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Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 13
Issue: 06

Res. Jr. of Agril. Sci. (2022) 13: 1941–1945

CARAS

Res. Jr. of Agril. Sci. (Nov-Dec 2022)
13(6): 1941–1945

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

www.rjas.org

Full Length Research Article

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Received: 13 Oct 2022 | Revised accepted: 05 Dec 2022 | Published online: 31 Dec 2022
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A B S T R A C T

We have estimated the growth rates of wheat production across the 16 major wheat-producing states in India during 1980- 81 to 2015-16. The secondary data on area, production and productivity of wheat are collected from the Ministry of Agriculture, Reserve Bank of India, EPWRF, Agricultural Statistical Glance and different issues of Statistical Abstract of India. We have estimated the growth rates of the non-stationary series related to the wheat crop by estimating the stochastic trend (i.e., TSP or DSP) method. The growth rates of stationary series, on the other, on area, production and productivity of wheat crop have been estimated by the deterministic trend using 'kinked exponential' trend equation during the study period from 1980-81 to 2015-16. Apart from estimating the whole period's growth rates, this study also deals with the measurement of sub-period growth rates, dividing the whole period into four sub-periods based on endogenous structural breaks (supported by the Chow test) of the series concerned on area, production and productivity. The production growth rates in wheat are significantly positive in a few states, but most of the states in the country experienced either negative or no growth in this production over the study period. In the case of sub-period growth rates, it is also observed that the production growth rates in most of the cases (across states) had been either significantly negative or insignificant in the fourth sub-period as compared to the other sub-periods in the country. The profitability of wheat cultivation decreases in most of the selected states in the country.

Key words: Growth, Exponential trend, Kinked exponential growth, Bai-perron test, Non-stationary, Profitability

Before Independence, the British government destroyed all the handicrafts and cottage industries in the country. As a result, many people lost their jobs during this period [1]. The condition of the agricultural sector was also precarious in the country during this period. After the Second World War, the country faced a great famine, food crisis and unemployment problem [2]. Further, the British government changed the cropping pattern from food crops to commercial crops to improve its revenue. This resulted in food scarcity in the country during this period [3]. After Independence, the Indian government took some policies to overcome the worst situations in agriculture. The public distribution system was implemented in 1947 to overcome the food crisis in the country. The public distribution system also contributed to the improvement of economic conditions of the Indian farmers because to run PDS the government purchased a huge amount of foodgrains from the farmers directly each year at a minimum support price. The government started a five-year planning system from 1951-52 for the improvement of the agricultural sector in general and foodgrains production in particular [4]. The country has faced an acute food shortage during this period. To overcome this problem the government adopted the first plan from 1951 to 1956. The main aim of the plan was to develop the agriculture for the foodgrains production in the country. The government invested 31 percent of the total plan's outlet for agricultural development in the first five-year plan. The first five-year plan was formulated based on the Harrod-Domar model. The model represents that investment is the key indicator for economic development [5]. During this period, the government took many types of irrigational polices and established the three largest dams, namely, Bhakra Nangal, Hirakud and Nagarjuna Sagar in the country with the recommendation of the planning commission. In this time period the government also took structural reforms policy, i.e., land reforms for betterment of agricultural sector in all over the country. The main objective of the policy was the abolition of intermediaries; tenancy reforms and consolidation of agricultural land in the country, which resulted into the rise in actual agricultural production exceeding the targeted level in the first five-year plan in the country [6]. The annual growth rate of agricultural crop production was 2.6 percent and the production growth rates of two main crops, namely rice and wheat played a significant role during this time period in the country [7]. The sufficiency of foodgrains did not exist for a long time in the country because the population pressure was continuously rising during this time period. Nearly 254 million

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population increased in 1960-61 compared to the previous decade [8]. The exponential growth rate of the population was 2.2 percent in 1965-66 in the country [9]. The Malthusian population theory was probably in operation during this time period, which resulted into the shortage of foodgrains. The government of India also faced some unforeseen situations during this time period. The government faced two important wars, one is Indo-China War (1962) and the other is the India-Pakistan was (1965), as a result of which a huge amount of money was diverted from the civilian development sector to military sector during this time period. The country also faced a great drought in the mid-1960s. The food crisis problem in the country due to the drought situations was so severe that the county was forced to import a huge amount of foodgrains from USA and foreign countries (like, PL-480 scheme) to meet the domestic demand for food. The actual growth rate achieved by the country was half of its targeted growth rate in the third five-year plan period (1961-66). As a result, the government of India suspended the five-year planning system and took three successive annual plans to overcome this worst situation. The government has taken several policies and reduce the food insecurity during this period. One of the most important policies is the green revolution. This revolution of agriculture might also be termed as the seed-water-fertilizer revolution. The agricultural production of foodgrains increased by using modern technology, like High-Yielding Varieties of Seed, Fertilizer, Pesticides, Agricultural Machinery and Modern Irrigation Facility in the country [10]. Here, we want to observe the impact of the green revolution on the growth patterns of wheat production in the country. Because wheat is one of the main food crops in the country.

From the past studies we know that before late 1960s India was a food-deficient country. Since 1967-68 the government of India undertook the new strategy in agriculture known as the green revolution to resolve the food deficit problem in the country. Further, since the early 1980s different institutional reforms in agriculture have been undertaken in many parts of the country. As a result of all these policies, India became self-sufficient in foodgrain production. Moreover, India has become a net exporter of foodgrains since 1995. The foodgrains production has increased from 94.9 million tonnes in 1971 to 252.22 million tonnes (Ministry of Agriculture) in 2015-16.

The impact of the green revolution on foodgrains production, specifically wheat production for selected states in India needs to be investigated afresh, along with the examination of their nature and pattern. Again, most of the earlier studies in this field suffer from some methodological weaknesses. The notable contributors in the field of measuring the growth of crop output in different countries in different periods used mainly different deterministic trend equations. It is now recognized that the conventional econometric approach of curve fitting may not often be adequate for trend analysis. It necessitates the examination of the performance of agriculture by using rigorous trend analysis as advocated in time series econometrics. The present study is a modest attempt to cover up most of these identified research gaps.

MATERIALS AND METHODS

We have selected the study period from 1980-81 to 2015-16 for estimating the state-wise agricultural growth performance of area, production and productivity of wheat in India. The state-wise time series secondary level data on the area (in thousand hectors), production (in thousand tonnes), and productivity (in quintal per hector) for wheat crop are collected from different issues of Statistical Abstract, EPWRF, different publications of Agricultural Statistical Glance, Ministry of Agriculture and the different publications of Reserve Bank of India for estimation of the agricultural growth pattern of wheat across the states in India during 1980-81 to 2015-16.

We have used the Phillips-Perron test for checking the unit root problem of the different series on area, production and productivity of wheat across the states in the country. The structural breaks of all the non-stationary and stationary series on area, production and productivity of wheat have also been checked by using the Bai-Perron test [11].

We have expanded the Zivot and Andrews test actually to take a maximum of 3 endogenous break points in the recent version of the Augmented Dicky-Fuller test for the measurement of the growth rates of non-stationary series. The regression equation is then given by:

$$\Delta Y_t = a + \beta t + \theta_1 DU1_t + \gamma_1 DT1_t + \theta_2 DU2_t + \gamma_2 DT2_t + \theta_3 DU3_t + \gamma_3 DT3_t + \rho Y_{t-1} + \sum_i^k \mathrm{Q_i}\, \Delta \mathrm{Y_{t-i}} + \epsilon_t \ldots\ldots\ldots\ldots \quad \text{(I)}$$

We have estimated the growth rates of non-stationary series on area, production and productivity for wheat by using this equation. Here $DU1_t$, $DU2_t$ and $DU3_t$ are the sub-period-wise dummy variables that represent the nature of the level of growth (i.e., either positive or negative) in the respective sub-periods. Here $DT1_t$, $DT2_t$ and $DT3_t$ are also the sub-period-wise dummy variables representing respective slopes or trend growth rates of the underlying series. Thus,

$$DUi_t = \begin{cases} 0 \ldots\ldots when\ t \leq TBi \\ 1 \ldots\ldots when\ \ t > TBi \end{cases}$$

$$DTi_t = \begin{cases} 0 \ldots\ldots when\ t \leq TBi \\ t - TBi\ when\ \ t > TBi \\ (\ sequentially\ like, 1,2,3, \ldots\ldots\ldots\ldots \end{cases}$$

where i = 1,2,3.

After careful consideration of these econometric criteria, we have selected the exponential trend equation for the measurement of crop-wise agricultural growth. The compound growth rates of area, production and productivity are measured by using an exponential trend equation and sub-period growth rates have been estimated by a kinked exponential trend equation.

We have taken the Cochrane-Orkutt two-step procedure for removing the autocorrelation problem in the situation of its presence. We have also estimated the profitability of wheat cultivation. Profit = total value of output (both main product and by-product) – total cost of C2.

RESULTS AND DISCUSSION

In (Table 3-4), we present the state-wise whole period production growth rate of wheat which is significantly medium in Gujarat with value 4.0% followed by Rajasthan (3.4%) and Haryana (3.1%), while Maharashtra (1.9%), Karnataka (1.0%) and India (1.8%) experience significantly low growth in wheat production. On the other hand, Assam registered significantly negative growth in wheat production with a value of -3.2%. The production growth rates of wheat increased in the states mainly due to productivity growth. The rest of the other states had insignificant results in the country [12].

In the case of the wheat crop, we see (Table 3) that the production growth rate in Haryana continuously decreased during all the sub-periods in the country. The production growth

rates of wheat increased in Gujarat and Karnataka, while it decreased in Rajasthan in the third sub-period compared to the second sub-period. Maharashtra is found to have a significantly medium growth (3.8%), while Andhra Pradesh (2.9%) registered significantly low growth in wheat production in the third sub-period. The wheat production growth rate in Bihar significantly decreased from 4.3 percent to 2.8 percent in the fourth sub-period compared to the second sub-period. Assam is the only state whose production growth rate of wheat is found to be significantly negative in all the sub-periods. The rest of the states have mainly insignificant growth in wheat production. We also observe that the positive production growth rate in wheat took place mainly due to its productivity growth in all the states during all the sub-periods in the country, while the negative area growth is the main responsible factor for the negative production growth of wheat [13].

From (Table 4) we see that the production growth (i.e., slope) of wheat significantly increased but the level of wheat production played its opposite role (i.e., decreased) in Orissa (1991-92) and Madhya Pradesh (2000-01). Again, in Orissa a significantly negative growth with a significantly negative level in wheat production occurred from 2000-01 onwards. The (Table 4) also indicates that there was no change in the production growth rates of wheat in Punjab (2002-03) and West Bengal (2004-05), but the level of wheat production in those two states is found to have significantly decreased [14].

Table 1 Estimated results of Phillips Perron unit root test for wheat in India during 1980-81 to 2015-16

	State	Production
North Indian States	Uttar Pradesh	-3.021 (0.140)
	Punjab	-3.175 (0.105)
	Haryana	-5.824*** (0.000)
South Indian States	Andhra Pradesh	-3.919** (0.021)
	Kerala	-
	Karnataka	-3.603** (0.044)
	Tamil Nadu	-
East Indian States	Assam	-5.603*** (0.000)
	Bihar	-4.753*** (0.002)
	Orissa	-1.234 (0.886)
	West Bengal	-3.252 (0.091)
West Indian States	Rajasthan	-3.797** (0.028)
	Gujarat	-4.361*** (0.007)
	Maharashtra	-6.407*** (0.000)
	Madhya Pradesh	-2.110 (0.522)
India		-3.772** (0.030)

***Significant at 1% level, **Significant at 5% level, Probability values are within parentheses

Table 2 Estimated results of Bai-Perron endogenous structural break test for wheat in India during 1980-81 to 2015-16

	States	Production			
		TB_1	TB_2	TB_3	F-statistic
North Indian States	Uttar Pradesh	1989-90	1997-98	2004-05	80.27
	Punjab	1987-88	1995-96	2002-03	122.96
	Haryana	1986-87	1994-95	2003-04	8.36
South Indian States	Andhra Pradesh	1986-87	1993-94	2011-12	21.64
	Kerala	-	-	-	
	Karnataka	1987-88	2001-02	2011-12	77.08
	Tamil Nadu	-	-	-	-
East Indian States	Assam	1992-93	2002-03	2010-11	96.56
	Bihar	1986-87	1997-98	2003-04	22.45
	Orissa	1992-93	2002-03	2010-11	39.61
	West Bengal	1985-86	1990-91	2004-05	186.0
West Indian States	Rajasthan	1986-87	2000-01	2011-12	73.13
	Gujarat	1985-86	1999-00	2005-06	5.97
	Maharashtra	1985-86	1991-92	2011-12	21.92
	Madhya Pradesh	1986-87	2000-01	2011-12	43.47
India		1999-00	2006-07	2011-12	9.21

Profitability of wheat production in India

Recently, the cost of cultivation of the wheat crop has increased day by day due to the increase in input costs, which has resulted in the profitability of wheat production decreasing continuously in the country. From the estimated results, the study observed that the profitability of wheat production is highest in Haryana and Punjab in the country. The profitability of Haryana is Rs. 39646.7 per hectare, while the profitability of wheat cultivation in Punjab is Rs. 30339.7 per hectare during 2020-21 in the country. The farmers of Bihar (Rs. 4460.4 / per hectare), Gujarat (Rs. 15010.8 / per hectare), Madhya Pradesh (Rs. 23569.8 / per hectare), Rajasthan (Rs. 11108 / per hectare) and Uttar Pradesh (Rs. 8854.96 / per hectare) also have faced a positive profit in 2020-21 in the country. But in the case of Maharashtra and West Bengal, the study observed that the farmers were facing a negative profit in the country. The farmers of Maharashtra had faced a positive profit during 2010-11 to 2013-14, but in the recent few years, the farmers of the state were facing negative profit. Recently, the farmers of the state lost Rs 7106.6 per hectare of wheat cultivation. In the case of West Bengal, the study observed that the farmers of the state were facing negative profits continuously. The loss of wheat

cultivation increased from Rs. 5672.3 per hectare in 2010-11 to Rs. 10778 per hectare in 2020-21 in the state. These estimated results clearly state that the cultivation of wheat is not a profitable business in the recent period in the country [15-16].

Table 3 State wise estimated sub-period growth rates of wheat production in India, 1980-81 to 2015-16

State	TB_1	TB_2	TB_3	Whole period	1st Sub period	2nd sub-period	3rd sub-period	4th sub-period	D.W+	R^2
Haryana	1986-87	1994-95	2003-04	3.1*** (27.289)	6.1*** (5.774)	4.7*** (8.041)	2.7*** (5.749)	2.0*** (5.577)	1.774	0.975
Andhra Pradesh	1986-87	1993-94	2011-12	-0.3 (-0.481)	-6.9 (-1.389)	-2.6 (-0.901)	2.9*** (2.843)	-19.8*** (-3.576)	2.063	0.368
Karnataka	1987-88	2001-02	2011-12	1.0** (2.687)	-7.9*** (-2.091)	2.4** (2.404)	2.6* (1.725)	-6.3 (-1.406)	1.825	0.425
Assam	1992-93	2002-03	2010-11	-3.2*** (-13.490)	-1.4* (-1.779)	-2.2** (-2.686)	-4.9*** (-4.359)	-7.6*** (-3.661)	2.236	0.905
Bihar	1986-87	1997-98	2003-04	0.9 (1.055)	1.8 (0.641)	4.3*** (3.637)	-4.6** (2.318)	2.8** (2.569)	2.003	0.571
Rajasthan	1986-87	2000-01	-	3.4*** (14.226)	3.9 (1.609)	3.9**** (5.867)	2.7*** (4.168)	-	1.820	0.929
Gujarat	1988-89	2003-04	-	4.0*** (6.091)	-2.6** (-2.248)	4.2*** (3.437)	7.1*** (2.762)	-	2.017	0.784
Maharashtra	1985-86	1991-92	2011-12	1.9*** (4.324)	-7.6 (-1.413)	1.4 (0.482)	3.8*** (5.141)	-13.8*** (-3.046)	1.778	0.585
India	1999-00	2011-12	-	1.8*** (5.886)	1.5*** (3.509)	-0.7*** (-3.167)	-3.1 (-1.668)	-	1.799	0.966

***Significant at 1% level, **Significant at 5% level. T-values are within parentheses

Table 4 State-wise estimated growth rates of wheat production for different break points in India, 1980-81 to 2015-16

State	Constant	Bt	θ_1	γ_1	θ_2	γ_2	θ_3	γ_3
Uttar Pradesh	-0.370	0.057	-0.135	-0.049	-0.050	-0.007	0.013	-0.006
	(-1.251)	(1.542)	(-1.612)	(-1.279)	(-0.684)	(-0.422)	(0.185)	(-0.386)
Punjab	0.585	-0.064	-0.059	0.063	-0.068	0.014	-0.106*	-0.010
	(1.202)	(-0.857)	(-0.869	(0.845)	(-1.193)	(1.019)	(-1.881)	(-0.929)
Orissa	-0.266	-0.006	-2.044***	0.332***	-1.244***	-0.272***	-0.629*	-0.172**
	(-0.577)	(-0.118)	(-6.831)	(4.986)	(-4.375)	(-4.831)	(-1.981)	(-2.189)
West Bengal	-0.055	0.002	-0.160	-0.004	0.101	0.008	-0.192*	0.011
	(-0.310)	(0.461)	(-1.326)	(-0.070)	(0.934)	(0.147)	(-1.934)	(0.993)
Madhya Pradesh	0.188	0.002	-0.060	0.007	-0.598***	0.052**	0.211	-0.059
	(1.099)	(0.420)	(-0.312)	(0.591)	(-3.861)	(2.625)	(1.009)	(-1.004)

***Significant at 1% level, **Significant at 5% level. T-values are within parentheses

Table 5 Hectare-wise profitability in wheat cultivation

Year	2010-11	2013-14	2016-17	2020-21
Bihar	7858.93	17505.2	13601.5	4460.41
Gujarat	18555.9	20607.9	20330.9	15010.8
Haryana	20613.3	20648.2	24737.3	39646.7
Madhya Pradesh	14196.1	16624.4	23975.8	23569.8
Maharashtra	4986.19	2831.58	-6231.3	-7106.1
Punjab	14728.6	24462	28467	30339.7
Rajasthan	20870.5	24385.5	22951.6	11108
Uttar Pradesh	11453.6	12877.9	14906.2	8854.96
West Bengal	-5672.3	-2825.2	-17151	-10778

CONCLUSION

We observe from the analysis that the production growth rates in wheat are significantly positive in a few states, but most of the states in the country experienced either negative or no growth in this production over the study period. In the case of sub-period growth rates, it is also observed that the production growth rates in most of the cases (across states) had been either significantly negative or insignificant in the latest fourth sub-period as compared to the other past sub-periods. The growth rates of area in wheat production for most of the states remained either negative or constant over time, while productivity growth rates were significantly positive for the states where positive production growth occurred. The profitability of wheat cultivation also decreases in most of the selected states in the country. From this scenario, we may conclude that the farmers probably changed their cropping pattern from traditional wheat crops to other high-value crops or horticultural crops in the country. It can further be concluded that the farmers in the country are presently behaving rationally.

LITERATURE CITED

1. Kundu DK. 2017. Origin and development of cottage industries in India: A study in pre-independence era. *International Journal of Research in Social Sciences* 7(12): 2249-2496.
2. Trentmann F. 2006. Coping with shortage: the problem of food security and global visions of coordination, C. 1890s–1950. *In*: *Food and conflict in Europe in the age of the two World Wars*. London: Palgrave Macmillan UK. pp 13-48.
3. Angus A, Burgess PJ, Morris J, Lingard J. 2009. Agriculture and land use: Demand for and supply of agricultural commodities, characteristics of the farming and food industries, and implications for land use in the UK. *Land Use Policy* 26: S230-S242.
4. Frankel FR. 1965. The politics of planning: Ideology and agricultural development policy in India. 1951-1965. *Doctoral Dissertation*, The University of Chicago.
5. Yan C. 2010. Study on optimum scale of China's Outward direct investment. *In*: *The 2nd International Conference on Information Science and Engineering*. pp 626-631.
6. Dandekar VM. 1996. *The Indian Economy, 1947-1992*. Sage Publications, New Delhi. pp 405. https://journals.sagepub.com/doi/10.1177/097172189600100215.
7. Tripathi A, Prasad AR. 2009. Agricultural development in India since independence: A study on progress, performance and determinants. *Journal of Emerging Knowledge on Emerging Markets* 1(1): 63-92.
8. Goli S, Arokiasamy P. 2013. Demographic transition in India: An evolutionary interpretation of population and health trends using change point analysis. *Plos One* 8(10): e76404.
9. James KS, Goli S. 2016. Demographic changes in India: Is the country prepared for the challenge. *Towson University Journal of International Affairs* 23(1): 169.
10. Varshney A. 1989. Ideas, interest and institutions in policy change: Transformation of India's agricultural strategy in the mid-1960s. *Policy Sciences* 22(3): 289-323.
11. Bai J, Perron P. 2003. Computation and analysis of multiple structural change models. *Journal of Applied Econometrics* 18(1): 1-22.
12. Rao BB, Chowdary PS, Sandeep VM, Pramod VP, Rao VUM. 2015. Spatial analysis of the sensitivity of wheat yields to temperature in India. *Agricultural and Forest Meteorology* 200: 192-202.
13. Nagarajan S, Jagadish SVK, Prasad ASH, Thomar AK, Anand A, Pal M, Agarwal PK. 2010. Local climate affects growth, yield and grain quality of aromatic and non-aromatic rice in northwestern India. *Agriculture, Ecosystems and Environment* 138(3/4): 274-281.
14. Mallika DV, Mageshwari J. 2025. Analysis of agricultural growth in India since the green revolution. *Journal of Social Science and Humanities* 7(1): 104-107.
15. Sahu A, Nahatkar S, Vani GK, Kolar P. 2021. Study on profitability of wheat in major wheat producing states of India. *Asian Journal of Agricultural Extension, Economics and Sociology* 39(7): 1-7.
16. Sahu A, Kolar P, Nahatkar S, Vani GK. 2021. Cost and profitability of wheat in the major wheat producing states of India. *Indian Journal of Economics and Development* 17(4): 786-796.