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Influence of area and yield on the production of Masoor in Chhattisgarh Plain

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Abstract
Estimation of Area, Production and Yield of Masoor in Chhattisgarh plain and it's constitute districts have been made. Based on this models predicted Area, Production and Yield for the future years 2013-14 to 2022-23. The productivity of Masoor in Chhattisgarh plain and it's constitute districts is expected to increase by the turn of this century, if its present growth trend is maintained. The partial compound growth rate of the area, production and productivity of the crop also be estimated and discussed. Periodic effects of five years as well as annual effects were found to be working in most of the districts. Based on postulated and estimated production function of area and productivity it was found that the major influent factor on the production of crop was its productivity. This influence of productivity was around 50% for the whole of Chhattisgarh plain and its constituting districts.

Keywords: Area, production of Masoor, growth rate

Introduction
The masoor (*Lens culinaris* or *Lens esculenta*) is an edible legume. It is a bushy annual plant known for its lens-shaped seeds. It is about 40 cm (16 in) tall, and the seeds grow in pods, usually with two seeds in each.
In South Asian cuisine, split lentils (often with their hulls removed) are known as *dal*. Usually eaten with rice or *rotis*, the lentil is a dietary staple throughout regions of India, Sri Lanka, Pakistan, Bangladesh and Nepal. As a food crop, the majority of world production comes from Canada, India and Australia.
Chhattisgarh is a predominantly tribal and rice growing region. its constituent agro climatic zones are Chhattisgarh plain, Bastar plateau, and Northan hills with 29 districts. Out of which 10 districts belong to Chhattisgarh plain. Being predominantly tribal, Chhattisgarh has been drawing continuous attention of governmental agencies to improve the scenario of crop production. The planners are still not sure of the position of production that will be in the coming year and that of its contributing factors i.e. area and productivity.

Material and Method
The time series secondary data on area, production and productivity Masoor for the ten districts of Chhattisgarh plain were collected for the period from 1998-99 to 2012-13 from various issues of publication such as 'Agricultural Statistics' published by Directorate of Agriculture Madhya Pradesh, Bhopal, 'Basic Agricultural Statistics' published by Commissioner of Land Records and Settlement Gwalior, Govt. of Madhya Pradesh and www.cggovt.in.
During analyses it was realized that a five year periodic effect is working on the response variable in most of the district/regions. Therefore, this periodic effect was considered as a structural effect changing every five years the area, production and productivity scenario of Masoor crop. A periodic effect variable 'P' was introduced to measure the periodic trend along with the annual effect variable 'T' to measure annual trend with in each period, the following multiple regression models was fitted in all cases using stepwise regression technique as

$$\ln Y = \ln t + bp\ P + bt\ T + \in \text{ or, } \widehat{\ln} Y = \ln t + bp\ P + bt\ T \quad \ldots\ldots\ldots\ldots (1)$$

where
$\widehat{\ln} Y$ = expected value of the natural logarithm of the response variable Y may be area, productivity or production of a given district/ region; lnt = intercept; P= periodic time variable. T = annual time variable taking values from 1 to 5 signifying the 1st, 2nd, 3rd, 4th or 5th, year for any period; bp = partial linear regression coefficient corresponding to variable P; bt = partial

linear regression coefficient corresponding to variable T; $\in$ = error/disturbance component normally distributed with mean zero and common variance σ^2, i.e. $\in \sim (0, \sigma^2)$.

Let T be fixed at a particular position in any period, i.e. at 1st, 2nd or 3rd etc. so that it may be considered constant within any period while P varies. Then we may write (1) in the form

$\widehat{ln}$ Y= C+ bp P, where C = lnt or, $Y_x = a e^{\theta x}$, where Y_x = Y, a= e^c, θ = bp, x=P

on putting x= 0 and 1 respectively in above equation, we get Y_0 = a and $Y_1 = a e^{\theta} = Y_0(1+r_1)$, where$(1+r_1) = e^{\theta}$,say. Then, we have $\%r_1 = \{(Y_p - Y_{p-1})/Y_{p-1}\}$ 100 for fixed T. Also, $r_1 = e^{\theta} - 1 = 1 + \theta - 1 = \theta$ = bp (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, ie., a partial compound growth rate. Similarly r_2 and b_t can be interpreted with respected to variable T.

For the influence of area and productivity on the production, we need an additive model with an error term. We have the identity, production = Area × Productivity. However, in actual practice the area, production and productivity are not always reported to be accurate enough to equal to above product, due to probably rounding errors and many a times due to human error in recording the data. Therefore, assuming that actual area, production and productivity are some powers of the reported data and representing the residual discrepancies with an error term, this identity can be written as the functional form:

$\widehat{ln}$ P (A, Y) = $c_0 + c_1$ lnA + c_2 lnY + ε or, $\widehat{ln}$ P (A,Y) = $c_0 + c_1$ lnA + c_2 lnY

or, $\widehat{P}$ (A,Y) = $d_0 A^{c1} Y^{c2}$, $d_0 = e^{c0}$ …… (3)

Where A, Y and $\widehat{P}$ (A, P) denoted 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 lnA and lnY respectively.

Result and Discussion

1. Compound Growth Analysis

It was observed from the table 1 that in Chhattisgarh plain periodic partial compound growth rate in area (2.022 percent) production (5.339 percent) and productivity (3.250 percent) had registered non significant. The Annual partial compound growth rate of Chhattisgarh plain in area (-1.590 percent) production (-0.608 percent) and productivity (0.999 percent) had registered non -significant.

As far as districts are concern the periodic partial compound growth rate for area in Durg (-8.948 percent), Rajnandgaon (12.64 percent), Bilaspur (9.213 percent),Korba (95.73 percent), Raigarh (15.05 percent) found statistically significant at 5% level, Kawardha (35.20 percent) and found significant at 1% level, Rest of the districts Raipur, Mahasamund, Dhamtari and Janjgir had registered non significant. The Annual partial compound growth rate in area of the constitute districts we find significant result in Dhamtari (-19.658 percent) at 5% level and remaining districts are non significant.

In the case of production under Masoor we find that the periodic partial compound growth rate in Rajnandgaon (15.79 percent), Bilaspur (12.432 percent) had found statistically significant at 5% level, Kawardha (41.1 percent), and Raigarh (46.326 percent) had found significant at 1% level and Janjgir (22.6 percent) and significant at 10% level. Remaining districts are found non -significant. Annual partial compound growth rate of production in Dhamtari (-18.074 percent) had registered significant at 5% level and rest of the districts Raipur, Mahasamund, durg, rajnandgaon, kawardha, Janjgir, bilaspur, korba and raigarh were non- significan.

For the productivity of Masoor the periodic partial compound growth rate in Janjgir (856.1 percent), Korba (216.45 percent), and Raigarh (4.472 percent) and found significant at 5% level. Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kawardha, Bilaspur respectively had registered non significant result. The Annual partial compound growth rate of productivity in Mahasamund (524.762 percent) had registered significant at 5% level and remaining districts were non-significant.

2. Production function

Table 2 indicated that the production functions of Masoor in terms of area and yield in Durg district found satisfactorily fits to the data as indicated by more than 60% except Raipur, Bilaspur, Raigarh, Rajnandgaon and Chhattisgarh plain and showed 65.494% R^2 value. column (1) and (2) showed that in most of the district's the production was influenced by the area of Masoor more than 26.377 percent barring the districts Raipur, Bilaspur, Raigarh, Rajnandgaon and Chhattisgarh plain. For the district Raigarh the production was influenced by the productivity.

3. Prediction of Area, Yield and Production

Fig. 1, 2, 3 show the prediction of area, production and productivity of Masoor between 2013-14 to 2022-23 in Chhattisgarh plain 10 districts namely Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kawardha, Bilaspur, Janjgir, Korba and Raigarh.

Table 1: Prediction models (w.r.t. time) of area, productivity and production under Masoor for Chhattisgarh plain and its constitute districts

Districts/Region		lnt	bp	%r_1 @	bt	% r_2 @	% R^2
Raipur	A	0.776	0.044	(4.535)	-0.033	(-3.250)	6.1480
	Y	5.840	0.000	(0.018)	0.008	(0.797)	1.583
	P	-0.378	0.062	(6.451)	-0.012	(-1.283)	3.893
Mahasamund	A	-4.107	-0.340	(-28.83)	-0.018	(-1.689)	2.930
	Y	-2.494	0.022	(2.279)	1.832**	(524.762**)	29.627
	P	-4.820	-0.022	(-2.207)	-0.122	(-11.570)	1.027
Dhamtari	A	0.629	-0.074	(-7.190)	-0.219**	(-19.658**)	33.128
	Y	5.930	0.001	(0.006)	0.006	(0.588)	3.274
	P	-0.450	-0.050	(-4.895)	-0.200**	(-18.074**)	25.802
Durg	A	1.994	-0.093**	(-8.948**)	-0.003	(-0.333)	27.290
	Y	5.619	0.046	(4.701)	0.015	(1.604)	8.115

	P	0.708	-0.049	(-4.742)	0.012	(1.252)	4.130
Rajnand gaon	A	-0.068	0.120**	(12.64**)	0.004	(0.442)	31.297
	Y	5.628	0.030	(3.039)	0.000	(0.084)	7.760
	P	-1.333	0.147**	(15.79**)	0.002	(0.258)	29.208
Kawardha	A	-0.256	0.301***	(35.20***)	0.031	(3.223)	78.288
	Y	5.450	0.054	(5.640)	0.018	(1.748)	8.786
	P	-1.660	0.344***	(41.1***)	0.041	(4.236)	57.533
Bilaspur	A	-0.146	0.089**	(9.213**)	0.0129	(1.291)	40.441
	Y	5.641	0.032	(3.252)	0.006	(0.501)	14.093
	P	-1.390	0.118**	(12.432**)	0.013	(1.382)	46.089
Janjgir	A	-5.812	0.499	(64.630)	0.268	(30.649)	26.536
	Y	-3.031	2.258**	(856.1**)	1.013	(175.478)	42.213
	P	-6.120	0.380*	(46.326*)	0.178	(19.367)	31.243
Korba	A	-5.868	0.671**	(95.73**)	0.359	(43.052)	36.561
	Y	0.906	1.152**	(216.45**)	0.543	(72.180)	40.349
	P	-6.030	0.410	(50.597)	0.197	(21.678)	27.427
Raigarh	A	-2.166	0.140**	(15.05**)	-0.038	(-3.750)	30.430
	Y	5.627	0.043**	(4.472**)	-0.002	(-0.252)	20.342
	P	-3.496	0.204***	(22.6***)	-0.043	(-4.266)	53.089
Plain Zone	A	2.598	0.020	(2.022)	-0.017	(-1.590)	5.949
	Y	5.674	0.031	(3.250)	0.010	(0.999)	8.323
	P	1.364	0.052	(5.339)	-0.007	(-0.609)	5.748

Table 2: Production function as influenced by the area and productivity of Masoor in Chhattisgarh plain and its constituent districts

Districts/Region	Production Function								(1)*	(2)$	(3)@
RAIPUR	ln P (A, Y) =	3.698	+	0.049	ln A	-	0.070	ln Y	0.341	0.138	0.478
MAHASAMUND	ln P (A, Y) =	3.092	-	0.038	ln A	+	0.015	ln Y	1.209	13.621	14.830
DHAMTARI	ln P (A, Y) =	0.843	-	0.081	ln A	+	0.414	ln Y	6.724	1.452	8.176
DURG	ln P (A, Y) =	2.505	-	0.496	ln A	+	0.296	ln Y	21.394	8.400	29.794
RAJNANDGAON	ln P (A, Y) =	2.361	+	0.454	ln A	+	0.154	ln Y	29.099	0.610	29.709
KAWARDHA	ln P (A, Y) =	3.422	+	0.487	ln A	-	0.057	ln Y	72.883	0.324	73.207
BILASPUR	ln P (A, Y) =	-0.392	+	0.807	ln A	+	0.639	ln Y	41.113	8.463	49.577
JANJGIR	ln P (A, Y) =	2.897	-	0.056	ln A	+	0.044	ln Y	26.346	19.499	45.844
KORBA	ln P (A, Y) =	2.77	-	0.046	ln A	+	0.081	ln Y	35.970	4.804	40.774
RAIGARH	ln P (A, Y) =	-0.937	+	0.335	ln A	+	0.863	ln Y	18.834	18.861	37.695
PLAIN ZONE	ln P (A, Y) =	0.776	-	0.033	ln A	+	0.456	ln Y	0.800	7.624	8.424

* Percent sum of squares explained by lnA, i.e. area effects
$ Percent sum of squares explained by inY, i.e. yield effect
@ total percent sum of squares explained by lnP(A, Y) i.e., by the model (3)

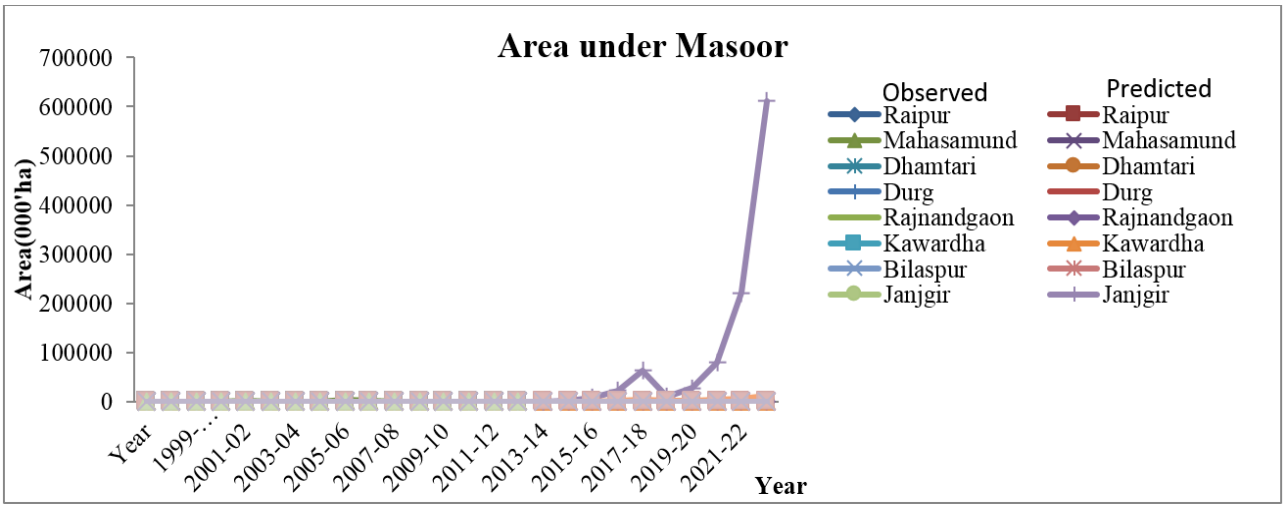

Fig 1: Observed and Predicted Area under Masoor in different districts of Chhattisgarh Plain

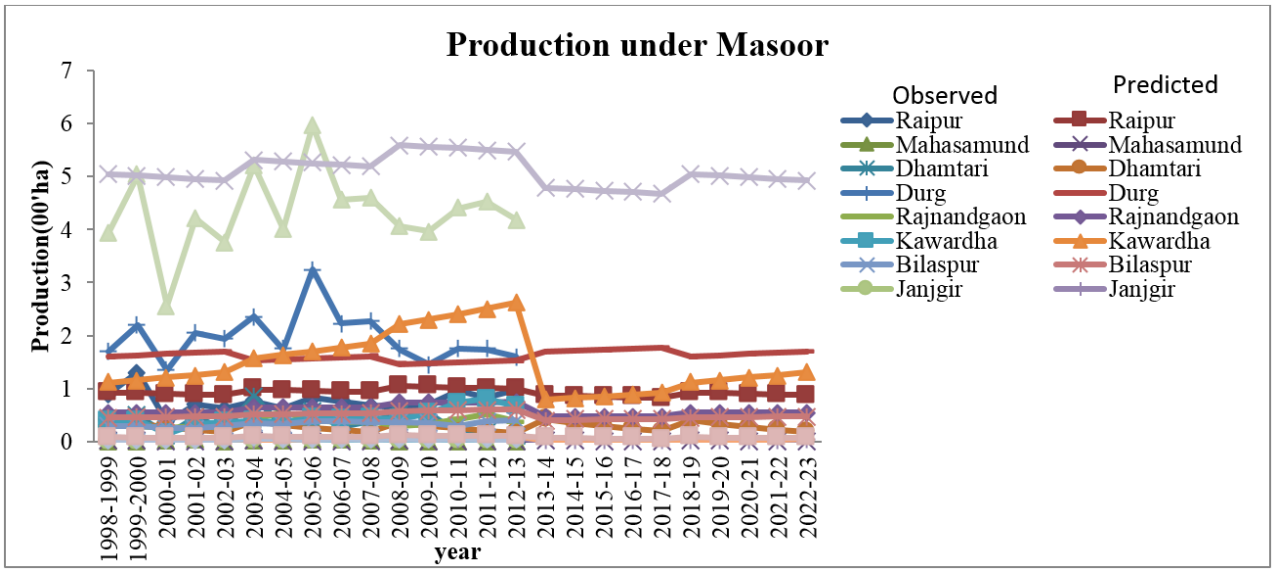

Fig 2: Observed and Predicted Production under Masoor in different districts of Chhattisgarh Plain

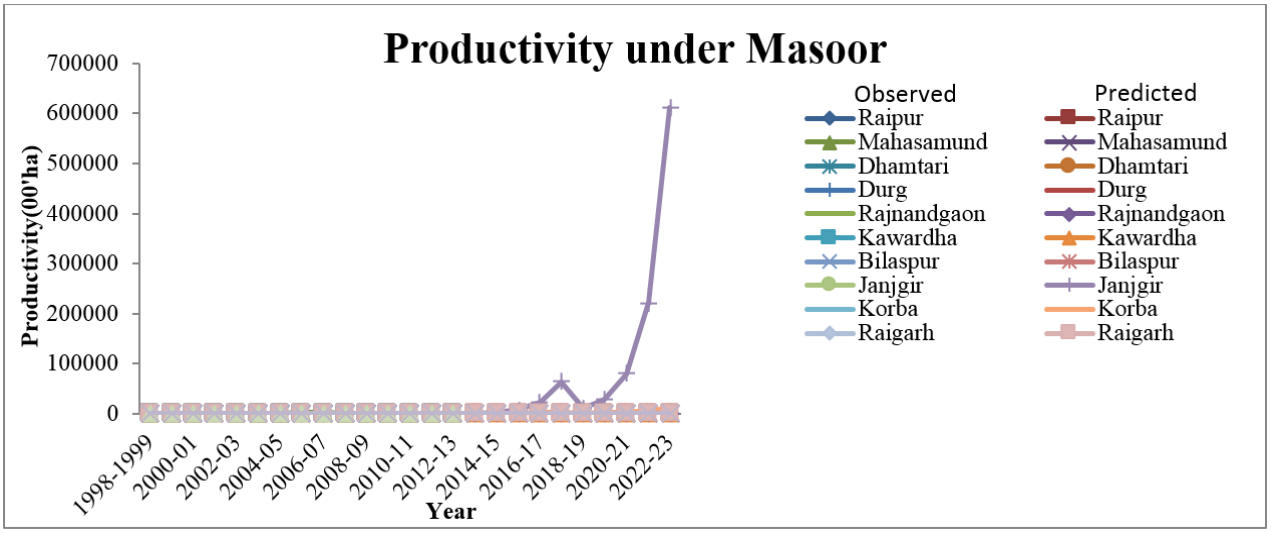

Fig 3: Observed and Predicted Productivity under Masoor in different districts of Chhattisgarh Plain

Conclusion

Performance of Masoor in Chhattisgarh plain periodic partial compound growth rate in area, production and productivity had non- significant same as Annual partial compound growth rate of Chhattisgarh plain. As for as districts are concern the periodic partial compound growth rate for area in Durg (-8.948 percent), Rajnandgaon (12.64 percent), Bilaspur (9.213 percent), Korba (95.73 percent), Raigarh (15.05 percent) found statistically significant at 5% level, Kawardha (35.20 percent) and found significant at 1% level, Rest of the districts Raipur, Mahasamund, Dhamtari and Janjgir non significant. The Annual partial compound growth rate in area of the constitute districts we find significant result in Dhamtari (-19.658 percent) at 5% level and remaining districts are non-significant. In the case of production under Masoor we find that the periodic partial compound growth rate in Rajnandgaon (15.79 percent), Bilaspur (12.432 percent) had found statistically significant at 5% level, Kawardha (41.1 percent), and janjgir (46.326 percent) had found significant at 1% level and Raigarh (22.6 percent) and significant at 10% level. Remaining districts are found non - significant. Annual partial compound growth rate of production in Dhamtari (-18.074 percent) significant at 5% level and rest of the districts Raipur, Mahasamund, durg, rajnandgaon, kawardha, Janjgir, bilaspur, korba and raigarh were non- significant. For the productivity of Masoor the periodic partial compound growth rate in Janjgir (856.1 percent), Korba (216.45 percent), and Raigarh (4.472 percent) and found significant at 5% level. Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kawardha, Bilaspur respectively had registered non significant result. The Annual partial compound growth rate of productivity in Mahasamund (524.762 percent) significant at 5% level and remaining districts were non-significant.

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