ECONOMIC IMPACT OF CLIMATE CHANGE ON THE PRODUCTION OF CITRUS FRUIT IN PUNJAB PROVINCE OF THE PAKISTAN

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***ABSTRACT*:** *Climate change is a rising issue for agriculture productivity and topographical area of Pakistan makes it insecure because of environmental changes. Climate change is fundamentally because of expansion in the Greenhouse Gases (GHGs) such as carbon dioxide, methane and nitrous oxide due to fossil fuel burning and other human activates. Greenhouse gases block the sun radiations and increases the earth's general temperature and causes global warming. The aim of study is to take a deep analysis of the climatic effects on citrus fruit production. The study utilizes Auto Regressive Distributed Lag (ARDL) model to assess the effect of climate change on the citrus production in Punjab. For this purpose, annual data from 1989 to 2015 were considered. The result estimated concluded that under climate change it has impact on citrus production. Through variation in the temperature, rainfall it directly affects the citrus production and also profitability of fruit. Consequently, the research also concluded that undoubtedly impact of climate change effects the production. On the contrary, if suitable adaptive and moderate practices in planting and better watering system, new technology and usage of hybrid seeds are applied then it can diminish this recently developing danger of climate change.*

Keywords: Citrus fruit, Climate effect, ARDL model, hybrid seeds, planting.

INTRODUCTION

Climate change is a physical process and no place on earth is immune its vulnerable effects [1, 2]. This phenomenon that explains the variations in world-wide temperature results in serious outcomes such as flood, water scarcity and from the deforestation activities to cause global warming due to emission of greenhouse gases like carbon dioxide, methane gases, nitrous oxide from the generation of power from fossil fuel. It has an exceptionally bad impact on the income wellness, output, sociology and is a huge threat for upcoming future [3-5]. Pakistan economy and its people occupation are largely based on agriculture due its rich fertile soil, old customs of farming crops with tress and large irrigation system. But in this region, the climate change is more obvious owing to its geographical location, arid and, semi-arid regions, warm climate and annual rainfall of less than 250 mm [6-8]. The current value of its agricultural products including vegetables and fruits is Rs. 550.27 billion. One of the major fruit crops of Pakistan is citrus species such as Clementine, oranges and mandarins and they are very famous all over the world. Production of fruits has great impact on the economy of Pakistan and its local atmosphere is reasonably suitable for its production in addition to sub-tropical fruit [9]. The production of citrus fruit was 1,960 tons in 1990-91 then

it increased to 2,168 tons in 2014-15 [10-13]. Citrus fruit production needs specific temperature requirements and its yield and quality is very sensitive to temperature. Climate change affects the land and crop production by the spread of diseases, pest and weeds, degradation in the product quality, less degree of flower pollination, soil erosion due to intense rainfall, more concentration of carbon dioxide in the atmosphere and increase in the investment cost such as soil fertilizers and pesticides for eradicating pests. These threats of climate change affecting the developing as well as developed country's economy and its outcomes are of great concern with respect to human development, especially for the under developed countries in the sense of poverty [14, 15]. Pakistan at the 10th rank of the largest producer of citrus fruits in the world. Many economists and scientists practices the agriculture sector based on empirical analysis, but citrus fruit production in relation with climate change has solely been discussed. In this work, we attempted to testify and analyze the long-term impact of climate conditions that strongly influence on the production of citrus fruit in Punjab province of Pakistan.

MATERIALS AND METHODS

Theoretical model

The production function approach depends on observational or exploratory production function to calculate the relationship between agriculture produce and climatic changes [25]. In this examination, yields are calculated under a number of ecological conditions. Climate variable, for example, temperature, precipitation and carbon dioxide are then entered at different levels and outcomes are recorded. A fundamental production function is then evaluated to assess the effect of environmental change on yield. [4] affirm the production function (Q) able to express in view of exogenous and endogenous variables and on variables that shows the capability or limits of producer [17-18]. In the present study technique of production function, explains the impact of changes in climatic condition in citrus production. Exogenous variables like the climate helps in measuring the output of crop. The crops growth depends on the availability of moisture level and vulnerability of temperature. The growing stages in plants are related to climatic factor such as flowering and germination due to precipitation. On the other side, the growth and maturation of fruits with required temperature [19].

Econometric model

This research the most important objective is to build up the long and short run relationship between the climatic factors

and citrus production in Pakistan. The time series data in this study are collected from publicaly available sources such as Pakistan Economic survey (various issues) and metrological department Islamabad and Lahore. The data of production of citrus of Punjab province are taken in thousand tons and the area where citrus is grown is also taken in thousand hectares. Other variables include the rainfall and temperature of various districts of Punjab whose average is taken over the period of 1989 to 2015 as the data was available for these years. The data is annual, covering the period 1989 to 2015, or a total of 26 observations based on secondary data.

RESULTS AND ANALYSIS

Firstly will have discussed stationary of the variables with respect to time, here the results four variables, two are integrated at a level that is rain fall and area are of order of integration, while the other two; area of production of citrus fruit and the temperature calculated for the Punjab province are integrated at 1^{ST} difference. Now, as two of the variables are stationary at level and two variables are stationary at first difference the ARDL approach is suitable to this model than any other. ARDL model needs to test some of the basic assumptions of time series data in order to make the results free from unbiasedness and inconsistent estimators including serial correlation functional form and heteroscedasticity. The Autoregressive distributed lag model for this analysis will be.

$$\Delta \ln \mathbf{PRO} = \alpha_0 + \sum_{j=1}^{n} \beta_j \Delta \ln \mathbf{PRO}_{t-j} + \sum_{j=0}^{n} \mu_j \Delta \ln \mathbf{AREA}_{t-j} + \sum_{j=0}^{n} \infty_j \Delta \ln \mathbf{TEMP}_{t-j} + \sum_{j=0}^{n} \Omega_j \Delta \ln \mathbf{RF}_{t-j} + \delta_1 \ln \mathbf{PRO}_{t-1}$$

$$+ \delta_2 \ln \mathbf{AREA}_{t-1} + \delta_3 \ln \mathbf{TEMP}_{t-1} + \delta_4 \ln \mathbf{RF}_{t-1} + \varepsilon_{1t}$$

Table 1: Analysis of Physical parameters.

Variables	Level	1st Difference	Inference
Production	-1.914031	-2.212015	
	(0.3131)	(0.0015)	**I(1)**
Area	-0.73648	-8.61615	
	-0.0027	-0.0002	**I(0)**
Temperature	-4.87683	-8.135385	
	(0.3427)	0	**I(1)**
Rainfall	-2.563481	-4.153128	
	-0.0128	0	**I(0)**

Table 2: Diagnostic results.

Test Statistics	LM -Version	F -Version
Serial Correlation	CHSQ(1)=.062557[.802]	F(1,19) = .045825[.833]
Functional Form	CHSQ(1)= 5.0282[.025]	F(1,19) = 4.5555[.046]
Normality	CHSQ(2)= 1.9553[.376]	Not applicable
Heteroscedasticity	CHSQ(1)= .36585[.545]	F(1,24 = .34253[.564]

Table 3: ARDL bound results.

Test Statistic	Value	K
F-Statistic	8.6312	4
Significance level	**Lower Bound Value**	**Upper Bound Value**
10%	3.0644	4.236
5%	3.7724	5.1809

Table 4: Dynamic results of the error correction model.

Error Correction Representation for the Selected ARDL Model			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
PRO(-1)	-0.28755	0.16095	-1.7866[.089]
AREA	2.1865	0.38234	5.7188[.000]
TEMP	43.6114	27.6183	1.5791[.130]
TEMP(-1)	73.6239	27.3886	2.6881[.014]
PRE	8.2416	4.1768	1.9732[.062]
INPT	-4685.4	1347.6	-3.4767[.002]
ecm(-1)	-0.36357	0.089471	-4.0636[.000]
ecm = Pro + 0.23320*area - 1.2387*temp + 4.1169*Rf +717.5687*INPUT + 9.7015*T			

The parameters β_j, μ_j, ∞_j, and Ω_j in the above equation are the coefficients of short run, whereas the later part of the equation with the symbol δ_i shows the long run multiplier of the bound and the value of i=1, 2, 3 and 4. Defining the hypothesis of the model the null hypothesis of this model is described as there does not exist any cointegration between the variables or

$$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$$

$H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$

Testing of these hypotheses is based on two sets of asymptotic critical values of F-test given in the [8]. Among these test values one set of F-test undertakes that given variables are integrated at level I (0) whereas the second set undertakes the assumption that all of the variables are integrated at one I (1).

Testing of Cointegration

The conventional method of co-interagtion only value of F statistic is used in case of long run relationship, the true or accurate values with the integration at the level I (0) and for the first difference I(0) are not available for F-statistic [20-23]. There is a supply bounds for the F-statistic for all the three cases for integration at level, for the first difference and if the order of integration is at the mix which are based on asymptotic distribution. Also for the number of variables (k+1), lower as well as upper bound is provided. The calculated value of F-stat for $\delta_1, \delta_2, \delta_3$ and δ_4 where $\delta's$ are the coefficient for the joint test for the long run. The value of lower bound is 3.7724 and for the upper bound it is 5.1809 and these values are significant at the 95 percent level of confidence having (k+1) = 4 numbers of variables, here k=3, it shows that there are three independent variables and one dependent variable. The calculated value of the F-statistic is 8.6312 which is larger than the upper bound, hence the null hypothesis is rejected concluding there is impact of climatic factors on production of citrus fruit.

Error Correction Mechanism

The dynamic results of the error correction model are reported in Table 4. The coefficient sign of ECM term is negative and significant. The higher value of ECM shows fast adjustment process. From the results, we can infer that the value of ECM term necessitates that change in citrus production from short run to long span of time is corrected by almost 34 percent each year with high significance. Thus, disequilibrium occurring due to a shock will take slightly more than a year to attain the equilibrium. The results show that any negative shock to citrus production in the short-run will be adjusted by area. Consequently, area will play an important role to absorb any negative shock to citrus production. The results support the previous studies made by Chaudhary and Ishfaq [23], which showed that there is significant effect of climate on citrus production not only on citrus fruit, but climatic factors also cause the production of other fruits as well [24].

CONCLUSIONS

After defining the theoretical model, time series for the variables are testified for the stationarity applying the objective approach and came across the finding that due to variables integrated at level and first difference. In this paper ARDL model is applied to check the long run, short run as well as error correction mechanism of the climatic factors on citrus production in Pakistan. It has been observed that there is short as well as long run relationship between the climate change and production of citrus. Climatic variables temperature as well as rainfall has very harmful effect on the production of citrus fruit. These result shows that there can be severe repercussion in Pakistan's horticulture. This sector of the economy shows a very negative effect put by climatic variables that are due to the variation in rainfall as well as temperature.

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