugarcane, and Maze is significant and positive and significantly negative for rice only. On the other hand, precipitation developed a significant and negative sign with Wheat, Rice and Cotton are highly significant and positive with sugarcane. This study may help the stakeholders of the agriculture sector to mitigate the permanent effects of weather uncertainty could be beneficial for the welfare of farmers than momentary measures.

* **Corresponding Author:** Naveed Wahid ✉ naveedawan@sbbusba.edu.pk

Introduction

In the recent era, the world is facing severe environmental threats because of climate change. The root cause of climatic change is the emission of greenhouse gases like sulfur dioxide (SO_2), nitrogen oxide (NO), carbon dioxide (CO_2), etc. Climate change initiates the rapid change in seasons, uplift sea level and excessive rainfalls that cause flood, extended monsoon and even droughts in affected areas of the world. Extensive energy consumption has increased the degree of climatic change and people are forced to consume more energy sources due to extensive economic pressure to meet the demand of living in the society and desire of earning more profit.

Climatic change directly puts emphasis on the agricultural sector and affects its production level. When climatic change exists and crosses a thresholds level it creates a severe impact over the society.

The main agents of climatic change are changing seasons, rise or fall of temperature and rainfall. It is not only the production level that is affected due to climate change but it also disturbs other sectors in downstream like supply chain, distribution and marketing strategies of agricultural crops. Developed countries have abilities to absorb the climate shocks because of their outreach of sophisticated technology and measures against climatic change but developing countries cannot perform well in this scenario due to their poor infrastructure, outdated technology, inefficient strategies and bad economic conditions.

More or less every country in the world cannot get rid of shocks of climate change but Asian countries are heavily suffering because of climate change in 2010. Pakistan and China significantly lost their infrastructure because of this environmental change.

In 2010 monsoon season was extended than it was expected and then floods destroy the human lives and properties. There is no hard and fast rule that climatic change only associated with floods and heavy rainfalls but also with droughts as well. In either case, agricultural output comes under threat.

Millions of people are associated with agricultural and found their selves around poverty line because of climate change, existence of climatic shocks destroy the agricultural productivity and leaves the farmers in poverty circles, particularly in developing countries (Adams R. M., Hurd B. H., Lenhart S., Leary, N. 1998).Climate change causes economic stress and puts pressure on the food scarcity and other hygiene factors (Gasper R., Blohm, A., Ruth, M. 2011).Agricultural crops particularly cotton; rice, wheat and maize have lost its maximum production volume in recent decades due to climate change in South East Asia (Ghude S. D., Jena, C., Chate D. M., Beig G., Pfister G. G., Kumar R., Ramanathan V. 2014).Economist are forecasting that production of these crops will fell down up to half of the current production till the mid of current century. A major cause of this production fall is burned out of water reservoirs in the said area. The maximum proportion of Pakistan's population is depending on agricultural earnings that has a major contribution in national income even after a long time of her independence (Naheed G., 1994; Mahmood A. 2009).A temperature fluctuation destroys the rainfall system that badly influences the agricultural sector (Gornall J., Betts R., Burke E., Clark R., Camp J., Willett, K., Wiltshire A. 2010).

Pakistan is underlined as high ranked among badly affected countries of the world (Hashmi H. N., Siddiqui Q. T. M., Ghumman A. R., Kamal M. A. 2012).Pakistan has the lowest degree of awareness and arrangements to overcome climate change shocks and aftershocks. Pakistan' climatic change ranging fall between 0°C -50°C, a variety of ecosystem and climatic change is sensitive to agriculture sector. Any change in the agricultural sector passes its impact to other sectors of the economy. Major agricultural crops in Pakistan are negatively influenced by climatic change, mainly a rise in temperature or decline in precipitation (Sultana H., Ali N., Iqbal M.M., and Khan A.M. 2009).

Pakistan's agricultural sector badly suffered during recent floods and fall in vulnerable conditions in general but particularly in KPK and Sindh province (Kazi A.2014). In this study, we are just concerned with Sindh performance influenced by climatic change. Sindh is not only affected by floods but it also contains a significant proportion of dry land. Climate change not only destroys the crops productions but also destroys the earning source of the people engaged with it. The basic objectives of said investigation is to highlight the shock of climate change on agricultural areas of Sindh and to mitigate the climatic impact on agriculture and earning gaps of the farmers associated with it. By taking into account the fallout and strategy commendation, the strategy makers can build up climate strategies to consider the said situation. Weather is an activity indicator that changes repeatedly, with lasting warming and cooling cycles. Nevertheless, current swift and wide-ranging changes are also intense to be considered as 'normal', and have been exposed to be strongly associated to variations in distinctive carbon as a result of a person's action.

Obviously, water and heat are the indicators which are affected by climatic changes, in a significant way. To have crop efficiency, carbon dioxide emission needs to be checked; but variations in temperature and rainfall can have a diverse outcome, as being capable of playing role in the CROPWAT analysis (Molua E.L., Lambi C.M. 2006). It is resulted by the elevated compassion of agricultural yields to intense proceedings such as floods, breeze storms, and cyclic factors like the periods of cold, heat peaks, and precipitation ways.

The forestry and cultivation sectors supply services for the mass of the residents in Pakistan approximately 60% of the deprived exist in country areas and find job mostly in agriculture. In relation to 45% of Pakistan GDP consist of agriculture and a connected activity, Pakistan's economy is therefore principally agrarian. Agriculture in Pakistan is reasonably productive and wisely (Begum R., Yasmeen G. 2011). The production of farms is at low cost, supply first-rate foodstuff to local customers and adds considerably to sell it abroad for the nation. Farmland is growing gradually over the previous three decades in Pakistan. The farm land has its importance in agriculture for the Asian economies as a whole and particularly for Pakistan's agricultural sector to enhance financial system at both micro and macro-fiscal considerations. Farming maintains the production of foodstuff, arrange possible unprocessed resources for domestic firms that lead to an expansion in GDP and provide employment to maximum inhabitants. It has the lasting power in the trade and industrial expansion of the homeland (Amjad N. 2004).

The problems that arise in construction of market are deprived marketing channels, road structure and addition of latest developed inputs. These problems need to be addressed through the government interference to overcome the worst climatic impacts. Agricultural experiences in most parts of the country remain unnoticed to deal with demands deficiencies of a growing population. Efforts to cure plant diseases, pest infestations and limited water supply are also results of climatic changes because of global warming. The said evidence of global warming needs to adjust the climatic shocks on a provision of foodstuff and its expenses have to be managed in Pakistan and further than to the Asian region. Present environmental situation is subject to lag climatic scenarios and has its impacts on intensities of the crop, vermin and diseases, the accessibility and way of irrigation water stores, and the harshness of soil destructions.

The climatic changes affect the individuals and markets in Pakistan. Agriculture production techniques are more modern now and the use of substandard pesticide is harmful not only for soil, livestock but also for and human as well (Ecobichon D.J. 2001). These changes are associated with time constraints and managerial costs. Even though there is no doubt in evaluation of climatic transformation on agriculture, fiscal action to adjust with associated cost of climatic changes, for the entire process. In order to recognize the cost to mitigate the damage and unstinting scenarios is to realize and have an eye on the potential long-term environmental changes. Climatic change is the distinctive condition under considerable period of time with respect to hotness, moisture, precipitation sunlight, shade wrap and breeze path. Climate is mostly a step–to–step or even hour-to-hour phenomenon. The distinct climate is the standard impressive condition that changes over an extended period of time (Hill H. S., Mjelde J. W., Love H. A., Rubas D. J., Fuller S. W., Rosenthal W., Hammer G. 2004).

The fundamental climatic changes leads tohave a control over the allocation of crop types and farming patterns, unlike agricultural yields need a diverse quantity of precipitation, moisture, temperature. The rainfall is the source of watering in agriculture; the weather is the key aspect to determine ways of harvest and yields. The climatic restrictions prove impractical or harmful to grow specific crops. Growing precipitation inconsistency consequences in droughts drop in soil wetness and as a result of a turn down in agricultural efficiency. To preserve soil richness without having chemical fertilizers, the part of the soil in farming is left uncultivated to restore its richness. Precipitation inconsistency and irregularity, floods, airstream storms and droughts frequently contain shocking possessions on agriculture (Sivakumar M.V. 2005).

In Thar, droughts have led to food shortage and survival proved difficult under such circumstances. Many individuals and thousands of livestock were badly affected by droughts throughout the existing decade. Pakistan needs to manage the floods that are frequently stuck between August and September. Some of these floods, particularly flood in 2010, cracked thousands of hectares. Arid periods are too long, where wet seasons are too short which destroyed the foodstuff, belongings and living.In the coastal areas of Karachi, Thatta and Dadu, storms and damp term floods demolish aside infrastructure and farming possessions. When such storms happen that destroy the farmland and crops. While precipitation does not get together the crop supplies, Pakistan's partial watering and its elevated resident's expansion enhances the likelihood of foodstuff shortages (Abid M., Schilling J., Scheffran J., &Zulfiqar F. 2016).

The current study is conducted to find out the relationship between crops and climate indicators along with the depth of environmental degradation on the agricultural phenomenon and to figure out the impact of environmental degradation on agricultural for stakeholders.

Literature review

Agriculture is the backbone of the domestic economy that contributes more than 20% to national income and accommodates major proportion of employment of the country. The brittle ecosystem is a threat to the basic survival needs of human and vulnerable towards precedence problems of Pakistan. The economy suffered in many ways due to climate change particularly social and economic situation becomes at stake and it affects the scenario of prospect growth. Environment variation is a worldwide occurrence and no state is invulnerable in the direction of it (Gasper D., Portocarrero A. V., Clair A. L. S. 2013).

Agriculture is the main source of raw materials supply to industries. Like any other developing countries, Pakistan is also depending on the agricultural sector which is very sensitive to climatic change. The impact of climatic change becomes worst due to the outdated, inefficient and inadequate invigilating ecosystem (Roohi R. 2004).

Arrhenius S. 1896, initially identified that absorption of carbon dioxide can alter the environment significantly and has its consequence worldwide. According to economic consideration and level of climatic change that create impacts on production within the economy (Nordhaus W. D. 1982).There are a number of economists who started their investigation about the vulnerability of climate to strengthen the above said view of Nordhaus. The literature is rich of work done by the known economist in the last decade of the 20^{th} century; their work provides a guideline to researchers and policymakers. At the beginning of the 21st century, a campaign to save the environment was on full swing. Task force report on climate change in 2010 describes that energy, food and water shortfall are under threat. The possible shocks of climatic change on the scheduled farmlands efficiency are investigated to calculate the magnitude of climatic change impacts and tried to develop a link between climate, irrigation and economics to forecast future impacts in order to avoid any lacking in life. (Parry M. L. 1990, Solomon A. M., Prentice I. C., Leemans R., & Cramer W. P. 1993). Many other studies investigate worldwide economic impacts due to drop in crops yields (Rosenzweig C., Tubiello F. N. 1997; Fischer G., Frohberg K., Parry, M. L., Rosenzweig C. 1994; Reilly J. *et al.,* 1996). The indicators like farm revenue and income have a vital role to capture the climate changes in any economy and examined that climate change and farm revenue are inversely related to each other (Mendelsohn R., Nordhaus W. D., Shaw D. 1994; Middelkoop H., Daamen K., Gellens D., Grabs W., Kwadijk J. C., Lang H., Wilke K. 2001; and Schimmelpfennig D., Lewandrowski J., Tsigas M., Parry I. 1996).

Fischer G., Frohberg K., Parry M. L., Rosenzweig C. 1994, adopted the structural approach to explain the impact of climatic change on our various aspects of life, in which they examined the relationship between crop yields, science and economics. After investigating different approaches they convert their findings into various economic models like General Circulation Models (GCM). These models help the policymakers to optimize individual utility with respect to climate change, the supply of crops social welfare. Adams R. M., Hurd B. H., Lenhar, S., & Lear, N. 1998, made an effort to develop a link between crops supply and market clearing pricing after having climate change. These models provide a guideline to minimize the costs and optimize the utility of stakeholders (Kaiser H. M., Riha S. J., Wilks D. S., Rossiter D. G., Sampath R. 1993; Adams R.M. *et al.*1998). The benefit of these kinds of approaches is to evaluate the understanding of the adjustment of economic responses due to climate changes.

Kaiser H. M., Riha S. J., Wilks D. S., Rossiter D. G., Sampath R. 1993, posted a suggestion to get some adjustment in the agriculture sector with respect of time to those who were trying to explain the economic interpretations of such approaches. If this is not accommodated then an account of damages might be over counted. He tries to prove his words by taking example of farm revenue with and without variation and found that the landlord could settle in climate change by altering the varieties of crops.

Many studies have considered the cost of environmental changes to agricultural by assuming that the current standards of land use will remain unchanged. Mendelsohn, R., Nordhaus, W. D., & Shaw, D. 1994, developed a relative estimation of change in land rent due to one-time environmental changes. The approach that investigates the environmental impact on agriculture, sometimes called sas a spatial- analogue approach that considers the difference on agricultural production within the regions, estimation uses the linear programming as a tool (Antle J. M., Capalbo S. M., Elliott E. T., Paustian K. H. 2004.).Nevertheless, an important restriction, which distinct the infrastructural moves to overlook probable changes in factor cost and quantity prices to have long-run stability. In addition, this way may not entirely untie undeveloped and fiscal measurements ended in reply to an environment on or after those considered in additional ways.

Dinar A., Mendelsohn R., Evenson R., Parikh, J., Sanghi A., Kumar K., Lonergan S. 19); Middelkoop H. *et al.* (2001); Molua E.L. (2002) and Mendelsohn R., Dinar A. 1999) used the Recardian restricted profit model that is helpful to estimate climatic impact on farm revenues (Pasinetti L. L. 1989). Ricardian model is helpless to control exercise across the forms because the farm varies to each other in many reasons. In order to control such limitation Ricardian introduce other indicators like solar radiation market access and land quality. Ricardian consider the farm prices constant for all farmland, even though the farms differentiate to each other on different causes, like soil fertility. Restricted profit function is strengthening the Ricardian model because it trials together with the failure to individual producers and any loss in customer excess if output changes due to the price difference.

Even though the structural and spatial analogue ways emphasize unstable standards of farmer edition, these are depending on the hypothesis that edition to the environment having low cost. Moreover, the likely spoil from environment change is overrated or its possible payback is not considered. Agriculture may be mainly weak to environmental change due to its reliance on the weather cycle for its efficiency (Gregory P. J., Ingram J. S., Brklacich,M. 2005).The literature is focused on the forecast and quantifying the shock of environment change on agricultural systems in numerous ways around the globe. A few degrees of temperature usually boost crop yields; the output of crops close to its utmost warmth acceptance and arid soil crops will diminish. A large decline in rainfall would contain even adverse outcome on yields. In count, deprivation of soil and a decline in water resources resulting from climate change are likely to have harmful results on international agriculture (Houghton J. T., Ding Y. D. J. G., Griggs D. J., Noguer M., van der Linden, P. J., Dai, X., Johnson C. A. (2001). The economic shock of environment change on agriculture is getting a growing notice in the literature. The benchmark for the temperature is 2.5 °C or more that are a source of turn down in crop yields and on time food prices to boost because growth in worldwide food order is faster than the growth of worldwide food ability (Parry M. L. 1990). Worldwide returns are likely to be a little with small changes in less developed regions and positive for developed regions. As a result, environmental transformation has consequence on the output, farm productivity, agricultural market forces, and trade volume (Drennen T., Kaiser H 1993). At hand a huge ambiguity exists in the accepting the timing, scale and tempo of environment change, it is vital to computing the fiscal shocks of variation in the environment on the farming zone.
The Ricardian model is able to customize it econometrically to approximate climatic shocks, socio-economic and physical indicators on the cost of farming which permits a quantity of the additional input which helps to capitalized in land value through the net farm revenue.

The theory of competitive market said that land worth will be alike to the present value of the prospect of annual net values resulting from the nearly all cost-effectively capable administration of the land. Thus, this replica not only captures the existing agricultural performance other than it permits land to be used for other purposes to respond the economic and ecological variation and changes. After that, as environment variations, the finest and nearly all gainful use of soil will too change.
Climate change is a global threat, needs to counter its impact on soil, livestock and humans.

It is only possible to have environmental agreements at the international level to foster efforts to reduce universal attention in the atmosphere. The Kyoto Protocol was managed by negotiators at government in December 1997 at the third parties conference to the United Nation Framework Convention on Climate Change (Santilli M., Moutinho P., Schwartzman S., Nepstad D., Curran, L., Nobre,C. 2005).The point of the Kyoto Protocol was to limit greenhouse gases emissions to avoid the harmful impacts of climate change. This protocol contains two objectives: (1) to have quantitative measures and (2) to develop policy guideline. Policy objectives is to take initiative to improve the energy consumption and carbon sinks as well as establishing sustainable forms of agriculture and forestry with respect to environmental change.

Dixon H. T. F. 1994; Segerson K. *et al.* 1999, accommodated the crop yields as explained variables and climatic measures as explanatory variables in their respective regression models. The mean of temperature and participation are considered in prior researches with a range of time from a day to a year (Maurer E. P., Adam J. C., Wood A. W. 2009). Furthermore, Sarker M. A. R., Alam K., Gow J. 2012, considered the mean of monthly maximum temperatures and precipitation.

Methodology

This study customized panel data approach to have a cross-sectional analysis of sevendistricts (Badin, Dadu, Hyderabad, Jacobabad, Larkana, Nawabshah and Sanghar) of Sindh, Pakistan. Literature provides an evidence of accommodating cross-sectional date to describe the behavior of crops yield against climatic measures. Segerson, Rosenzweig, Bryant, Adams, McCarl, Dixon, and Ojima (1999) considered 30 years mean periodic temperature and precipitation variations for the months January, April, July and October. Weber and Hauer (2003) used the 1996 census of Canada to develop a relationship between crops yield and climatic measures. Temperature and Precipitation are taken as independent variables and crops at an individual level taken as dependent variables(Prasad, Chai, Singh, &Kafatos 2006).Data of temperature and precipitation is collected from metrological department of Sindh, and crops yield data of major agricultural crops (wheat, rice, cotton and sugarcane) are collected from the ministry of agricultural Sindh, Pakistan. The study time period is taken into account from 1981 to 2012.

In order to develop an economic model, a relationship is developed between grain productivity indicators and the sources of climatic changes as under

$$Productivity\ Grains\ indicators = f\,(Climatic\ change\ measures)$$

Or

$$(Wheat, Rice, Cotton, Sugarcane) = f\,(Temerature, Percipitation)$$

Panel Ordinary Least Square method beside fixed effect model is used as an econometric technique, decision to apply fixed effect model is taken on the bases of Housman test. The economic model to check the influence of climatic variables on the productivity of grains is given below:

Where a matrix equation for the econometric model is given below.

$$\begin{bmatrix} WHT_{it} \\ RICE_{it} \\ COTN_{it} \\ SUGC_{it} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} + \begin{bmatrix} \alpha_{11}\alpha_{12} \\ \alpha_{21}\alpha_{22} \\ \alpha_{31}\alpha_{32} \\ \alpha_{41}\alpha_{42} \end{bmatrix} \begin{bmatrix} MNTEM_{it} \\ MNPER_{it} \end{bmatrix} + \begin{bmatrix} \mu_{i1t} \\ \mu_{i2t} \\ \mu_{i3t} \\ \mu_{i4t} \end{bmatrix} \quad (1)$$

$$Y = \alpha + \beta \cdot CA + \mu$$

Where, the matrix Y represents the grain productivity such as *WHT*,*RICE*, *COTN* and *SUGC* represents respective crops in tones per acres for respective cross section$i$ at time period t. α is called the matrix of intercepts. Matrix β is the slope coefficient matrix of respective variables, such as *MNTEM*, *MNPER* represents mean of annual temperature and mean of annual precipitation for respective time period$t$ and cross section$i$. Such explanatory variables are the part of matrix CA. μ is name to the matrix of error terms.

In a more elaborative way, the study is trying to check the influence of climatic variables on the productivity of different types of grains independently, in different districts of Sindh. So the independent econometric models for such analysis are given below:

$$WHT_{it} = \alpha_1 + \alpha_{11}MNTEM_{it} + \alpha_{12}MNPER_{it} + \mu_{i1t} \quad (2)$$

$$RICE \quad = \alpha_2 + \alpha_{21}MNTEM_{it} + \alpha_{22}MNPER_{it} + \mu_{i2t} \quad (3)$$

$$COTN_{it} \quad = \alpha_3 + \alpha_{31}MNTEM_{it} + \alpha_{32}MNPER_{it} + \mu_{i3t} \quad (4)$$

$$SUGC_{it} \quad = \alpha_4 + \alpha_{41}MNTEM_{it} + \alpha_{42}MNPER_{it} + \mu_{i4t} \quad (5)$$

Empirical results

Table 1 explains the minimum and maximum value of annual temperature that range from 21.4 to 32.5 with a mean value of 27.317 for the said sample; the range indicates the notified variations in temperature.

Table 1. Descriptive Analysis of independent and dependent variables.

??	Mean	Median	Maximum	Minimum	Std.Dev.	Observations
MNTEM	27.31705	27.3	32.5	21.4	2.157	224
MNPER	180.071	165	613.8	0	121.385	224
WHT	175.9018	121.35	578.6	24.6	128.459	224
RICE	163.1388	103.25	714.6	0.2	182.289	224
COTN	1123.937	560.3	4430.7	0.6	1245.457	224
SUGC	134.046	35.35	712.3	0	169.314	224

Precipitation shows variation up to great extent; ranges from 0 to 613.8, similarly wheat ranges from 24.6 to 578.6 have higher average value. Rice ranges, from 0.2 to 714.6 with its mean value 163.13. Sugarcane values exist from 0.6 to 4430.7 but its mean value is quite high as 1123.937, whereas cotton more or less has the same characteristics as rice contains. The standard deviation of sugarcane is quite high than in other crops.

Table 2. Correlation statistics of independent and dependent variables.

??	TEM	PER	WHT	RICE	COTN	SUGC
MNTEM	1					
MNPER	0.125	1				
WHT	0.147	-0.232	1			
RICE	-0.180	-0.137	-0.556	1		
COTN	0.363	-0.131	0.803	-0.599	1	
SUGC	0.364	0.296	0.100	-0.479	0.121	1

Table 2 indicate that the Correlation of each crop with temperature and precipitation is less than 0.50, it means temperature and precipitation can be accommodated in the same model with respective crops. So, we can have four different models for the said study. There is no proof multicollinearity in the concerned models.

Table 3 shows all of the six employed indicators are included of order one as the Augmented Dickey-Fuller test Phillips-Perronsexperiment, show the evidence of non-stationary at levels but stationary at first differences at 5% level of significance. From the above Table, we conclude that all the variables are included in order one.

Table 3. Panel Unit Root Analysis (ADF and PP).

	ADF				PP			
Variables	I(0)		I(1)		I(0)		I(1)	
	None	Trend	None	Trend	None	Trend	None	Trend
MNTEM	-0.342	-3.456	4.564*	6.434*	-0.34	-2.907	-9.263*	-9.453*
MNPER	-0.632	-4.653	-3.962*	-6.345*	-0.240	-3.097	-5.457*	-5.873*
WHT	-2.853*	-3.590	-4.563*	-3.453*	-1.235	-2.253	-7.342*	-8.453*
RICE	3.534*	4.371**	6.978*	6.453*	3.982*	4.653**	9.653*	12.345*
COTN	-2.485	-2.753	5.942*	5.293*	-2.136	-2.345	-6.290*	-7.434*
SUGC	3.573**	0.844	9.453*	5.631*	4.532*	1.931	7.345*	14.345*

* and ** mean significant at 5 % and 10 % level of significance respectively.

Mean of Temperature (MNTEM)

Model-1 to Model-4 represented in table.4, Wheat, Sugarcane, Rice and Cotton (dependent variable) for all seven districts of Sindh (pooled sample) for Ordinary Least Square (OLS), whereas same models are regressed with Fixed Effect approach.

The results are customized with OLS and FE approaches, describe that temperature is highly significant and responsible of increasing crops yield for all concerned districts but the results are vice versa in extreme temperature cases (when temperature cross the subsistence level) as presented in model-3. Temperature has negative sign with Rice, shows that increasing temperature will reduces the rice production; this result is same for both OLS and Fixed Effect. This result is consistent with Cabas, J., Weersink, A., Olale, E. 2010, explained that extreme hotness in summer has negative impact over yield of crops.

Table 4. Results of all Respective variables of Sindh's Districts.

Variables	OLS				FE			
	Model-1	Model-2	Model-3	Model-4	Model-1	Model-2	Model-3	Model-4
MNTEM	10.644 (2.757)*	191.496 (5.455)*	-13.955 (-2.49)**	30.254 (6.217)*	11.96417 (2.838)*	192.1089 (5.088)*	-14.17 (-2.3)**	33.28 (6.40)*
MNPER	-0.269 (-3.925)*	2.605 (4.175)*	-0.174 (-1.75)**	-0.251 (-2.894)*	-0.327 (-3.907) *	3.159 (4.175) *	-0.174 (-1.422)	-0.340 (-3.403) *
Constant	-66.367 (-0.632)*	-4576.3 (-4.79)*	575.726 (3.7840)*	-647.312 (4.8928)*	-92.122 (-0.8104)	-4692.9 (4.22214)*	581.795 (3.501)*	-713.9 (-5.0)*
R^2	0.0854	0.195657	0.045554	0.163502	0.118523	0.247804	0.0643	0.2295
t. Stat	10.308	26.87928	5.273986	21.59838	0.774158	1.896775	0.39615	1.7154
DW-Stat	0.2117	0.257	0.098	0.203	0.197	0.261	0.076	0.227
Obs.	224	224	224	224	224	224	224	224

T-statistics standards are specified, *'** and *** are statistically at 1, 5 and 10 % correspondingly, FEis fixed effect method; DW-stat is Durbin Watson figures.

Mean of Precipitation (MNPER)

Table 4, Model-1 to Model-4 presents the results with dependent variables (Wheat, Sugarcane, Rice and Cotton) for all seven districts of Sindh (pooled sample) for Ordinary Least Square (OLS), whereas same models are regressed with Fixed Effect approach. The results are customized with OLS and FE approaches, describe that precipitation is highly significant and responsible of increasing Sugarcane yield for all concerned districts.

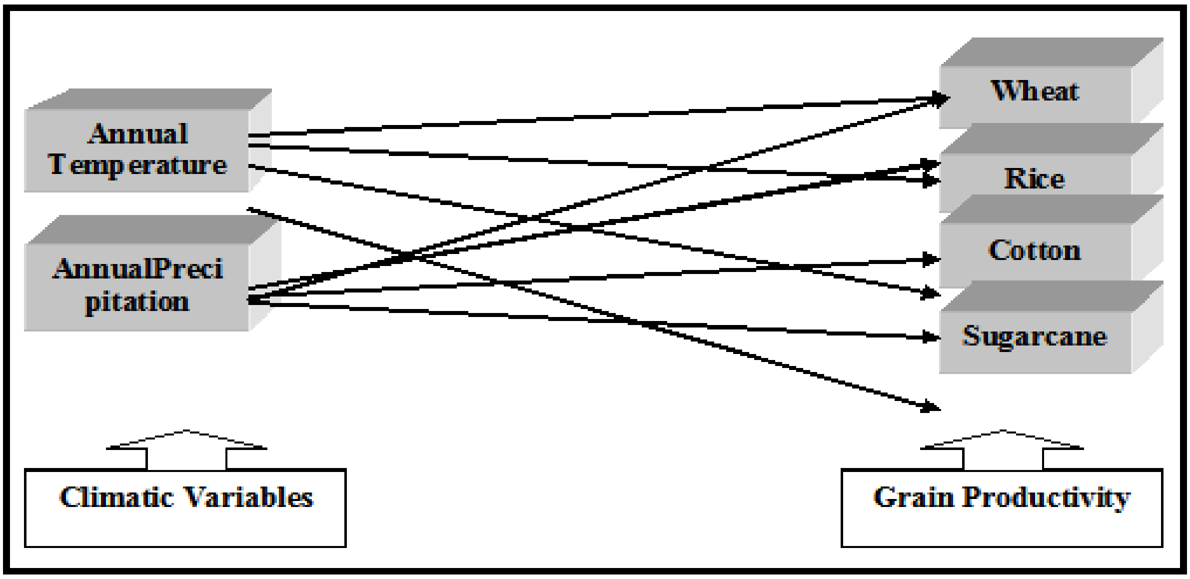

Table 1. Descriptive Analysis of independent and dependent variables.

Precipitation has a negative sign with Wheat, Rice and Cotton show that increasing precipitation will reduce the Wheat, Rice and Cotton production; this result is the same for both OLS and Fixed Effect.. These are consistent with Weber, M., Hauer, G. 2003, Mendelsohn, R., & Reinsborough, M. 2007, both obtained that the precipitation time frame also create impact over crops, arise in precipitation at initial stage of season increases production and opposite is true for latter stages of seasons.

Conclusion

It is concluded that each crop has its own threshold level against temperature and precipitation. This scenario differs from circumstances to circumstances; it means there is no hard and fast rule in this regards. Before reaching the threshold level temperature and precipitation behave positively with the crop production and vice versa after crossing it. The harsh impact of temperature and precipitation depends on other factors as well, like wind flow, watering source, fertility of land and use of protection measures against climatic changes are not considered due to lack of data availability. This leaves the place blank for other researchers to fill it with their upcoming research efforts. Some policy measures are suggested, it needs to have a strict check over industrial production to warn them over their careless efforts to protect the environment. Climate units have to be awarded to industrial units and make it possible so they should remain in limits if they cross then they have to fine.A series of seminars has to be launched to educate firms, individuals and all stakeholders on environmental issues to protect their earnings and lives. Everyone has to be informed about the root causes of pollution, climatic change and its impacts on our society. The government needs to step forward to investigate to develop a coordination mechanism between all those authorities and researchers those working to make measurement against climate changes and free the society from its negative impacts.

References

Abid M, Schilling J, Scheffran J, Zulfiqar S F. 2016. Climate change vulnerability, adaptation and risk perceptions at farm level in Punjab, Pakistan. Science of the Total Environment 447-460.

Adams RM, Hurd BH, Lenhart S, Leary N. 1998. Effects of global climate change on agriculture: an interpretative review. Climate research **11(1),** 19-30.

Ahmed SA, Diffenbaugh NS, Hertel TW. 2009. Climate volatility deepens poverty vulnerability in developing countries. Environmental research letters **4(3),** 034004.

Amjad N. 2004. Country report: Pakistan. In Symposium of Technical Advisory Committee (TAC) of the Asian and Pacific Centre for Agriculture Engineering and Machiner, 1-27.

Antle JM, Capalbo SM, Elliott ET, Paustian KH. 2004. Adaptation, spatial heterogeneity, and the vulnerability of agricultural systems to climate change and CO 2 fertilization: an integrated assessment approach. Climatic Change **64(3),** 289-315.

Arrhenius S. 1896. On the influence of carbonic acid in the air upon the temperature of the ground. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, **41(251),** 237-276.

Begum R, Yasmeen G. 2011. Contribution of Pakistani women in agriculture: productivity and constraints. Sarhad Journal of Agriculture **27(4),** 637-643.

Cabas J, Weersink A, Olale E. 2010. Crop yield response to economic, site and climatic variables. Climatic change **101(3-4),** 599-616.

Chang CC. 2002. The potential impact of climate change on Taiwan's agriculture. Agricultural Economics, **27(1),** 51-64.

Dinar A, Mendelsohn R, Evenson R, Parikh J, Sanghi A, Kumar K, Lonergan S. 1998. Measuring the impact of climate change on Indian agriculture. The World Bank.

Dixon HTF. 1994. Environmental scarcities and violent conflict: evidence from cases. International security, **19(1),** 5-40.

Drennen T, Kaiser H. 1993. Agricultural dimensions of global climate change.

Easterling WE, Crosson PR, Rosenberg NJ, McKenney MS, Katz LA, Lemon KM. 1993. Paper 2. Agricultural impacts of and responses to climate change in the Missouri-Iowa-Nebraska-

Kansas (MINK) region. Climatic Change **24(1-2),** 23-61.

Ecobichon DJ. 2001. Pesticide use in developing countries. Toxicology **160(1-3),** 27-33.

Fischer G, Frohberg K, Parry ML, Rosenzweig C. 1994. Climate change and world food supply, demand and trade: Who benefits, who loses?. Global Environmental Change **4(1),** 7-23.

Gasper D, Portocarrero AV, Clair ALS. 2013. The framing of climate change and development: a comparative analysis of the Human Development Report 2007/8 and the World Development Report 2010. Global Environmental Change **23(1),** 28-39.

Gasper R, Blohm A, Ruth M. 2011. Social and economic impacts of climate change on the urban environment. Current Opinion in Environmental Sustainability **3(3),** 150-157.

Ghude SD, Jena C, Chate DM, Beig G, Pfister GG, Kumar R, Ramanathan V. 2014. Reductions in India's crop yield due to ozone. Geophysical Research Letters **41(15),** 5685-5691.

Gornall J, Betts R, Burke E, Clark R, Camp J, Willett K., Wiltshire A. 2010. Implications of climate change for agricultural productivity in the early twenty-first century. Philosophical Transactions of the Royal Society B: Biological Sciences **365(1554),** 2973-2989.

Gregory PJ, Ingram JS, Brklacich M. 2005. Climate change and food security. Philosophical Transactions of the Royal Society B: Biological Sciences **360(1463),** 2139-2148.

Hashmi HN, Siddiqui QTM, Ghumman AR, Kamal MA. 2012. A critical analysis of 2010 floods in Pakistan. African Journal of Agricultural Research ***7*(7),** 1054-1067.

Hill HS, Mjelde JW, Love HA, Rubas DJ, Fuller SW, Rosenthal W, shammer G. 2004. Implications of seasonal climate forecasts on world wheat trade: a stochastic, dynamic analysis. Canadian Journal of Agricultural Economics/Revue canadienned'agroeconomie **52(3),** 289-312.

Houghton JT, Ding YDJG, Griggs DJ, Noguer M, van der Linden PJ, Dai X, Johnson C. A. 2001. Climate change 2001: the scientific basis.

Kaiser HM, Riha SJ, Wilks DS, Rossiter DG, Sampath R. 1993. A farm-level analysis of economic and agronomic impacts of gradual climate warming. American journal of agricultural economics ***75*(2),** 387-398.

Kazi A. 2014. A review of the assessment and mitigation of floods in Sindh, Pakistan. Natural hazards, ***70*(1),** 839-864.

Maurer EP, Adam JC, Wood AW. 2009. Climate model based consensus on the hydrologic impacts of climate change to the Rio Lempa basin of Central America. Hydrology and Earth System Sciences **13(2),** 183-194.

Mendelsohn R, Dinar A. 1999. Climate change, agriculture, and developing countries: d``oes adaptation matter? The World Bank Research Observer **14(2),** 277-293.

Mendelsohn R, Reinsborough M. 2007. A Ricardian analysis of US and Canadian farmland. Climatic change **81(1),** 9-17.

Mendelsohn R, Nordhaus WD, Shaw D. The impact of global warming on agriculture: a Ricardian analysis. The American economic review, 753-771.

Middelkoop H, Daamen K, Gellens D, Grabs W, Kwadijk JC, Lang H, Wilke K. 2001. Impact of climate change on hydrological regimes and water resources management in the Rhine basin. Climatic change **49(1-2),** 105-128.

Molua EL. 2002. Climate variability, vulnerability and effectiveness of farm-level adaptation options: the challenges and implications for food security in Southwestern cameroon. Environment and Development Economics **7(3),** 529-545.

Molua EL, Lambi CM. 2006. Climate, hydrology and water resources in Cameroon. CEEPA, Pretoria, **37.**

Naheed G, Mahmood A. 2009. Water requirement of wheat crop in Pakistan. Pakistan Journal of Meteorology **6(11),** 89-97.

Nordhaus WD. 1982. Economic policy in the face of declining productivity growth. European Economic Review **18(1),** 131-157.

Parry ML. 1990. Climate change and world agriculture. Earthscan Publications Ltd.

Pasinetti LL. 1989. Ricardian debt/taxation equivalence in the Kaldor theory of profits and income distribution. Cambridge Journal of Economics **13(1),** 25-36.

Prasad AK, Chai L, Singh RP, Kafatos M. 2006. Crop yield estimation model for Iowa using remote sensing and surface parameters. International Journal of Applied Earth Observation and Geoinformation **8(1),** 26-33.

Reilly J, Baethgen W, Chege FE, Van De Geijn SC, Erda L, Iglesias A, Rosenzweig C. 1996. Agriculture in a changing climate: impacts and adaptation. In *Climate change 1995; impacts*, adaptations and mitigation of climate change: scientific-technical analyses 427-467.

Roohi R. 2004. Farm Mechanism Options under Climate Change Scenario in Pakistan.

Rosenzweig C, Tubiello FN. 1997. Impacts of Global Climate Change on Mediterranean Agrigulture: Current Methodologies and Future Directions. An Introductory Essay. Mitigation and adaptation strategies for global change, **1(3),** 219-232.

Santilli M, Moutinho P, Schwartzman S, Nepstad D, Curran L, Nobre C. 2005. Tropical deforestation and the Kyoto Protocol. Climatic Change **71(3),** 267-276.

Sarker MAR, Alam K, Gow J. 2012. Exploring the relationship between climate change and rice yield in Bangladesh: An analysis of time series data. Agricultural Systems **112,** 11-16.

Schimmelpfennig D, Lewandrowski J, Tsigas M, Parry I. 1996. Agricultural adaptation to climate change: issues of longrun sustainability, 2017-3845.

Segerson K, Rosenzweig C, Bryant KJ, Adams, RM, McCarl BA, Dixon BL, Ojima D. 1999. The economic effects of climate change on US agriculture, 18-54.

Sivakumar MV. 2005. Impacts of natural disasters in agriculture, rangeland and forestry: an overview. In Natural disasters and extreme events in Agriculture, 1-22.

Solomon AM, Prentice IC, Leemans R, Cramer WP. 1993. The interaction of climate and land use in future terrestrial carbon storage and release. In Terrestrial Biospheric Carbon Fluxes Quantification of Sinks and Sources of CO2, 595-614.

Sultana H, Ali N, Iqbal MM, Khan AM. 2009. Vulnerability and adaptability of wheat production in different climatic zones of Pakistan under climate change scenarios. Climatic Change, **94(1-2),** 123-142.

Weber M, Hauer G. 2003. A regional analysis of climate change impacts on Canadian agriculture. Canadian Public Policy-Analyse De Politiques **29(2),** 163-180.