Extended Abstract

Paper Title	The Sensitivity of Agricultural Productivity to Climate Change: District Level Evidence from Pakistan

Abstract prepared for presentation at the 97th Annual Conference of the Agricultural Economics Society, The University of Warwick, United Kingdom

27th – 29th March 2023

Abstract	***200 words max***
According to the World Bank, Pakistan is amongst the most vulnerable countries to climate change risk. We Study the impact of climate change on the productivity of five major crops: wheat, rice, maize, sugar cane, and cotton in a panel of 82 Pakistani districts over a period of 21 years i.e., from 2000-2020. We designed a special composite index based on 30-year weather data from 7 weather stations across the country to calculate each district's climate change score. Using Panel Corrected Standard Errors (PCSE) estimation, we find that agricultural productivity is negatively related to climate change in 62 out of the 82 districts, while in 20 districts it was found to be positively related with agricultural productivity. We contribute to the literature in several ways. First, we provide district-level evidence on the impact of climate change on the productivity. Secondly, as opposed to several previous studies who consider a single climate factor, we consider a number of climate related factors simultaneously. Finally, to the best of our knowledge, we are the first ones to introduce a specially designed composite index to measure climate change at each district using long term weather data.	

Keywords	Climate Change, Pakistan, Food and Cash Crops, Agricultural Productivity
JEL Code	e.g. Energy: Demand and Supply Q41 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction

100 – 250 words

Developing countries, like Pakistan are most affected by climatic changes as they have a scarcity of resources to cope with it (Schelling, 1992). Pakistan has had political and economic instability right from the time of its inception in 1947. Geologically, Pakistan is in South Asia and is classified in the extreme-temperatures zone where the summers are becoming more and more scorching while the winters are getting colder. The rise in the temperature is adversely impacting its human health, labour force efficiency, unexpected rainfalls, uncertain water availability, and the yields of major food crops. The Asian development Bank estimates that Pakistan will have a further average increase in temperature of 1.3°C–4.9°C based on 1986–2005 baselines. (WDG_ADB, 2021).

Given this context, we investigate the impact of climate change on the agricultiral productivity of Pakistan. Our study is differed from the studies of Aggarwal and Sivakumar (2011), Sultana and Ali (2006), and Ahmad et al. (2013) in different ways. First, most of these studies are based on a single or two climate factors (e.g., average temperature), we develop a composite climate change index with data on several weather factors from seven weather stations. Second, we provide evidence on the impact of the climate change on agriculture productivity with the help

of data from eighty-two districts of the country. Third, instead of focusing on the productivity of a single crop, we use productivity data of five major crops, cotton, rice, maize, sugarcane, and wheat, to gain better insights into the overall agriculture productivity.

Methodology *100 – 250 words*

We tested the impact of climate change on agricultural productivity of five major crops (Wheat, Maize, Rice, Sugarcane and Cotton) in eighty-two districts of Pakistan over a period of 21 years i.e., 2000-2020 (1,722 district-year observations). We introduce a specially designed composite index to measure climate change at each district using long term weather data on changes in a number of climate related factors simultaneously. We identified important climate change related factors based on previous literature to constitute our index. These factors included annual average of Minimum and Maximum Temperatures (Guntukula, (2020), Average Annual Rainfall (Ali et al., 2017) and Humidity (Angon et al., 2021).

The data on climate factors i.e., Average annual Minimum and Maximum Temperatures, Average annual Rainfall and Humidity was taken from 9 Weather Stations of the Meteorological Department of Pakistan. The climate index was then calculated as the sum of dummy variables for each of the climate factors, such that the dummy is coded 1 if the factor's value is greater than the 60^{th} (or lower than the 30^{th}) percentile of the deviation of actual values of the factors from the 15 years average of that factor. Next, we regressed the agricultural productivities of major crops produced in 82 districts of the country over the climate change index to estimate the climate change sensitivities of agricultural productivity. We used Panel Corrected Standard Error Regression (PCSE) technique to deal with the possible issues of heteroscedasticity and serial correlation due to nature of our data set.

Results *100 – 250 words*

We find that agricultural productivity has been negatively related to climate change in most of the sample districts. In 62 out of the 82 districts, climate change was found to be adversely affecting the agricultural productivity of major crops, while in 20 districts it was found to be positively related with agricultural productivity. We believe that this positive relationship could be due to the diverse geography of the country where climate change varies from favorable to worse. Moreover, Climate events such as Floods which may have had adverse effects in one region have left positive effects on the agricultural production.

Discussion and Conclusion *100 – 250 words*

In an agricultural economy, the decline in productivity of food and cash crops sugarcane and cotton may be an alarming signal in the coming years. The government of Pakistan needs to take steps on an emergency basis to cope with climate change. While the government has recently taken some steps to curb climate change and its impacts such as a mega plantation drive of planting one billion trees, ban on plastic bags and instead introducing Biodegradable bags besides several other steps, however, in order to have the positive outcomes of these steps, the government needs to observe a consistent implementation of such measures. Farmer education and timely and accurate weather information systems across the country is also a need of the day so that the farmer at gross root level stay informed of any possible short term and long-term shifts in climate and hence accordingly adjust their choice of crops. Weather and disease resistant seeds might either be indigenously developed or imported on emergency basis so that the country's food and economic needs from the agricultural sector are well met.