# CHAPTER- 4

# DATA ANALYSIS AND INTERPRETATION

The first part of this chapter fulfills the first objective of this study by analyzing the trends of area, production and productivity of agriculture produce – rice and apple. In the second part of this chapter, multi-variate regression analysis is done with the application of four regression models.

## 4.1 Trends in Area, Production and Productivity

### 4.1.1 Trends in Rice Crop

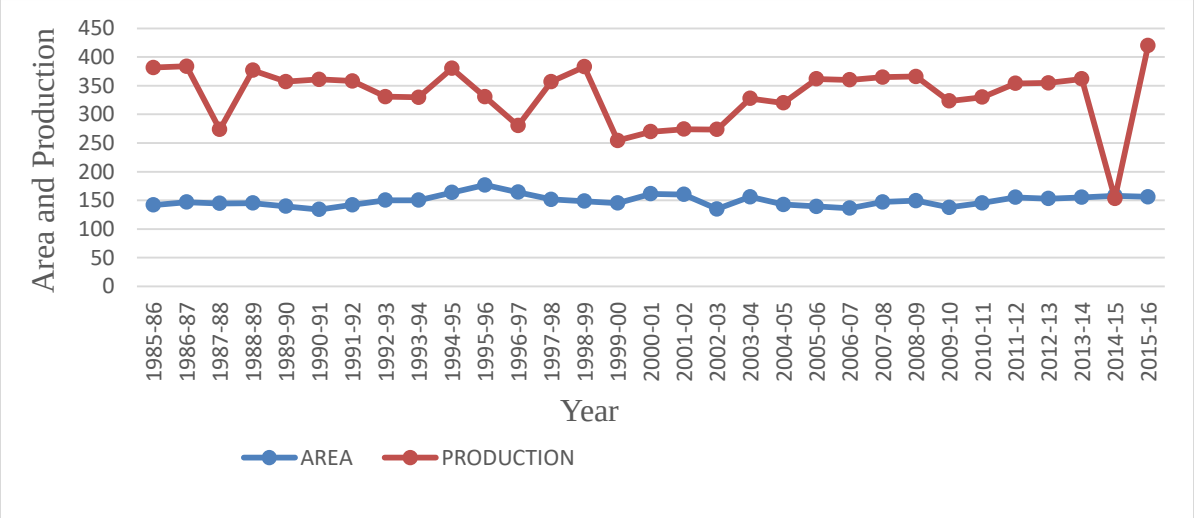
**Table 4.1.1: Trends in Area, Production and Productivity of Rice from 1985-86 to 2015-16**

| Year | Area ('000 Hect.) | Production ('000 Tons ) | Productivity Qtls./Hect. |
|---|---|---|---|
| 1985-86 | 141.9 | 381.6 | 26.9 |
| 1986-87 | 147 | 383.8 | 26.1 |
| 1987-88 | 144.7 | 273.5 | 18.9 |
| 1988-89 | 145.2 | 376.7 | 25.9 |
| 1989-90 | 139.7 | 356.9 | 25.6 |
| 1990-91 | 134.1 | 360.8 | 26.9 |
| 1991-92 | 142.2 | 358 | 25.2 |
| 1992-93 | 150.2 | 330.7 | 22 |
| 1993-94 | 150.1 | 329.6 | 22 |
| 1994-95 | 163.5 | 380.1 | 23.2 |
| 1995-96 | 176.8 | 330.5 | 18.7 |
| 1996-97 | 164.2 | 280.4 | 17.1 |
| 1997-98 | 151.6 | 357 | 23.5 |
| 1998-99 | 148.5 | 382.9 | 25.8 |
| 1999-00 | 145.3 | 254.2 | 17.5 |
| 2000-01 | 161.5 | 269.7 | 16.7 |
| 2001-02 | 160.4 | 274.2 | 17.1 |
| 2002-03 | 134.8 | 273.7 | 20.3 |
| 2003-04 | 156 | 327.7 | 21 |
| 2004-05 | 142.8 | 319.9 | 22.4 |
| 2005-06 | 139.2 | 361.9 | 26 |
| 2006-07 | 136.4 | 360.1 | 26.4 |
| 2007-08 | 147.1 | 364.8 | 24.8 |
| 2008-09 | 149.4 | 366 | 24.5 |

| | | | |
|---|---|---|---|
| 2009-10 | 137.6 | 323.3 | 23.5 |
| 2010-11 | 145.4 | 330 | 22.7 |
| 2011-12 | 155.3 | 354 | 22.8 |
| 2012-13 | 153 | 354.9 | 23.2 |
| 2013-14 | 155.3 | 361.8 | 23.3 |
| 2014-15 | 158 | 153.3 | 9.7 |
| 2015-16 | 156.2 | 420.2 | 26.9 |

**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

**Figure: 4.1.1 Trends in Area and Production of Rice from 1985-86 to 2015-16 (in '000 hectares and '000 tons)**

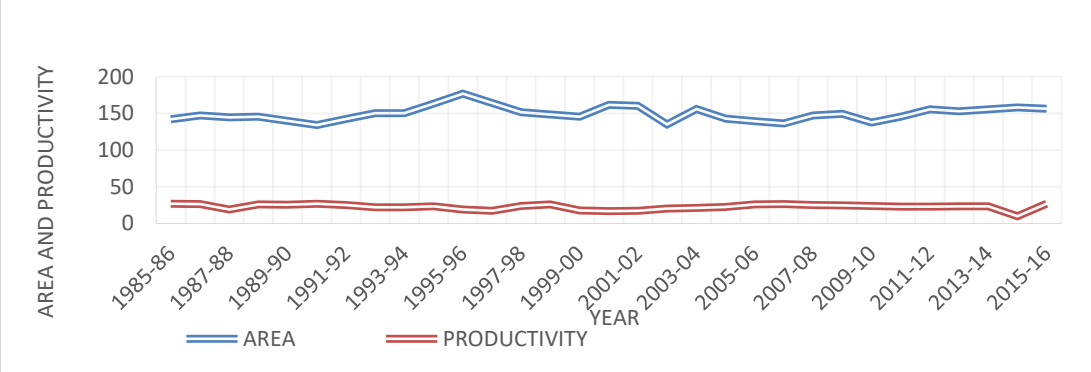



**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

The above given graph shows the area and production trend of rice over the time period 1985- 15. The production trend of rice depicts continuous fluctuations with least consistency. From the beginning i.e. 1985, production trend exhibits continuous troughs and crusts till 2015. Various reasons are responsible for this non-linear production trend like droughts, floods and continuous cropping pattern shifts etc. In contrast to the production trend area trend depicts minimal fluctuations. It is depicted by the graph that the variations in area trend didn't match the production trend and vice versa. At certain

points both the trends show positive correlation while overall there exists no unanimity between the two trends in general. The production trend reveals that there is no relevance between the fluctuations in production curve and area under the rice crop. Thus it can be concluded from here that production is least affected by the area than other factors. The other factors that may be responsible for these uneven fluctuations are variations in climate variables, droughts, floods, cropping pattern shifts etc. The production trend falls to the highest ever figure in 2014- 15 because over this time period floods washout the production of various crops particularly rice and apple throughout the valley.

**Figure: 4.1.2 Trends in Area and Productivity of Rice from 1985-86 to 2015-16**




**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

The above given graph compares the area and productivity trend of rice over the specified time period 1985- 2015. The figure reveals that over the time period 1985- 2015 area trend depicts various ups and downs. These ups and downs in the area trend occur due to the continuous shifts in cropping pattern over the specified time period in order to combat the various climate changes like droughts, water scarcity and various other changes which farmers consider production inhibiting for a certain crop. In comparison to area trend, productivity trend is smooth which reveals that area has least impacted the

productivity of rice and there are other changes which impact the productivity like in 2014 -2015, productivity falls to the highest ever figure due to the floods.

### 4.1.2 Trends in Apple Crop

**Table 4.1.2: Trends in Area, Production and Productivity of Apple from 1985 to 2016**

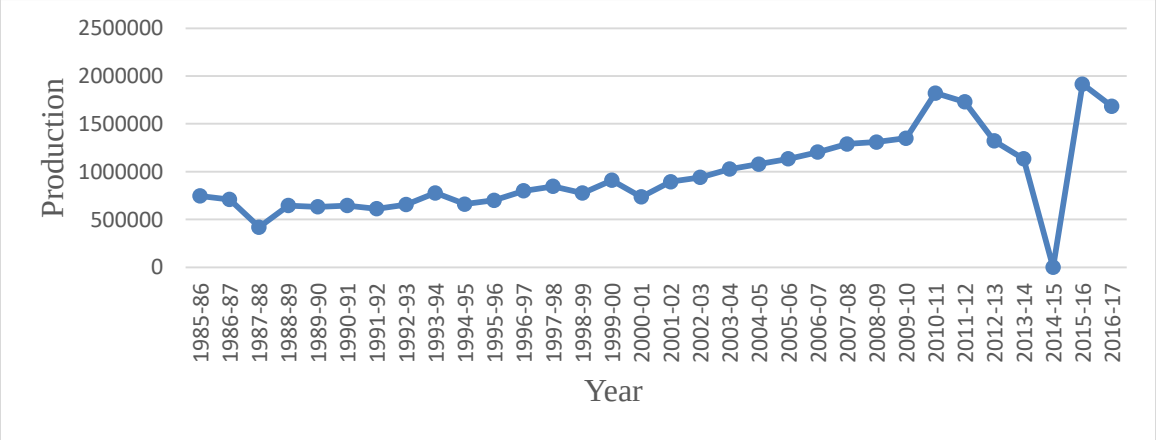
| Year | Area.(Hectares) | Production.( M.Tons) | Yield (Kg/Hect.) |
|---|---|---|---|
| 1985-86 | 57416 | 745452 | 12983 |
| 1986-87 | 60328 | 709349 | 11758 |
| 1987-88 | 60716 | 418522 | 6893 |
| 1988-89 | 61012 | 645090 | 10573 |
| 1989-90 | 61381 | 631918 | 10295 |
| 1990-91 | 61851 | 645002 | 10428 |
| 1991-92 | 62537 | 611980 | 9785 |
| 1992-93 | 63327 | 655875 | 10356 |
| 1993-94 | 65793 | 776895 | 11808 |
| 1994-95 | 67491 | 660565 | 9787 |
| 1995-96 | 70206 | 700537 | 9978 |
| 1996-97 | 72324 | 799729 | 11057 |
| 1997-98 | 74320 | 846842 | 11394 |
| 1998-99 | 75002 | 775752 | 10343 |
| 1999-00 | 77986 | 910442 | 11674 |
| 2000-01 | 79334 | 736284 | 9280 |
| 2001-02 | 81115 | 894019 | 11021 |
| 2002-03 | 85758 | 939657 | 10957 |
| 2003-04 | 91397 | 1027526 | 11242 |
| 2004-05 | 98234 | 1078730 | 10981 |
| 2005-06 | 101038 | 1134472 | 11228 |
| 2006-07 | 107177 | 1204011 | 11233 |
| 2007-08 | 115235 | 1289551 | 11190 |
| 2008-09 | 119730 | 1310362 | 10944 |
| 2009-10 | 123322 | 1349672 | 10944 |

| | | | |
|---|---|---|---|
| 2010-11 | 125788 | 1822058 | 14485 |
| 2011-12 | 137891 | 1730609 | 12550 |
| 2012-13 | 139017 | 1321317 | 9504 |
| 2013-14 | 143472 | 1134637 | 7908 |
| 2014-15 | 143472 | 0 | 0 |
| 2015-16 | 142501 | 1915448 | 13441 |

**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

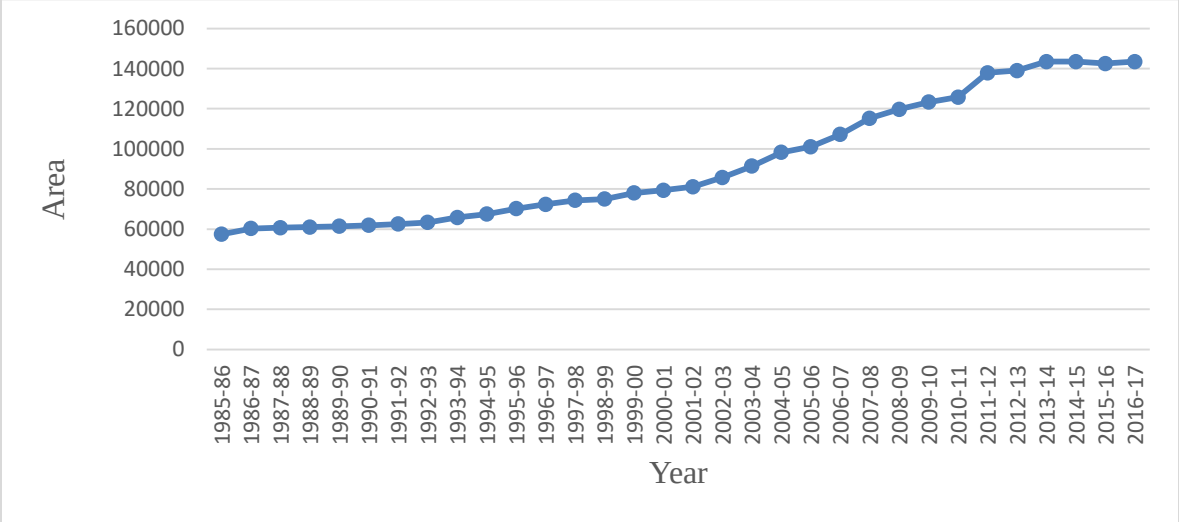
The below given two graphs depict the production and area trends of apple. The graphical trend reveals that the apple production exhibits little but continuous fluctuations in the preliminary phase (from 1985 up to 2001), after which it increases continuously for a decade and then again diminishes between 2011-2015 but soon attains recovery and touches the highest ever production level in 2015. In contrast to it area trend reveals increasing tendency since the beginning and continuously goes on increasing till a dip occurred in 2014-15.The comparative analysis of both the graphs is given below.

**Figure: 4.2.1 Trends in production of Apple from 1985-86 to 2016-17 (in mt. tons)**




**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

**Figure: 4.2.2 Trends in Area of Apple from 1985-86 to 2016-17 (in hectares)**

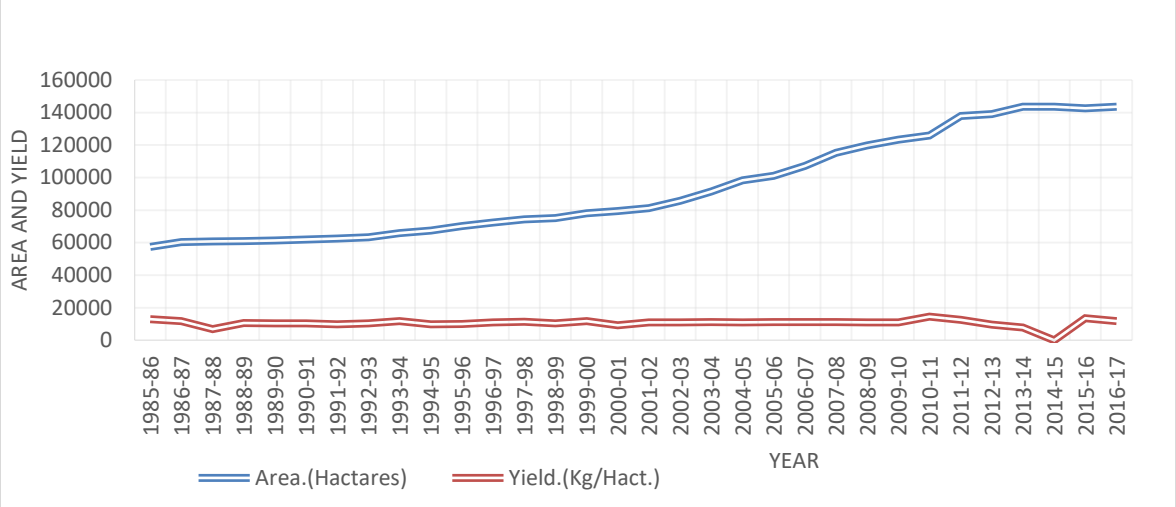



**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

In the above graph apple production trend is depicted with respect to the time series data 1985-2015. The figure reveals that since 1985 – 2000, apple production depicts short term fluctuations and after the year 2000 production continuously sustains the increasing trend till 2010-2011 after which production falls continuously and fell to the highest ever value (0) in 2014 -15 due to the floods. After 2014- 15 production once again attains the increasing trend and reaches to the highest ever point since 1985 and then falls again in 2016- 17. The main reason behind these fluctuations between the time periods 1985 – 2001 was the lack in technical knows how about the methods of apple production, lack of production enhancing fertilisers, equipment deficiency and lack of hybrid plants. Also area was almost stagnant up to this point which is another cause of these short term fluctuations and supports the law of diminishing returns. The logic behind the increasing trend between the time period 2000- 2010 is that during this decade area under apples got increased. When we compare the above two graphs it gets revealed that with increase in

area, production also increases and vice versa. This shows that the production has a direct correlation with the area which means that an increase in the area leads to the increase in production of apples and vice versa.

**Figure: 4.2.3 Trends in Area and Productivity of Apple from 1985-86 to 2016-17**




**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

The above given graph related to the area and productivity of apples reveals that with the continuous increase in area productivity didn't increase, however it shows the consistency in slope except in 1987-88 and 2014 -15 when a dip occurred in productivity due to drought and floods respectively. It can be here concluded that the consistency in productivity will sustain till area increases continuously and vice versa.

### 4.2: Descriptive Statistics (1985-2015)

As said earlier the second part of this chapter deals with the multiple regression of which descriptive and inferential results with interpretations are given below. The descriptive statistics portrays the basic properties of all concerned variables. The first table delineates the basic characteristics of area occupied under Apple and Rice production with second

table describing the overall production characteristics. Table third portrays the descriptive figures of Average yield over the 31 years in both Apple and Rice crop while the Table fourth, the last one exhibits the basic features of two climate variables viz., Rainfall (mms) and Average temperature (°c).

**Table: 4.2.1: Area under Apple and Rice Crop 1985-86 to 2016-17**

| Statistics | Variables | |
|---|---|---|
| | Apple (Hectares) | Rice('000 hectares) |
| Mean | 91166.8 | 149.5 |
| Std. Deviation | 29926.1 | 9.794 |
| Maximum | 143472 | 176.8 |
| Minimum | 57416 | 134.1 |
| Skewness | 0.625 | 0.64 |
| Kurtosis | -1.118 | 0.53 |
| Observations | 31 | 31 |

**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

The above table delineates the descriptive properties of Apple and Rice with respect to the area covered under them. The mean area under apples over 31 years is 91166.8 hectares, with Maximum and Minimum values equal to 143472 hectares and 57416 hectares respectively. The increment in area from thousand hectares (57416 hectares) to lakh hectares (143472 hectares) within 31 years depicts the shift in cropping pattern at a rapid pace.

On the other hand, the mean value of area under rice is 149.5 thousand hectares over 31 years with Maximum value 176.8 thousand hectares and Minimum value 134.1 thousand hectares. Even though the area under Rice increased as gets revealed from the Minimum

and Maximum value, yet the increasing pace of area is too slow as compared to the Apple area.

**Table: 4.2.2: Production of Apple and Rice Crop 1985-86 to 2016-17**

| Statistics | Variables | |
|---|---|---|
| | Apple(Metric Tons) | Rice((‘000) Tons) |
| Mean | 949107 | 333.94 |
| Std. Deviation | 410796 | 52.67 |
| Maximum | 1915448 | 420.2 |
| Minimum | 0 | 153.3 |
| Skewness | 0.53 | -1.49 |
| Kurtosis | 0.77 | 3.319 |
| Observations | 31 | 31 |

**Source:** Author’s calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

The apple results for 31 observations in the above table show that the maximum and minimum production values have very high difference with respect to the mean value. Maximum value is 1915448 metric tons while the minimum value is 0. The main reason behind the minimum value being zero (0) is the floods of September, 2014 which devastated the whole apple production. For better comparisons we will take here second minimum value from the data which is 418522 metric tons. When we compare maximum apple production value and second minimum apple production value they still differ hugely. This means that within 31 observations production has increased from 418522 metric tons to 1915448 metric tons, which is the indication of rapidly increasing production.

In rice production, mean value is 333.94 thousand tons, minimum value is 153.3 thousand tons and maximum value is 420.2 thousand tons. The given statistics regarding

rice didn't reveal any certainty about the production trend and thus to assess the production on such statistics will be absurd.

**Table: 4.2.3: Productivity of Apple and Rice Crop 1985-86 to 2016-17**

| Statistics | Variables | |
|---|---|---|
| | Apple(Yield (kg per hectare) | Rice Yield (Qtls. Per hectare) |
| Mean | 10517 | 22.47 |
| Std. Deviation | 2434 | 3.94 |
| Maximum | 14485 | 26.9 |
| Minimum | 0 | 9.7 |
| Skewness | -2.75 | -1.3 |
| Kurtosis | 11.57 | 2.15 |
| Observations | 31 | 31 |

**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

The above given table reveals the descriptive characteristics of apple and rice with respect to their productivity. The mean productivity of apple is 10517 kgs/hectare with maximum productivity equal to 14485 kgs/hectare and minimum productivity equal to zero (0). Minimum productivity equal to zero (0) accrue in the year 2014 when whole apple production in Kashmir got devastated by the floods.

The average value of Rice over the 31 years is 22.47 quintals/hectare, with maximum and minimum values equivalent to 26.9 and 9.7 quintals per hectare respectively. The minimum value equivalent to 9.7 quintals per hectare exhibits the flood impact of 2014 on production.

**Table: 4.2.4: Descriptive Statistics of the Climate Variables for the Time Period 1985-2015**

| Statistics | Variables | |
|---|---|---|
| | Rainfall (mms) | Average Temperature (°c) |
| Mean | 6775.4 | 20.32 |
| Std. Deviation | 1366.7 | 1.012 |
| Maximum | 9264 | 22 |
| Minimum | 4350 | 18 |
| Skewness | -0.013 | -0.096 |
| Kurtosis | -0.69 | -0.303 |
| Observations | 31 | 31 |

**Source:** Author's calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice Development Patna, RBI, IMD Srinagar.

In the above table, minimum value of rainfall is 4350 mms, mean rainfall value is 6775.4 mms, and the maximum value of rainfall is 9264 mms. The increase in the total rainfall from 4350 mms to 9264 mms in the span of just 31 observations reveals high fluctuation and is the indication of changing climate. Average temperature (°c) over the 31 observations increases from 18 °c to 22 °c with mean 20.32 °c gives the evidence of changing climate.

The basic limitation with the descriptive statistics is that we can't justify to which extent independent variable impacts the dependent variable, we can only make a comparison with descriptive results and thus to conclude results with only descriptive figures will be absurd. Thus for clear impact assessment we move on to the multi- variate regression model results which are shown below;

### 4.3: Stationarity and Unit Root

As the present data set contains more than 20 observations, therefore it becomes mandatory to verify the Stationarity in the series before applying the regression. For doing this a very famous method namely Augmented Dickey Fuller (ADF) test is used. Hence, Augmented Dickey Fuller (ADF) test is applied so as to test the presence of unit roots in the series. The results of the Augmented Dickey Fuller test (ADF) are given in the following table;

**Table: 4.3.1: Results of Augmented Dickey-Fuller (ADF) unit root test**

| Series | t statistic | ADF at 1% Level | ADF at 5% Level |
|---|---|---|---|
| AA | 1.259 | -3.661 | -2.960 |
| ΔAA | -3.914 | -3.670 | -2.963 |
| AP | 0.011 | -3.699 | -2.976 |
| ΔAP | -6.670 | -3.699 | -2.976 |
| APD | **-4.073*** | -3.689 | -2.971 |
| ΔAPD | -5.366 | -3.699 | -2.976 |
| RF | **-2.992*** | -3.670 | -2.963 |
| ΔRF | -8.237 | -3.679 | -2.976 |
| AT | **-4.516*** | -3.670 | -2.963 |
| ΔAT | -9.107 | -3.679 | -2.967 |
| RA | **-3.131*** | -3.670 | -2.963 |
| ΔRA | -6.507 | -3.679 | -2.967 |
| RP | **-5.551*** | -3.661 | -2.96 |
| ΔRP | -6.68 | -3.679 | -2.967 |
| RPD | **-4.734*** | -3.661 | -2.960 |
| ΔRPD | -5.928 | -3.679 | -2.967 |

**Source:** Authors calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice development Patna, RBI, IMD Srinagar.

**Note:** The "*" defines variables are stationary at level.

AA= Apple Area, AP= Apple Production, APD= Apple Productivity.

RF= Rainfall.

AT= Average Temperature.

RA= Rice Area, RP= Rice Production, RPD= Rice Productivity.

Above table 1 depicts the results of Stationarity test for the selected variables in the present study. For checking the stationary ADF has been selected at 5% level as well as at 1% level. If t-statistics is greater than ADF critical value, the null hypothesis is then accepted, i.e., unit root exists which means that the data is non-stationary. If t-statistics is less than the ADF critical value, we reject the null hypothesis, i.e., unit root does not exist which means that the data is stationary. So the results of above table reveal that the six variables out of eight variables are stationary at 5% level of significance. The t-statistic values of APD, RF, AT, RA, RP RPD are lesser than the ADF critical value. So we reject the null hypothesis and data is stationary at 5% level.

**4.4: Results of Regression Models**

**Table: 4.4.1: Regression between AP, RF and TR**

| **AP** | **Coef** | **Std. Err** | **P** | **t** | **$R^2$** | **Obs** |
|---|---|---|---|---|---|---|
| RF | 2.183841 | 42.7736 | 0.960 | 0.05 | 0.881 | 31 |
| TR | 71103.17[a] | 21288.67 | 0.002 | 3.34 | | |

**Source**: Authors calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice development Patna, RBI, IMD Srinagar.

**Note*:*** *Superscripts "a" denote 5% level of significance.*

In the above table, AP stands for the Apple production, RF stands for the Rainfall and TR stands for the Average temperature. The table shows the multi-variate regression results between these three variables in Kashmir over the time period 1985- 2015. Here Apple production is regressed upon the two climate variables Rainfall and Average temperature. Regression analysis generates a statistical relationship between one or more predictor variables and the response variable. The above table exhibits the relationship between the

variables. The results of the model explained that there is a positive relationship between the variables. P-value of TR indicates that the relationships are statistically significant at 5% level; P-value 0.002 is less than 0.05. It means that we fail to accept the null hypothesis. But the p-value of RF is 0.960 which greater than the 0.05, so in this case we fail to reject the null hypothesis. $R^2$ value means that 88% of the variations of w-values around the mean are explained by the α-values. In other words, 88% of the values fit the model. Among the two climate variables Rainfall doesn't impacts Apple production. The reason behind this is that the Apple production is totally independent of the Rains and is thus least affected by this climate variable.

In contrast to this Average temperature is affecting the Apple production significantly. The basic fact behind this is that the Average temperature plays a crucial role throughout the growth and development stages of the Apple. It plays a key role at the time of flower sprouting to color picking stage of the Apple.

**Table: 4.4.2: Regression between APD, RF and TR**

| **APD** | **Coef** | **Std. Err** | **P** | **t** | **$R^2$** | **Obs** |
|---|---|---|---|---|---|---|
| RF | 0.0124648 | 0.2586989 | 0.962 | 0.05 | 0.957 | 31 |
| TR | 515.5876a | 88.41596 | 0.000 | 5.83 | | |

**Source:** Authors calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice development Patna, RBI, IMD Srinagar.

**Note*:*** *Superscripts "a" denote 5% level of significance.*

Here APD means Apple productivity, RF means Rainfall and TR means Average temperature. The above given table 2 shows the relationship between the APD, RF and TR. The results of the model explained that there is a positive relationship between the variables. P-value of TR indicates that the relationship is statistically significant at 5%

level. P-value 0.000 is less than 0.05. Here null hypothesis gets rejected. The p-value of RF is 0.962 which is greater than 0.05, so in this case we have fail to reject the null hypothesis. $R^2$ value means that 95% of the variations of x-values around the mean are explained by the β-values. In other words, 95% of the values fit the model.

**Table: 4.4.3: Regression between RP, RF and TR**

| RP | Coef | Std. Err | P | t | $R^2$ | Obs |
|---|---|---|---|---|---|---|
| RF | .0126714 | .0062684 | 0.053 | 2.02 | 0.976 | 31 |
| TR | 17.87001a | 3.119829 | 0.000 | 5.73 | | |

**Source:** Authors calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice development Patna, RBI, IMD Srinagar.

In the above given table, RP denotes the Rice production, RF the Rainfall and TR the Average temperature. The above table denotes the multi-variate regression results between these variables in Kashmir over the time period 1985-2015. Rice production is regressed upon the climate variables; Rainfall and Average temperature. Results revealed that the Rainfall and Average temperature are able to show variations in the Rice production. The results of the model explained that there is a positive relationship between the variables. P-value 0.000 of TR, which is less than 0.05, indicates the relationship is statistically significant at 5% level and here null hypothesis is rejected. On the other hand, the p-value of RF is 0.053 which is almost equivalent to 0.05, so in this case we fail to reject the null hypothesis. $R^2$ value means that 97% of the variations of y-values around the mean are explained by the γ-values. In other words, 97% of the values fit the model.

**Table: 4.4.4: Regression between RPD, RF and TR**

| RPD | Coef | Std. Err | P | t | $R^2$ | Obs |
|---|---|---|---|---|---|---|
| RF | .0005093 | .0004199 | 0.235 | 1.21 | 0.975 | 31 |
| TR | .9367942[a] | .1435159 | 0.000 | 6.53 | | |

**Source:** Authors calculation, using the data of DES of J&K, Directorate of Horticulture Srinagar, Directorate of Rice development Patna, RBI, IMD Srinagar.

**Note***: Superscripts "a" denote 5% level of significance.*

In the above table RPD stands for Rice productivity, RF for the Rainfall and TR for the Average temperature. The results of the model explained that there exists a positive relationship between the variables. P-value of TR indicates that the relationship is statistically significant at 5% level. Here P-value of TR is 0.000 which is less than 0.05. In this case null hypothesis is rejected, but the p-value of RF is 0.235 which is greater than 0.05. So in this case we fail to reject the null hypothesis. Furthermore, $R^2$ value means that 97% of the variations of z-values around the mean are explained by the θ-values. In other words, 97% of the values fit the model.