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PREDICTIVE MODELS FOR THE AREA, PRODUCTION AND PRODUCTIVITY OF THE MAJOR PULSE CROPS IN DIFFERENT DISTRICTS OF NORTHERN HILLS OF CHHATTISGARH

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ABSTRACT

Three models has been used for the study of trend analysis of the Tur and Gram for the three district (Sarguja, Koria and Jaspur). Linear and Quadratic Models has been used for Sarjuja and Koria and used for Sarguja, Koria and Jaspur district. Present study period was 1979-80 to 2012-13, which divided into three group i.e. period- I (Pre-establishment of IGKV, Raipur: 1979-80 to 1986-87), period-II (Post-establishment of IGKV, Raipur and pre-period of M.P. and C.G. partition: 1987-88 to 1997-98), and period-III (Post-period of M.P. and C.G. partition: 1998-99 to 2012-13). CGR (%), CV (%) and Instability Index have been calculated for the respective periods and all three models. The studies is very necessary not only for understanding the growth trends and magnitude of fluctuations in crop production, but are also useful for scientific planning and effective implementation of agricultural developmental at different levels.

KEYWORDS: CGR, CV, Exponential, Linear and Quadratic Models and Instability Index, *etc*

INTRODUCTION

Pulses occupy an important place in Indian agricultural economy as they are rich sources of proteins and constitute 10 to 15 per cent of India's food grain diet. They are relatively the richest, cheapest and easiest source of best quality proteins and fats, have a vast multiplicity of uses as food and industrial products. India is the largest producer and consumer of pulses in the world accounting for 33 per cent of the world area and 22 per cent of world production and about 30 per cent of consumption. Pulses complement cereals in both production and consumption (Joshi and Saxena, 2002). About 90 percent of the total global area under pigeonpea, 65 percent under chickpea and 37 percent under lentil is contributed by India, with a corresponding share of production of 93 percent, 68 percent and 32 percent, respectively (Reddy, 2004).

The important states engaged in growing pulses are Madhya Pradesh (22.90 %), Uttar Pradesh (18.12 %), Maharashtra (14.25 %), Rajasthan (10.84 %), Andhra Pradesh (8.64 %), Karnataka (5.76 %) and others (19.49 %). Shailendra, (2011)

The total area, production and productivity was 22.46 (Mha), 10.63 million ton and 473 kg/ha respectively during 1980-81, which increased to 24.66 million hectares, 14.26 million ton and 578 kg/ha during 1990-91. During 2000-01, 20.35 (Mha), 11.08 million ton and 544 kg/ha. During 2000-01 the country imported about 4.73Mt of pulses export earnings were a little less crores which increased to 23.50 million hectares, 14.60 million ton and 689 kg/ha during 2010-11. Production of pulses during 2011-12 was 14.60 million tonnes which was slightly less than the 32.48 million

tonnes recorded in 2010- 11. (GoI, 2012)

Chhattisgarh is a state in Central India. It is the 10th largest state in India, with an area of 13.5 million hectare. It is the 16th most-populated state of the nation having a total population of 25.5 million. The State has three agroclimatic zones, i.e. Chhattisgarh plains, Bastar plateau and Northern Hill Region spreading over a total geographical area of 13.60 million hectares. Forest occupies 1.85 million hectares in the State. The net area sown is 4.82 million hectares, which is 35.44 per cent of the geographical area. The cropping intensity is 117.0 per cent. Chhattisgarh is an important State as it contributed about 5.72 per cent of the total annual pulses area, Production and productivity in Chhattisgarh during 2010-11 were 0.81 (Mha), 0.49 million ton and 605 kg/ha (State of Indian Agriculture, 2012-13) respectively.

MATERIAL AND METHODS

The study was confined to the Northern Hills of Chhattisgarh state and its districts. There were only one district in Northern Hill zone is Sarguja. After the resettlement of district there are three districts in Northern Hill zone, namely; Sarguja, Koriya and Jashpur. There are nine blocks in Raigarh district but only Dharamjaigarh (Udaipur) block are under Northern Hill zone. In the year 2012, Sarguja was further split into Sarguja, Surajpur, Balrampur districts. We left Surajpur, Balrampur and Raigarh district (Dharamjaigarh Block), because it was quite impossible to obtain the data for the block. In the present study we have investigated only three districts as mentioned above. Pigeonpea *(Cajanus cajan)*, Cheakpea *(Cicer arietinum)*were considered for the study, because most of the districts of Northern Hill of Chhattisgarh had some appreciable area under these crops.

The present study mainly hinges on secondary sources of data for analysis, drawing inferences and arriving at relevant conclusions. The time series secondary data on area, production and productivity of Pigeonpea, Gram, Blackgrm, Greengram, Pea, Lentil, Grasspea, Kulthi other pulses and total pulses for the three districts were collected for the period from 1979-80 to 2012-13 from various issues of publication such as 'Agricultural Statistics' published by Directorate of Agriculture, Government of Madhya Pradesh, Bhopal (1979-80 to 1997-1998) and 'Basic Agricultural Statistics' (1979-80 to 1997-1998) published by Commissioner of Land Records and Settlement Gwalior, Government of Madhya Pradesh and from the website www.agridept.cg.gov.in/agriculture/ kharif.htm (1998-99 to 2011-12) and "Table of Agriculture Statistics" (2012-13) published by Commissioner, Land Records and Settlement, Raipur, Chhattisgarh.

The data on area, production and productivity for pulses in Chhattisgarh for the period of 1979-80 to 2012-13 formed the basis of the present study.

However, the entire period has been divided into three periods to assess the trend analysis (linear, quadratic and exponential trends) as shown below:

- Pre-establishment of IGKV, Raipur: 1979-80 to 1986-87 (period- I).

- Post-establishment of IGKV, Raipur and pre-period of M.P. and C.G. partition: 1987-88 to 1997-98 (period-II).

- Post-period of M.P. and C.G. partition: 1998-99 to 2012-13 (period-III).

The main consideration underlying the choice of these sub-periods was based on the fact that 'Indira Gandhi Krishi Vishwavidyalaya' and newly formed State Chhattisgarh started functioning from the year 1987-88 and 1998-99 respectively and number of districts is different in different study period.

In order to quantify the growth of area, production and productivity of cereal crops, district wise trend in area, production and productivity were worked out for the cereal crops of Northern Hills of Chhattisgarh, for the three separate periods viz., (1) Pre-establishment of IGKV, Raipur: 1979-80 to 1986-87 (period- I); (2) Post-establishment of IGKV, Raipur and pre-period of M.P. and C.G. partition: 1987-88 to 1997-98 and (3) Post-period of M.P. and C.G. partition: 1998-99 to 2012-13. To analyse the trend in area, production and productivity of different cereal crops, the following different functional forms were fitted.

- Linear function $Y = a + bx$

- Quadratic function $Y = a + bx + cx^2$

- Exponential function $Y = a.b^x$

Where, Y = Area, production and productivity of different food grain crops

x = Time variable

The functional form having the highest co-efficient of determination (R^2) is selected for fitting the trend. Similarly, the growth rate of area, production and productivity of different cereal crops were also computed.

Compound Growth Rate was also computed for area, production and productivity of different cereal crops based on the exponential function for the period. The Compound Growth Rate was computed as follows:

Compound Growth percentage (CGR %) = (b-1) ×100

To measure the magnitude of variability in area, production and productivity the co-efficient of variation (%) was computed. Further the instability index was also calculated to examine the instability area, production and productivity of different cereal crops in different districts of Chhattisgarh plain over the time period by using the formula:

Instability Index (I) = $(1-R^2) \times CV^2$

RESULT AND DISCUSSIONS

4.2 Linear Trend Analysis

This section contains the result obtained linear trend Analysis of Pulses crops namely Tur, Gram, Urd, Moong, Masoor, Pea, Kulthi, Tiwra for the period 1978-79 to 2012-13.

The period under study are divided into three Period I (1979-80 to 1986-87), Period II between (1987-88 to 1997-98) and Period III (1998-99 to 2012-13) between. In the first period and second period Northern Hills of Chhattisgarh constitute one districts namely Surguja. Third Period III having three districts namely, surguja, jashpur and koriya, due to the formation of new districts. We discuss the results for all the periods separately.

Period I (1979-80 to 1986-87)

Period II (1987-88 to 1997-98)

Period III (1998-99 to 2012-13)

Performance of Tur

The linear trend of area, production and productivity of tur computed for period-I (1979-80 to 1986-87), period-II

(1987-88 to 1997-1998) and period-III (1998-99 to 2012-13) are shown in Table 3.

The Sarguja had a positive linear trend in area (R2= 93.87%), production (R2= 76.56%) and productivity (R2= 74.53%) the increase were found to be highly statistically significant at 1% level of significance of tur crop during period-I. The Sarguja had positive linear trend in area (R2= 93.81%), production (R2= 1.31%) and negative linear trend in productivity (R2= 33.94%) of tur crop during period-II. The area and productivity were found to be statistically significant in area at 5% level of significance respectively but production was found non-significant. The Sarguja had positive linear trend in area (R2= 2.51%), and negative linear trend in production (R2= 25.33%), productivity (R2= 25.71 %) of tur crop during period-III. the increase were found to be highly statistically significant for production and productivity significant at 10% level of significance and area was not found significant. The Jaspur district had linear trend in area (R2= 32.72 %) production (R2= 22.29%) and productivity (R2= 28.51%) of tur crop during period-III. The increase were found to be positively significant at 5% and 10% level of significance for area productivity and production (R2= 22.29%). The linear trend in Koriya district was found positively trend in area (R2= 66.45 %), was found to be at 1% level of significance While negatively linear trend in production (R2= 2.63%) and productivity (R2= 28.75%) was found to be non-significant.

Performance of Gram

It was observed form the Table 4 that the Sarguja district had a positive linear trend of area (R2= 86.55%), production (R2= 84.71%) were found to be highly statistically significant at 1% level of significance and productivity (R2= 48) was found significant at 5% level of significance of gram crop during period-I. The Sarguja district had a negatively linear trend of area, and productivity were found to be negatively significant at 5% and 10% level of significance. While production was found to be non-significant for Period-II. The Sarguja district had a positively linear trend in production (R2= 56.02 %), productivity (R2= 61.89 %) were found to be statistically highly significant at 1% level of significance While area (R2= 2.58%) was found to be statistically non significant for gram crop during period-III.

The jaspur district had a negatively linear trend of area(R2=77.74%), was found to be negatively significant at 1% level of significance. while production and productivity found to be non-significant for gram crop during period- III.

The Koriya district had a positively linear trend of area, production and negatively linear trend of productivity were found to be statistically non-significant for gram crop during Period- III.

Growth Trend Analysis

Performance of Tur

The growth trend of area, production and productivity of tur computed for three Period -I (1979-80 to 1986-87), Period -II between (1987-88 to 1997-98) and Period -III (1998-99 to 2012-13) are shown in Table 3 respectively.

The Sarguja districts had a positive growth trend in area (R2= 92.86 %), production (R2= 70.42%) and productivity (R2= 72.85%) were found to be statistically highly significant at 1% level of significance for tur crop during study period- I. The Sarguja districts had a positive growth trend in area (R2= 94.67%) and productivity (R2= 31.67%) for tur crop during study period- II, The increase were found to be significant at 1% and 10% level of significance for area and production. While production (R2= 1.49%) was found to be statistically non- significance. The Sarguja districts of had a positive growth trend in production (R2=23.65%) and productivity (R2=22.28%) was found to be statistically negatively significant at 10% level of significance while area was found to be statistically non-significance for tur crop during study period- III .

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The Jaspur districts in had a positive growth trend in area (R2= 46.80%) was found to be statistically significant at 1% level of significance, while production (R2=23.36%) and productivity (R2=25.90%) was found to be positively and negatively significant at 10% level of significance of tur crop during study period- III.   The koriya districts of had a positive growth trend in area (R2= 65.89%), and productivity (R2= 24.86%) though the increase was found to be statistically positively and negatively significant at 1% and 10% level of significance while production (R2= 0.73%) was non-significant for tur crop during study period- III.

Performance of Gram

It was observed form the Table 4 that the Sarguja districts of had a positive growth trend in productivity (R2= 52.03%), was found to be statistically significant at 5% level of significance while area (R2= 22.33%), production (R2= 33.33%) was found to be non-significant of gram crop during study period- I. The Sarguja districts of had a positive growth trend in area (R2= 40.53%) was found to be negatively significant at 5% level of significance, while production (R2= 8.11%) and productivity (R2= 22%) was found to be non-significant of gram crop during study period- II. The Sarguja districts of had a positive growth trend in production (R2= 54.56%) and productivity (R2= 61.29%) was found to be statistically significant at 1% level of significance while area (R2= 2 %) was found to be found to be non-significant of gram crop during study period- III.

The jaspur districts of had a positive growth trend in area (R2= 80.88 %),was found to be statistically negatively significant at 10% level of significance, while production (R2= 1.72%) and productivity (R2= 0.03%) was found to be non-significant gram crop during study period- III. The Koriya district had a growth trend in area, and production, productivity found to be statistically non-significant for gram crop Period- III.

Quadratic Trend Analysis

The quadratic trend of area, production and productivity of tur had computed for period-I (1979-80 to 1986-87), period-II (1987-88 to 1997-98) and period-III (1998-99 to 2012-13) are presented in Table 3.

Performance of Tur

The quadratic trend of area, production and productivity of tur had computed for period-I (1979-80 to 1986-87), period-II (1987-88 to 1997-98) and period-III (1998-99 to 2012-13) for Sarguja district, both the linear and quadratic regression coefficient were found to be non- significant for area, production and productivity under study period-I. Aacharya et al(2012) Reported the same result for the Karnataka State for the major crops.

Bera et.al. (2011) reported same result for the West Bengal on Food Grains. The linear and quadratic regression coefficient were found respectively negative and positive significant for production (R2= 52.42) under study period-II for tur crop. It was found significant at 5% level of significance. The linear and quadratic regression coefficient were found respectively positive and negative significant for area (R2= 39.56), production (R2= 45.58), and productivity (R2= 89.37), but productivity was negative significant for linear. It was found to be significant at 5% level of significance of tur crop during study period III.

The Jaspur both the linear and negatively quadratic regression coefficient were found to be significant at 5% level of significance for production (R2=51.18), and productivity (R2= 51.94) while area (R2=23.52) was non significant of tur crop during study period III. The Koriya districts both the linear and quadratic regression coefficient were found

respectively positive and negative significant in area (R2=38.707), production (R2= 47.08), under study period III for tur crop. It was found significant at 5% level of significance. Chaudhari *et. al.*(2014) reported the same result for the Oil seed crops at Bangladesh. Pushpa *et.al.*(2014) reported the recent trend in Agricultural growth in India. Singh *et.al.*(2013) reported that the extent of variation in major pulse of India.

Performance of Gram

Table 4 Relavent that the Sarguja districts only quadratic regression coefficient was found to be significant at 1% level of significance while production, productivity found to be non-significant for area of gram crop during study period-I. The Sarguja linear and quadratic regression coefficient were found to be positive and negative significant at 5% level of significance respectively for production (R2= 62.45) under study period- II for gram. Aarea and productivity were not found significant. The Sarguja districts linear and quadratic regression coefficient in area, production and productivity were found to be non-significant of gram crop during study period- III.

The jaspur districts linear and quadratic regression were found to be positive and negative significant respectively for productivity (R2= 90.42) under study period- II for gram. It was found significant at 5% level of significance while production and area, were found to be non-significant. The Koriya districts only linear was found to be positive significant at 1% level of significance respectively for production and productivity (R2= 53.76) under study period-III for gram crop. while area wasfound to be non-significant.

Instability Analysis

Performance of Tur

The Compound growth rate (%), co-efficient of variation (%) and instability index of area, production and productivity of wheat had computed for period-I (1979-80 to 1986-87), period-II (1987-88 to 1997-98) and period-III (1998-99 to 2012-13) and presented in Table 1. Growth and instability in major Pulse crops of Andhra Pradesh reported by Samarpitha (2013)

The coefficient of variation for area is very low while production and productivity is crosses over 10% in the tur crop period-I for the Sarguja district with the significant positive growth rate. The coefficient of variation for area, production and productivity is crosses over 10% in the tur crop period- II for the Sarguja district with the area was positive and productivity was negatively significant growth rate while Production was non significant. The coefficient of variation for area, production and productivity is crosses over 15% in the tur crop period- III for the Sarguja and koriya district with the significant positive growth rate.

Performance of GRAM

Table 2 revealed that the coefficient of variation for area is crosses over 20 percent in almost all districts. All districts in all period showed negative significant growth rate, which indicate that the gram crop is grown in all over the Northern hills of Chhattisgarh with varying area in all period. Though the area exhibits negative significantly growth rate in all of the districts of Northern hills of Chhattisgarh.The production and productivity at all the districts and all period showed positive growth rate in Period- III-and period –I was found to be negative growth rate period II. The coefficient of variation for almost all the districts and all the period was found to be very highly almost more than 20 percent in period-I and III and more than 30 percent in period- II, which indicating a good sign of gram crop productivity and production.

These results evaluated in highlyer instability level since all the growth rates are positive. This instability indicates significantly highly risk for continuing/ growing gram crop.

REFERENCES

1. Acharya S.P., Basvaraja H., Kunnal L. B., and Bhat A.R.S. (2012). Growth in area, production and productivity of major crops in Karnataka. *Karnataka J. Agric. Sci.*, 25 (4): 431-436.

2. Bera, B. K., Chakraborty, A.J and Nandi, A.K. (2011). Growth and instability of food grains production of India and West Bengal. J*ournal of Crop and Weed;* **7**(1):94-100.

3. Chowdhury, M. A. B., Uddin, M.T., Uddin, M. J. (2014). Oil Seeds: Area and Production. Variability in Bangladesh, *J. of Applied Quantitative Method*, 5(1): 101-117.

4. GoI. (2012). Data Base on Indian Agriculture, Department of Agriculture and Cooperation. Ministry of Agriculture.

5. Joshi, P.K. and Saxena, R. (2002). A profile of pulses production in India: Facts, trends and opportunities. *Indian Journal of Agricultural Economics*, 57 (3): 326-339.

6. Pushpa, Nagrale B. G., Chandel B.S. and Chauhan A.K. (2014). Recent Trends in Agricultural Growth: Are We Running or Creeping. *Agricultural Economics Research Review*, 26(5): 20.

7. Reddy, A. (2004). Consumption patter, trade and production potential of pulses. *Economic and Political Weekly*. 34(44):4854-4860.

8. Samarpitha A. (2013) Growth and instability in area, production, and productivity of major pulses in Andhra Pradesh *A Journal of Radix International Educational and Research Consortium,* 2(10): 1-8.

9. Shailendra. (2011). Marketing of pulses in India. *Research Report. CCS National Institute of Agricultural Marketing*. Jaipur, Rajasthan.

10. Singh,D. P., Paikra M. S., Thakur A.K. and Shanka D.(2013) To measure the extent of variation in major pulses crop. *International Journal of Emerging Technologies in Computational and Applied Science*, 7(3): 282-287.

APPENDICES

Table 1: Compound Growth Rate (%), Co-Efficient of Variation (%) and Instability Index of Area, Production and Productivity of Tur Crop

Aspects	Aspects	Period				
		I	II	III		
		Sarguja	Sarguja	Sarguja	Jashpur	Koriya
A	CGR (%)	2.55***	3.41***	-0.23 NS	6.49***	3.28***
	CV (%)	5.90	10.95	24.72	58.19	15.61
	Instability Index	0.025	0.063	9.992	18.01	0.841
P	CGR (%)	13.76***	0.044 NS	3.56 *	3.70*	0.43 NS
	CV (%)	29.64	10.68	26.13	46.72	22.99
	Instability Index	2.59	1.12	5.213	16.72	5.246
Y	CGR (%)	14.90***	-2.25*	-3.38 *	-4.00**	3.79*
	CV (%)	31.69	12.78	38.80	42.25	42.45
	Instability Index	2.72	1.11	11.70	13.22	1.354

Table 2: Compound Growth Rate (%), Co-Efficient of Variation (%) and Instability Index of Area, Production and Productivity of Gram Crop

Aspects	Aspects	Period				
		I	II	III		
		Sarguja	Sarguja	Sarguja	Jashpur	Koriya
A	CGR (%)	-40.14 NS	-5.34**	-0.20 NS	- 2.00***	1.46 NS
	CV (%)	26.28	30.60	6.21	10.15	108.94
	Instability Index	5.364	5.568	3.779	18.01	1.168
P	CGR (%)	146.5**	-3.90 NS	1.72***	-1.722 NS	0.49NS
	CV (%)	18.28	47.07	20.25	28.29	18.76
	Instability Index	1.602	20.35	1.863	7.865	3.476
Y	CGR (%)	0.87 NS	-7.37 NS	3.75***	0.03 NS	1.93 NS
	CV (%)	35.56	52.95	20.19	31.00	28.71
	Instability Index	8.430	21.86	1.577	9.444	7.995

Note: ***, **,* & NS: Significant at 1per cent, 5 per cent, 10 per cent probability

level and Non Significant respectively A= Area, P= Production, Y=Yield/Productivity

Prediction Table

Table 3: R2 Value of Linear, Quadratic and Exponential and Forecast for Tur Crop

District	Aspects	R^2 (in %)			Forecasted area and production		
		Linear	Quadratic	Exponential	Years		
		Y= a+bx	Y= a+bx+cx2	Y= a.bx	2013-14	2014-15	2015-16
Sarguja	Area	2.51	39.56	0.08	8.71	13.07	17.88
	Production	25.33	45.58	23.65	2.25	2.28	2.30
Jashpur	Area	32.72	23.52	46.80	6.42	6.82	7.27
	Production	22.29	51.18	23.36	3.09	3.29	3.33
Koriya	Area	66.45	38.07	65.89	4.12	4.26	4.39
	Production	2.63	47.08	0.73	1.66	1.65	1.64

Table 4: R2 Value of Linear, Quadratic and Exponential and Forecast for Gram Crop

District	Aspects	R^2 (in %)			Forecasted area and production		
		Linear	Quadratic	Exponential	Years		
		Y= a+bx	Y= a+bx+cx2	Y= a.bx	2013-14	2014-15	2015-16
Sarguja	Area	2.58	57.89	2.00	3.34	3.40	3.47
	Production	56.02	59.38	54.56	3.03	3.19	3.38
Jashpur	Area	77.74	7.14	80.88	1.08	1.06	1.03
	Production	0.04	30.94	1.72	0.75	0.73	0.72
Koriya	Area	6.14	7.71	1.52	1.24	1.38	1.53
	Production	0 .60	6.84	1.23	0.31	0.33	0.34