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Climatic Changes Effects on Agricultural Production: An Assessment in Case of Pakistan

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Abstract *The emission of carbon from electricity, gas fuel consumption, residential building and commercial buildings has raised the temperature of the region, affecting agricultural production. The agaric sector is sensitive to change in temperature. This paper examines the climatic variations due to CO2 emission from different sources is inclined to the yield of production by taking time series data over the period from 1984 -2015. The Auto-Regressive Distributive lag model was applied to estimate the results. Moreover, diagnostic test, stability test and error correction mechanism were operated on the dataset, reveals the rising temperature, pollution and emission from residential affects the agaric production negatively I case of Pakistan. I have reviewed the literature on this topic, but a very limited portion of the literature discusses this issue. Hence this paper will contribute a lot in agricultural economics fields.*

Key Words: Crop production, Temperature, CO2 from Residential Buildings, CO2 Emission from electricity and Heat, Air Pollution from Carbon Emission, Environmental Pollution

JEL Classification: N50, Q54, Q51

Introduction

The variation in climate has been a valuable topic of empirical research, and the change in climate has linked to the agriculture sector over the world. The theoretical concept of environmental effect on agaric area has converted into empirical context with better results. The rising temperature and environment in the form of unexpected rainfall, floods and drought have an adverse climatic effect on agricultural production of developing countries (Cline 1996, 2007).

The natural combination of gases as nitrogen (N_2O), carbon dioxide (CO_2), methane (CH_3) and chlorofluorocarbons exit in the environment maintains the temperature warmer and protective. Life of species and crop production cannot be sustained without such a specific number of gases because the temperature of the world could be decreased up to -15C^0 where human life becomes impossible. The specific number of gases in the environment maintains the global standard temperature at 15C^0, but where the co_2 emission increases more than specific standard, the greenhouse gases raise the temperature and pollution in the world. The carbon emission from electricity, heat,

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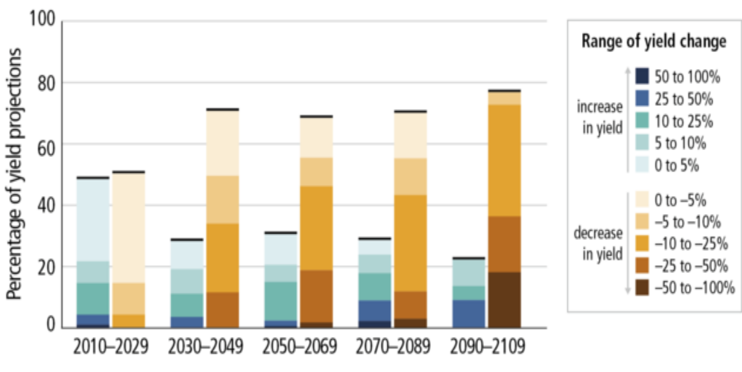
emission from gas fuel consumption and carbon emission from residential buildings and commercial and public services have increased the Green House Effect, which is also raising the world temperature of the earth. The higher temperature badly affects crop production (Brown 1998), (Edwards, 1999).

In 2018 Pakistan declared the most affected country from climate variation and this region is going to become the most water-stressed up to 2040 and its surface of water slipped down further, create agricultural, industrial and human consumption of water problems. Hence the production of major crops has drastically decreased, caused the hyper increase in prices and low per capita income (Global Climate Risk Index, 2018).

The sensitivity of climatic change has an adverse effect in the Asian region, particularly the agricultural producing countries. The environmental change harmed the crop production of the economy in the last few years. The country has experienced hydrological cycle taken in different forms as drought, periods of water availability, heat waves with a more intense and frequent amount, changing the precipitation events and pattern natural disaster of climatic change. The projected climatic variation raises the monsoon, which causes the floods that harmed the crop production in the agricultural sector. The farmers reside in northern or southern regions, and both extremely effect from the climate variation results as the change in growing season length, the stress of heat, the additional requirement of water and low efficiency of farmers due to change in the natural environment has decreased the yield of the agricultural sector by 6 to 18%. Pakistan has been less Green House Gases producing country but environmentally affected more in the world (Ministry of Climate Change, Pakistan Report, 2016).

The rising temperature of the region affects the agaric sector through changing the cropping season, an excessive requirement of water in irrigation, more heat stress on agricultural production, an increase of water evaporation, change the sowing hour of crops, extra use of water for yield and modification of changing season. These climatic effects on agriculture are threats which are reducing the agaric production continuously of Pakistan. The agricultural role has the worth of backbone for raising food and curtailing the poverty of the region. No doubt Pakistan is characterized by rich canals and rivers networks which are adding the agricultural production of the country, but the changing temperature and climatic has an adverse effect on agricultural production shown by the picture and figure (Yousuf, I.; Ghumman, A.R.; Hashmi, H.N, Kamal, M.A. 2014**)**.



Source: *IPCC, 2014, 5th assessment*

The issue of climatic change bears the great worth for this region because the agriculture sector totally inclines to environmental variation. The crop production contributes to economic growth, receipts from exports, job opportunities and expansion of the market. The climatic change is the main factor like political, social and economic factors upon which the performance this sector is linked. The emerging issues of the day are scarcity of water resources or stress of water, drought or floods, extra evaporation, the stress of heat and change of the growing length of season crop, an extra requirement of water and precipitation which has aggravated the economy Barron (E. J. 1995), (Carter, T. R., K. Jylha and H. Tuomenvirta 2003) (Change, I. C. 2007) and (Change, O. C. 2001). So these factors and implications urge the researcher to conduct an empirical study on this transitional issue.

Literature Review

S. Ali et al. (2017) reported about the weather forecast which is unpredictable in the changing seasons. The lack of rainfall in winter may affect the hard cash crop production while the heavy amount of rains is the threats of floods and serious harmful results for the agricultural sector. The other side, hydro-meteorological change because of CO_2 emission as a melt of glaciers, cyclone, storms, deforestation, heatwaves and floods are the great risk for agaric sector.

Burke & Emerick (2016) investigated the frequent changes in climate reduces the livelihood of the agricultural society in rural areas. The change in temperature has long-lasting results on agaric sector not only a specific region but on the whole world.

Ji-kun (2014) discussed the variation in climate is dangerous for agriculture sector because it depends upon the environment. The frequent variability in climate causes the major cause of harm and risk for the yields of agaric sector, decreases its productivity.

Bocchiola & Diolaiuti (2013) investigated the carbon emission contribution from developing countries to greenhouse gases was not more than 0.8 % which is 135th part of developed countries. But this region has such a geographical location where the average temperature is measured higher than the average temperature of the global world. Most people directly or indirectly are linked to the agaric sector, which is sensitive to the climatic changes, hitting this sector more or less every year.

Alexandratos & Bruinsma (2012) examined the agriculture sector productivity, which is required a specific level of co_2, rainfall, moderate climate and temperature to grow and survive. The imbalance in these ingredients affects the crop production badly in the form of bugs. Moreover, all types of crops, the fertilization is compulsory.

Lobell, Schlenker, & Costa-Roberts (2011) emphasized on the climatic variation, which is associated with social and economic livelihood 0f the farmer society. The South Asian region countries lying Pakistani and Indian agriculture network was badly affected by a high frequency of floods and pushed them into a poverty trap.

Lal (2011) highlighted the insignificant role of climatic change in the agricultural sector in the short run of South Asian area. But over the long run after 2050, the dangerous implications of temperature in the form of floods and drought will adversely affect the crop production of Kharif and Rabi.

Gornall (2010) analyzed the favorable and unfavorable precipitation, and the temperature is associated with the agriculture sector. These factors are the most determinant of the cop sector production. The many agaric models of climatic variation have shown an adverse effect on developing countries.

Halicioglu (2009) focused that co2 emission from different sources exists positive and negative results. The carbon emission has direct effects soil, water and photosynthesis cycle in plants. The co2 emission of more than 60 % in the environment creates warming in temperature. It further causes extreme happenings like a flood, drought, water uncertainty, high temperature and land degradation will affect the agricultural production of the country.

Molua (2007) emphasized on the most prevailing factor for crop production of Cameroon. The cross-section view of Ricardian and surveying reports of 800 different farms. The study predicted that net income decreases as the temperature rises.

Calzadilla et al. (2006) highlight the adverse climatic effects on factor productivity. The rising temperature is harmful to the agricultural sector in the form of a decrease in yield. The reduced production is affecting the model of long-run equilibrium and growth of the neoclassical model.

Mendelsohn et al. (2001) examined the dual effects of temperature in the same country but in different regions. The Northern areas have a low temperature; the rising temperature will advantage in the yield production in such localities. The yield will decrease in the regions which characterized with hot temperature.

Mendelsohn and Dinar (1999) inclined the less grain yield to the increasing temperature from carbon emission. India and Brazil consider more the local climate is affecting the agricultural production rather than global climate. No doubt the agaric sector is sensitive to the climate; the mentioned countries are trying to minimize the adverse effects of global warming.

Reilly (1995) reported the harmful effects of variation of temperature in developing countries. The study revealed that higher temperature would cause water stress and insufficient water, reduced agricultural production.

Model Specification and Data Source

CP = f (CEH, CGF, CRCP)

CP = $\beta_0 + \beta_1$ CEH + β_2 CGF + β_3 CRCP + ε_i

CP = Crop Production is used proxy for agaric production

CEH = CO2 Emission from electricity and Heat, the proxy for Rising temperature,

GCF = CO2 Emission from Gas Fuel Consumption as a percentage, the proxy for Air pollution.

CRCP = CO2 Emissions from Residential Buildings and Commercial and Public Services (% of Total Fuel Combustion), the proxy for environmental pollution.

The dataset of the variables like crop production, carbon emission from electricity, gas fuel consumption, and residential building for temperature and pollution have been taken by World Development Indicator during the period from 1984-2015.

Unit Root Test

Dickey-Fuller and Augment Dickey-Fuller test was applied to test the stationary of the data. The tests have cleared that none of the variables is on 2nd difference, so the results are not spurious. Some coefficients are at the first difference I (1) and the other one at level I (0). Hence the most appropriate model is proposed for estimation is ARDL.

Autoregressive Distributive Lag (ARDL) Method to Cointegration and Theoretical Background

Auto-Regressive Distributed Lag technique approach was first time introduced by Pesaran (1997). Later, the other economists Pesaran and Shin (2001) refined and applied it on small and large sample size dataset. This technique is better than other approaches because of many advantages. Engle-Granger technique includes limited variables only up to two; hence it cannot be applied to this model because it included many variables. The other two techniques to cointegration could be applied if the model was having a number of explanatory variables. But theoretical background ARDL Technique confirmed the preference of this technique over to Johnson Likelihood approach for many benefits.

1) The variables which are having different orders like at level or first difference I (0) and I (1) or both mixed, the ARDL technique can be applied to them. But Johnson Likelihood approach can be employed on a specific order of first difference I (1). ARDL technique has the characteristic of flexibility in ordering.
2) ARDL approach is more consistent, accurate and reliable results in case of small sample size 30 to 80 values as well as large sample size up to 500 observations than Johnson Likelihood approach. Further results of the t-test are more reliable if it is estimated by ARDL technique. Johnson technique is efficient only in case of large sample size.
3) ARDL technique is better in performing and efficient in estimating for coefficients and keeps us at a distance from the problems caused by serial correlation and endogeneity. It also overcomes the problem of omitted variable and autocorrelation and provides an unbiased estimation of parameters.
4) The variables which are having different orders like at level or first difference I (0) and I (1) or both mixed, the ARDL technique can be applied to them. But Johnson Likelihood approach can be employed on a specific order of first difference I (1). ARDL technique has the characteristic of flexibility in ordering.

So because of such major qualities, ARDL technique to cointegration is preferred to other techniques in the model.

Conditions for Operating ARDL to Co Integration Test

(1) In ARDL model, pretesting of variables whether they are at I(0) or I(1) classification of into level or first difference is not necessary when underlying variables are shown in a single equation. The compulsory condition for the application of ARDL is that none of the variables in the specified model should be at 2nd difference. Otherwise, it can be applied.

(2) When the sample size is finite or small, and large long-run relationship among variables exist, the Bound Test (Wald Test) is applied. Further, the error correction reflection becomes more efficient than other estimation.

(3) In the presence of multiple long-run relationships, ARDL gives the spurious or misleading results. If a dependent variable of a single equation is sourcing feedback effect from other variables, the case will be tackled with multiple long-

run relationships. Hence alternative method to estimate the cointegration is Johansen cointegration test introduced by Juselius (1990).

(4) If there exists a single long-run relationship with maximal eigenvalue, ARDL approach is appropriate for the application. Otherwise, the alternative method of multivariate cointegration will be applied.

Results Analysis

Table 1. Bound Tests

F-Calculated	95% confidence interval		90% confidence interval	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
6.209	3.648	4.923	2.978	4.103

Source: Author's estimation

The computed value of F-statistics 6.209 crosses over the lower and upper critical values implies that there exist a long-run link between the variable in the mentioned period. The cointegration is present among coefficients portrayed by the low values of lower and upper limit values than F-Calculated values. If the value of bound statistics remains below the critical values, the sign of no cointegration among variables.

Table 2. Long Run Estimation of the Model Implies ARDL Method
(Dependent Variable = Crop Production (Cr)

Variables	Coefficients	T-Ratio(P-Value)
LCEH	-.374	-2.010 (.043)
LCGF	-.324	-10.957 (.00)
LCRCP	-.464	- 2.491 (.018
C	2.964	5.589 (.006)

Source: Researcher's Own Estimation.

The table shows the negative effect of carbon emission on agriculture production is negative as 1% increases in temperature CO_2 emission from electricity and heat, decreases agriculture production by .374 %. As the 1% rises in air pollution emission from gas fuel consumption, reduces the agaric production by 0.324 % and 1% increases in CO_2 emission from residual building and commercial, public service adversely affect the arid production by 0.464% in Pakistan. The empirical results revealed the effect of carbon emission agriculture in the form of electricity, gas fuel consumption & residential and commercial building is negative with statistically significant at 1 % & 5 %.

Table 3. Dynamic of ARDL Short Run Estimation of the Model

Variables	Coefficients	T-Ratios (p-value)
LCP(-1)	-.745	-8.192 (.000)
LCEH	-.095	-3.226(.003)
LCGF	-.189	-3.722(.001)

Variables	Coefficients	T-Ratios (p-value)
LCGF (-1)	-.106	-2.325 (.028)
LCRCP	-.001	-.045 (.964)
LCRCP (-1)	-.11	-2.795 (.009)
C	.753	4.045 (.013)

Source: Author's Own Estimation

In the table, the lagged value of dependent variable CP (-1) is significant in affecting the agriculture al production. As 1% increases in the lag value, CP (-1) brings about the negative change in agaric production by 0.745 %. While the other lagged values independent variables like carbon emission from gas fuel consumption CGF (-1) and carbon emission from residential building and service CRCP (-1) are significant at 5 % and 1% respectively. The other coefficients are also statistically significant in the short run.

Table 4. A good fit of the Model

R^2	Adjusted R^2	D.W-Statistics	F (8,22)
0.913	0.871	2.024	24.352

In the above table, the value of R^2 is .913 means the 91.3 variation is explanatory variables while the other change is due to residual term. The adjusted value of R^2 is attached to a degree of freedom. The Durban Watson value is 2.024, the sign of no autocorrelation. The ARDL method of cointegration overcomes the problem of autocorrelation. The more value of F represents the overall significance of the model.

Table 5. Application of Diagnostic Test

Problem	LM-Version (P.V)	F-Version (P.V)
Serial Correlation	(.101)	(.200)
Functional Form	(.670)	(.711)
Normality	(.740)	Not applicable
Heteroscedasticity	(.408)	(.424)

Source: Researcher's Own Calculation

In the table, the Lagrange multiplier test indicates about the residual's correlation. The more p-value of LM and F-version than 10 % represents the residuals are not correlated with each other, the sign of no serial correlation. Ramsey Reset test implies on the functional form of the model that responds correct functional form. The application of JB test is for normality, representing the normal distribution of the data. Breusch-Pagan-Godfrey devised the test about Heteroscedasticitythe LM and F-version values are portraying the absence of this problem.

Table 6. Mechanism of Error Correction Under ARDL Model Based on SBC (Dependent Variable = Crop Production (CR)

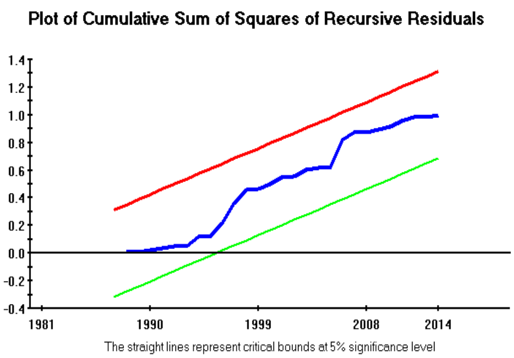
Variables	Coefficients	t-Ratios (p-value)
dlnCEH	-.095	-3.22(.000)
dlnCGF	-.189	- 3.722(.000)
dlnCRCP	-.0019	-.045(.964)
Ecm(-1)	-.542	-2.793(.000)

Source: Researcher's Own Calculation

In the table, the phenomenon of error correction model draws the picture of sort run results. As 1 % increases in temperature from CO_2 electricity and heat emission, declines the agricultural production by 0.95 % and 1 % increases in air pollution of carbon emission from gas and fuel includes in the environment, decreases agaric production by 0.189 %. While the 1 % raises CO_2 emission from residential building and service, reduces the yield of agriculture by 0.542 %.

The dynamic of a short run is presented with the concept of the short-run phenomenon; the negative value of Ecm_{t-1} coefficient indicates the model is highly statistically significant. The negative value of Ecm_{t-1} represents the self-adjustment operation towards equilibrium, while the positive value of Ecm_{t-1}, the sign of divergent from equilibrium.

Stability Test



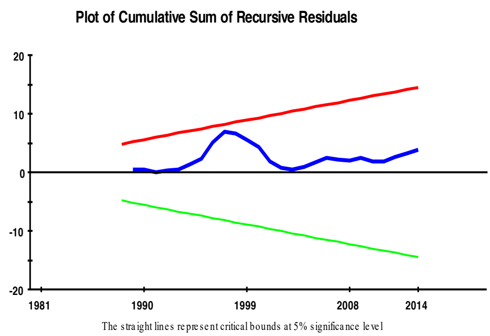


Figure 1 **Figure 2**

In the above figures, the Cumulative Sum of Recursive Residual COSUM and COSUM sum of square graph lines are in the space of boundaries of critical lines at 5% significance level. It also shows that model is stable without structural breaks.

Conclusion

The variation of temperature from its mean has been noted in this region, particularly in Pakistan. The high consumption of electricity, gas fuel and residential buildings and

Emission of carbon has raised the average temperature from 0.2 C^0 to 0.3 C^0 every year since last decade. The change in climate and environment have serious effects on the most dominant agricultural sector. Pakistan is experiencing the threat of extreme weather conditions which adversely affect the livelihood of rural areas and agaric base industry. Hence the importance of climatic variation has become a critical issue; it demands the more attention and suitable strategy be adopted against the climate variations. Otherwise, the climatic variables will affect the production negatively.

Pakistan is facing the serious harms of climatic variation in the form's floods, drought, water stain, the low water level of earth surface and extra water for crop production. This study has estimated the climatic effect on crop production by adopting the time series dataset from1984 -2015. The ARDL approach was applied to estimate the CO_2 Emission from electricity, gas fuel consumption, and residential buildings have raised the temperature and pollution of the world, particularly of this region.

The study measures the long run results that as 1% increases in temperature, reduces agriculture production by .374 %. As the 1% rises in air pollution, declines the agaric production by 0.324 % and 1% increases in carbon emission from residual building and commercial, public service adversely affects the arid production by 0.464 % in Pakistan. The study narrates statistically significant effect of temperature, pollution and carbon emission from residential buildings on agriculture is negative.

The short-run results are as 1 % increases in temperature, declines the agricultural production by 0.95 % and 1 % rises in air pollution, decreases agaric production by 0.189 %. While the 1 % pollution of carbon emission residential building and service, reduces the yield of agriculture by 0.542 %.

The dynamic of short run is presented with the concept of short run phenomenon, the negative value of Ecm_{t-1} coefficient indicates the model is highly statistically significant. The negative vale of Ecm_{t-1} represents the self-adjustment operation towards equilibrium while the positive value of Ecm_{t-1}, the sign of divergent from equilibrium. The Cumulative Sum of Recursive Residual COSUM and COSUM sum of square graph lines are in the space of boundaries of critical lines at 5% significance level. It also shows that model is stable without structural breaks.

The study recommends the comprehensive strategy be adopted to tackle with the climatic changes so that the reduction in crop production is not experienced by the country. The increased food productions exported over the world.

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