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# GROWTH, PERFORMANCE AND DETERMINANTS OF AGRICULTURAL VARIATION IN PUNJAB: AN INTER DISTRICTS STUDY

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## ABSTRACT

*Punjab agriculture has been known for the green revolution of the late 1960s. Not only has it achieved an irrigation coverage of 97.4 per cent of the net sown area, cropping intensity of 190, and 98 per cent HYV's seed coverage which are all the highest among the Indian states, but even the yields of major crops - wheat and paddy - are of a very high order, i.e., 4,507 kg/per hectare and 4,022 kgs/per hectare respectively. Punjab contributes 43.8(p) percent of India's wheat production and 25.4(p) percent paddy. The state's agricultural production sector is highly capital-intensive and mechanised. It has 9.96 lakh energized tubewells, and no. of tractors 72 per/ 1000 hect. (net sown area) [GoP 2009].*

## KEYWORDS

Determinants of agricultural variation, Growth of agriculture and Performance of agriculture sector.

## 1.1 INTRODUCTION

The Punjab model of agrarian transformation was born out of the food shortages of the 1960's when the nation lacking the resources to buy food grains from abroad and to ask for food aid from the US under the PL-480. Given the income level and its distribution, there was a gap of around 20 per cent between the market demand and domestic production of food grains. This could not be filled through imports.

It is understood that there were only two ways to increase the food grains production. One option was to implement radical land reforms for land redistribution. It was conclusively established that smaller holdings had higher productivity than their large counterparts (Sen. 1964) and the redistribution of land in favour of smaller landholders and landless laborers would lead to an increase in aggregate output. Alternatively the nation had to find a technological solution to the country's chronic food shortages within the existing institutional framework through adoption of high yielding varieties of seeds and package of cheap subsidized inputs along with provision of credit. Given the class character of the Indian state, it was not feasible to carry out any radical land reform particularly when there was no such pressure from small peasants and landless workers who lacked organizational strength. In this scenario India opted for the second alternative i.e. expansion of technological.

Punjab has entered the new millennium with problems in the agriculture sector. During the mid-nineteen-sixties, the green revolution transformed the states agriculture and contributed significantly in making the country self-reliant in food. The increase in production and productivity of wheat and rice in the state is legendary in the history of agriculture in India. These achievements presented a rosy picture of agriculture in Punjab until recently, as the achievements of the state in agriculture have run out of steam. Growth rates in agricultural production and productivity are stagnating and profitability in farming progressively getting reduced. Sustainability in agricultural production and the natural resource base are under threat, as warnings have been sounded on over-exploitation of land and water resources, and degradation of the environment and ecology.

The fast-track adoption of production-augmenting technologies has led to several growth-related problems on the economic, social and environmental fronts in Punjab agriculture, so much so that the sustainability of wheat-paddy rotation is being doubted and debated.

Today, Punjab is at the crossroads, as the existing production pattern and marketing systems are out of tune with the immediate and long-term supply and demand situation in both national and international markets. A package of dynamic, pro-active and responsive policies and action programmes are required to revive Punjab agriculture, so as to meet the oncoming pressures of free trade, liberalization and globalization.

Looking in to foregoing discussion one finds that the situation of agriculture in Punjab has reached to a stagnating stage. This is because the technology diffusion and use is highest in Punjab and further growth in agriculture is not possible under the present conditions. Hence, the problem needs further analysis of past trends in growth rates of area, production and yield of major crops. Keeping this in mind present study intends to attempt to analyse the diffusion of agricultural technology and impact on productivity in Punjab.

## 1.2 THE OBJECTIVES OF THE STUDY

1. To analyse the trends in growth rates of area, production and yield of major food grains crops after post green revolution period.
2. To identify the determinant and responsiveness of agricultural productivity in Punjab.

The paper organized in four sections. Section I provides a few details about data selection/collection, methodology adopted and period covered in the study. In section II highlights the district wise growth performance of area, production and yield of selected crops. Section III related to the determinants of variation of yield for selected crops. And IV section provides conclusion and policy suggestion.

## 2 DATA BASE AND METHODOLOGY

To fulfill the objectives of the present study, secondary data were collected from different published sources of Punjab Govt. viz., Statistical abstract of Punjab from 1970 to 2009. Although there are alternative methods by which the Compound Growth Rates can be calculated for a specified data series. In present paper compound growth rates of Area, Production and Yield were estimated by fitting log linear function as below:-

$$\log Y = a + b_t$$

Where "Y" is Area/Production/Yield and "t" represents time variable.

The growth rates were estimated by  $(e^b - 1) \times 100$ . The data series used for the estimation of growth are the three- yearly moving average. Three-yearly moving average was worked out in order to minimise the effect of extreme climatic variation.

Growth rates were estimated for main food grain crops for the four time periods viz., Period I(1970-71 to 1979-80); Period II(1980-81 to 1989-90); Period III (1990-91 to 1999-2000) and Period IV(2000-01 to 2008-09).

The determinants of yield variation for major food grain crops were estimated by fitting multiply regression equation of the following form using time series data for the period 1970-71 to 2008-09.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + U$$

Where Y is yield in kg/hact.;  $X_1$  is HYV's seeds,  $X_2$  is Consumption of Power in Agriculture (Million K.W.H.),  $X_3$  is % Gross irrigated area to total cropped area,  $X_4$  is Consumption of chemical fertilizer in Punjab District (000, Nutrients tonns),  $X_5$  is % Net irrigated area to Net cropped area and  $X_6$  is No. of tractors per/000hect. (net sown area),  $\beta_0, \beta_1, \dots, \beta_n$  are constant.

To compare the explanatory power of inputs adjusted coefficient of determination ( $R^2$ ) has been also calculated.

$$R^2_{1, 2, 3, \dots, k} = 1 - \frac{(n-1)}{(n-k)} \{ 1 - R^2 \}$$

## 3.1 RESULTS AND DISCUSSION

District wise compound growth rates of area under different crops for selected period of time presented in table 1. Its clear from table that the growth rate of area under rice and wheat highly increased during the I period (1970-71 to 1979-80) then it grow, but with slow rate. In case of Jalandhar, Ludhiana, Bathinda and Sangrur districts, area under rice highly increased by 17.5, 32.5, 21.4 and 23.1 respectively during I period of study. The increasing trend in growth rates over each successive period was more pronounced in the case of area under wheat. Decreasing area, in case of other crops like maize, bajra, gram, moong and masser over the all period of study. In case of area under masser increasing trends in I and II period of time, then highly decreasing in III and IV period of time in Hoshiarpur district.

District wise compound growth rates of production of different crops shows in table 2. For all districts, the resulting growth rates of rice and wheat were observed during the I, II, III and IV periods respectively. In case of maize for Ludhiana district decreasing trend of production -13.7 and -10.1 percent per annum for period I and II, then increasing by 5.91 and 3.7 percent per annum during the III and IV periods. The growth rates of production of gram, moong and masser all most decreasing trend over all periods of study.



TABLE 1: COMPOUND GROWTH RATES OF AREA

District	Time period	Rice	Maize	bajra	wheat	gram	moong	masser
Gurdaspur	I	5.81	-5.37	-10.3	2.23	-2.09	-10.2	1.372
	II	1.76	-0.64		0.79	-5.01		-8.62
	III	1.22	-2.37	-2.37	0.26			-0.5
	IV	0.54	-1.74		0.65			2.519
Amritsar	I	8.05	-4.75	-14.6	2.39	0.91	11.6	6.92
	II	3.01	-5.73		1.42		6.5	-9.79
	III	1.57	-6.72	-6.72	0.27		4.3	-1.34
	IV	1.1	-4.86		0.64		-4.2	-6.21
Kapurthala	I	8.85	-3.97		3.58		5.2	5.398
	II	4.11	-5.48		1.42			-13.1
	III	0.65	-3.81		-0.4		-10.9	
	IV	0.81	-2.49	-3.81	1.06			
Jalandhar	I	17.5	-1.49		1.69	-6.81		1.478
	II	5.83	-4.02		0.23		2.38	-5.38
	III	-0.9	-9.4		-3.2		9.78	
	IV	0.97	0.063	-9.4	1.04		-4.97	
Nawanshehar	I							
	II							
	III							
	IV	0.56	0.27		2.78			-3.02
Hoshiarpur	I	3.19	0.482	-4.73	1.22	-2.21	2.6	12.15
	II	2.31	0.451		0.71	-12.4	7.3	0.259
	III	0.09	-2.31	-2.31	-1.9	-13.2		-10
	IV	0.72	0.231		0.56	-6.69		-7.09
Rupnagar	I	14.1	-0.48		1.69	-2.78		5.426
	II	4.85	-0.65		1.19	-4.68	-2.77	-1.05
	III	4.19	-1.93	-1.93	0.67	-2.69		-1.44
	IV	1.84	-0.68		0.56	-17.7		-3.45
Ludhiana	I	32.2	-1.51	-7.54	0.99	-4.34	3.6	4.611
	II	9.08	-13.8		0		4.1	15.45
	III	1.91	-14	-14	-0.3		1.01	
	IV	-0.3	2.927		0		-10.4	
Firozpur	I	9.28	-7.5	-17.3	-1.8	-5.87	7.8	-4.5
	II	3.43	-10.8		1.75	-14.3	5.1	-3.49
	III	1.33			0.61	-8.48	0.07	
	IV	-0.8			-1.2	-4.86	-16.1	
Faridkot	I							
	II	6.27	-7		1.64	-14.4	7.7	-13.9
	III	-4.6			-10		-10.3	
	IV	4.32			0.48		-16.7	
Muktsar	I							
	II							
	III							
	IV	12.5			1.74	-16.4	-7.33	
Moga	I							
	II							
	III							
	IV	5.25	-9.3	-11.1	4.57		-6.36	
Bathinda	I	21.4	-8.1	-13.4	-1.1	-1.82	-5.11	-0.6
	II	7.3			3.2	-9.73	8.69	-9.67
	III	5.77		4.315	-3.9	-19.6	4.57	
	IV	7.73			1.72	-16.1	-6.35	
Mansa	I							
	II							
	III							
	IV	2.87	-3.23		0.78	-14.2	-7.44	
Sangrur	I	23.1	-16.8	-6.58	1.56	-5.06	7.77	-0.8
	II	10.4		-4.18	1.5	-17.8	17.8	-11.4
	III	3.48			0.38	-2.5	3.79	
	IV	1.02		0.31	-0	-2.65	-9.68	
Patiala	I	11.6	-3.7	-9.33	2.16	-6.18	8.8	1.566
	II	2.75	-8.45		0.74	-15.4	-10.7	-2.35
	III	-0.4	-2.8	-2.8	-2		7.7	-3.49
	IV	0.37	-7.53		0.63		-5.16	-3.96
Fatehgarh sahib	I							
	II							
	III							
	IV	-0.1			-0.1			

Note;-Period I-1970-71 to 1979-80; Period II- 1980-81 to 1989-90; Period III- 1990-91 to 1999-2000 and Period IV- 2000-01 to 2008-09

Source: Statistical abstract of Punjab, various issues, govt. of Punjab.

TABLE 2: COMPOUND GROWTH RATES OF PRODUCTION

District	Time period	Rice	maize	bajra	wheat	gram	moong	masser
Gurdaspur	I	9.47	-1.97		0.6			1.996
	II	2.75	0.707		4.48			-0.21
	III	2.88	0.6		2.61			
	IV	1.42	-0.02		2.03			
Amritsar	I	10.1	-3.62		2.87	-5.29		6.454
	II	4.51	-4.88		4.56			-2.44
	III	3.27	-4.94		1.6		9.8	
	IV	0.46	-3.27		0.97		-4.7	
Kapurthala	I	12.8	-3.04		5.41			
	II	4.04	-7.07		5.28			
	III	1.68	3.223		0.4			
	IV	2.72	1.162		2.53		-5.71	
Jalandhar	I	23.4	-0.31		2.69	-10.9		3.572
	II	6.41	-3.57		3.85			-1.84
	III	-0.3	-6.27		-2		9.17	
	IV	1.63	2.571		2.21		-7.14	
Nawanshehar	I							
	II							
	III							
	IV	0.91	3.639		3.64			
Hoshiarpur	I	6.54	3.427		5.19	-2.42		5.639
	II	3.51	-1.4		3.8	-14.2		6.928
	III	1.96	2.352		-0.1	-14.7		
	IV	0.47	3.07		1.55	-4.63		
Rupnagar	I	23.3	0.924		4.09	-6.45		10.98
	II	6.92	-0.4		3.26			0.559
	III	3.6	2.318		2.84	1.46		
	IV	2.67	2.244		0.73	-16.7		
Ludhiana	I	4.5	0.495		1.49	-6.31		-3.71
	II	9.49	-3.7		2.24		4	2.071
	III	1.35	-10.1		0.44		2.7	
	IV	2.54	5.913		1.02		-11.1	
Firozpur	I	3.6	-8.7		1.42	-6.93		
	II	4.55	-10.7	-16.6	4.43	-12.4	9.8	-9.23
	III	3.18			1.93	-6.17	1	
	IV	-0.2			-1.4	-5.95	-17.2	
Faridkot	I							
	II	7.83	-14.2		4.02	-11.8	1.5	
	III	-5.2			-7.8	-28.3	-13	
	IV	4.74			0.25	14.3	-17.6	
Muktsar	I							
	II							
	III							
	IV	4.7			3.33	-18.3	-5.98	
Moga	I							
	II							
	III							
	IV	5.87				9.17	-8.78	
Bathinda	I	3.4	-11.5	-11.2	4.71	-2.32		-1.48
	II	9.2	-1.86		0.94	-9.76	12.7	-7.54
	III	6.5			4.95	-16.7	1.82	
	IV	7.93		2.655	-2	-14.6	-7.21	
Mansa	I				2.22			
	II							
	III							
	IV	3.87			1.45	-20.8	-7.99	
Sangrur	I	31.8	-3.18	-7.49	3.87	-6.83		
	II	11.4	-15.6		4.57	-17.8	9.9	
	III	3.46		-1.38	1.28	-0.75	6.89	
	IV	2.37	-3.18	-3.07	0.42	-2.15	-10.3	
Patiala	I	17.1	-7.57	-11.6	5.32	-10.4		
	II	4.64	0.157		3.9			6.024
	III	-0.9	-6.73		-0.8	2.15	8.7	9.587
	IV	2			1.25	0.48	-10	
Fatehgarh sahib	I							
	II							
	III							
	IV	2.27	6.207		0.13			

Note;-Period I-1970-71 to 1979-80; Period II- 1980-81 to 1989-90; Period III- 1990-91 to 1999-2000 and Period IV- 2000-01 to 2008-09

Source: Statistical abstract of Punjab, various issues, govt. of Punjab.

TABLE 3: COMPOUND GROWTH RATES OF YIELD

District	Time period	Rice	maize	bajra	wheat	gram	moong
Gurdaspur	I	3.76	3.47	1.31	0.87	-5.6	
	II	0.98	1		3.673		
	III	1.66	3.11		1.903		
	IV	0.87	1.7		0.223		
Amritsar	I	2.61	1.56	0.61	2.123	-7.7	6.7
	II	1.27	1.3	0.39	8.6		-2
	III	1.74	2.2		0.628		-0.8
	IV	-0.6	1.13		1.406		
Kapurthala	I	3.93	1.41				
	II		-1.5		3.876		
	III	0.99	7.33		-0.62		
	IV	1.88	3.01		2.298		7.62
Jalandhar	I	5.58	1.5		0.168	-4.7	
	II	1.42	0.79		3.611		
	III	-0.5	3.23		-0.26		-0.8
	IV	0.63	2.48		2.679		0.33
Nawanshehar	I						
	II						
	III						
	IV	0.32	3.47		0.785		
Hoshiarpur	I	3.52	3.03		1.76	-3.2	
	II	1.04	-1.9		3.127	6.63	
	III	1.94	4.82		1.18	-0.8	
	IV	-0.3	2.71		1.705	1.98	
Rupnagar	I	8.19	1.51		7.612	-3.2	
	II	2.12	0.26		2.259	9.11	
	III	-0.5	4.17		1.918	1.56	
	IV	0.76	3.2		-0.02	0.44	
Ludhiana	I	7.68	-0.4		2.653	-4.7	1.53
	II	0.35	-0		2.259		0.68
	III	-0.5	4.33		0.103		1.19
	IV	2.32	2.73		1.012		0.63
Firozpur	I	4.09	-2.5	-1.2	7.634	2.38	2.49
	II	1.11	2.1	-0.8	2.637	2.77	2.22
	III	1.83			0.714	2.19	0.7
	IV	0.6			0.08	-1.3	0.17
Faridkot	I			7.12			
	II	1.43	4.1	-2.3	2.397	2.91	2.6
	III	-0.2			1.873	-1.9	-3.5
	IV	0.38			0.396	6.37	0.82
Muktsar	I						
	II						
	III						
	IV	1.16			3.026	-0.9	1.69
Moga	I						
	II						
	III						
	IV	0.55			0.209	0.99	-1.6
Bathinda	I	8.6	-2.5	3.53	2.498	0.69	3.24
	II	1.32	-1.1	-1.7	1.704	-0.1	3.13
	III	0.93			1.02	2.69	-1.7
	IV	0.2			2.838	0.49	-2.1
Mansa	I						
	II						
	III						
	IV	0.82			2.681	0.45	-1.9
Sangrur	I	11.3	0.02	-1.5	3.814	3.81	3.68
	II	0.99	0.32	-1.6	3.017	3.02	0.18
	III	0.05		2.45	0.623	0.62	2.9
	IV	1.34		-2.5	0.892	0.89	-0.1
Patiala	I	6.36	0.85	-3.8	4.162	4.16	-8
	II	-1.6	-0.5		3.137	3.14	7.9
	III	4.71	3.97		0.536	0.54	0.32
	IV	1.63	1.44		1.464	1.46	-5.2
Fatehgarh sahib	I						
	II						
	III						
	IV	2.31	5.59		1.295	1.3	

Note;-Period I-1970-71 to 1979-80; Period II- 1980-81 to 1989-90; Period III- 1990-91 to 1999-2000 and Period IV- 2000-01 to 2008-09

Source: Statistical abstract of Punjab, various issues, govt. of Punjab.

Table 3 represents district wise compound growth rate of yield of major crops over the period of study. It's clear from table that the increasing trend in yield of rice over the all selected periods of study. The growth rates of yield slowdown in case of rice and wheat, over the selected periods of time during 1970-71 to 2008-09. In some cases (rice and wheat) the growth rates are negative like Amritsar -0.6 in IV period, Kapurthala -0.62 in II period respectively.

### 3.2 DETERMINANTS OF GROWTH RATES OF YIELD

Table 4 shows the Impact of HYV's seeds, Consumption of Power in Agriculture (Million K.W.H.), % Gross irrigated area to total cropped area, Consumption of chemical fertiliser in Punjab Districts (000, Nutrients tonnes), % Net irrigated area to Net cropped area and No. of tractors per/ooohect. (net sown area) on Yield of Rice. HYV's seeds, use electricity, % net irrigated area to net cropped, use of fertiliser and no. of tractor per/1000 hect. Net sown area are the most important factors to determining yield variation in rice.

TABLE 4: IMPACT OF SELECTED INDICATORS ON YIELD OF RICE

District	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	$\beta_5$	$\beta_6$	$R^2$
Gurdaspur	1636.654	-0.129	-0.152	0.198	0.119	-0.006	.901*	0.729
Amritsar	10362.62	0.233	-0.016	0.059	0.31	-0.485	0.89	0.558
Kapurthala	10660.325	0.19	-0.204	-0.751	0.258	-0.108	1.165***	0.407
Jalandhar	325.714	-0.057	0.287	0.302	0.33	-0.035	0.077	0.302
Nawanshehar	3305.172	0.083	.810**	0.589	0.199	-0.711	0.17	0.753
Hoshiarpur	1802.913	-0.051	0.116	0.157	-0.388	0.319	0.692	0.641
Rupnagar	2018.641	0.268	0.224	-0.428	0.335	0.775	-0.498	0.293
Ludhiana	5505.393	0.266	0.143	-0.305	-0.105	0.082	.737***	0.691
Firozpur	909.543	-0.538	0.529	0.131	0.192	0.28	0.026	0.319
Faridkot	34.616	0.296	-0.37**	0.292	-0.066	0.022	0.345	0.325
Muktsar	53411.267	-0.37	-0.199	-0.819	1.305***	-0.72	-0.341	0.476
Moga	27439.838	0.502	-0.334	0.166	0.531	-0.189	0.35	0.328
Bathinda	2050.472	-0.37	-0.392	0.109	0.162	-0.198	1.429**	0.555
Mansa	-5443.518	-0.514	0.473	0.181	0.947	0.335	-1.05	0.37
Sangrur	725.508	-0.577	0.394	-0.12	-0.319	0.366	0.835	0.22
Patiala	-8416.005	-0.117	-0.077	2.469**	-0.786	-1.88***	.728***	0.227
Fatehgarh sahib	10225.147	0.045	-0.153	0.115	0.445	-0.025	0.282	0.067

\* Significant at 1 per cent, \*\* at 5 per cent and \*\*\* at 10 per cent level of signification.

Source: Statistical abstract of Punjab, various issues, govt. of Punjab.

The coefficient of these variables was found to be positive in a large no. of cases, indicating that an increased use of these variables would increase the yield of rice. But all most coefficient were not significant, this is due to the problem of multicollinearity. Because the independent/explanatory variables are highly correlated with each other for example use of fertiliser and % gross irrigated area to total cropped area has highly correlated each other.  $R^2$  represented the explanatory power of regression model. Its clear from the table that the all variable jointly explains high explanatory power in case of Gurdaspur, Amritsar, Nawanshehar, Hoshiarpur, Ludhiana, and Bathinda district.

Consumption of Power in Agriculture (Million K.W.H.), % Gross irrigated area to total cropped area, Consumption of chemical fertilizer in Punjab District (000, Nutrients tonnes), % Net irrigated area to Net cropped area and No. of tractors per/ooohect. (net sown area) on Yield of Maize, shows in table 6. It's clear from the table that many coefficients were found to be positive and significant in many cases, indicating that change in these variable would change in yield of maize. In case of use of tractor coefficient were found to be negative which indicates that increase in no. of tractor would decrease in yield of maize, in case of Rupnagar, Firozpur, Muktsar, Moga, Bathinda, Sangrur and Patiala district. The effect of use of electricity on yield of maize was found to be positive and significant in Amritsar and Faridkot district.  $R^2$  represent the explanatory power of model fit. In cases of Amritsar, Kapurthala, Jalandhar, Nawanshehar, Rupnagar, Ludhiana, Faridkot, Muktsar, Moga and Patiala,  $R^2$  value was found to be high shows the goodness of model fit.

TABLE 5: IMPACT OF SELECTED INDICATORS ON YIELD OF WHEAT

District	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	$\beta_5$	$\beta_6$	$R^2$
Gurdaspur	2624.716	-0.76	.321**	0.042	-0.41	-0.171	.800**	0.79
Amritsar	17302.637	-0.373	1.001	-0.009	-0.596	0.335	-0.049	0.46
Kapurthala	12181.07	0.033	-3.34	1.565*	-0.56	-1.267	.943*	0.84
Jalandhar	-3570.408	-0.115	-0.066	0.089	-0.092	0.155	.737***	0.8
Nawanshehar	-7527.536	1.803***	0.231	0.396	-0.869***	0.565	-0.894	0.39
Hoshiarpur	1354.162	-0.051	0.056	-0.13***	0.125	0.242	.648***	0.94
Rupnagar	-69.894	0.505	0.107	.682*	-0.053	-0.212	-0.076	0.71
Ludhiana	-2338.956	0.209	-0.132	-0.28***	-0.22	0.285	1.312*	0.83
Firozpur	18743.081	-0.046	0.29	-1.1***	0.089	0.167	1.544	0.84
Faridkot	3151.464	-0.834**	.591**	-0.014	0.011	0.067	0.204	0.72
Muktsar	91131.895	2.713**	0.523	.874***	-0.429	-1.322	2.282***	0.88
Moga	96715.38	0.613	-1.42	0.678	1.171	0.52	0.307	0.38
Bathinda	-2080.96	0.044	0.095	0.07	-0.485**	-0.082	.829**	0.84
Mansa	10995.823	1.573	-0.448	0.93	-0.744	0.053	0.023	0.16
Sangrur	-3154.468	0.672	-0.488**	-0.23	-0.42	0.366	1.063*	0.86
Patiala	-4347.481	-0.434**	-0.308	0.878	.490**	-0.317	0.107	0.85
Fatehgarh sahib	5681.056	0.423	-0.363	0.062	-0.155	-0.22	0.72	0.04

\* Significant at 1 per cent, \*\* at 5 per cent and \*\*\* at 10 per cent level of signification..

Source: Statistical abstract of Punjab, various issues, govt. of Punjab.

TABLE 6: IMPACT OF SELECTED INDICATORS ON YIELD OF MAIZE

District	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	$\beta_5$	$\beta_6$	R <sup>2</sup>
Gurdaspur	849.69		-4.282	-0.174	1.349	0.511	3.001	0.53
Amritsar	8226.079		-1.121	-0.04	.92**	-0.623	1.559	0.61
Kapurthala	4382.345		0.164	-0.992	-0.407	-0.221	2.063**	0.93
Jalandhar	1455.319		.58***	-0.727	0.365	0.276	0.434	0.93
Nawanshehar	741.04		0.22	0.121	0.579	-0.486	0.37	0.89
Hoshiarpur	1236.54		1.079	0.094	-1.152	-0.84	0.867	0.49
Rupnagar	682.37		-0.047	0.094	-1.17**	2.668*	-1.653**	0.97
Ludhiana	1993.62		-1.11**	1.628*	0.914	-3.343*	1.536***	0.91
Firozpur	1224.62		-0.64	0.945	1.028	-0.951	-0.372	0.56
Faridkot	2868.15		-0.682	-0.321	.804**	-0.182	0.066	0.69
Muktsar	180808.87		0.262	-1.17***	-0.115	-0.556	-1.77**	0.94
Moga	-3863.17		0.38	-0.027	0.647	0.035	-0.248	0.96
Bathinda	800.87		0.266	0.565	-0.2	-0.546	-0.598	0.54
Mansa	4509.647		-0.33	-0.807	-0.938	0.36	1.605	0.54
Sangrur	-1299.27		0.379	0.68	0.242	-0.459	-0.74	0.33
Patiala	459.58		1.853*	1.35	-0.864	-1.313	-0.76	0.62
Fatehgarh sahib								

\* Significant at 1 per cent, \*\* at 5 per cent and \*\*\* at 10 per cent level of signification.

Source: Statistical abstract of Punjab, various issues, govt. of Punjab.

Impact of HYV's seeds, Consumption of Power in Agriculture (Million K.W.H.), % Gross irrigated area to total cropped area, Consumption of chemical fertiliser in Punjab District (000, Nutrients tonnes), % Net irrigated area to Net cropped area and No. of tractors per/ooohect. (net sown area) on Yield of Bajra, shows in table 7. The effect of use no. of tractor on yield of bajra was found to be positive and significant in Gurdaspur, Amritsar, Kapurthala, Hoshiarpur, Rupnagar, Ludhiana, Sangrur, Patiala and Fatehgarh Sahib. In cases of Faridkot and Moga coefficient was found negative and significant value, indicating the negative effect of % gross irrigated area to total cropped area on yield of bajra. Explanatory power of model fit represented by R<sup>2</sup> in case of Gurdaspur, Kapurthala, Hoshiarpur, Rupnagar, Ludhiana, Faridkot, Muktsar, Bathinda, sangrur and Fatehgarh Sahib, high explanatory power of model fit.

TABLE 7: IMPACT OF SELECTED INDICATORS ON YIELD OF BAJRA

District	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	$\beta_5$	$\beta_6$	R <sup>2</sup>
Gurdaspur	947.065	-0.069	-0.18	-0.144	.388**	0.042	.796*	0.74
Amritsar	10379.606	-0.242	-0.342	-0.066	0.298	-0.303	1.33**	0.55
Kapurthala	16020.83	-0.006	-0.146	-1.212***	0.24	0.396	1.436*	0.73
Jalandhar	1455.3		0.584	-0.727	0.365	0.276	0.434	0.87
Nawanshehar	3448.569	0.311	0.737	0.352	-0.042	-0.561	0.209	0.68
Hoshiarpur	477.324	-0.541**	-0.09	0.007	-0.084	0.092	1.305**	0.73
Rupnagar	65.987	0.135	-0.091	0.073	-0.346	0.318	.723**	0.81
Ludhiana	10733.659	-0.022	-0.265	0.045	-0.039	-0.784*	4.04*	0.64
Firozpur	17542.66	-0.135	-0.774	-2.182	0.954	0.679	1.328	0.39
Faridkot	10902.19	-0.438	-0.446	-1.867**	1.054**	1.049*	0.25	0.88
Muktsar	27239.46	neg	1.046	0.276	0.73	-1.31	1.296	0.73
Moga	78414.2	neg	0.872	-1.009*	-1.067	-0.401	-0.414	0.53
Bathinda	3258.14	-0.063	0.471	-0.971	0.008	0.874	0.062	0.28
Mansa	13709.93		-0.037	0.223	0.101	-0.698	-0.371	0.65
Sangrur	2322.204	0.254	-0.52	-0.141	-0.09	0.02	1.522**	0.58
Patiala	664.22	-0.009	0.025	0.197	-0.101	-0.265	.886**	0.6
Fatehgarh sahib	66603.05	0.248	0.041	0.339	-0.263	-0.087	1.095**	0.8

\* Significant at 1 per cent, \*\* at 5 per cent and \*\*\* at 10 per cent level of signification.

Source: Statistical abstract of Punjab, various issues, govt. of Punjab.

#### 4 CONCLUSION AND POLICY IMPLICATION

It was concluded from the foregoing analysis that Punjab agriculture towards stagnation. The study reveals that in the case of area under rice and wheat, grows at high rate during the I and II period of study (1970-71 to 1979-80 and 1980-81 to 1989-90) then growth rate sharply decline. It's founded that the growth rate in yield of rice and wheat reached at peak position, even the growth rate of these crops, during the III and IV period of time (1990-91 to 1999-2000 and 2000-01 to 2008-09), negative trends in case of Kapurthala, Jalandhar, Rupnagar, Ludhiana, Faridkot and Patiala district. The main determinants of agricultural performance were found to be the HYV's seeds and % gross irrigated area to total cropped area over the I and II period, then use of fertilizer respectively.

In Punjab there is need to shift new production profile. Punjab farmer needs to diversify their crop base into crops like soybean, maize, fruit and vegetables. Developing dairy industries to produce milk and milk products for urban centers of north India is another way of diversifying the crop base in Punjab. Establishing plants for processing vegetables and fruits; and for processing dairy and poultry is also an economically efficient way of diversifying the agricultural base. Expanding crop diversification and increasing agro industrialization requires the building of a golden triangle with farmer, agro industry, and the banker as the corners of the triangle.

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