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Prediction of area and production along with production function for area, production and productivity of linseed crop in undivided bastar region of Chhattisgarh

Komal Chawla and AK Singh

Abstract
Bastar region comes under Bastar plateau, agro climatic zone of Chhattisgarh. In the present study, an attempt has been made to study the predictive models for area and production of linseed crop in undivided Bastar region of Chhattisgarh. Time series data for the period from 1983-84 to 1997-98 on linseed were utilized for the study. The predictive model under study included a unique feature of structural periodic effect as a factor to capture the cyclic pattern, if any, along with trend effect in the time-series data. This periodic effect was estimated for area and production of the linseed. Apart from this model as a first case, wherein 4-year periodic cyclic effect is assumed along with annual effect working within it as a nested effect; another model has also been assumed with an overall periodic effect variable in combination with overall trend effect variable without any nesting, for comparison with the first case. Additionally, influences of area and productivity of the crops were also worked out to understand the impact of influencing factor (either area or) on the production of linseed.

Keywords: Undivided Bastar region, linseed, area, production, productivity, predictive model, production function and prediction

Introduction

Chhattisgarh State has three agro climatic zones, Chhattisgarh Plains, Bastar plateau and Northern Hills Region. The plateau region comprises of Bastar, Dantewada, Kanker, Narayanpur, Bijapur, Kondagaon and Sukma. The Bastar plateau has undergone two divisions in 1998-99 and 2006-07. However, in the present study the undivided Bastar region has been studied for area and production of linseed crop in Bastar plateau region of Chhattisgarh. The time series secondary data were collected for these parameters from 1983-84 to 1997-98.

Predictive model proposed by Singh and Baghel (1991-94) has been fitted separately for area and production for undivided Bastar region in addition to assessment of their growth rates. Predictions were also made for the next 8 years wherever model diagnostics permitted.

Apart from above a production function was also estimated to understand the influences of area and productivity on the production of the linseed crop in undivided Bastar region during this period.

Thus, the objective of present study is (i) to develop predictive models for area and production of linseed crop for undivided Bastar region, (ii) to assess growth rate of area and production of linseed crop for undivided Bastar region and (iii) to assess the influencing factor (area and productivity) on production of linseed crop for undivided Bastar region.

Material and Methods

The required time series data for the study were collected from various publications of Agricultural Statistics (1980-81 to 1997-1998).

A prediction model was hypothesized as proposed by Singh and Baghel (1991-94), assuming a periodic effect present in the data for a given response variable for a given region. The predictive model included a unique feature of structural periodic effect as a factor to capture the cyclic pattern, if any, along with trend effect in the time-series data. This periodic effect was estimated for area and production of the linseed crop wherein, 3-year periodic cyclic effect as a factor was assumed along with annual effect within these periodic effects; another model was also assumed with an overall periodic variable, *without assuming cyclic effect*, in combination with overall trend effect, for comparison with the first case and for prediction. Thus, the following predictive model was fitted using step-wise regression technique as per Draper and Smith (1981).

$$\ln Y = Int + b_P P + b_{t(p)} T + \varepsilon \quad \text{….(1a)}$$
$$l\hat{n}\, Y = Int + b_P P + b_{t(p)} T \quad \text{....(1b)}$$

where, $l\hat{n}Y$= expected value of the natural logarithm of the response variable; Y: area or production of given region; Int = intercept; P = periodic time variable taking values from 1 to 5 signifying Period-1, i.e., first period for 1983-84 to 1985-86; Period-2, i.e., second period for 1986-87 to 1988-89; Period-3, i.e., third period for 1989-90 to 1991-92; Period-4, i.e., fourth period for 1992-93 to 1995-96; Period-5, i.e., fifth period for 1996-97 to 1998-99 T= annual time variable taking values from 1 to 4 signifying the 1st, 2nd, 3rd, 4th or 5th year nested within each of periods 1 to 5; b_P= partial linear regression coefficient corresponding to variable P; $b_{t(p)}$ = partial linear regression coefficient corresponding to variable T nested within different periods; ε = error/disturbance component.

Apart from fitting above model as a first case, another model has also been fitted with a little deviation of assuming only an overall periodic variable, *without cyclic effect*, in combination with overall trend effect, for comparison with the first case, as well as for the prediction, because dummy value, otherwise in the former case, is difficult to be assigned any value with confidence for future case, *due to its being a factor (not taking any numerical value)*.

The growth rates can be estimated from the aforesaid equation (1b) only as follows. Let T be fixed at a particular position in any period, say at 1st, 2nd or 3rd etc. so that it may be considered constant within any period while P varies. Then we may write (1b) in the form.

$$l\hat{n}\, Y = C + b_P P, \text{ where } C = Int \text{ (since } b_{t(p)}= 0 \text{ for constant T)} \quad \text{……(2a)}$$
$$\text{Or, } Y_x = a\, e^{\theta x}, \text{ where } Y_x = Y,\ a = e^c,\ 0 = b_p,\ x = P \quad \text{…...(2b)}$$

Again, on putting x=0 and 1 respectively we get Y_0 = a and Y_1 = a e^{θ}= Y_0 (1+r_1), where (1+r_1) = e^{θ}, say. Then we have %r_1 = {(Y_p – Y_{p-1})/ Y_{p-1}}100 for fixed T. Also, r_1=e^{θ}-1 ≈ 1 + θ-1= θ = b_p (higher powers of θ in e^{θ} may be ignored). Therefore, r_1 may be defined as the proportional rate of growth in response variable Y per unit change of P for fixed T, *i.e.*, a partial compound growth rate. Similarly %r_2 = {($Y_{t(p)}$ – $Y_{t(p)-1}$)/ $Y_{t(p)-1}$}100 and $b_{t(p)}$ were interpreted with respect to variable T.

Lastly, our interest was to find the extent of influence of area and productivity on the production of linseed in Bastar region of Chhattisgarh. For this, an additive model with an error term ε ~ N (0, σ^2) was hypothesized, of course, subject to the subsequent diagnostic tests. Since we have an identity, namely, "Production= Area × Productivity ", in actual practice the area, production and productivity are not always reported to be accurate enough to give above identity, due to probably rounding errors and many a times due to human error in recording the data. Therefore, assuming that the error term is approximately some powers of discrepancies in the reported data compared to actual area, production and productivity; this identity could be written in the functional form. Thus, after taking natural logarithms, denoting the error component by ε′ ~ N (0, σ^2) and then by introducing the intercept term the following linear statistical model have been obtained:

$$\ln P(A,Y) = c_0 + c_1 \ln A + c_2 \ln Y + \varepsilon \quad \text{….(3a)}$$
$$\text{Or, } l\hat{n}\, P(A, Y) = c_0+c_1\ln A + c_2 \ln Y \quad \text{….(3b)}$$
$$\text{Or, } \widehat{P}(A, Y) = d_0 A^{c1} Y^{c2},\ d_0 = e^{c0} \quad \text{…. (3c)}$$

where A, Y and $\hat{P}$(A,Y) denote the area, productivity and estimated production of a given region, the constant c_0 is the intercept and (c_1, c_2) are the partial regression coefficients corresponding to variables In A and In Y influencing the production, assuming that $\epsilon \sim N(0, \sigma^2)$.

Result and Discussion

Predictive models and partial growth rates

The predictive model-1 and model-2 along with their estimated regression coefficients for periodic and annual effects/growth rates for area and production are shown in Table A-1 of Appendix-A. Thus, it is evident from Table A-1, that the estimated predictive models as defined in equations 1(a) and 1(b) for area and production under linseed crop in undivided Bastar region were highly significant for model-1 with respective R^2 98.31%, and 92.29% (P≤0.05), and for model-2 with respective R^2 65.16% and 55.09% (P≤0.05). For area under linseed, model-1, the regression coefficients which were found to be significant only for periodic effect period-4 and annual effects/growth rates for Year-2 and Year-4(-9.89% and 25.89%, P≤0.05). Similarly for model-2 both the periodic effect and annual effect were found to be significant (having growth rate -5517.4% and 2.75% respectively). For production under linseed, model-1, the regression coefficients which were found to be significant is for periodic effects period-4 only (34.66% growth rate) at 1% level of significance and whereas for model-2 both the periodic effect and annual effect/growth rate were found to be significant at 1% level of significance (having growth rate -5391.0% and 2.69% respectively).

The diagnostic plots are given in Appendix-B. From the diagnostic plots of the model-1 given in Fig.B.1 to Fig.B.6, it is evident that the predictive models are good fit for area and production in which case a quadratic fit based on time series variable may improve the model.

Prediction of Area and Production for next 9 years

The predictions for area and production of undivided Bastar region along with the standard errors and confidence intervals are given in tables Table A-2 to Table A-4 of Appendix-A, and depicted graphically from Fig.B.8 to Fig. B.10 in the Appendix-B, on whose perusal it is clear that the expected area under linseed in undivided Bastar region would increase from 1.852 log(000'ha) i.e. 3.671(000'ha) approx. in 1998-99 to 3.612 log(000'ha) i.e. 37.023 (000'ha) approx in 2006-07 after 9 year, and the expected production under linseed in undivided Bastar region would increase from 0.518 log(000'tonnes) i.e.1.679 (000'tonnes) approx. in 1998-99 to 2.313 log(000'tonnes) i.e.10.100 (000'tonnes) approx. in 2006-07 after 9 year. From figures Fig. B.7 to B.9, it is evident that the predictions for area and production are good enough from 1998-99 to 2003-04, beyond which the confidence interval widens, as is expected because the extrapolated predictions of regression models are valid within a close range only.

Production Function

The production function equations are given in 3(a), 3(b) and 3(c). The coefficients of determination R^2 (Adj-R^2), as shown in Table A-5 of the Appendix-A, for the production function is 97.63*** (97.24), with significant regression coefficients 1.0109*** (*P*<0.001) and 0.9394*** (*P*<0.001) respectively corresponding to area and yield components. From the diagnostic plot given in the figure Fig B.10 of Appendix-B, it is moderately a good model fit (i.e. a robust fit). The influence of area and productivity on production has been determined from this production function and the estimated influence of area and productivity has been given in Table A-5. It was found for undivided Bastar region that, the area as well as yield effects were highly significant; area effect to the extent of 82.26% (*P*<0.01) while the yield effect has not much influence on production (only 15.37%, *P*<0.01). This shows that there is lack of awareness among farmers of linseed with respect to use of technology in linseed production in undivided Bastar region.

Table-A.1: Estimated prediction models for area, production and productivity of undivided Bastar region under linseed for Period 1, Period2, Period3, Period 4 And Period 5 (Undivided Bastar Region: 1983-84 To 1997-98) @

Bastar:		$B_p(\%R_1)$					$B_t(\%R_2)$					$\%R^2$	$\%Adj\ R^2$	Remark
		Int/Period1	Period2	Period3	Period4	Period5	Year1	Year2	Year3	Year4	Year5			
A	(1)$	22.847	175.059	42.552	-537.951**	58.690	-0.0107	-0.098*	-0.032	0.258***	-0.040	98.31***	95.26	P4, Y2, Y4
							(-1.075)	(-9.89)*	(-3.22)	(25.89)***	(-4.002)			
	(2)	1.871***	-55.174***				0.027***					65.16**	59.36	I,P,Y
			(-5517.4)***				(2.75)***							
P	(1)$	199.1	50.53	-199.4	-890.3*	-118.9	-0.100	-0.125	-6.2E-15	0.346**	-0.040	92.29*	78.43	P4,Y4
							(-10.03)	(-12.57)	(-6.2E-13)	(34.66)**	(-4.002)			
	(2)	0.315	-53.910**				0.026**					55.09**	47.6	P,Y
			(-5391.0)**				(2.69)**							

Note: Significance Codes- 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘#’ 0.1 ‘ ’ 1; $ Row(1) Indicates Estimates With Structural Periods While Row(2) Indicates Estimates Assuming Non-Structural Periods; @ Periodicity Of Different Periods: 03 Years

Table A.2: Prediction Of Area For Undivided Bastar Region Under Linseed For Next 9 Years From 1998-99 To 2006-07

Year	Predicted log(Area) log(000'ha)	Log(S.E.) log(000'ha)	Confidence Interval (95%) log(000'ha) Lower limit	Upper limit	Observed Amalgamated Area(000'ha)	Predicted Area (000'ha)
1998-99	1.852	0.120	1.591	2.113	3.4	6.371
1999-2000	2.017	0.148	1.694	2.341	3.8	7.519
2000-01	2.183	0.180	1.792	2.574	2.24	8.873
2001-02	2.428	0.232	1.922	2.934	2.46	11.337
2002-03	2.621	0.270	2.032	3.210	1.22	13.753
2003-04	2.814	0.309	2.140	3.489	1.94	16.684
2004-05	3.170	0.385	2.332	4.008	2.12	23.806
2005-06	3.391	0.430	2.454	4.328	1.97	29.688
2006-07	3.612	0.476	2.575	4.648	2.33	37.023

Note: since Bastar was divided in 1998-99 into the districts; Bastar, Dantewada and Kanker,the observed area /production in this column were amalgamated by adding the area/production of the component districts. However, the observed productivity were averaged instead of addition

Table A.3: Prediction of production for UNDIVIDED BASTAR REGION under Linseed for next 9 years from 1998-99 to 2006-07

Year	Predicted log(Production) log(000'tonnes)	Log(S.E.) log(000'tonnes)	Confidence Interval (95%) log(000'tonnes) Lower limit	Upper limit	Observed Amalgamated Production (000'tonnes)	Predicted Production (000'tonnes)
1998-99	0.518	0.162	0.165	0.871	1	1.679
1999-2000	0.680	0.201	0.243	1.117	1.2	1.974
2000-01	0.842	0.243	0.313	1.371	0.7	2.321
2001-02	1.118	0.314	0.435	1.802	0.89	3.060
2002-03	1.307	0.365	0.512	2.103	0.29	3.696
2003-04	1.496	0.418	0.585	2.407	0.85	4.465
2004-05	1.881	0.519	0.749	3.013	0.8	6.559
2005-06	2.097	0.581	0.831	3.362	0.66	8.139
2006-07	2.313	0.643	0.912	3.713	0.79	10.100

Note: since Bastar was divided in 1998-99 into the districts; Bastar, Dantewada and Kanker,the observed area /production in this column were amalgamated by adding the area/production of the component districts. However, the observed productivity were averaged instead of addition

Production Function As Influenced By The Area And Productivity Of Linseed In Undivided Bastar Region For Period1, Period2, Period3, Period 4, And Period5 (Undivided Bastar Region:1983-84 To 1997-98)

Crop	Model: $Lnp(A,Y) = C_0+C_1lna+C_2\ Lny$							
	Production Function				Area Effect	Yield Effect	Total (R^2)	%Adj R^2
Linseed		Lnt	Lna	Lny				
	Lnp(A,Y)=	-6.6009**	1.0109***	0.9394***	82.26***	15.37***	97.63***	97.24

Note: Signifiance Codes- 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘# ’ 1

Conclusion

It can be concluded from the present study that the estimated predictive models for area and production under linseed crop in undivided Bastar region were highly significant for both the model-1 and model-2. For area under linseed, model-1, predictive model was mainly dependent on the changes occurring in period-4 and on annual growth rates for Year-2 and Year-4. Similarly for model-2 both the periodic effect and annual effect/growth rate were effective. For production under linseed, model-1, the predictive model mainly depended on changes due to periodic effects period-4 and annual effects/growth rates under Year-4 whereas for model-2 both the periodic effect and annual effect/growth rate were effective.

The predictions for area and production of undivided Bastar region are good enough from 1998-99 to 2003-04, beyond which the confidence interval widens. The influence of area and productivity on production gives a moderately good model fit (i.e. a robust fit), wherein it is concluded that the area alone has significantly contributed towards production of linseed in undivided Bastar region to the extent of 82.26% in contrast to the influence of (15.37%), which shows that there is lack of awareness among farmers of linseed with respect to use of technology in linseed production in undivided Bastar region.

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The authors acknowledge the staff of Land Records of Chhattisgarh and publications of erstwhile Land Record of Madhya Pradesh, who have provided the secondary data for linseed crop used in the study. Further, this research work has been successfully completed with facilities extended by the Department of Agricultural Statistics and Social Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur.

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Appendix-B (Figures)

ESTIMATED PREDICTION MODELS FOR AREA OF UNDIVIDED BASTAR REGION UNDER LINSEED FOR PERIOD 1 , PERIOD2 , PERIOD3, PERIOD4 AND PERIOD 5 (UNDIVIDED BASTAR REGION:1983-84 TO 1997-98)

Crop:		$b_p(\%r_1)$					$b_t(\%r_2)$					%R^2	%Adj R^2	Remark
Linseed		Int/Period1	Period2	Period3	Period4	Period5	Year1	Year2	Year3	Year4	Year5			
A	(1)$	22.847	175.059	42.552	-537.951**	58.690	-0.0107	-0.098*	-0.032	0.258***	-0.040	98.31***	95.26	P4, Y2, Y4
							(-1.075)	(-9.89)*	(-3.22)	(25.89)***	(-4.002)			
	(2)	1.871***	-55.174***				0.027***					65.16**	59.36	I,P,Y
			(-5517.4)***				(2.75)***							

Note : Significance codes- 0 '***' 0.001 '**' 0.01 '*' 0.05 '#' 0.1 ' ' 1 ; $ Row(1) indicates estimates with structural periods while Row(2) indicates estimates assuming non-structural periods.

Model Diagnostic Plot

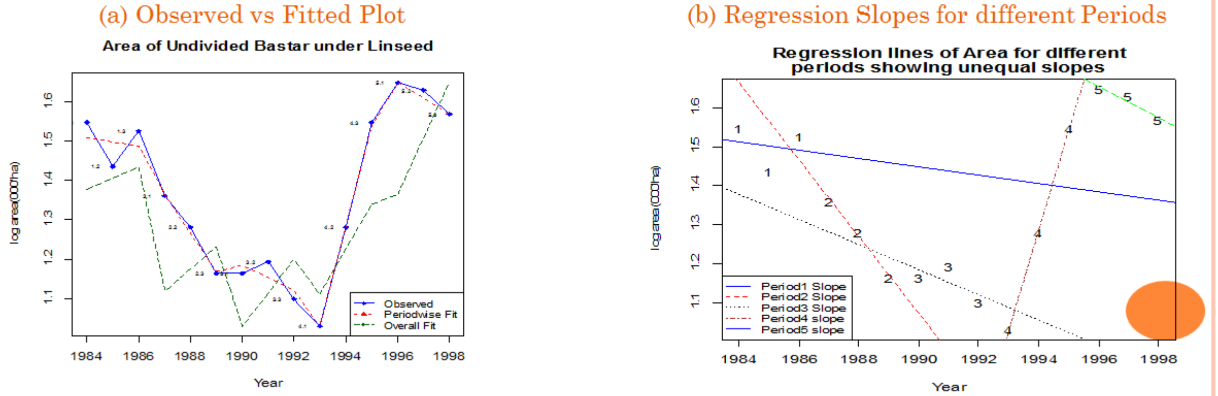


Fig B.1: Prediction models for Area of Bastar Plateau under Linseed from 1983-84 to 2010-11 (a) Observed vs. Fitted Plot (b) Regression slopes for different periods.

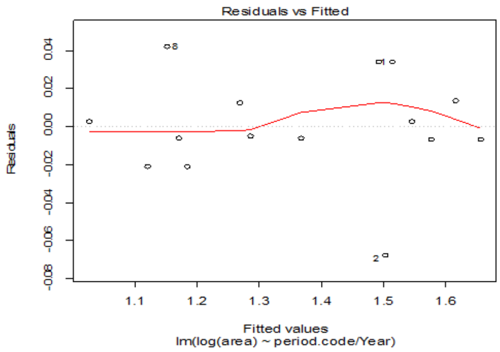
ESTIMATED PREDICTION MODELS FOR AREA OF UNDIVIDED BASTAR REGION UNDER LINSEED FOR PERIOD 1, PERIOD2, PERIOD3, PERIOD4 AND PERIOD 5 (UNDIVIDED BASTAR REGION:1983-84 TO 1997-98)

Crop:		$b_p(\%r_1)$					$b_t(\%r_2)$					%R²	%Adj R²	Remark
Linseed		Int/Period1	Period2	Period3	Period4	Period5	Year1	Year2	Year3	Year4	Year5			
A	(1)$	22.847	175.059	42.552	-537.951**	58.690	-0.0107	-0.098*	-0.032	0.258***	-0.040	98.31***	95.26	P4, Y2, Y4
							(-1.075)	(-9.89)*	(-3.22)	(25.89)***	(-4.002)			
	(2)	1.871***	-55.174***				0.027***					65.16**	59.36	I,P,Y
			(-5517.4)***				(2.75)***							

Note : Significance codes- 0 '***' 0.001 '**' 0.01 '*' 0.05 '#' 0.1 ' ' 1 ; $ Row(1) indicates estimates with structural periods while Row(2) indicates estimates assuming non-structural periods.

Model Diagnostic Plot

(c) Residual Plot



(d) Q-Q Plot for Normality test

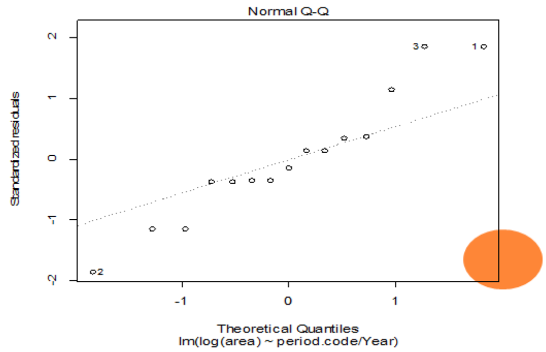


Fig B.2: Prediction models for Area of Bastar Plateau under Linseed from 1983-84 to 2010-11 (c) Residual Plot (d) Q-Q Plot for Normality test.

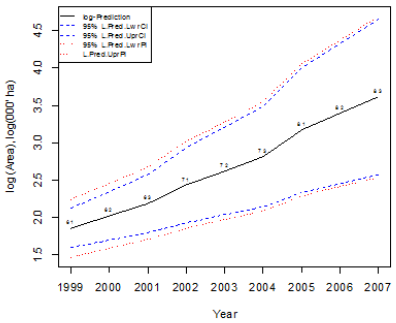
PREDICTION OF AREA FOR UNDIVIDED BASTAR REGION UNDER LINSEED FOR NEXT 9 YEARS FROM 1998-99 TO 2006-07

Year	Predicted log(Area) log(000'ha)	Log(S.E.) log(000'ha)	Confidence Interval (95%) log(000'ha) Lower limit	Upper limit	Observed Amalgamated Area(000'ha)	Predicted Area (000'ha)
1998-99	1.852	0.120	1.591	2.113	3.4	6.371
1999-2000	2.017	0.148	1.694	2.341	3.8	7.519
2000-01	2.183	0.180	1.792	2.574	2.24	8.873
2001-02	2.428	0.232	1.922	2.934	2.46	11.337
2002-03	2.621	0.270	2.032	3.210	1.22	13.753
2003-04	2.814	0.309	2.140	3.489	1.94	16.684
2004-05	3.170	0.385	2.332	4.008	2.12	23.806
2005-06	3.391	0.430	2.454	4.328	1.97	29.688
2006-07	3.612	0.476	2.575	4.648	2.33	37.023

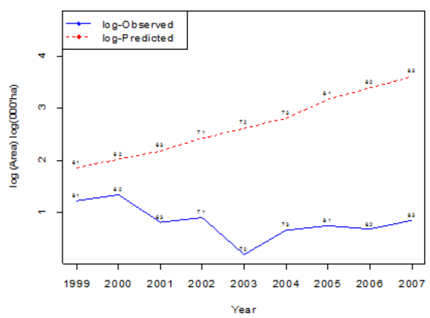
Note: since Bastar was divided in 1998-99 into the districts; Bastar, Dantewada and Kanker,the observed area /production in this column were amalgamated by adding the area/production of the component districts. However, the observed productivity were averaged instead of addition

PREDICTION PLOT OF AREA FOR UNDIVIDED BASTAR REGION UNDER LINSEED FOR 9 YEARS

(a) Prediction of log (Area) from 1999 to 2007



(b) Prediction of log(Area) in for Undivided Bastar Region (1999 to 2007)
(Log-predicted Area compared with log-Observed Area)



c) Prediction of Area for Undivided Bastar Region (1999 to 2007)
(Prediction compared with Observed Area in Original Units)

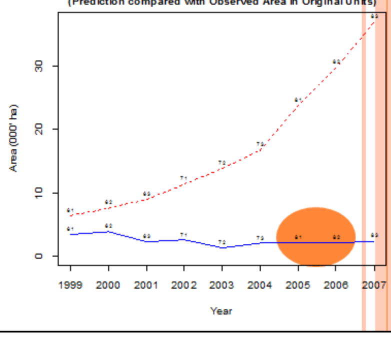


Fig B.3: Prediction models for Production of Bastar Plateau under Linseed from 1983-84 to 2010-11 (a) Observed vs. Fitted Plot (b) Regression slopes for different periods.

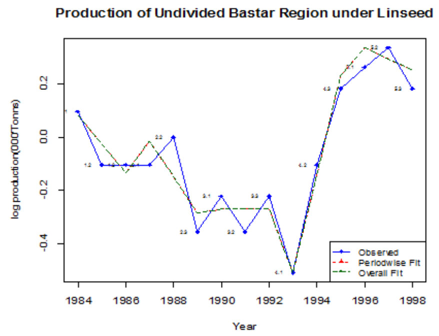
ESTIMATED PREDICTION MODELS FOR PRODUCTION OF UNDIVIDED BASTAR REGION UNDER LINSEED FOR PERIOD 1 , PERIOD2 , PERIOD3, PERIOD4 AND PERIOD 5 (UNDIVIDED BASTAR REGION:1983-84 TO 1997-98)

Crop:		$b_p(\%r_1)$					$b_t(\%r_2)$					%R^2	%Adj R^2	Remark
Linseed		Int/Period1	Period2	Period3	Period4	Period5	Year1	Year2	Year3	Year4	Year5			
P	(1)$	199.1	50.53	-199.4	-890.3*	-118.9	-0.100	-0.125	-6.2E-15	0.346**	-0.040	92.29*	78.43	P4,Y4
							(-10.03)	(-12.57)	(-6.2E-13)	(34.66)**	(-4.002)			
	(2)	0.315	-53.910**				0.026**					55.09**	47.6	P,Y
			(-5391.0)**				(2.69)**							

Note : Significance codes- 0 '***' 0.001 '**' 0.01 '*' 0.05 '#' 0.1 ' ' 1 ; $ Row(1) indicates estimates with structural periods while Row(2) indicates estimates assuming non-structural periods.

Model Diagnostic Plot

(a) Observed vs Fitted Plot



(b) Regression Slopes for different Periods

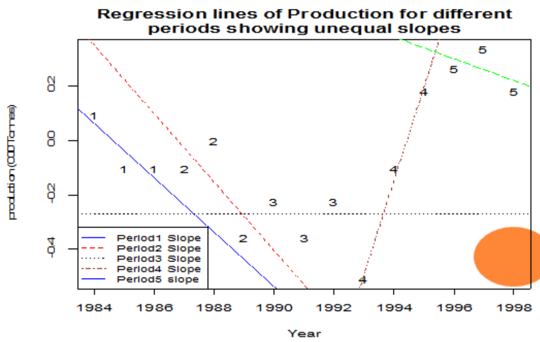


Fig B.4: Prediction models for Production of Bastar Plateau under Linseed from 1983-84 to 2010-11 (c) Residual Plot (d) Q-Q Plot for Normality test.

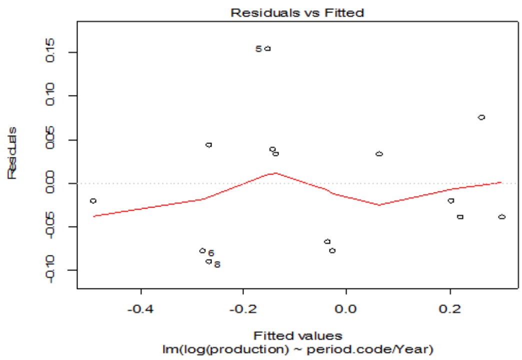
ESTIMATED PREDICTION MODELS FOR PRODUCTION OF UNDIVIDED BASTAR REGION UNDER LINSEED FOR PERIOD 1 , PERIOD2 , PERIOD3, PERIOD4 AND PERIOD 5 (UNDIVIDED BASTAR REGION:1983-84 TO 1997-98)

Crop:		$b_p(\%r_1)$					$b_t(\%r_2)$					%R^2	%Adj R^2	Remark
Linseed		Int/Period1	Period2	Period3	Period4	Period5	Year1	Year2	Year3	Year4	Year5			
P	(1)$	199.1	50.53	-199.4	-890.3*	-118.9	-0.100	-0.125	-6.2E-15	0.346**	-0.040	92.29*	78.43	P4,Y4
							(-10.03)	(-12.57)	(-6.2E-13)	(34.66)**	(-4.002)			
	(2)	0.315	-53.910**				0.026**					55.09**	47.6	P,Y
			(-5391.0)**				(2.69)**							

Note : Significance codes- 0 '***' 0.001 '**' 0.01 '*' 0.05 '#' 0.1 ' ' 1 ; $ Row(1) indicates estimates with structural periods while Row(2) indicates estimates assuming non-structural periods.

Model Diagnostic Plot

(c) Residual Plot



(d) Q-Q Plot for Normality test

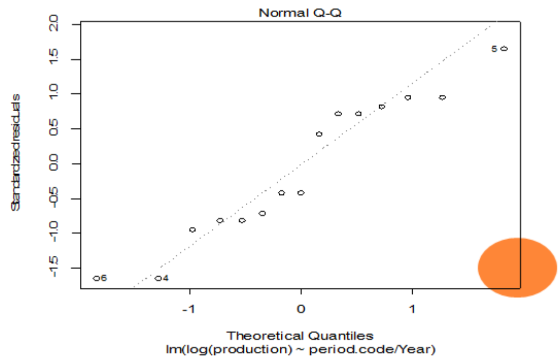


Fig B.5: Prediction models for of Bastar Plateau under Linseed from 1983-84 to 2010-11 (a) Observed vs. Fitted Plot (b) Regression slopes for different periods.

PREDICTION OF PRODUCTION FOR UNDIVIDED BASTAR REGION UNDER LINSEED FOR NEXT 9 YEARS FROM 1998-99 TO 2006-07

Year	Predicted log(Production) log(000'tonnes)	Log(S.E.) log(000'tonnes)	Confidence Interval (95%) log(000'tonnes)		Observed Amalgamated Production (000'tonnes)	Predicted Production (000'tonnes)
			Lower limit	Upper limit		
1998-99	0.518	0.162	0.165	0.871	1	1.679
1999-2000	0.680	0.201	0.243	1.117	1.2	1.974
2000-01	0.842	0.243	0.313	1.371	0.7	2.321
2001-02	1.118	0.314	0.435	1.802	0.89	3.060
2002-03	1.307	0.365	0.512	2.103	0.29	3.696
2003-04	1.496	0.418	0.585	2.407	0.85	4.465
2004-05	1.881	0.519	0.749	3.013	0.8	6.559
2005-06	2.097	0.581	0.831	3.362	0.66	8.139
2006-07	2.313	0.643	0.912	3.713	0.79	10.100

Note: since Bastar was divided in 1998-99 into the districts; Bastar, Dantewada and Kanker,the observed area /production in this column were amalgamated by adding the area/production of the component districts. However, the observed productivity were averaged instead of addition

PREDICTION PLOT OF PRODUCTION FOR UNDIVIDED BASTAR REGION UNDER LINSEED FOR 9 YEARS

(a) Prediction of log (Production) from 1999 to 2007

(b) Prediction of log(Production) in for Undivided Bastar Region (1999 to 2007) (Log-predicted Production compared with log-Observed Production)

(c) Prediction of Production for Undivided Bastar Region (1999 to 2007) (Prediction compared with Observed Production in Original Units)

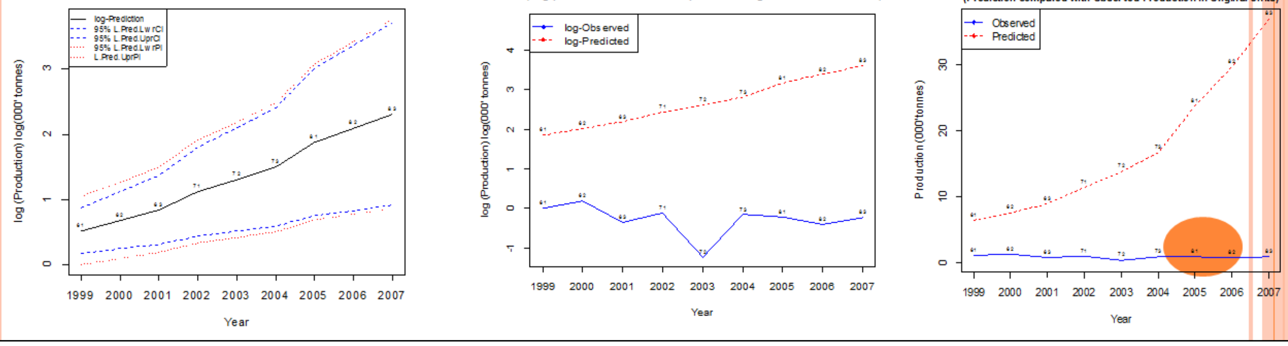


Fig B.6: Prediction models for of Bastar Plateau under Linseed from 1983-84 to 2010-11 (c) Residual Plot (d) Q-Q Plot for Normality test.

PRODUCTION FUNCTION AS INFLUENCED BY THE AREA AND PRODUCTIVITY OF LINSEED IN UNDIVIDED BASTAR REGION FOR PERIOD1, PERIOD2, PERIOD3, PERIOD 4, AND PERIOD5 (UNDIVIDED BASTAR REGION:1983-84 TO 1997-98)

Crop	Model: $\ln P(A,Y) = c_0 + c_1 \ln A + c_2 \ln Y$							
	Production Function				Area effect	Yield effect	Total (R^2)	%Adj R^2
Linseed		lnt	lnA	lnY				
	lnP(A,Y)=	-6.6009**	1.0109***	0.9394***	82.26***	15.37***	97.63***	97.24

Note:Significance codes- 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '#' 1

Model Diagnostic Plot

(a) Observed vs Fitted Plot

(b) Residual Plot

(c) Q-Q Plot for Normality test

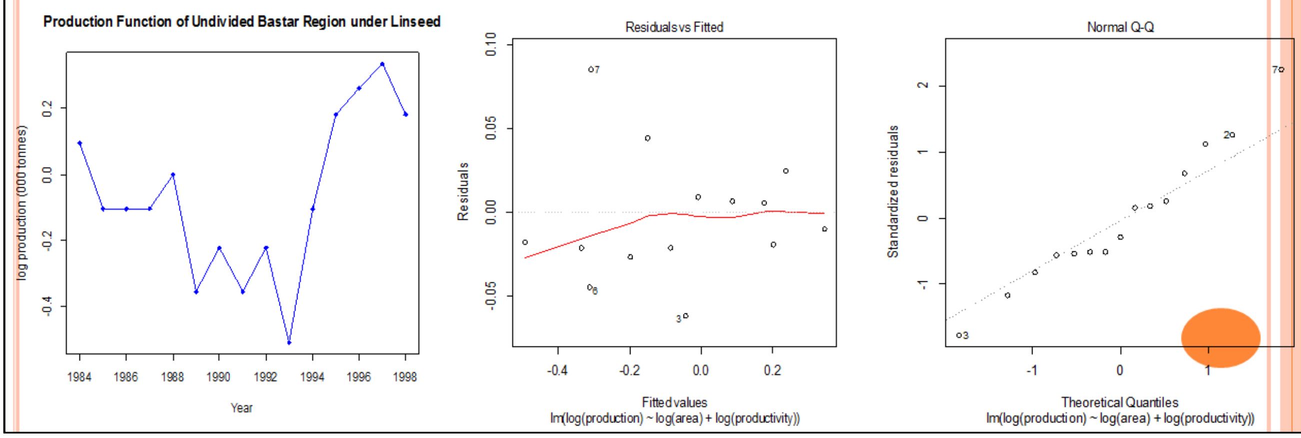


Fig B.7: Production function as influenced by Area and under Linseed in Bastar Plateau from 1983-84 to 2010-11 (a) Observed vs. Fitted Plot (b) Residual Plot (c) Q-Q Plot for normality test.