

## **CHAPTER- 3**

### **RESEARCH METHODOLOGY**

Research methodology is the systematic layout for carrying and conducting the research towards its desired end. Different types of methodologies were used by various researchers at national as well as at international level while assessing the climate change, depending on the nature of the objectives concerned. In the present study, there are two objectives which address the two different things.

The first objective covers the trends in area, production and productivity of rice and apple between the years 1985-2015 which are discussed in the chapter 4<sup>th</sup> of the present study. Firstly trends of rice with respect to production, area and productivity are discussed in detail followed by the trends of apple in same spheres viz. production, area and productivity. These trends help in the comparative analysis of both the crops.

The second objective which is the main objective of the present study assesses the impact of climate variables (average temperature and rainfall) on rice and apple production using the time series data from 1985-2015. For accomplishing the second objective multi-variate regression analysis has been used to identify the extent of impact on the production and productivity of rice and apple crop respectively. Augmented Dickey Fuller (ADF) test is used to check the Stationarity in the data before employing the regression model. A multi linear regression model is used to examine the relation between independent and dependent variables. The rice and apple production data is regressed upon the climatic variables in order to estimate the effects of climate variables on the production and productivity of rice and apple crop respectively.

Following Sarker et.al (2012), two climatic variables (average temperature and rainfall) are used as independent variables with rice and apple (production and productivity) as dependent variables. Like Lobell and field (2007), only growing period data is used in order to capture the net effect of climatic variables upon the rice and apple production and productivity. In this study temperature is pronounced as the average temperature while rainfall is used as the total rainfall like in the previous studies of Granger and Chang in 1980 and 2002. Following Amin et.al (2015) Augmented Dickey Fuller (ADF) test is used to check the stationarity in the data. In the present study there are two dependent variables (rice and apple), whose production and productivity is assessed by four simultaneous regression equations which are discussed below.

ADF Equation without constant and trend:

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{s=1}^m \partial_s \Delta Y_{t-s} + V_t$$

### 3.1 Regression Models

#### 3.1.1 Model 1: Rice production

$$W (\text{Rice}_p)_t = \alpha_0 + \alpha_1 \text{avg.temp}_t + \alpha_2 \text{train}_t + \mu_t \dots\dots\dots 1$$

Where,  $W (\text{Rice}_p)_t$  is the production of rice (in thousand tons), avg.temp. is the average temperature in ( $^{\circ}\text{C}$ ), train is the total rainfall (mm),  $\alpha_1$  measures the variations in W with respect to average temperature and  $\alpha_2$  measures the change in W with respect to the total rainfall.  $\mu_t$  is the error term which we pronounce as the disturbance term because we can't capture the influence of each and every variable and t denotes time (i.e., 1 year).

### 3.1.2 Model 2: Rice productivity

$$X (\text{Rice}_{pd})_t = \beta_0 + \beta_1 \text{avg.temp}_t + \beta_2 \text{train}_t + \mu_t \text{-----} 2$$

In the regression equation 2,  $X (\text{Rice}_{pd})_t$  denotes the productivity of rice (in Qtls./Hectare),  $\text{avg.temp.}$  is the average temperature in ( $^{\circ}\text{C}$ ),  $\text{train}$  is the total rainfall (mm),  $\beta_1$  measures the variations in  $X$  with respect to average temperature and  $\beta_2$  measures the change in  $X$  with respect to the total rainfall.  $\mu_t$  is the error term which we also call as disturbance term. Error term denotes that we can't reveal the impact of each and every variable on the dependent variable.  $T$  is the notion for time (i.e., 1 year).

### 3.1.3 Model 3: Apple Production

$$Y (\text{Apple}_p)_t = \gamma_0 + \gamma_1 \text{avg.temp}_t + \gamma_2 \text{train}_t + \mu_t \text{-----} 3$$

Where,  $Y (\text{Apple}_p)_t$  is the apple production (in metric tons),  $\text{avg.temp.}$  is the average temperature in ( $^{\circ}\text{C}$ ),  $\text{train}$  is the total rainfall (mm),  $\gamma_1$  quantifies the variations in  $Y$  in response to average temperature,  $\gamma_2$  calculates the variations in  $Y$  with respect to the total rainfall,  $\mu_t$  is the error term and  $t$  represents the time (i.e., 1 year).

### 3.1.4 Model 4: Apple Productivity

$$Z (\text{Apple}_{pd})_t = \theta_0 + \theta_1 \text{avg.temp}_t + \theta_2 \text{train}_t + \mu_t \text{-----} 4$$

In this regression model,  $Z (\text{Apple}_{pd})_t$  depicts the apple productivity (in kg/hectare),  $\text{avg.temp.}$  is the average temperature in ( $^{\circ}\text{C}$ ),  $\text{train}$  is the total rainfall (mm),  $\theta_1$  exhibits the variations in  $Z$  with respect to average temperature,  $\theta_2$  calculates the variations in  $Z$  in response to the total rainfall,  $\mu_t$  is the disturbance term and  $t$  mentions the time (i.e., 1 year).

### **3.2 Area and Period of the Study**

Kashmir valley which comprises of 10 districts is selected as the study area and the period of the study stretches over 1985-2015.

### **3.3 Data and Data sources**

The present study is based on the secondary sources of data and the data related to Rice and Apple is collected from Directorate of Statistics and Economics (Srinagar), Annual Statistical Digests of Jammu and Kashmir, Directorate of Horticulture (Srinagar), Directorate of Rice Development (Patna) and Reserve Bank of India, while the data related to climate variables (Average temperature and rainfall) is collected from the Indian Meteorological department (Srinagar).