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Trends in the Food Crop Productivity of Major Crops Grown in Jammu and Kashmir- A Spatio-temporal Analysis

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Abstract

The present paper attempted to find out the spatio-temporal changes in the agricultural productivity in Jammu and Kashmir at district level. The agricultural productivity is the function of various physical and socio-economic factors, viz, climate, nature of landscape, irrigation, capital, etc. which is manifested in the district level variations in the per capita productivity. The analysis of the productivity data revealed that in context of paddy, Kashmir province has more productivity levels than Jammu province because of proper and assured irrigation and suitability of land. The productivity in Kashmir province increased by 13.48 quintals/hectare (11.45 q/ha in 1980-81 to 24.93 q/ha in 2008-09), while as in Jammu province it increased by 11.16 quintals/ha (8.96 q/ha in 1980-81 to 20.12 q/ha in 2008-09). However, in case of productivity of wheat, Jammu province has more productivity levels than Kashmir province as it is staple food of Jammu province and moreover in Kashmir valley it is cultivated on little area and that too in winter season which is not much favourable for its cultivation. The productivity of wheat in Kashmir province increased by 8.13 quintals/hectare (6.58 q/ha in 1980-81 to 14.71 q/ha in 2008-09), while as in Jammu province it increased by 9.22 quintals/ha (7.76 q/ha in 1980-81 to 16.98 q/ha in 2008-09). Similarly, the productivity of maize is also more in Jammu province than Kashmir Province and in fact recorded more increase (8.91 q/ha) than Kashmir province (7.55 q/ha) during these twenty eight years. The district level analysis depicts that the districts which are lying either in Jammu plains or have more area under Jhelum valley floor in Kashmir valley, for example, Pulwama, Anantnag, Srinagar, and Baramulla posses more productivity in Paddy and Wheat than those which have undulating topography and are nestled between the mountains (Doda, Udhampur, Rajouri, Poonch etc). But on contrarily, these hilly districts have more maize productivity than the other districts.

Keywords: Productivity, Cultivation, Crop, District, Province, Topography.

Introduction

Agriculture has a dominant role in the economy of many developing countries, as it is a vital source of nourishment for citizens and a means of livelihood for the most vulnerable members of these countries. As a consequence, increasing agricultural productivity is an important policy goal for concerned governments and development agencies[1]. Agricultural productivity is the output produced by a given level of input(s) in the agricultural sector of a given economy[2]. More formally, it can be defined as *"the ratio of the value of total farm outputs to the value of total inputs used in farm production"*[3]. Agricultural productivity is measured as the ratio of final output to inputs[4,5]. It depends both on the physical as well as socio-economic factors, *viz*, climate, soil, per capita income, literacy, sex ratio, occupational structure etc[6]. Productivity growth in agriculture has captured the interest of economists for a long time. The development of agriculture releases resources to other sectors of the economy as well. This has been in fact the base of successful industrialization in developed economies such as the United States, Japan or countries in the European Union. Thus, agricultural development remains an important precondition of structural transformation and lays foundation towards industrial development, as it precedes and promotes industrialization[7]. Agricultural productivity plays most vital role in the process of industrialization and development of any geographical region. Krueger, Valdes, Schiff and Stern stress on the plea that countries with high levels of productivity growth and only modest discrimination against their agricultural sectors were successfully industrialized. Meanwhile, countries with low levels of productivity growth and a strong bias against agriculture through trade and pricing policies remained unsuccessful in industrialization process[8,9]. The overall agricultural productivity in the state of Jammu and Kashmir is low as compared to other states of India like Punjab, Haryana, Chhattisgarh and West Bengal. The low productivity in the state is on account of climatic constraints, lack of easy advance borrowings, irrigation, credit facilities, and agricultural policy etc[10].

Study area: Jammu and Kashmir is northern most extremity of India and is situated between 32°17′ to 36°58′ N latitude and 73° 26′ to 80°30′E longitude. It lies in the great northwestern complex of the Himalayan Ranges with marked relief variation, snow-capped summits, antecedent drainage, complex geological

structure and rich flora and fauna[11]. The state is 640 km in length from north to south and 480 km from east to west. It consists of territories of Jammu, Kashmir, Ladakh and Gilgit and is divided among three Asian sovereign states of India, Pakistan and China. The total geographical area of the State is 2, 22, 236 km^2 comprising 6.93 per cent of the total area of the Indian territory including 78,114 km^2 under the occupation of Pakistan and 42,685 km^2 under China[12].

Materials and methods

Materials: i. The Survey of India toposheets (1971) on scale 1:50,000 were used to generate a base map of the study area. ii. Agricultural Productivity of different crops has been obtained from Financial Commissioner's office, Srinagar / Directorate of agriculture, Jammu and Srinagar.

Methodology: Determination of change in productivity: For depicting the spatio-temporal change in the productivity, the data sets generated were analysed. The temporal change has been calculated by using the following formula[13];

$$Change\ (V_1) = \frac{St1 - St2}{St1} \times 100$$

Where: V_1 = Change in any variable, St_1= Status at time t_1, St_2 = Status at time t_2.

Determination of levels of Productivity: For the determination of levels of productivity, proportional standardized mean and composite Index tools were used.

Proportional Standardized Mean and Composite Index: As the variables taken for the study are not equally important, therefore different weights have been assigned to these variables by the method of '*Proportional Standardized Mean*', that is, the weight assigned to one indicator is measured by calculating $\frac{\overline{X}}{\sigma}$ for any indicator.

Where: $\overline{X}$ is the average of the series of one particular indicator and **σ** is the standard deviation of same series

Then composite index was worked out by the following formula[14];

$$C.I = \frac{x_1 \frac{\overline{x_1}}{\sigma_1} + x_2 \frac{\overline{x_2}}{\sigma_2} + x_3 \frac{\overline{x_3}}{\sigma_3}}{\frac{\overline{x_1}}{\sigma_1} + \frac{\overline{x_2}}{\sigma_2} + \frac{\overline{x_3}}{\sigma_3}} \qquad (1)$$

$$C.I = \frac{x_1 w_1 + x_2 w_2 + x_3 w_3}{w_1 + w_2 + w_3}$$

The results were then depicted by graphical representation method. Moreover, the data was subjected to GIS treatment to show clearly the spatial variation in the levels of productivity across the state.

Results and discussion

Trends in the productivity of Paddy: The paddy productivity in Jammu and Kashmir has increased over the period of time. It has increased from 8.75 quintals/hectare to 19.31 quintals/hectare, thus implies a total increase of 10.56 quintals/hectare during these twenty eight years. The productivity has increased at a slower rate in the first fifteen years (1980-1995) and in the last thirteen years (1995-2008), it increased at a considerable rate (Table-1 and Figure-1). The productivity has generally increased more in Kashmir province (13.48 quintals/ha) than Jammu province (11.16 quintals/ha).

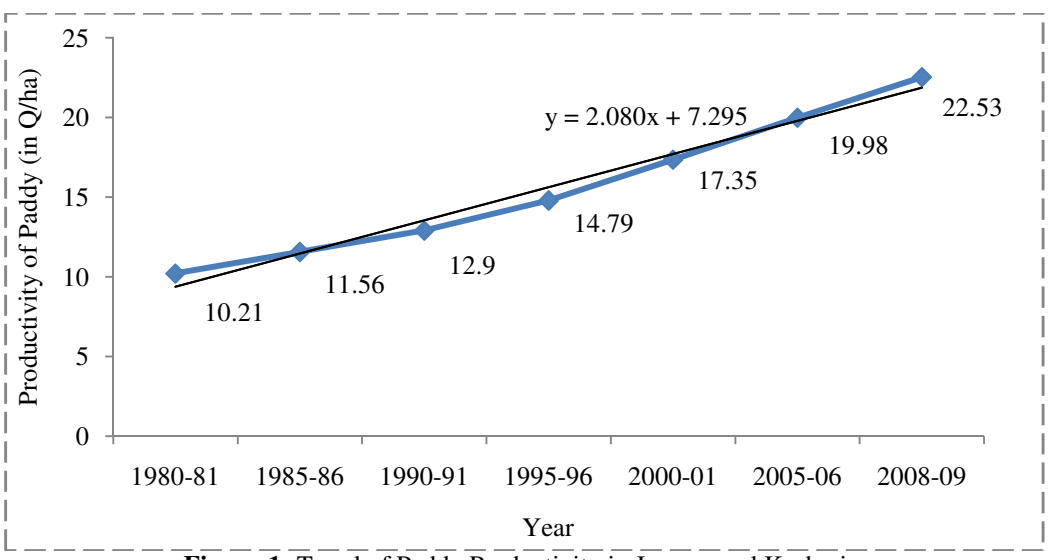

Figure-1: Trend of Paddy Productivity in Jammu and Kashmir.

Table-1: Productivity of paddy in Jammu and Kashmir (1980-81 to 2008-09)[15].

District	Productivity of paddy (quintals/hectare)							
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2008-09	Change (q/ha)
Srinagar	12.61	12.93	14.27	16.38	18.72	22.39	26.10	13.49
Budgam	11.25	12.65	13.78	15.16	18.58	21.68	24.38	13.13
Baramulla	13.15	14.6	16.34	19.11	22.04	24.37	26.52	13.37
Kupwara	7.9	8.75	10.84	11.28	14.24	16.59	18.28	10.38
Pulwama	12.54	13.14	15.21	17.79	20.32	22.31	26.88	14.34
Anantnag	11.27	13.52	15.09	17.92	20.88	24.14	27.41	16.14
Jammu	10.66	11.90	13.10	15.49	18.32	22.73	26.05	15.39
Kathua	8.13	10.59	11.91	13.73	15.78	17.82	19.45	11.32
Doda	9.26	11.45	12.11	13.71	15.81	17.38	18.54	9.28
Poonch	8.15	9.82	10.6	12.31	14.51	16.27	18.65	10.5
Rajouri	8.64	9.5	10.59	11.86	13.66	15.86	18.55	9.91
Udhampur	8.94	9.85	10.9	12.79	15.32	18.27	19.50	10.56
Leh	-	-	-	-	-	-	-	-
Kargil	-	-	-	-	-	-	-	-
Average	10.21	11.56	12.90	14.79	17.35	19.98	22.53	12.31
J.D	8.96	10.52	11.54	13.32	15.57	18.06	20.12	11.16
K.D	11.45	12.60	14.26	16.27	19.13	21.91	24.93	13.48

Where: J.D and K.D means Jammu and Kashmir division respectively.

Five districts out of six in Kashmir province have more productivity increase than state average (12.31 q/ha), while as in Jammu province, only Jammu district has productivity more than the state average (Figure-2).

Trends in the productivity of Maize: The productivity of maize in all the districts of the state has increased during these twenty eight years taken for the study. It has increased from 8.14 quintals/hectare to 16.38 quintals/hectare, thus implies a total increase of 8.23 quintals/hectare. The productivity has increased at a slower rate in the first fifteen years (1980-1995) and in the last thirteen years (1995-2008), it increased at a considerable rate (Table-2 and Figure-3). The productivity has increased more in Jammu province (8.91 q/ha) than Kashmir province (7.55 q/ha).

The highest growth is recorded in Udhampur district (11.04 percent) followed by Rajouri (10.37 percent) and Pulwama (9.16 percent), while the lowest is observed in Baramulla (5.94 percent). In Jammu province, Doda and Kathua produce yields below state average, while as in Kashmir province, only Pulwama and Kupwara are above state average and rest are below it (Figure-4).

Trends in the productivity of Wheat: The wheat has also shown significant increase in productivity in all the districts of the state. It has increased from 6.15 quintals/hectare to 13.58 quintals/hectare, thus implies a total increase of 7.43 quintals/hectare (Table-3 and Figure-5).

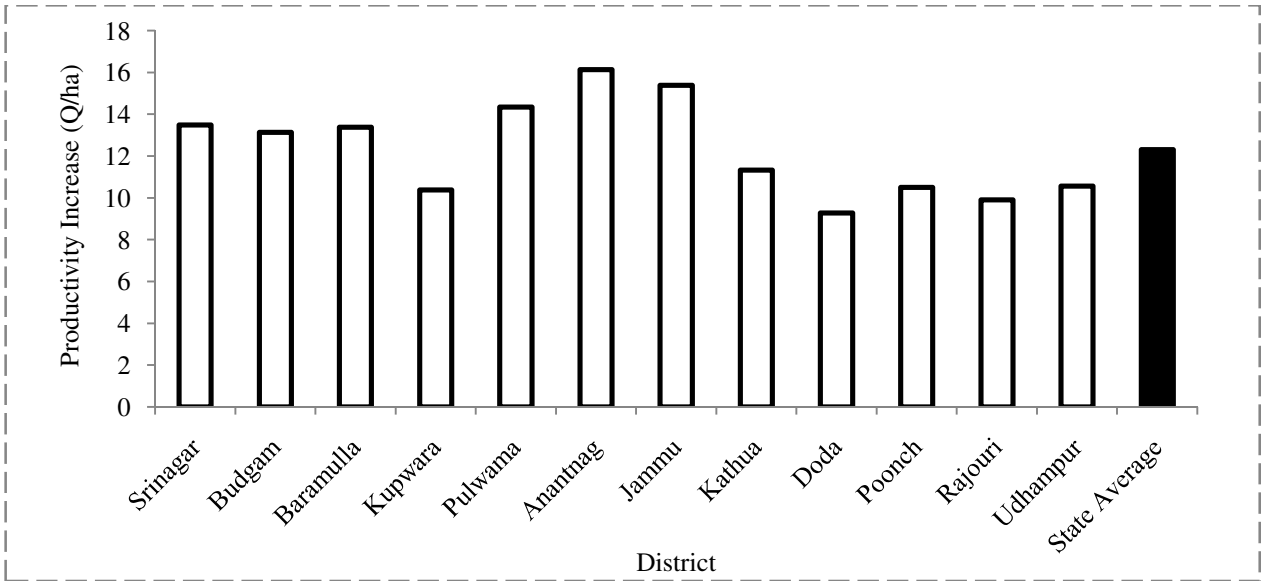

Figure-2: Productivity increase across districts from 1980 to 2008.

Table-2: Productivity of maize in Jammu and Kashmir (1980-81 to 2008-09)[16].

District	Productivity of maize (quintals/hectare)							
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2008-09	Change (q/ha)
Srinagar	9.28	10.13	11.23	12.81	13.16	14.3	15.81	6.53
Budgam	5.14	5.04	6.17	6.97	8.62	11.72	13.07	7.93
Baramulla	7.75	7.91	8.64	9.8	10.91	12.78	13.69	5.94
Kupwara	6.65	7.43	8.2	9.49	11.58	13.66	15.5	8.85
Pulwama	7.99	8.28	9.82	11.82	13.93	15.08	17.15	9.16
Anantnag	8.12	9.16	10.21	11.32	12.64	13.92	15.03	6.91
Jammu	11.12	12.15	13.25	14.56	15.74	17.81	19.42	8.3
Kathua	8.56	9.63	10.74	11.61	12.66	14.1	15.88	7.32
Doda	9.29	10.55	11.75	12.72	14.18	16.78	16.9	7.61
Poonch	7.61	8.9	9.86	11.69	13.16	15.02	16.45	8.84
Rajouri	8.63	9.86	10.94	12.8	14.97	17.8	19	10.37
Udhampur	7.56	8.67	10.14	12.37	14.66	16.94	18.6	11.04
Leh	-	-	-	-	-	-	-	-
Kargil	-	-	-	-	-	-	-	-
Average	8.14	8.98	10.08	11.50	13.02	14.99	16.38	8.23
J.D	8.80	9.96	11.11	12.63	14.23	16.41	17.71	8.91
K.D	7.49	7.99	9.05	10.37	11.81	13.58	15.04	7.55

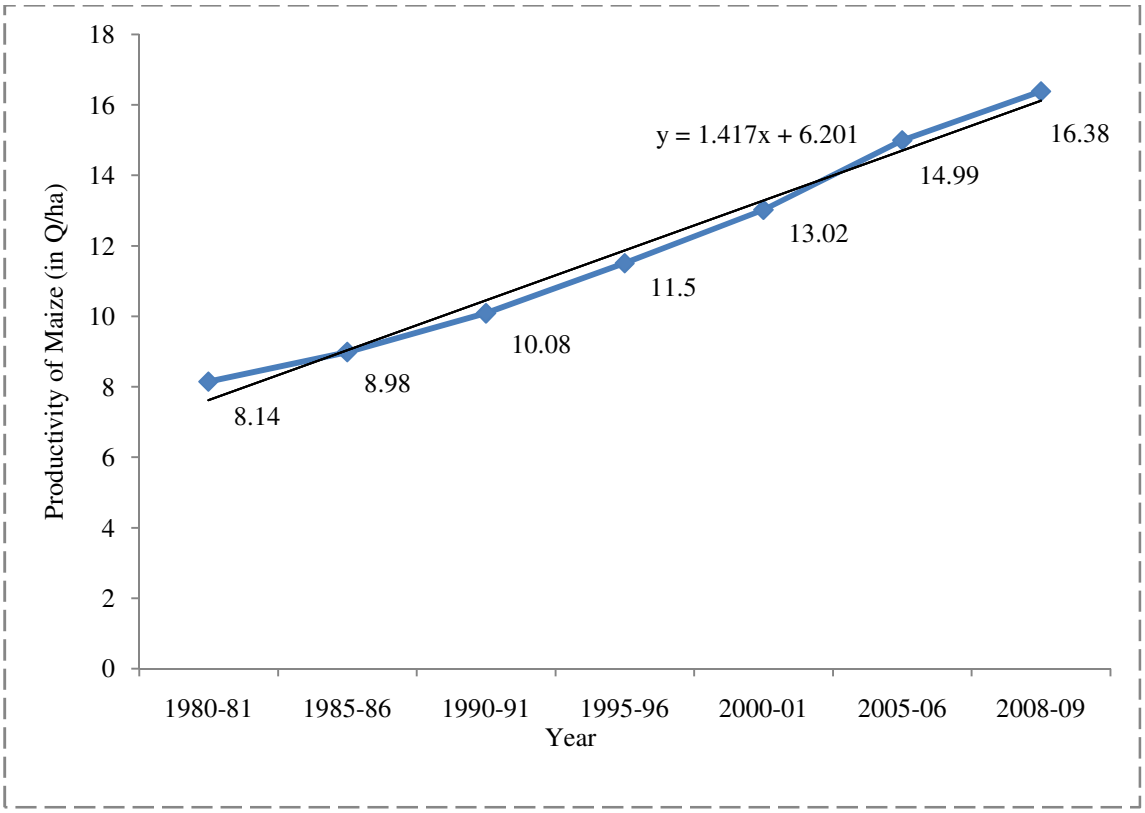

Figure-3: Trend of Maize Productivity in Jammu and Kashmir.

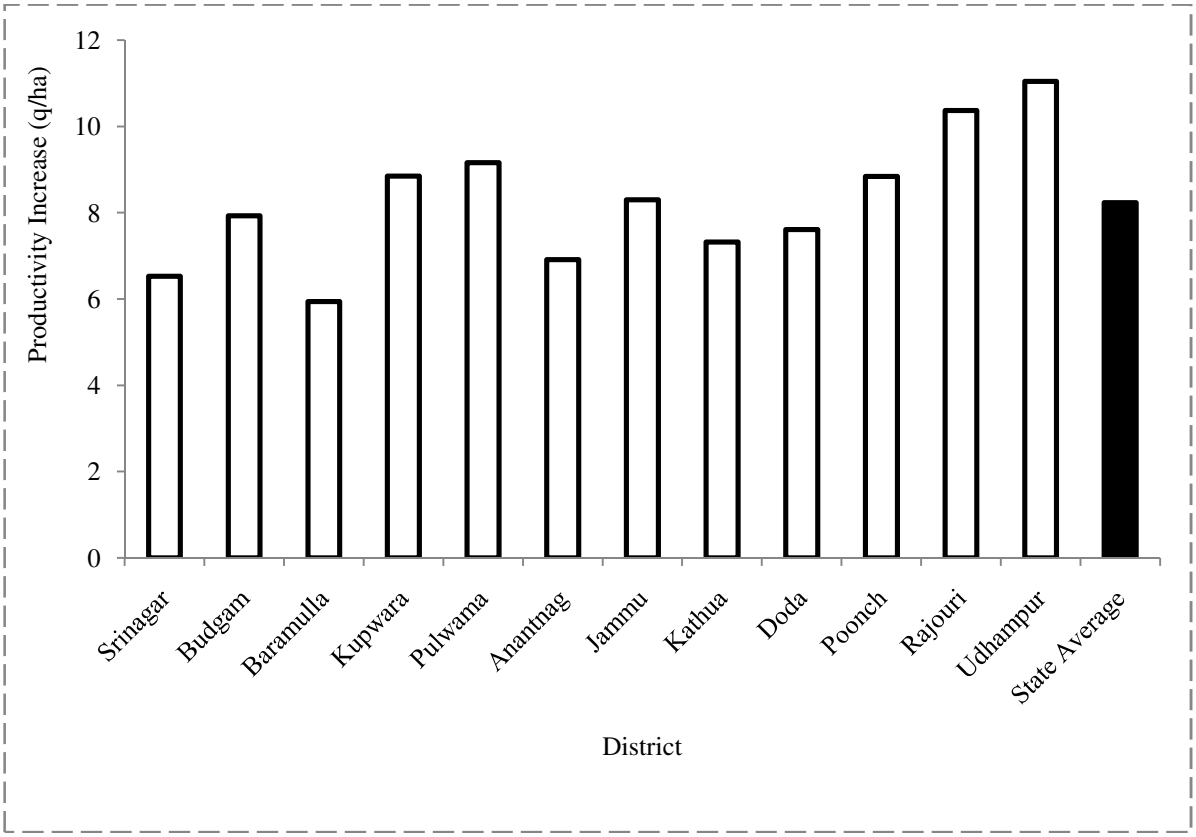

Figure-4: Productivity increase across districts from 1980 to 2008.

Table-3: Productivity of wheat in Jammu and Kashmir (1980-81 to 2008-09)[16].

District	Productivity of wheat (quintals/hectare)							
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2008-09	Change (q/ha)
Srinagar	5.86	6.28	6.65	7.17	8.84	10.6	12.65	6.79
Budgam	5.9	6.2	7.5	8.36	11.17	14.25	16.15	10.25
Baramulla	8.32	10.87	12.36	14.77	15.38	16.67	17.75	9.43
Kupwara	6.46	6.93	8.86	10.8	11.85	13.68	15.8	9.34
Pulwama	8.18	8.36	9.23	10.9	11.96	13.36	14.3	6.12
Anantnag	4.76	5.41	6.23	6.93	7.71	9.3	11.6	6.84
Jammu	10.51	11.83	13.36	14.72	14.97	16.43	17.85	7.34
Kathua	6.11	7.15	8.98	11.87	13.12	14.65	16.24	10.13
Doda	8.11	9.53	10.11	11.6	12.39	14.75	16.75	8.64
Poonch	6.57	7.59	8.95	10.58	12.21	14.81	15.75	9.18
Rajouri	7.15	8.43	9.83	11.52	13.61	16.28	17.35	10.20
Udhampur	8.13	9.15	10.78	12.28	14.31	16.48	17.95	9.82
Leh	7.27	8.26	9.43	10.55	12.38	14.72	17.87	10.60
Kargil	7.73	8.92	10.12	12.05	14.64	16.73	18.76	11.03
Average	6.15	6.98	8.06	9.39	10.54	12.23	13.58	7.43
J.D	7.76	8.95	10.34	12.10	13.44	15.57	16.98	9.22
K.D	6.58	7.34	8.47	9.82	11.15	12.98	14.71	8.13

Like in case of paddy and maize, the productivity of wheat has also increased at a slower rate in the first fifteen years (1980-1995) than the last thirteen years (1995-2008). The productivity has generally increased more in Kashmir province (9.22 q/ha) than Jammu province (8.13 q/ha). The highest growth is recorded in district Kargil (11.03 q/ha) followed by Leh (10.60 q/ha) and Budgam (10.25 q/ha), while the lowest is observed in Pulwama (6.12 q/ha). Four districts out of fourteen namely Srinagar, Jammu, Anantnag and Pulwama recorded increase less than state average (Figure-6).

Spatial variation in the levels of crop productivity: The determination and measurement of spatial variation of agricultural productivity is of vital importance for agricultural planning and development. In the present study, for the determination of the levels of crop productivity among the different districts of Jammu and Kashmir, the productivity of the three crops discussed above has been taken. Since the agricultural productivity is not uniform in the different districts of the study area but exhibit great variations. The respective weights of the indicators chosen are: W_1= 6.34 for paddy, W_2= 6.62 for maize and W_3=5.87 for wheat for the year 1980-81 and W_1= 6.86, W_2= 9.92 and W_3=9.04 for the year 2008-09. Thus it is observed that the highest weight is shown for the productivity of maize and the lowest is observed for productivity of wheat (Table-4).

The indices for all the districts have also been calculated by taking state as 100 (for average composite index of 18.83 and 25.83 respectively for the year 1980 and 2008) as given below (Table-5).

$$\text{Indices} = \frac{\text{Composite index of any unit}}{\text{Average Composite Index}} \times 100 \qquad (2)$$

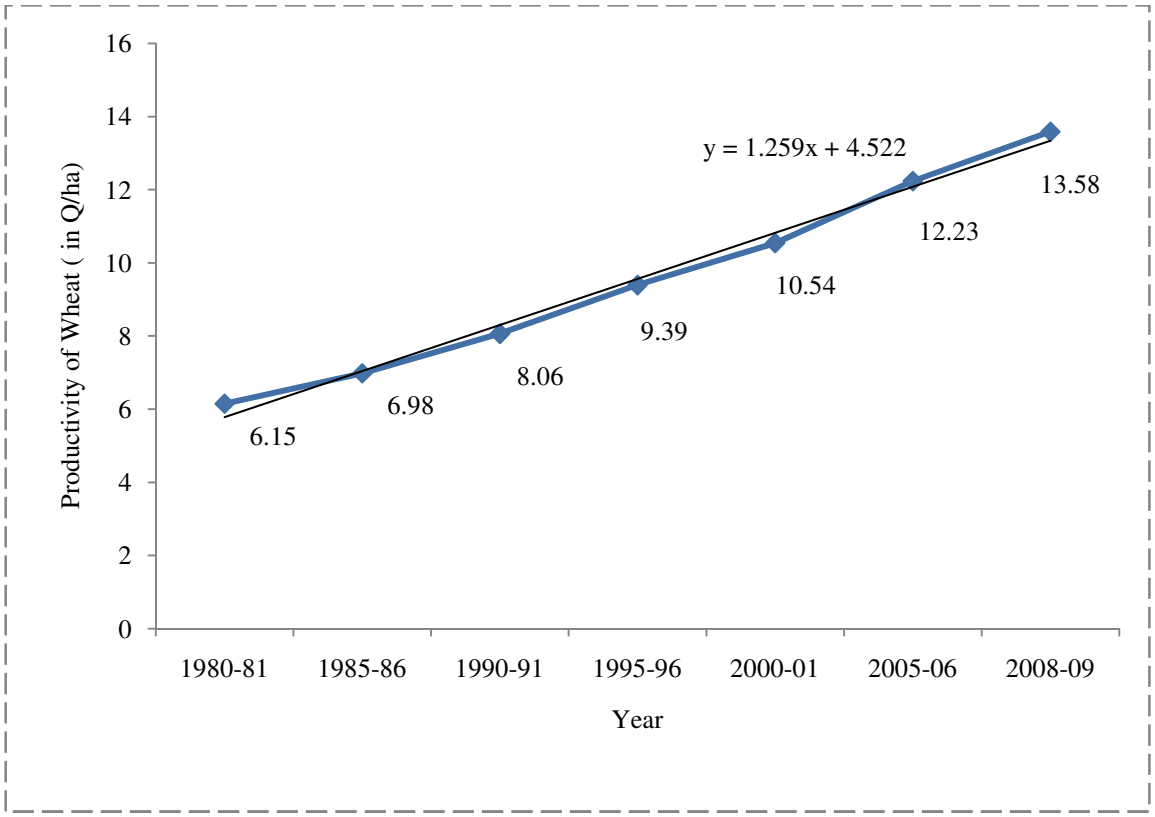

Figure-5: Trend of Wheat Productivity in Jammu and Kashmir.

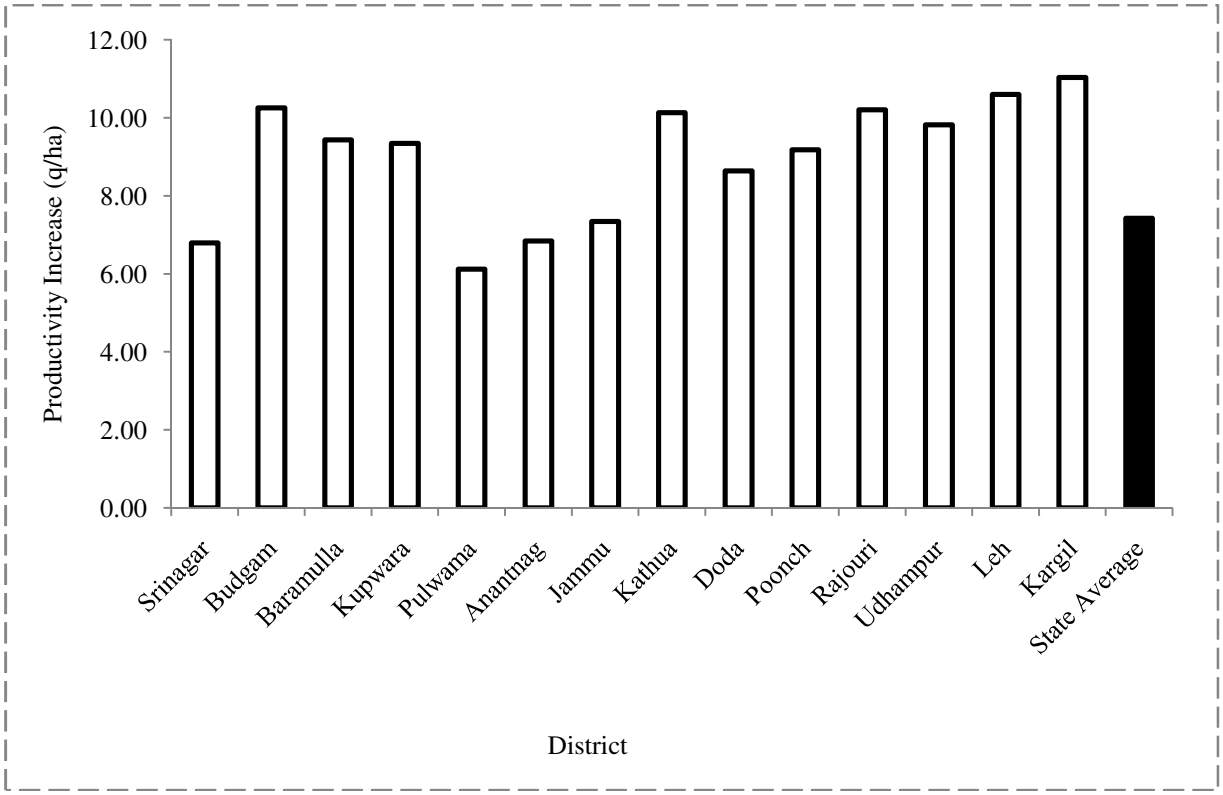

Figure-6: Productivity increase across districts from 1980 to 2008.

Table-4: Agricultural productivity of districts of Jammu and Kashmir for the year 1980 and 2008[15,16].

District	Agricultural Productivity (in Quintals/hectare)					
	1980-81			2008-09		
	Paddy	Maize	Wheat	Paddy	Maize	Wheat
Srinagar	12.61	9.28	5.86	26.1	15.81	12.65
Budgam	11.25	5.14	5.9	24.38	13.07	16.15
Baramulla	13.15	7.75	8.32	26.52	13.69	17.75
Kupwara	7.9	6.65	6.46	18.28	15.5	15.8
Pulwama	12.54	7.99	8.18	26.88	17.15	14.3
Anantnag	11.27	8.12	4.76	27.41	15.03	11.6
Jammu	10.66	11.12	10.51	26.05	19.42	17.85
Kathua	8.13	8.56	6.11	19.45	15.88	16.24
Doda	9.26	9.29	8.11	18.54	16.9	16.75
Poonch	8.15	7.61	6.57	18.65	16.45	15.75
Rajouri	8.64	8.63	7.15	18.55	19	17.35
Udhampur	8.94	7.56	8.13	19.5	18.6	17.95
Leh	0	0	7.27	0	0	17.87
Kargil	0	0	7.73	0	0	18.76
Total	122.50	97.70	101.06	270.31	196.50	226.77
Mean	12.25	9.77	8.42	27.03	19.65	18.90
S.D	1.93	1.47	1.43	3.94	1.98	2.09
Z-Score (Weight)	6.34	6.62	5.87	6.86	9.92	9.04
Total weight	18.83			25.83		

The range of composite indices varied significantly across the districts from the minimum value of around 40 to the maximum of around 140 which shows that the former are highly disadvantaged in the agricultural productivity and the latter are highly advanced. The composite indices of agricultural productivity of different districts in the state are grouped into four categories and the overall spatio-temporal change in the levels of crop productivity across the districts of the study area are highlighted in the Figure-7.

Table-5: Composite Index of Agricultural Development in Jammu and Kashmir.

District	1980-81		2008-09	
	Composite index	Composite Indices	Composite index	Composite Indices
Srinagar	9.34	122	17.43	108
Budgam	7.43	97	17.15	106
Baramulla	9.75	127	18.51	114
Kupwara	7.01	92	16.34	101
Pulwama	9.58	125	18.73	116
Anantnag	8.13	106	17.11	106
Jammu	10.77	141	20.62	127
Kathua	7.65	100	16.95	105
Doda	8.91	116	17.28	107
Poonch	7.47	98	16.78	104
Rajouri	8.17	107	18.30	113
Udhampur	8.20	107	18.60	115
Leh	2.27	30	6.25	39
Kargil	2.41	31	6.57	41
Average	7.65	100	16.19	100

Source: Compiled from by using Table-4 and formula (2).

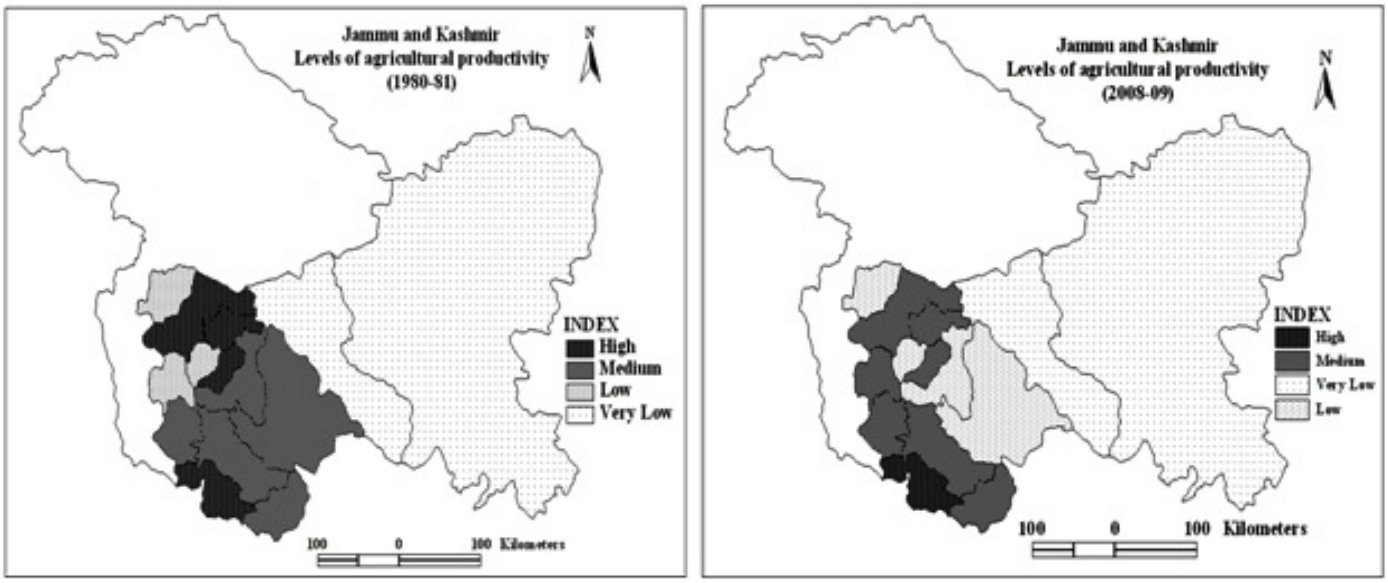

Figure-7: Levels of Agricultural Productivity (1980 and 2008) in Jammu and Kashmir.

Conclusion

The analysis of the data shows that overall the productivity of all the major crops grown in the state increased though with spatial variations. It is clear from the above discussion that the districts which have comparatively plain topography and posses better irrigation facilities have more productivity levels, for example Jammu, Pulwama, Srinagar, Baramulla, Kathua, Anantnag etc. while as the districts which have more hilly topography have less productivity levels. The two districts of the Ladakh division of the state (Leh and Kargil) have very low productivity because of the geo-physical constraints like harsh climate, short growing season, undulating topography, infertile soils etc. The productivity in the state can be increased by using modern methods of farming and enhancing the irrigation capacity. Increasing agricultural productivity requires an increase in output and input with output increasing proportionately more than inputs or an increase in output while inputs remain the same. Moreover, a decrease in both output and input with input decreasing more or decreasing input while output remains the same also leads to increasing productivity. Increasing inputs in order to maximize output involves raising both the quality and quantity of inputs, for example, mechanization of agricultural processes, use of high yield varieties, use of fertilizers, irrigation in areas where rainfall is inadequate, and the use of agrochemicals such as herbicides and pesticides. All of the aforementioned activities or tasks have the potential for productivity enhancement but the smallholder farmers, who account for the vast majority of farmers in developing countries, often cannot afford these investments due to their limited resource strength and restricted access to credit[17,18]. The Government must frame a comprehensive agricultural policy for all the regions of the state keeping in view all the physical and socio-economic parameters.

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