The Journal of Rural and Agricultural Research Volume 24 No. 1, 103-109 (2024)
Received March 2024; Acceptance June 2024

Analysing the Growth in Area, Production and Productivity of Wheat Crop in Bundelkhand Region of Uttar Pradesh

PARVAT SINGH
Research Scholar, Department of Economics, University of Lucknow, Lucknow, Uttar Pradesh, 226007, India
Email: singhparvat29@bhu.ac.in

Abstract

The present study assessed the area's growth rates, instability, wheat production, and productivity in Uttar Pradesh. Also, the relative contribution of area and productivity to change in output was estimated using decomposition analysis. The study is based on secondary data over the last 22 years, i.e., 1999-2000 to 2022-2023. The secondary data were compiled from the Directorate of Economics and Statistics, the Ministry of Agriculture and Farmers Welfares, GoI. The data has been divided into sub-periods to examine the growth and instability patterns of the area, production, and productivity of wheat and sub-periods were as follows: period I (1999-2000 to 2009-2010), period II (2010-11 to 2022-23) and overall (1999-2000 to 2022-23). The study revealed that the growth rates for Bundelkhand and Uttar Pradesh overall were positive for the area, production and productivity and were statistically significant. The Coppock's instability indices revealed that the magnitude of instability for area and production was low in the study period. The decomposition analysis revealed that the focus should be on improving productivity to meet the future demand for wheat crops.

Keywords: Growth, Instability Index, Wheat Crop, Bundelkhand, Uttar Pradesh

Introduction

Despite intense study at the national level, there are contradictory views on the impact of the green revaluation on the instability in production and productivity of Indian agriculture. While some studies (Mehra, 1981; Hazell, 1982; Ray, 1983; Roa et al., 1988) indicate that the adoption of modern technology has contributed to instability in production, others show a decline (Deshpande, 1986; Dev, 1987; Dhawan, 1987). In 1981, Mehra conducted a comparative analysis of production instability before and after introducing new farm technology. The study covered 1950 to 1965 and 1968 to 1978. The study concluded that production instability increased during the later period, and fluctuations in productivity were the primary factor contributing to this instability. Hazell (1982) conducted a study to examine the factors that contributed to the change in variation of India's total cereal production during two periods covering 1955 to 1965 and 1968 to 1978. The study found that in the II period, the simultaneous changes in the area, productivity and cropping pattern were responsible for increased instability in cereal production. The cropping pattern indicates that paddy and wheat are the most essential crops in Uttar Pradesh. Most of the area is used to cultivate food grains, of which only 13.8 per cent is covered under pulses—about 79.8 per cent of the total cropped area dedicated to the production of food grains, sugarcane, potato, mustard, groundnut, gram, pea and lentil are other important crops grown in the state (Nilachala, 2016). On the other hand, evidence from the studies, Deshpande (1986) discovered that instability decreased as growth rates increased in Maharashtra. Dev (1987) conducted

an inter-state analysis, revealing that wheat crop instability declined in most states with high growth rates. The main reason for the variability between wheat and rice is that the expansion of irrigation in rice was lower than in wheat. Rice area under irrigation increased from 37% to 43% between 1965 and 1988. agriculture and food production instability are also essential for food management (Chand & Raju, 2009).

Agriculture in the state and the region is highly vulnerable to extreme climatic shocks of drought and water crisis in the region. The study covers only wheat crops in the Bundelkhand region of Uttar Pradesh. Its specific objectives are to examine the growth of area, production, and productivity (yield) of wheat in the Bundelkhand region of Uttar Pradesh and measure the instability and contribution of area and yield to change in the output of wheat crops in the Bundelkhand region as well as Uttar Pradesh.

Materials and Methods

The present study is based on secondary data of time-series data related to the area, production, and productivity of wheat in the Bundelkhand region of Uttar Pradesh for 23 years were collected from the Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Government of India. District-wise data on wheat area, production, and productivity in Uttar Pradesh state were also collected. Compound annual growth rates (CAGRs) and coefficient of variation of area, production and yield were worked out for each district under study. A decomposition analysis of growth in wheat production in different periods was undertaken to study the area, yield, and their interaction effects.

The study covers seven districts in the Bundelkhand Region of Uttar Pradesh. The entire study period has been divided into three periods: period I (1999-2000 to 2009-10), period II (2010-11 to 2022-23), and the overall period (1999-2000 to 2022-23).

The district-wise growth rate of area, production, and productivity was computed to study the growth and patterns in area, production, and productivity in the Bundelkhand region of Uttar Pradesh over each period.

Growth Analysis

The compound annual growth rate of area, production, and productivity has been estimated using the exponential growth technique, represented by the following:

$$Y = ab^t$$

The log form of the above exponential equation is expressed as:

$$\log(Y) = \log(a) + t\log(b)$$

Y= a + bt

Where;

where Y= acreage/production/productivity of wheat crops,

t = time/year (independent variable)

a = constant/intercept

b = regression coefficient

r%= [Antilog (B) -1} *100

The significance of the estimated compound annual growth rate was tested with the help of a student's t-test.

Cuddy-Della Valle Index

Instability in area, production and productivity was estimated to examine the extent of risk in these variables using the Cuddy-Della Valle Index (Cuddy & Della Valle, 1978).

$$CDVI = CV * \sqrt{(1 - \bar{R})^2}$$

CDVI = Cuddy Della Valle Index (%), CV presents the coefficient of Variation, $\overline{R^2}$ Indicates the coefficient of Determination from a time trend regression. Instability will be low if CDVI lies between 0 to 15, medium if 15 to 30 and high if greater than 30.

Coppock's Instability Index = $Antilog\left(\sqrt{logV} - 1\right)_* 100$

$$\text{Log V} = \frac{[(\log \frac{X_t - 1}{X_t})m]^2}{N - 1}$$

X_t = area/production/productivity of wheat in the year 't'

N = number of years; *m* = mean of the difference between logs of X_{t+1}, X_t

Log V = Logarithmic variance of the series.

Decomposition Analysis

Minhas and Vaidyanath (1964) worked in the line of the decomposition analysis model used to measure the relative contribution of area and productivity to the total change in wheat production. Wheat production was decomposed into three components: area, productivity and their interaction effect.

Change in production = Area effect + Yield effect + Interaction effect.

$$P = \frac{A_0 \Delta Y \times 100}{\Delta P} + \frac{Y_0 \Delta A \times 100}{\Delta P} + \frac{\Delta Y \Delta A \times 100}{\Delta P}$$

Here, A_0 and Y_0, area, yield in the base year and A_n and Y_n are the area and yield in the current year.

ÄA, ÄY and ÄP represent changes in area, yield and production, respectively.

ÄA=change in area (A_n - A_0), ÄY=change in yield (Yn-Y_0) and ÄP= change in production

The analysis is done for two periods, i.e., 2000 to 2010, 2011 to 2023 and overall (2000 to 2023).

Results and Discussion

Uttar Pradesh is the wheat bowl of Central India. The area under wheat crop has increased from 8994 thousand hectares to 10193 thousand hectares during the period (2000-2023). Similarly, the productivity (yield) has increased from 2.81 t/ha to 3.73 t/ha during the same period. The data in Table 1 depicts wheat's area, production and productivity in Uttar Pradesh from 1999-2000 to 2022-23. It was observed that wheat production in Uttar Pradesh increased from 25253 thousand tonnes in 1999-2000 to 38070 thousand tonnes in 2022-23.

Compound annual growth rate

Table 2 presents the compound annual growth rate in the area and the production and productivity of food grains in Uttar Pradesh from 1999-2000 to 2022-23. The annual growth rate for area, production, and productivity registered a positive growth rate (-0.6 per cent, 2.13 per cent and 2.26 per cent, respectively) and was statistically significant, except the area was negative during the period I (1990 to 2000).

\

Table 1: Area, production and productivity (yield) of wheat crop in Uttar Pradesh from (1999-2000 to 2022-23)

Year	Area (Thousand ha)	Production (Thousand Tonnes)	Yield (Tonne/ha)
2000	8994	25253	2.81
2001	9239	25168	2.72
2002	9256	25498	2.75
2003	9163	23745	2.59
2004	9443	26350	2.79
2005	9373	23430	2.50
2006	9164	23574	2.57
2007	9198	25443	2.77
2008	9115	25679	2.82
2009	9513	28554	3.00
2010	9668	27518	2.85
2011	9637	30001	3.11
2012	9731	31892	3.28
2013	9734	31332	3.22
2014	9839	31493	3.20
2015	9846	20055	2.04
2016	9645	26874	2.79
2017	9885	34971	3.54
2018	9753	35646	3.65
2019	9856	38040	3.86
2020	9853	36210	3.68
2021	9851	37479	3.80
2022	10192	38057	3.73
2023	10193	38070	3.73

During Period II, the growth rates for production (0.51) and productivity (0.92) per cent were statistically insignificant, while the negative growth rate (-.41 per cent) for the area was statistically insignificant.

Instability in area, production and productivity of foodgrains

During Period I, the instability for the foodgrain was medium instability (27.09%) with respect to overall foodgrains productivity in the state was estimated over the study period (1990-22), with variations from 3.57 per cent in Period I to 14.97 per cent in period III. However, the instability index for overall area coverage under foodgrains was observed to be low in all periods, period I (2.05%), period II (2.32%), period III (1.27%) and overall period (0.32%). In similar lines, the instability index

Table 2: Growth and instability in area, production and yield of foodgrains in Uttar Pradesh

Period	CAGR (%) of Food grains			Instability Index		
	Area	Production	Yield	Area	Production	Yield
Period I(1990 to 2000)	-0.60**	2.13***	2.26***	2.05	3.32	3.57
Period II(2001 to 2010)	-0.41	0.51	0.92	2.32	6.74	5.28
Period III(2011 to 2022)	-0.15	1.87 ***	3.17**	1.27	8.93	14.97
Overall Period (1990 to 2022)	-0.60**	2.13***	-3.20***	0.32	7.83	27.09

***Significant at 1% level, **Significant at 10% significance level

Table 3: The growth (%) rate of area, production and wheat yield in Uttar Pradesh for the period 2000-10, 2011-2023 and 2000-2023

Particulars	Particular	Period I	Period II	Period overall
Bundelkhand	Area	-0.51	1.1	1.69***
	Production	-1.22	5.17**	3.70***
	Yield	-1.02	4.43**	2.05***
Uttar Pradesh	Area	0.37**	0.35***	0.46***
	Production	0.9	2.80**	2.09***
	Yield	0.72	2.73**	2.22***

***Significant at 1% level, **Significant at 5%, *Significant at 10% level of significance.

of production was noted to be low (3.32%) for the period I (1990-00).

Growth Trends in Area, Production and Productivity of Wheat Crop

The compound annual growth rates of area, production and productivity in Uttar Pradesh for the two periods and the overall study period have been examined and presented. Analysis results revealed the compound annual growth rates of area, production and productivity variation during the study period.

Examining the Bundelkhand region, the period I growth rates for the area, production, and wheat yield were -0.51, -1.22, and -1.02, respectively and statistically not significant in three components. In period II, the production and yield were positive and significant at a 5% significance level. In the overall period growth rate for the area, production and productivity of wheat in Bundelkhand were positive in all three components and statistically significant at a 1 per cent significance level.

In Uttar Pradesh, the growth rate was positive in all periods and statistically significant except for period I. Overall, the highest growth rate was recorded for yield (2.22***) and the lowest in the area (0.46***), and it was statistically significant at the 1 per cent significance level (Table 3). However, over the entire study period. Bundelkhand and Uttar Pradesh maintain a positive growth rate of 3.70 and 2.09 per cent in production associated with 2.05 and 2.22 per cent in productivity, respectively,

Instability Analysis

Instability in wheat area, production and yield in Uttar Pradesh for the overall period (1999-2000 to 2022-23) and sub-periods is presented in Table). The present study employed the Cuddy Della Valle Index and Coppock's index.

Cuddy-Della Valle Instability Index

During Period I, Medium Instability was observed in production, low area, and productivity in the Bundelkhand region—low instability in all three components in Uttar Pradesh.

During the overall Period, Uttar Pradesh registered low instability in the area, production and productivity. Medium instability was registered in production and productivity except in the area.

Coppock's Instability Index

During Period I, the Bundelkhand region observed low instability for area, production, and productivity (40.78, 45.76, and 42.22, respectively). A similar pattern was observed in the state (37.19, 53.27, and 47.82 per cent). During Period II, the Bundelkhand region registered the highest production instability (51.30 per cent) and low instability for area and productivity. In the state, all three components were observed to have low instability (Table 4).

Over the entire study period, Bundelkhand had low instability in the area (43.19), low productivity (47.82), and high production (53.27).

In Uttar Pradesh, the area, production, and productivity under the wheat crop corresponding to Coppock's instability index value were estimated to be 38.12, 44.37, and 43. 28 per cent, respectively, during the overall period.

Decomposition Analysis

Decomposition analysis finds the area, production, and interaction effects on the growth of wheat production in Uttar Pradesh for the overall period (1999-2000 to 2022-23).

Examining the results of area, productivity, and their relative contribution to production in Bundelkhand, it was found that, in the overall period, Bundelkhand's area effect was highly responsible for production variability. The study shows the yield effect (1279.53 and 218.05, respectively) in the Bundelkhand during Periods I and II (Table 5).

In the overall period, the area effect is higher than the yield effect in the Bundelkhand region of Uttar Pradesh; the yield effect is less compared to period I. The interaction effect is almost higher than in Periods I and II.

In Uttar Pradesh, the highest area effect was observed during Period II (74.04 per cent) with a yield and interaction effect of 21.45 and 4.28 per cent, respectively. While during the overall period, yield effect, area effect and interaction effect were recorded at 26.29, 64.56 and, 8.61 per cent, respectively.

Sources of Low Growth Rates

The input use patterns and other factors are presented in Table 6; the results of the area under cultivation, including net sown area and gross sown area, have marginally changed after 2001. However, if we compare the data between 1990 and 2020, then the gross sown area was 17399 thousand

Table 4: Instability in area, production and yield of wheat in Uttar Pradesh

(Per cent)

Particulars	Periods	Area			Production			Yield		
		CV	CDVI	CII	CV	CDVI	CII	CV	CDVI	CII
Bundelkhand	I	9.34	9.76	40.78	18.75	19.56	45.76	12.72	13.04	42.22
	II	9.18	8.57	40.55	28.68	22.1	51.30	25.37	20.08	49.6
	overall	15.47	10.11	43.19	36.4	24.27	53.27	25.35	20.03	47.82
Uttar Pradesh	I	2.11	1.80	37.57	6.26	5.74	39.14	5.21	5.13	38.77
	II	1.76	1.16	37.44	16.05	12.65	44.15	15.19	12.72	43.81
	overall	3.53	1.46	38.12	18.76	11.2	44.37	15.99	10.87	43.29

Table 5: Decomposition analysis for area, yield and Interaction effect

Particulars	Period	Area Effect	Yield Effect	Interaction Effect
Bundelkhand	I	-1246	1279.5	-54.41
	II	413.55	218.05	117.33
	Overall	339.19	244	125.9
Uttar Pradesh	I	15.89	83.64	1.19
	II	74.04	21.45	4.28
	Overall	64.56	26.29	8.61

Table 6: Changing Patterns of Input Use and Other Factors in Uttar Pradesh

Year	Net sown area('000 ha)	Gross sown area('000 ha)	Gross Irrigated area ('000 ha)	Net irrigated area ('000 ha)	Cropping intensity (%)	Fertiliser use (NPK) (kg/ha)
1990-91	17299	25480	14771	10542	147.3	88.7
1995-96	17399	25793	16972	11675	148.2	102.0
2000-01	16825	25304	17690	12401	150.4	115.3
2005-06	16633	25307	18970	13075	152.2	140.4
2009-10	16589	25440	19354	13383	153.4	171.0
2015-16	16469	26203	20882	14231	159.1	155.5
2020-21	16368	27109	22994	14334	165.6	189.0

Source: compiled from various issues of Handbook of Statistics on India States, RBI

hectares in 1980, which, after ups and downs in between, decreased to 16368 thousand hectares in 2020-21, depicting an increase of 6.39 per cent after nearly three decades. In the case of the net irrigated area, there was an increasing trend, and the percentage increase was 35.97 per cent. The ratio of gross irrigated area to gross sown area presents a depressing picture. It was 57.9 per cent in 1990 and increased to 69.9 per cent in 2000.

However, again, it increased to 76.0 per cent in 2010 and reached 84.8 per cent. The area under irrigation can be expanded by more than 3 per cent per annum in Madhya Pradesh, Maharashtra, Himachal Pradesh and West Bengal. The Scope for Irrigation Expansion in Uttar Pradesh was 1.67 per cent (Chand et al., 2005). However, compared with other states like Bihar, Madhya Pradesh, West Bengal, Tamil Nadu, Andhra Pradesh and Assam, they have a higher proportion of cultivated area under assured irrigated (Bhalla & Singh, 2009).

Fertiliser, measured as the amount of nitrogen, phosphorous, and potassium used, is regarded as one of the yield-augmenting technologies; results show its use persistently increased from 1990 but declined to 9.06 from 2010 to 2015. A comparison of fertiliser use in other Indian states shows that fertiliser use is as low as 28kg/ha in Assam and as high as 328kg/ha in the net sown area in Punjab. Similarly, fertiliser use is below 40kg/ha in Rajasthan and Madhya Pradesh and 55kg/ha in Orissa. Increasing fertiliser use is a significant option for increasing agriculture output in most states (Chand et al., 2007).

Conclusion

The study showed that the growth rate for area, production and productivity of wheat registered to be positive and statistically significant for the area, production and yield In the Bundelkhand region and Uttar Pradesh. The Coppock's indices revealed the degree of instability for the area, and production and productivity were estimated to be 43.03, 53,27 and 47.82 per cent in the Bundelkhand region, respectively. A similar pattern was observed for area, production and productivity at the state level. In the case of decomposition analysis, the primary reason for variability during the study period was the area and yield effect. The results revealed that the area, yield, and interaction effects were recorded at 64.56, 26.29, and 8.61 per cent, respectively. It was found that the area under wheat cultivation is limited, improving the productivity to meet future demand for rice in Uttar Pradesh. It has been achieved by using the new high-yielding varieties and crop management techniques.

References

Bhalla, G. S.; and Singh, G. (2009). Economic liberalisation and Indian agriculture: a statewise analysis. *Economic and Political Weekly*, 34-44.

Chand, R. (2005). Exploring possibilities of achieving four percent growth rate in Indian agriculture. NCAP-Working Paper (01)/2005, National Centre for Agricultural Economics and Policy Research, New Delhi.

Chand, R. and Raju, S.S. (2009). Instability in Indian Agriculture during different phases of technology and policy, Indian J. Agric. Econ. 64, 187-207.

Chand, R.; Raju, S. S. and Pandey, L. M. (2007). Growth crisis in agriculture: Severity and options at national and state levels. *Economic and Political Weekly*, 2528-2533.

Cuddy, J. D. A. and Della, P. A. (1978). Measuring the instability of time series data. *Oxford Bulletin of Econ. Stat* (40). 79–85.

Deshpande, R. S. (1986). Drought prone areas in Maharashtra economy. *Current Economic Issues in India's Development, Marathwada Univ., Aurangabad*.

Dev, Mahendra S. (1987). Wheather, Growth and Instability: An interstate analysis of foodgrain production in India. Presented at National Symposium on Growth and Instability in Agriculture held at IASRI, New Delhi.

Dhawan, B.D. (1987). "How stable is Indian irrigated agriculture? Presented at National Symposium on Growth and Instability in Agriculture" held at IASRI, New Delhi.

Hazell, P.B.R. (1982). "Instability in Indian foodgrain production", Res. Rep. 30, IFPRI, Washington, D.C.

Mahendradev, S. (1987). Growth and instability in foodgrains production: an inter-state analysis. *Economic and Political Weekly*, A82-A92.

Mehra, S. (1981). Instability in Indian agriculture in the context of the new technology, 25, IFPRI, Washington, D.C.

Minhas, B. S. and Vaidyanath, A. (1964). Growth of crop output in India 1951-54 to 1956-61: An analysis by component elements. Journal of Indian Society of Agri Stat (17).230-252.

Nilachala, A.; Sabita, P. and Arabinda, A. (2016). Public Expenditure towards Agriculture with Specific Reference to Smallholder Agriculture and Women Farmers in Uttar Pradesh - A Study. OXFAM, India.

Rao, C. H.; Ray, S. K. and Subbarao, K. (1988). *Unstable agriculture and droughts: implications for policy* (No. 47, pp. vii+-192pp).

Ray, S. K. (1983). An Empirical Investigation on the Nature and Causes for Growth and Instability in Indian Agriculture: 1950-80. *Indian Journal of Agricultural Economics*, *38*(4), 459-474.