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Short Communication

Effect of rainfall on cropping pattern in mid Himalayan region

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The analysis of effect of rainfall during the last 20 years is needed to evaluate cropping pattern in the rain-fed region. In this study, trends in annual, seasonal and monthly rainfall of district of Himachal Pradesh in India over the past 20 years were examined. The annual rainfall varies from 863.3 to 1470.0 mm. During the summer season, the highest total rainfall was 1089.7 mm during 2000, whereas lowest rainfall was 287.9 mm. The average rainfall for 20 years was found to be highest in the month of June whereas the rainy days were highest in the month of August. Fifteen years yield data of four crops in the area was analyzed. The trends in wheat and rice are upward whereas barley trends were downward and maize trends were constant.

Key words: Rainfall, cropping pattern, rain-fed region.

INTRODUCTION

India ranks first among the rain-fed agricultural countries of the world in terms of both extent (86 M ha) and value of produce. Rain-fed areas in India are highly diverse, ranging from resource-rich areas with good agricultural potential to resource-constrained areas with much more constrained potential. It is in the rain-fed regions where cultivation of nutritious (coarse) cereals (91%), pulses (91%), oilseeds (80%) and cotton (65%) predominates. Rosegrant et al. (2002) employing the IMPACT model have estimated that even by 2025, one-third of India's cereal production shall be contributed by rain-fed areas. Rain-fed agriculture supports 40% of India's population. Earlier, rain-fed farming systems were dependent upon locally available inputs and grew traditional drought-resistant crops. But over-time cropping systems have changed (Kanwar, 1999) and farmers have started cultivating high-value crops requiring intensive use of costly inputs.

Besides several other factors related to the agriculture sector as a whole, adverse meteorological conditions resulting in long dry spells and droughts, unseasonal rains and extended moisture-stress periods with no mechanisms of storing and conserving the surplus of rain to mete out during the deficit periods were the major causes of non-remunerative yields. It is only recently that the Government of India has constituted a National Rain-fed Area Authority (2006) to address these issues and develop and implement a comprehensive single-window program for the development of rain-fed areas in the country. There have been some studies by the various authors to analyse rainfall pattern in India. (Subash et al. 2012) revealed that there was a slight increase in 0.5% of rainfall in Bihar during 1999-2008 as compared to 1989-1998. (Kumar et al, 2010) studied the trend analysis of rainfall data of all India for 135 years (171-2005) found that there was no significant trend for annual, seasonal and monthly rainfall on an all-India basis. (Choudhury et al., 2012) in their study in mid Altitude Meghalaya, North-East India analyzed long time (1983-2010) weather variables to detect trend changes using non-parametric

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Table 1. 15 years wise yield of different crops in Solan district.

Year/yield (kg/hectare)	Crop			
	Wheat	**Barley**	**Maize**	**Rice**
1996-97	1266.905	1010.442	1842.626	1826.779
1997-98	1760.977	1681.799	2123.829	1921.200
1998-99	1562.293	1240.735	2674.233	1688.163
1999-00	1679.132	1070.720	2162.918	1851.040
2000-01	368.645	457.938	2031.878	2114.312
2001-02	1789.423	1136.197	2356.827	1862.672
2002-03	1435.621	831.443	1624.775	1592.283
2003-04	1525.479	719.256	2071.319	1468.820
2004-05	1922.838	1143.716	1763.141	2193.449
2005-06	1577.559	600.571	1671.576	1754.544
2006-07	1877.701	1267.392	2166.276	2366.944
2007-08	1254.410	859.394	2364.519	2327.317
2008-09	1442.840	595.247	2408.814	2479.996
2009-10	1683.555	984.237	1896.514	2199.139
2010-11	1988.198	970.531	2440.690	2467.049

Table 2. Monthly average rainfall data (mm) for the period of January 1991 to December 2010.

Season	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Winter	190.2	214.1	184.0	168.9	178.5	210.6	154.2	102.2	215.3	186.2
Spring	204.0	101.6	162.0	114.2	103.5	119.6	248.2	235.1	211.9	184.2
Summer	534.9	622.7	480.8	578.2	910.9	614.6	585.7	492.3	743.8	1089.7
Autumn	127.4	197.3	192.7	118.6	239.8	235.0	148.0	463.7	149.4	9.9
Total	1056.5	1135.7	1019.5	979.9	1432.7	1179.8	1136.1	1293.3	1320.4	1470
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Winter	43.2	128.6	178.2	127.8	221.6	88.4	238.0	83.8	50.6	178.7
Spring	179.6	235.4	134.0	99.8	73.3	210.1	199.8	134.3	99.9	51.9
Summer	686.6	513.0	613.2	518.6	453.8	599.5	539.7	625.0	287.9	824.8
Autumn	1.0	245.6	135.8	188.6	157.6	71.4	112.6	367.8	424.9	410.1
Total	910.4	1122.6	1061.2	934.8	906.3	969.4	1090.1	1210.9	863.3	1465.5

Mann Kendall test. Results revealed that total annual rainfall trend increased non-significantly at the rate of 3.72 mm/year.

Climate is the most significant environmental variable affecting the production of crops. The distribution of crops in Himachal Pradesh is influenced mainly by climate than any other factor.

In Himachal Pradesh, major rivers like Beas, Satluj and Ravi are mostly snow fed. Hence, regional climate change will influence not only the current production systems but also the river hydrology. Any adverse change in meteorological parameters, be it annual or seasonal (winter, spring, summer and autumn), will influence production systems of the region. The rains are the main source of water in Himachal Pradesh. The kinds of crops that can be successfully produced in any area are selected on the basis of the amount of water needed by the crop. It is evident that in addition to rainfall, the temperature and character of soil may add in determining which crops are to be grown.

METHODOLOGY

The variations in precipitation were analyzed season wise, that is, summer (June, July and August), autumn (September, October and November), winter (December, January and February) and spring (March, April and May). The rainfall data for 1991-2010 for Nauni (Solan) has been taken for analysis. In addition, the trends in 15 years of yield data of the four major crops in the area has been analyzed and presented in Table 1. The monthly average rainfall data (mm) for the period Jan 1991 to December 2010 are presented in Table 2.

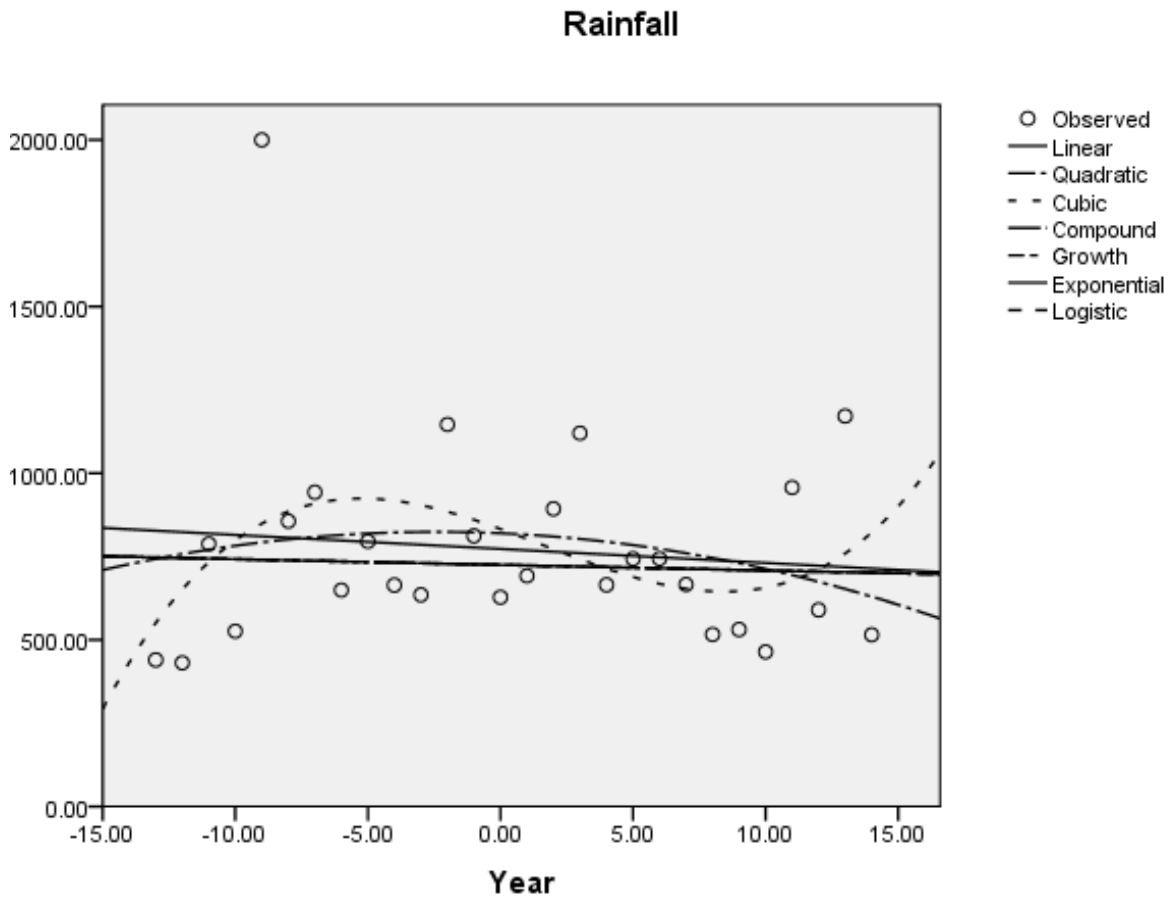

Figure 1. Annual rainfall variation.

RESULTS AND DISCUSSION

Annual, seasonal and monthly trends

Rainfall trends are presented in this section. The annual rainfall variation shows a downward trend during this period (Figure 1). The spring season shows a large downward trend, the autumn season shows an increasing trend, the summer season shows a decreasing trend and the winter season shows a significant downward trend (Figure 2). The average rainfall during last 20 years along with total rainy days is presented in Table 3. Month wise rainfall trends are presented in Table 4. The month wise rainfall trends are shown in Figure 3.

During the last two decades, the annual highest rainfall was 1470.0 mm in the year 1999 (highest annual rainy days, 108 in 2007) whereas the lowest annual rainfall was 863.3 mm in the year 2008 (lowest annual rainy days, 54 in 2001). The table shows hardly any relationship between rainfall and rainy days.

Season wise analysis of recorded data shows that during winter the highest total rainfall was 238.0 mm during 2007 (highest total rainy days, 17 in 1993) whereas lowest rainfall was 43.2 mm in 2001 (lowest total rainy days, 5 in 2001 and 2009). During spring the highest total rainfall was 248.2 mm during 1997 (highest total rainy days 30 in 1997) whereas lowest rainfall was 51.9 mm in 2010 (lowest total rainy days, 5 in 2010). During summer, the highest total rainfall was 1089.7 mm during 2000 (highest total rainy days 55 in 2010) whereas lowest rainfall was 287.9 mm in 2009 (lowest total rainy days 22 in 2002). During autumn, the highest total rainfall was 463.7 mm during 1998 (highest total rainy days 21 in 1997) whereas lowest rainfall was 1.0 mm in 2001(lowest total rainy days 0 in 2001).

Effect on cropping pattern

Figure 1 shows the deceasing trend of annual rainfall in the region, whereas Figure 4 shows the increasing trend of yield in wheat and rice. The increasing trend in rice may be due to the fact that rainfall in the month of May to July has increasing trend (Figure 3) which is the sowing period of rice in the region. However, the winter season has downward trend in rainfall (Figure 3) which is the sowing period for wheat, whereas wheat yield shows increasing tend (Figure 4) in the region. This may due to fact that the farmers have adopted some other sources of irrigation.

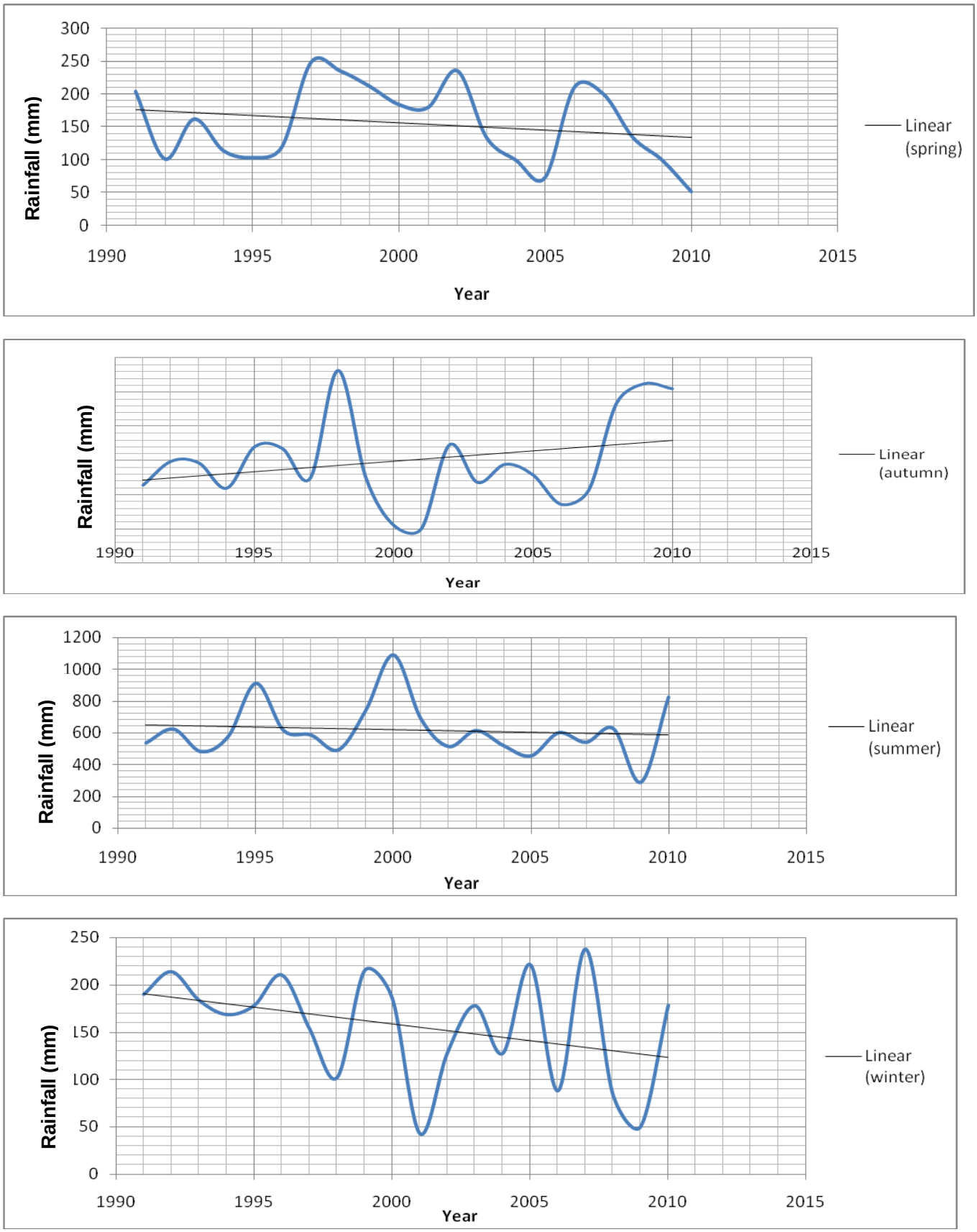

Figure 2. Seasonal rainfall variation.

Table 3. Average rainfall during the last 20 years along with total rainy days.

Month	Rainfall (mm)	Rainy days
January	76.13	41.3
February	61.0	77.9
March	38.67	145.9
April	55.45	222.5
May	142.4	290.9
June	242.2	335.2
July	231.1	363.6
August	159.2	435.5
September	32.4	301.8
October	8.3	185.6
November	19.4	106.8
December	61.6	52.2

Table 4. Month wise rainfall trends.

Month	Trend
January	Sharp downward
February	Straight
March	Downward
April	Sharp downward
May	Slightly upward
June	Straight
July	Upward
August	Sharp deceasing
September	Sharp upward
October	Slightly downward
November	Slightly downward
December	Downward

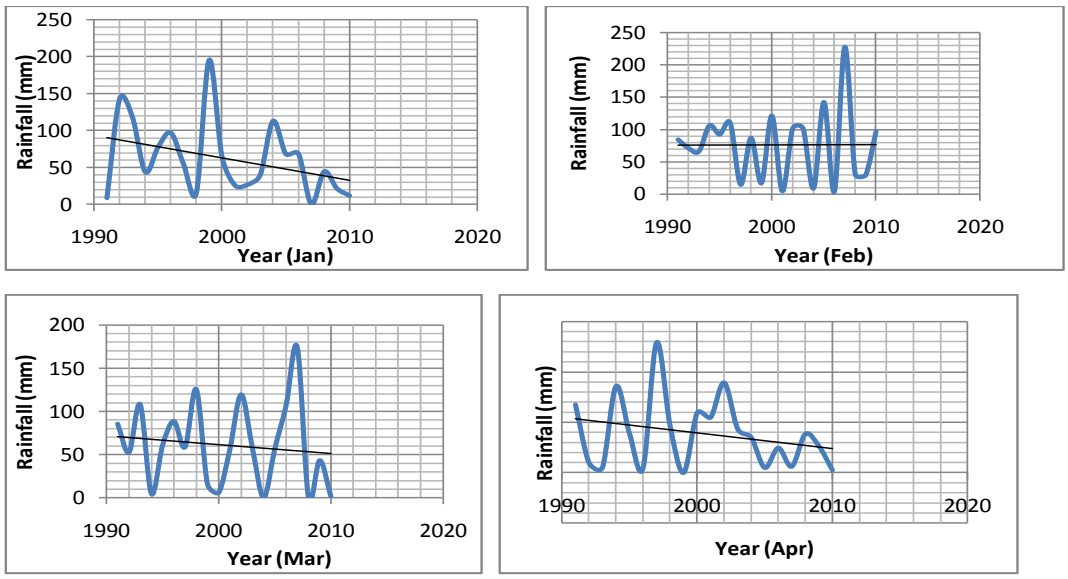

Figure 3. Month wise variation of rainfall.

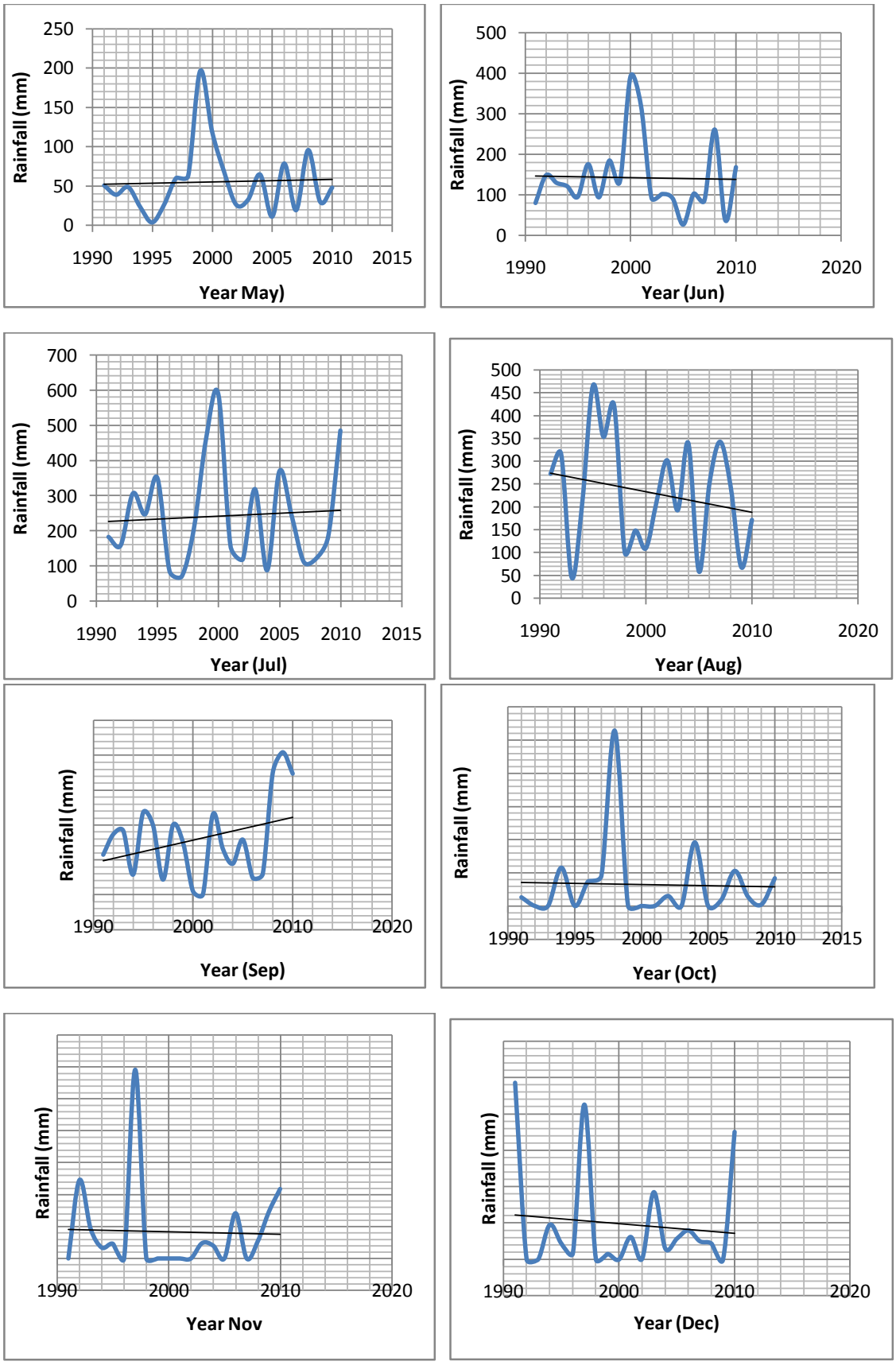

Figure 3. Contd.

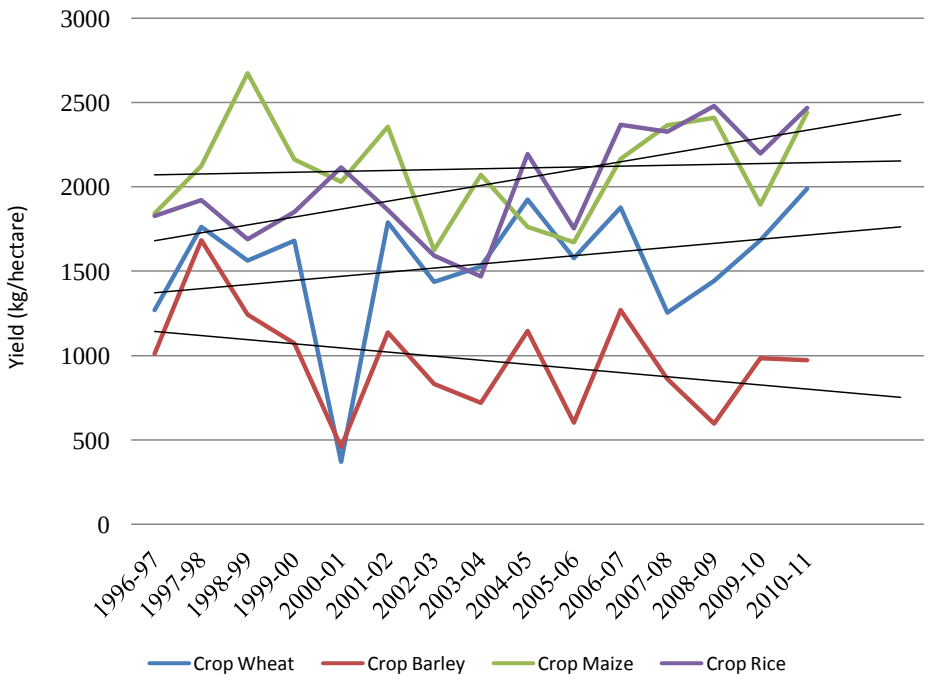

Figure 4. Year wise yield of different crops in Solan district.

Rainfall does not have any effect on the yield of maize which has constant trend (Figure 4). The barley shows deceasing trend in yield. The statistically analyzed rainfall trend is shown in Figure 1. This shows that annually, there is no particular trend in the region during the last 20 years.

Conclusion

The rainfall is a major requirement for crop production not only in this region but also in India. With the change in climate, the rainfall pattern has also changed. In spite of change in rainfall pattern, the crop yield does not fall sharply. This implies that the crop yield is not affected by rainfall significantly. The study also reveals that there is no trend in rainfall in the region.

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