Decomposition Analysis of Cereals Production in Nagpur Division

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The huge demand for cereals in the global market is creating an excellent environment for the export of Indian cereal products. The present investigation was undertaken to study to growth rate in Nagpur division, production and productivity of important cereal crops viz; wheat and rice. The study concluded that compound growth rate for area and production under cereals has increase in some district of Nagpur division of Maharashtra during study period. The study also revealed that the compound growth rate of wheat production in period I and period II was same in Nagpur division as whole. The area, production and productivity instability in cereals was observed in almost all districts in the state. It may be because the crop largely depends on vagaries of nature which causes heavy losses. Percent contribution of yield effect was more responsible for production of the selected cereals. Maximum instability was found in the overall period for selected cereals crops. For trend analysis among the competitive parametric models, in all district the area, production and productivity for wheat and rice only the cubic models are found best fitted.

[**Keywords :** Growth rate, Instability, Decomposition analysis, Cereals production]

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1.   Introduction

Agriculture is the most important sector in Indian economy. India is the world's second largest producer of rice, wheat and other cereals.Cereals are the basic ingredient and important source of calories in the diets of a vast majority of the Indian population. As they provide perfect mix of vegetarian protein component of high biological value when supplemented with pulses, cereals are important alternative to vegetable for supplementing the diet of most food of the country. The huge demand for cereals in the global market is creating an excellent environment for the export of Indian cereal products.

The important cereals are wheat, paddy, sorghum, millet (Bajra), barley and maize etc. According to the final estimate for the year 2011-12 by Ministry of Agriculture of India, the production of major cereals like rice, maize and bajra stood at 105 million tonnes, 21.76 million tonnes and 10.28 million tones, respectively,India is not only the largest producer of cereal as well as largest exporter of cereal products in the world. India's export of cereals stood at Rs. 58279.80 crore during the year 2014-15.

In Maharashtra particularly in the Nagpur division of Maharashtra no such studies have been attempted so far, the Nagpur division on Maharashtra being an agrarian region, it has a wide scope for such studies. That's way formulating valuable planning polices of agriculture of this region. Keeping in view these aspects the present study was based on decomposition analysis of cereals production in Nagpur division.

2.   Methodology

The whole study was divided under the following sub-heads :

2·1 Selection of Area

The study was confined to five district of Nagpur division of Maharashtra state namely Nagpur, Bhandara, Gadchiroli, Chandra-pur and Wardha district for the analytical purpose.

2·2 Selection of Period

The data were collected for area, production and productivity of cereals grown in the period from 1995-96 to 2014-15 (20 years) the

entire study period was split into two sub-period and overall as follows:

Period I : 1995-96 to 2004-05

Period II : 2005-06 to 2014-15

Overall : 1995-96 to 2014-15

2·3 Sources of Data

The district-wise time series data on area, production and productivity was collected from Government publication viz. Agricultural statistical information, Maharashtra

2·4 Analytical Tools

Growth Rate Analysis : The district-wise compound growth rates of area, production and productivity were estimated by using following exponential model.

$$Y = abt$$

$$Log\ Y = log\ a + t\ log\ b$$

$$CGR = [Antilog\ (log\ b\text{-}1)] \times 100$$

Where, CGR = Compound growth rate

t = time period in year

Y = Area/production/productivity

a & b = Regression parameters.

't' test was applied to test of significance of 'b'

Instability Analysis : To measure the instability in area, production and productivity, an index of instability was used as a measure of variability.

The coefficient of variation (CV) was calculated by using the formula.

$$C.V.\ (\%) = \frac{Standard\ Deviation}{Mean}\ 100$$

Decomposition Analysis : Measure the relative contribution of area, yield to the total output change for the major crops, Minhas (1964) and decomposition analysis model as given below was used. Sharma (1977), redeveloped the model and several research workers used this model and studied growth performance of crop in the state. Ao, Po and Yo are area, production and productivity in base year and

An, Pn and Yn are values of the respective variable in n^{th} year item, respectively.

$$P_o = A_o \times Y_o \text{ and}$$
$$P_n = A_n \times Y_n \qquad \qquad ...(1)$$

Where, A_o and A_n represent the area and Y_o and Y_n represents the yield in the base year and nth year, respectively.

$$P_n - P_o = \quad P$$
$$A_n - A_o = \quad A$$
$$Y_n - Yo = \quad Y \qquad \qquad ...(2)$$

From equation (1) and (2) we can write

$$P_o + \quad P = (A_o + \quad A)(Y_o + \quad Y)$$

Hence,

$$P \quad \frac{A_o \quad YY_o \quad A}{P} \quad 100 \quad \frac{Y \quad A}{P} \quad 100 \quad \frac{}{P} \quad 100$$

Production = Yield effect + area effect + interaction effect

Thus, the total change in production can be decomposed into area effect and the interaction effect due to change in yield and area.

3.   Results and Discussion

3·1   Growth Rate

In this study, the growth in area, production and productivity of cereals were estimated using compound growth rates as indicated in the methodology. In this analysis the general growth performances of the crop in Nagpur division were examined by fitting exponential growth function with time normalization on area, production and productivity.

The Table-1, revealed that during period I, the compound growth rates of area were negative for all district and Nagpur division as whole except Wardha district. In period II, the compound growth rate were positive for all district and Nagpur division as whole except Wardha district for productivity of wheat. The highest compound growth rate in productivity was estimated in Gadchiroli (4.17) followed by Chandrapur (3.31), Bhandara (3.26) and Nagpur (0.63) district respectively.

The compound growth rate for production in Nagpur division as whole was estimated 4.19 per cent per annum in last 20 years. At the

overall period, the compound growth rate were negative but non-significant in Wardha district in productivity of wheat crop. The compound growth rate in Nagpur division as whole for area, production and productivity were positive except area in period I is negative.

Table-1 : District wise Compound Growth Rate for Wheat

Particular		Wardha	Nagpur	Bhandara	Chandrapur	Gadchiroli	Nagpur division
Period-I	Area	0.18	-7.26	-13.47	-2.51	-8.34	-5.60
	Production	3.63**	-4.73	-11.11	-3.07	-9.24	4.18**
	Yield	-5.89	2.73*	2.77*	-0.54	-0.98	1.51
Period-II	Area	-1.70	6.47**	0.71	-4.03	-6.10	2.27*
	Production	-1.47	7.79**	4.01**	-0.81	-2.09	4.18**
	Yield	-1.36	0.63	3.26**	3.31**	4.17**	2.14
Period-III	Area	1.26	3.33**	-3.53	-0.23	-3.10	1.35
	Production	4.09**	5.62**	-0.01	2.65	0.05	4.19**
	Yield	-0.26	2.30*	3.52**	2.91*	3.11*	0.12

Note : **Significant at 1% level; *Significant at 5% level

The growth performance of rice pertaining to two period and overall was presented in the Table-1, which revealed that during period-I, the compound growth rate of productivity was recorded negative in all district and Nagpur as whole except Wardha district. The compound growth rate for area in period II was found to positive and significant in Nagpur district. The highest compound growth rate for area in period I was registered in Wardha district i.e. 23.16 per cent per annum followed by Nagpur (3.69) district, respectively. The highest compound growth rate for area in period II was registered in Nagpur district per cent.

The compound growth rate for production in period I were negative but non-significant in all district and Nagpur division as whole except Nagpur district. The compound growth rates of production in overall period were positive in Nagpur district. The highest (5.92) compound growth rate of production was found in Nagpur district in period II.

Table-2 : District wise Compound Growth Rate for Rice

Particular		Wardha	Nagpur	Bhandara	Chandrapur	Gadchiroli	Nagpur division
Period-I	Area	23.16**	3.69**	-9.23	0.59	-0.16	-3.59
	Production	-19.01	2.47*	-12.09	-2.83	-7.80	-7.72
	Yield	1.69	-1.17	-3.15	-3.32	-7.67	-3.88
Period-II	Area	-	6.79**	1.16	1.14	-0.16	1.66
	Production	-	8.58**	3.81**	-1.62	1.02	2.18
	Yield	-	-0.44	2.62*	-2.73	0.37	0.15
Period-III	Area	-	5.25**	-2.56	0.29	0.32	-0.50
	Production	-	5.92**	-1.33	0.02	0.49	0.02
	Yield	-	0.67	1.26	-0.28	-0.01	-1.18

Note : **Significant at 1% level; *Significant at 5% level

4.   Instability of Crop

One should not obvious of instability by taking the growth rates only. Because the growth rates will explain only the rate of growth over the period, whereas, instability judge, whether the growth performance is stable or unstable for the period for the pertinent variable. To facilitate better understanding of the magnitude and pattern of changes in the level of production, cropped area and productivity of crop in the different cereals growing region, instability of production, area and productivity of cereals crop have been worked out for the periods mentioned in methodology. In order to know the instability in area, production and yield of crop, the fluctuation measured with the help of coefficient of variation. The results are presented in Table-3 and discussed as under for the period with ten years breakage and overall also. Fluctuation in area production and productivity due to the uncontrollable factors like climatic conditions can cause upward biqs in coefficient of variation.

4·1   Wheat

As seen from Table-3, that coefficient of instability for area under wheat in Wardha district was found to be lowest i.e.10.17 per

cent followed by Chandrapur (16.03), whereas c.v. of high in Gadchiroli (29.10), Bhandara (42.39) district followed by Nagpur (30.14) and Gadchiroli (29.10). The coefficient of instability for production of wheat less in period II as compare to period I in all district. However in overall period, the coefficient of instability for production under wheat was in between 28.94 to 37.16 except Nagpur (46.63) district.

Table-3 : District wise Instability Indices in Wheat

Particular		Wardha			Nagpur			Bhandara		
		S.D.	Mean	C.V.	S.D.	Mean	C.V.	S.D.	Mean	C.V.
Period I	Area	19.3	187.2	10.17	133.24	442	30.14	65.92	155.5	42.39
	Production	60.20	213.2	28.24	177.29	457.1	38.79	56.97	117.2	48.62
	Yield	306.37	1120.7	21.34	249.6	1047.3	23.83	192.19	765.6	25.10
Period II	Area	46.49	230.4	20.18	158.71	688.1	23.07	20.16	112	18.01
	Production	94.63	239.4	27.88	271.76	883.1	30.78	494.6	120.8	24.46
	Yield	150.55	1457.1	10.33	204.94	1298.8	15.78	132.2	1067.8	12.38
Period II	Area	41.07	208.8	19.67	190.97	565.05	33.71	52.4	133.75	39.20
	Production	100.74	276.3	36.46	312.46	670.1	46.63	44.21	119	37.16
	Yield	291.5	1288.9	22.62	257.01	1173.01	21.91	233.18	916.7	24.35

Particular		Wardha			Nagpur			Bhandara		
		S.D.	Mean	C.V.	S.D.	Mean	C.V.	S.D.	Mean	C.V.
Period I	Area	41.95	261.5	16.03	3.25	11.2	29.10	224.91	1057.4	21.27
	Production	47.45	174.5	27.20	2.61	7.8	33.54	308.04	969.8	31.76
	Yield	166.0	670	24.78	130.68	690.9	18.92	168.14	858.9	19.58
Period II	Area	51.34	283.9	18.09	3.06	9.6	31.90	181.2	1324	13.69
	Production	64.19	261.1	24.59	2.20	9.2	23.92	370.4	1613.6	22.96
	Yield	213.4	933.6	22.87	170.74	983.5	17.36	126.39	1148.16	11.01
Period II	Area	47.04	271.7	17.25	3.18	10.4	30.63	241.28	1190.7	20.26
	Production	70.65	217.8	32.44	2.46	8.5	28.94	467.99	1291.7	36.23
	Yield	230.05	801.8	28.69	210.78	837.2	25.18	207.315	1003.53	20.66

CV = Coefficient of variation; SD = Standard Deviation

Further instability in productivity in relation instability in area was contributed marginality toward production fluctuation. This instability of wheat in the zone was the effect of the instability experienced by wheat grower, probably due to the introduction of improved wheat technology in the farming system, Where the local varieties also under production.

4·2   Rice

The Table-4 revealed that coefficient of instability for area under rice in Chandrapur district was found the lowest (3.25) followed by Gadchiroli (3.86) district, Nagpur (14.93) district, Bhandara (35.71) district, respectively. The coefficient of instability for productivity of rice in Wardha district was found highest i.e. 127.8 per cent followed by Gadchiroli (31.07) district, Chandrapur (24.32) district, Nagpur (19.68) district and Bhandara (19.10), respectively. The coefficient of instability of Nagpur division as whole, in period I was the highest as compare to the period II and overall period for variable area, production and productivity. The coefficient of instability for production under rice in period I was between 24.83 to 43.84 except Wardha (91.22) district.

Table-4 : District wise Instability Indices in Rice

Particular		Wardha			Nagpur			Bhandara		
		S.D.	Mean	C.V.	S.D.	Mean	C.V.	S.D.	Mean	C.V.
Period I	Area	3.977	6.6	60.27	56.96	381.5	14.93	855.01	2394.4	35.71
	Production	4.92	5.4	91.22	110.83	446.4	24.83	1348.06	3074.7	43.84
	Yield	1667.1	1303.7	127.88	222.73	1167.4	19.68	239.97	1256.4	19.10
Period II	Area	-	-	-	132.34	643.3	20.57	73.37	1838	3.99
	Production	-	-	-	233.45	813.4	28.70	745.4	2815	26.48
	Yield	-	-	-	220.99	1305.5	16.93	386.8	1526.4	25.35
Period II	Area	-	-	-	166.94	512.4	32.58	655.97	2116.2	31.00
	Production	-	-	-	258.99	629.9	41.12	1068.5	2944.85	36.29
	Yield	-	-	-	227.27	1236.45	18.38	342.5	1331.4	24.62

Particular		Chandrapur			Gadchiroli			Nagpur Division		
		S.D.	Mean	C.V.	S.D.	Mean	C.V.	S.D.	Mean	C.V.
Period I	Area	46.50	1430.2	3.25	55.63	1443	3.86	789.70	5655.7	13.96
	Produc-tion	417.23	1637.7	25.48	567.37	1724.4	32.90	2142.6	6888.6	31.10
	Yield	278.66	1145.9	24.32	369.7	1189.9	31.07	429.25	1212.66	35.40
Period II	Area	189.92	1456.1	13.04	128.4	1494.5	8.60	368.78	5431.9	6.79
	Product-ion	605.60	1824.8	33.19	448.98	2010.6	22.32	1742.0	7463.8	23.34
	Yield	255.06	1241.1	24.32	288.20	1313	21.95	224.23	1077.2	20.82
Period II	Area	135.23	1443.15	9.37	99.91	1468.75	6.80	610.74	5543.8	11.02
	Product-ion	515.17	1731.25	29.76	519.0	1867.5	27.80	1923.3	7176.2	26.80
	Yield	314.46	1993.5	26.34	328.78	1251.45	26.27	340.4	1144.93	29.74

CV = Coefficient of variation; SD = Standard Deviation

The Nagpur division had shown the highest yield instability than area instability and likewise they contribute toward production fluctuation.

5. Decomposition Analysis

A quantitative assessment of contribution of the various factors to production in the districts of Nagpur division is helpful in reorienting the programmes and setting priorities of agricultural development so as to achieve higher growth rates of agricultural production. There are many factors which affect the growth of crop output. These factors believed to affect the production of crop viz., area, yield and their interaction have been considered in the present study. The result of decomposition scheme was worked for two equally divided sub period and overall period as pooled of 20 years data. The Table-5 demonstrates the contribution of area, yield and their interaction for increasing/decreasing of production in Nagpur division over period of time.

The above data showed that during period I, in Wardha district yield effect 72.60 per cent per annum and interaction effect 4.54 per cent per annum. Chandrapur and Gadchiroli district the yield effect was not existence -275.86 and -206.35 per cent per annum respectively. In overall period Gadchiroli showed the highest area effect 596.45 as compare to period I. The Bhandara district showed the highest yield effect i.e. 157.55

Table-5 : Per cent Contribution of Area, Yield and their Interaction for Increasing Production of Wheat

Particular		Wardha	Nagpur	Bhandara	Chandrapur	Gadchiroli	Nagpur division
Period I	Area effect	22.86	157.27	113.53	82.11	96.72	142.32
	Yield effect	72.60	-91.88	-33.10	20.53	5.77	-59.96
	Interaction effect	4.54	36.61	19.57	-2.64	-2.49	17.64
Period II	Yield effect	78.13	96.16	-47.47	299.97	226.10	38.40
	Yield effect	24.95	2.73	157.55	-275.86	-206.35	56.77
	Interaction effect	-3.08	1.11	-10.08	75.89	80.25	4.83
Period III	Yield effect	30.73	46.61	421.13	-21.57	596.45	19.65
	Yield effect	55.62	36.70	-593.43	133.20	-831.55	70.65
	Interaction effect	13.65	16.69	272.15	-11.63	335.10	9.70

Table-6 : Per cent Contribution of Area, Yield and their Interaction for Increasing Production of Rice

Particular		Wardha	Nagpur	Bhandara	Chandrapur	Gadchiroli	Nagpur division
Period I	Area effect	95.74	119.50	84.76	-22.57	3.10	56.10
	Yield effect	14.92	-15.18	27.82	118.28	98.24	55.14
	Interaction effect	-10.65	-4.32	-12.58	4.29	-1.33	-11.23

Period II	Yield effect	-	127.24	45.11	-63.58	979.29	201.58
	Yield effect	-	-17.33	51.11	151.92	-842.12	-91.38
	Interaction effect	-	-9.91	3.78	11.66	-37.17	-10.20
Period III	Yield effect	-	85.70	169.78	66.88	223.28	37.15
	Yield effect	-	6.50	-117.51	31.12	-113.89	70.46
	Interaction effect	-	7.80	47.73	2.00	-9.38	-7.61

Table-6 showed that in period I, the Gadchiroli district has the highest area effect i.e. 979.29. As compared to period I and period II Chandrapur district show the highest yield effect i.e. 151.92 in period II where Nagpur division as whole the period II showed the highest area effect i.e. 201.58.

6.   Conclusions

Compound growth rates of production of wheat was 4.18 per cent in Nagpur division. The area, production and productivity instability in cereals was observed in almost all districts in the state. It may be because the crop largely depends on vagaries of nature which causes heavy losses. Percent contribution of yield effect was more responsible for production of the selected cereals. Maximum instability was found in the overall period for selected cereals crops.The compound growth rate of wheat production in period I and period II was same in Nagpur division as whole. The highest coefficient of variance for area and production was found only in Bhandara district i.e. 42.39 per cent per annum and 48.62 per cent per annum respectively during period I. The Chandrapur district was recorded the lowest instability (3.25 per cent) for area under rice 3.25 in period I. During period I the highest (36.61) interaction effect was found in Nagpur district followed by Bhandara (19.57). In overall period, the area effect was positive in all district except Bhandara district and Nagpur division as whole. In all districts the area, production and productivity for wheat and rice only the cubic models are found best fitted.

7.   Implications

Provision of subsides, various facilities to the farmer on crops like wheat and rice is necessary along with Social awareness programmes by extension expert to meet the demand of cereals. Also allow the mill and other industrial corporate in input growing area to avoid loss of products. In add the technology so far generated by the State Government Institution and other agencies be transferred to the farmer by state extension agencies.

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