Impact of Climate Change Calamity on Rice Productivity using Vector Autoregression (Var): Case of Sindh Province, Pakistan

Mumtaz Joyo[1], Nanik Ram[2] , Muhammad Ismail Kumbhar[3] and Naeem Ahmed Qureshi[4]

Unusual changes in weather pattern are generally referred to as climate change defined as a rise in the average surface temperature of Earth. This is also acknowledged as global warming. Climate can be termed as change in weather pattern. Climate is a product of weather, so when changes are encountered in expected weather, this is called climate change. During 2010, Pakistan topped the list of countries worst affected by climate linked calamities. Similarly during 2011, the country ranked third. Because of rapid and parallel variations in the demographic and topographic scenery of the country, it is considered amongst highly vulnerable countries facing adverse impacts of climate change. The aim of the present research is to estimate the dependent variable i.e., the drastic and considerable decline in rice productivity due to known or fixed values of explanatory variables: temperature and precipitation/rainfall level.

Rice is typically the most popular among all crops cultivated in Asia due to large scale production and the land usage of around 90%. It is consumed at a similar level: rice is a popular staple in the region as well as among almost half (50%) the world's population as well as more than 70 percent (75%) of the poor.

In Sindh province of Pakistan, rice is cultivated on nearly 2 million acres with per acre outputs of 45 to 50 mounds. Approximately half of the rural labour force engages in rice cultivation and produce 35 percent of the country's total rice production: 3.5. million tons annually. The favorable conditions on which its growth is based are the moderate temperature and availability of water I n Sindhi. Rice is a tropical crop and needs high temperatures over a period of approximately 4 to 6 months. These
temperatures need to exceed 80 degrees fahrenheit (°F) and should in no way fall short of 70 degrees (°F) for the rapidly growing varieties.

[1] *Department of Agricultural Economics, Sindh Agriculture University Tandojam joyo.mumtaz@gmail.com*
[2] *Department of Economics, University of Sindh Jamshoro*
[3] *Department of Agril. Education, Extension & Short Courses, SAU Tandojam*
[4] *Department of Statistics, Sindh Agriculture University Tandojam*

In the province of Sindh, Sukkur is well-known for its quality rice closely followed by Larkana and other rice bowls in Khairpur, Nawabshah, and Hyderabad districts respectively. The main strains of rice common to the province of Sindh are Kangni, Beghi, Irri-8 etc. The Irri variety thrives in Pakistan due to high exposure to sun shine rays and rich irrigation. Irri yields three to four times the productivity of other domestic varieties when appropriately directed, thus enabling the country to amplify rice yield with high production. For 2015, rice earned through export resulted in foreign exchange of around US$ 1.53 billion; 20 percent short 2014. The present research estimates the dependent variable i.e. rice crop of Sindh in Pakistan. The rice yield/productivity depends on associated explanatory factors or variables i.e. temperature and precipitation and other factors are agricultural credit, rice procurement price, fertiliser, and land and water availability. Time series data for the last 20 years (1994-95 to 2014-15) has been processed using the Vector Auto Regression *(VAR)* model.

The research is based on two methodological approaches to determining the impact of climate change using temperature and precipitation levels: two variables affecting rice productivity and other production practices in cultivating rice. The method applies two different tools: the exploratory research method with the *vector auto regression (VAR)* is an econometric model, denoted *VAR(p),* as used to capture the linear interdependencies among multiple time series model based approach. The research results is based on the developed equation for the study that *Rice productivity* $= ß_{1} – ß_{2Temp} + ß_{3Precip} + ß_{4Acrdt} + ß_{5rpp} + ß_{6Fert} + ß_{7Tech} + ß_{8Lr} + ß_{9Wa} + U_{i}$, while The1results of econometric VAR model inference to central research parameters, that is rice output (Rp), average precipitation (Preci.), agricultural land under the rice crop, average temp., (Temp.) and water availability (Wa). The statistical values of t-statistics for given variables are less significant with the more value of F-statistics so that statistically signifies model's for all lag terms. The coefficient value (R) squared has in linking 0 to 1 which define the validity of fit of model. Look upon VAR lag 2 since the points of Schwarz Sc an Akaike AIC of the data used as lag 2 is lesser than that of lag 3, lag 4 and so on, as a result the minor values Schwarz Sc 19.23172 and Akaike AIC 17.11070 for lag 2 help to model highly preferable. Consequently, the VAR equation model for lag 2 for the research is highly suitable as other lag points/values. The *ADF* test shows the variables of model to be non- stationary at conventional levels of significance (at 5% level of significance) and point to that the parameters are stationary at number one difference, that highlight the all parameters are in order 1, in other side water adequacy data has in the stationary form eventually. Rice production during 2015-16 was forecasted at 6.9 million tones, unchanged from the current year's production as per the *VAR* interpretation. Area is not expected to be different from

the 2014-15. Yield is forecasted as 42.6 (*40kgs/hectare)*, which is a good yield, but not a historical improvement because of climatic uncertainty. The production through 2015 is also adjusted upwards in accordance with the figures provided by the country, given earlier rice production data. The main reason for enhanced crop output is the greater land area used to grow rice. Although better than the crops yielded during successive floods several years back, these crops have been less productive due to shifts in temperature and precipitation levels. A fear started to grow after the monsoon floods that the rice crop would be adversely affected, especially in areas where, the Basmati variety is grown. On the contrary, the increase in production shows that the initial flood damage reports were exaggerated and the floods, in fact, benefited the rice crop. The econometric results illustrated that the increase in temperatures and a decreased precipitation, negatively impact rice productivity in Sindh, where yield/productivity will decrease by 7.3% in the short-run and 13.3% in the long-run with an increase in temperature by 1°C and similarly 10% decrease in precipitation. Further, results show that decline in the productivity of the crop in the study area would be an alarming situation and the big threat to rice productivity. The results and predicted values after analysis also show that the raise in temperature will decrease the rice productivity. The coefficient for the precipitation level and temperature were depressing as well as insignificant with a signifying negative link between planting periods and their productivity or yield.

Well-defined planning and sagacious policies will be crucial to adaptation among rice growers. New hybrid and climatic resistant controlled varieties with higher heat and malnourishment tolerance may be introduced. Lastly, the government could organise irrigation with other advanced projects. The high temperature regions and inadequate irrigation system need modern irrigation technologies to increase agricultural productivity.

Key words: Climate Change, Rice, Productivity, Vector Auto-regression (VAR) and Sindh.