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# Predictive models for Pigeonpea in Northern Hills of Chhattisgarh

# 4 ABSTRACT

5 Three models have been used for the study of trend analysis of the Pigeonpea for the three districts 6 (Sarguja, Koriya and Jashpur). Linear and Quadratic Models has been used for Sarjuja and Koriya 7 and used for Sarguja, Koriya and Jashpur district. Present study period was 1979-80 to 2012-13, 8 which divided into three groups i.e. period-I (Pre-establishment of IGKV, Raipur: 1979-80 to 1986-87), 9 period-II (Post-establishment of IGKV, Raipur and pre-period of M.P. and C.G. partition: 1987-88 to 10 1997-98), and period-III (Post-period of M.P. and C.G. partition: 1998-99 to 2012-13). CGR (%), CV 11 (%) and Instability Index have been calculated for the respective periods and all three models. The 12 study is very necessary not only for understanding the growth trends and magnitude of fluctuations in 13 crop production, but are also useful for scientific planning and effective implementation of agricultural 14 developmental at different levels.

# 15 **1. INTRODUCTION**

16 Pulses occupy an important place in Indian agricultural economy as they are rich sources of proteins 17 and constitute 10 to 15 per cent of India's food grain diet. They are relatively the richest, cheapest and 18 easiest source of best quality proteins and fats, have a vast multiplicity of uses as food and industrial 19 products. India is the largest producer and consumer of pulses in the world accounting for 33 per cent 20 of the world area and 22 per cent of world production and about 30 per cent of consumption. Pulses 21 complement cereals in both production and consumption [5]. About 90 per cent of the total global area 22 under pigeon pea, 65 per cent under chickpea and 37 per cent under lentil is contributed by India, 23 with a corresponding share of production of 93 per cent, 68 per cent and 32 per cent, respectively [6].

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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%) [7].

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The total area, production and productivity was 22.46 million hectares, 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 million hectare, 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 [4].

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Chhattisgarh is a state in Central India. It is the 10<sup>th</sup> largest state in India, with an area of 13.5 million 37 hectare. It is the 16<sup>th</sup> most-populated state of the nation having a total population of 25.5 million. The 38 39 State has three agro-climatic zones, i.e. Chhattisgarh plains, Bastar plateau and Northern Hill Region 40 spreading over a total geographical area of 13.60 million hectares. Forest occupies 1.85 million 41 hectares in the State. The net area sown is 4.82 million hectares, which is 35.44 per cent of the 42 geographical area. The cropping intensity is 117.0 per cent. Chhattisgarh is an important State as it 43 contributed about 5.72 per cent of the total annual pulses area, production and productivity in 44 Chhattisgarh during 2010-11 were 0.81 million hectares, 0.49 million ton and 605 kg/ha (State of 45 Indian Agriculture, 2012-13) respectively.

#### 46 2. MATERIAL AND METHODS

The study was confined to the Northern Hills of Chhattisgarh state and its districts. There was 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.

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The time series secondary data on area, production and productivity of Pigeonpea for 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 (1998-99 to 2011-12) and 'Table of Agriculture Statistics' (2012-13) published by Commissioner, Land Records and Settlement, Raipur, Chhattisgarh.

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

- 1. Pre-establishment of IGKV, Raipur: 1979-80 to 1986-87 (period-I).
- 62 2. Post-establishment of IGKV, Raipur and pre-period of M.P. and C.G. partition: 1987-88 to
  63 1997-98 (period-II).
- 64 3. 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.

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To analyse the trend in area, production and productivity of pigeonpea, the following differentfunctional forms were fitted.

- 721. Linear functionY = a + bx732. Quadratic function $Y = a + bx + cx^2$ 743. Exponential function $Y = a.b^x$ 75Where, Y = Area, production and productivity of pigeonpea crop
- 76 x = Time variable

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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 pigeonpea crop were also computed.

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

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Compound Growth percentage (CGR %) =  $(b-1) \times 100$ 

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

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

# 92 3. RESULTS AND DISCUSSION

The linear, growth and quadratic trend of area, production and productivity of Pigeonpea computed forall three periods and three years forecasting are shown in Table 1.

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The Sarguja had a positive linear trend in area ( $R^2$ =0.9387%), production ( $R^2$ = 0.7656%) and 96 productivity (R<sup>2</sup>=0.7453%) the increase were found to be highly statistically significant at 1% level of 97 98 significance of pigeonpea crop during period-I. The Sarguja had positive linear trend in area 99 (R<sup>2</sup>=0.9381%), production (R<sup>2</sup>=0.0131%) and negative linear trend in productivity (R<sup>2</sup>=0.3394%) of 100 this crop during period-II. The area and productivity were found to be statistically significant in area at 5% level of significance but production was found non-significant. The Sarguja had positive linear 101 trend in area (R<sup>2</sup>=0.0251%), and negative linear trend in production (R<sup>2</sup>=0.2533%), productivity 102 103 (R<sup>2</sup>=0.2571%) of pigeonpea crop during period-III. the increase were found to be statistically 104 significant for production and productivity at 10% level of significance and area was not found significant. The Jaspur district had linear trend in area ( $R^2$ =0.3272%) production ( $R^2$ =0.2229%) and 105 106 productivity (R<sup>2</sup>=0.2851%) of pigeonpea crop during period-III. The increases were found to be 107 positively significant at 5% and 10% level of significance for area and productivity. Koriya district was found positively trend in area (R<sup>2</sup>=0.6645%) at 1% level of significance, while negatively linear trend in 108 production ( $R^2$ =0.0263%) and productivity ( $R^2$ = 0.2875%) was found to be non-significant. 109

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The Sarguja districts had a positive growth trend in area ( $R^2=0.9286\%$ ), production ( $R^2=0.7042\%$ ) and productivity ( $R^2=0.7285\%$ ) were found to be statistically highly significant at 1% level of significance for pigeonpea crop during study period-I. The Sarguja districts had a positive growth trend in area ( $R^2=0.9467\%$ ) and productivity ( $R^2=0.3167\%$ ) for pigeonpea crop during study period-II, the increase were found to be significant at 1% and 10% level of significance respectively for area and productivity

while production (R<sup>2</sup>=0.0149%) was found to be statistically non-significance. The Sarguja district had 116 a positive growth trend in production ( $R^2=0.2365\%$ ) and productivity ( $R^2=0.2228\%$ ) was found to be 117 118 statistically negative significant at 10% level of significance while area was found to be statistically 119 non-significance for pigeonpea crop during study period-III. The Jaspur district had a positive growth 120 trend in area (R<sup>2</sup>=0.4680%) was found to be statistically significant at 1% level of significance, while production (R<sup>2</sup>=0.2336%) and productivity (R<sup>2</sup>=0.2590%) was found to be positively and negatively 121 122 significant at 10% level of significance of pigeonpea during study period-III. The Koriya district had a 123 positive growth trend in area (R<sup>2</sup>=0.6589%), and productivity (R<sup>2</sup>=0.2486%) though the increase was 124 found to be statistically positively and negatively significant at 1% and 10% level of significance while production (R<sup>2</sup>=0.0730%) was found non-significant for pigeonpea crop during study period-III. 125

	Aspects		R <sup>2</sup> (in %)	Forecasted area and production					
District		Linear	Quadratic	Exponential	Years				
		Y= a+bx	Y= a+bx+cx <sup>2</sup>	Y= a.b <sup>x</sup>	2013-14	2014-15	2015-16		
0	Area	0.0251	0.3956	0.0008	8.71	13.07	17.88		
Sarguja	Production	0.2533	0.4558	0.2365	2.25	2.28	2.30		
Jashpur	Area	0.3272	0.2352	0.4680	6.42	6.82	7.27		
	Production	0.2229	0.5118	0.2336	3.09	3.29	3.33		
Korivo	Area	0.6645	0.3807	0.6589	4.12	4.26	4.39		
Ronya	Production	0.0263	0.4708	0.0730	1.66	1.65	1.64		

126 Table 1: R<sup>2</sup> value of linear, quadratic and exponential and Forecast for Pigeonpea

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128 The Sarguja district quadratic trend were found to be non-significant for area, production and 129 productivity under study period-I.

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The quadratic trend were found positive significant for production (R<sup>2</sup>=0.5242%) under study period-II 131 for pigeonpea crop. It was found significant at 5% level of significance. The quadratic trend were 132 found respectively positive and negative significant for area ( $R^2$ =0.3956%), production ( $R^2$ =0.4558%), 133 134 and productivity (R<sup>2</sup>=0.8937%), but productivity was found to be significant at 5% level of significance 135 of pigeonpea crop during study period-III. The Jaspur district quadratic regression coefficient were found to be significant at 5% level of significance for production (R<sup>2</sup>=0.5118%), and productivity 136 (R<sup>2</sup>=0.5194%) while area (R<sup>2</sup>=0.2352%) was non-significant for pigeonpea crop during study period 137 138 III. The Koriya district quadratic regression coefficient were found positive significant in area  $(R^2=0.3807\%)$ , production  $(R^2=0.4708\%)$ , under study period-III for pigeonpea crop. It was found 139 140 significant at 5% level of significance.

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142 The Compound growth rate (%), co-efficient of variation (%) and instability index of area, production 143 and productivity of pigeonpea had computed for all the periods and presented in Table 2.

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The significant compound growth rate in area under pigeonpea was about 2.55%, production is growing at around 13.76% and productivity increment of 14.90% was found also the coefficient of 147 variation for area is very low while production and productivity is crosses over 10% with very low value 148 of instability index for this crop in period-I for Sarguja district. The significant compound growth rate in 149 area under pigeonpea was about 3.41%, production is growing non-significantly at around 0.044% 150 and productivity was found decreases significantly of about 2.25% also the coefficient of variation for 151 area, production and productivity is not more than 12% with very low value of instability index for this 152 crop in period-II for Sarguja district. The negative non-significant compound growth rate in area under 153 pigeonpea was about 0.23%, production is growing significantly at around 3.56% and productivity was 154 found decreases significantly of about 3.38% also the coefficient of variation for area, production and 155 productivity is crosses over 20% with low to moderate value of instability index for this crop in period-156 III for Sarguja district. The highly significant compound growth rate in area under pigeonpea was 157 about 6.49%, production is growing significantly at around 3.70% and productivity was found 158 decreases significantly of about 4.00% also the coefficient of variation for area, production and 159 productivity is crosses over 40% with moderate value of instability index for this crop in period-III for 160 Jashpur district. The significant compound growth rate in area under pigeonpea was about 3.28%, 161 production is growing non-significantly at around 0.43% and productivity was found significant 162 increment of about 3.79% also the coefficient of variation for area, production and productivity is 163 crosses over 20% with low value of instability index for this crop in period-III for Koriya district.

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							Perio	ods				
	production a	and proc	luctivity of	Pigeonpea								
able 2:	Compound	growth	rate (%),	co-efficient	of	variation	(%)	and	instability	index	of	area,
	able 2:	able 2: Compound production	able 2: Compound growth production and proc	able 2: Compound growth rate (%), production and productivity of	able 2: Compound growth rate (%), co-efficient production and productivity of Pigeonpea	able 2: Compound growth rate (%), co-efficient of production and productivity of Pigeonpea	able 2: Compound growth rate (%), co-efficient of variation production and productivity of Pigeonpea	able 2: Compound growth rate (%), co-efficient of variation (%) production and productivity of Pigeonpea	able 2: Compound growth rate (%), co-efficient of variation (%) and production and productivity of Pigeonpea Periods	able 2: Compound growth rate (%), co-efficient of variation (%) and instability production and productivity of Pigeonpea Periods	able 2: Compound growth rate (%), co-efficient of variation (%) and instability index production and productivity of Pigeonpea Periods	able 2: Compound growth rate (%), co-efficient of variation (%) and instability index of production and productivity of Pigeonpea Periods

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

166 *Note*: \*\*\*, \*\*, \* & NS: Significant at 1 per cent, 5 per cent, 10 per cent probability level and Non 167 Significant respectively

168 A=Area, P=Production, Y=Yield/Productivity

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#### 170 **4. CONCLUSION**

From the above findings the area under pigeonpea crop in all three districts is increasing but production has very low increasing rate. However the productivity of this crop is almost stagnant. Thus there is a need to take up productivity enhancing measures like varietal improvement, improved cultural practices, distribution of planting materials, disease control measures, and selection of appropriate crop according to agro climatic conditions and irrigation facilities.

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