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Growth and Instability in Food Grains Production in West Bengal: A District Level Study

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A B S T R A C T

We have examined the growth pattern and stability of total food grains production for different districts in West Bengal during 1990-91 to 2014-15. Here annual compound growth rates have been measured by fitting exponential trend equations and sub-period growth rates have been estimated by kinked exponential trend equation. The production variability of food grains has been estimated by using Cuddy-Della Valle index. The secondary data on area, production and productivity are collected from the Ministry of Agriculture, different statistical district handbook and different issues of Statistical Abstract of West Bengal. The production growth rate of total food grains is significantly positive in all the districts with low value except Bankura, Howrah and Nadia in the state over the study period. The production growth rates of total food grains significantly decreased in second sub-period compared to the first sub-period in all the districts as well as West Bengal as a whole. The production instabilities of food grains are found to be medium in all the districts except Howrah, Darjeeling, Purulia, Bankura, Mursidabad and West Bengal as a whole.

***Key words*:** Growth, Instability, Kinked equation, Exponential trend equation, Cuddy-Della Valle index

The economic condition of West Bengal mainly depends on agriculture and its allied activities. Nearly 60 percent of the population of the state is engaged in this sector. Agriculture did not play a significant role in the economy prior to independence because the British government destroyed agriculture-based industries, such as handicrafts and cottage and small-scale industries, as a result of the colonial exploitation system [1]. Following independence, the Indian government implemented a five-year planning system and adopted a variety of policies to promote the development of Indian agriculture. The green revolution of agriculture in India began in the late 1960s, with various technological developments like the introduction of high-yielding variety seeds, chemical fertilizers, pesticides, new irrigation sources, agricultural machinery, and so on, all of which resulted in significant increases in agricultural production and productivity in the country as well as in the state [2]. West Bengal is an important food grains producing state in the country. The total reporting land area of the state is 327.8 million hectares. The area of food grains cultivation is 6275.8 thousand hectors and the production of food grains is 17763.2 thousand tonnes in this state in 2014-15 (Data are collected from Statistical Abstract). Many types of food crops like, Rice, Wheat, Maize, Gram, Tur, Ragi, Kesari etc. are grown here. Rice is the main crop of the state. Recently, many horticultural crops and oilseeds are also grown in the state [3]. But in recent years the agricultural situation in the state is not very well. In recent time a sizeable number of cultivators has attempted suicide due to probably their huge unpaid debt burden as alleged by the opposition parties and media. Further, the massive rise in prices of agricultural inputs coupled with more or less constancy of prices of agriculture outputs.

After the liberalization period i.e., 1991-92, the economy of the country was open to the global market. Foreign direct investment and foreign portfolio investment were entree in the Indian agricultural market which resulted in the infrastructural development has been increasing for the production of commercial and horticultural crops but the small and marginal food grains producers have been deprived continuously due to FDI inflow in the agricultural market in the country [4]. On the other side, the agricultural input producers export a huge amount of chemical fertilizer and pesticides to the world market due to the openness of the market. The price of agricultural inputs has been continuously rising after the liberalization period but the price of agricultural commodities slightly increased or remains constant. Further, the yield growth rates of traditional food crops have saturated in the current time period in the state. This resulted that the income and profitability of the agricultural farmers have been decreasing continuously [5].

In the research study, we want to examine the district-wise growth rates of food grains production in West Bengal and also to examine whether the production growth rates are caused by a change in acreage or change in yield. Further, we want to also find out whether the instability of food grains production decreases or not over the district in the state.

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MATERIALS AND METHODS

This research study mainly depends on secondary time series data. We have taken the study period from 1990-91 to 2014-15 for our research study. Further, we have divided the study period into two sub-periods, viz. early liberalization period (1990-91 to 2002-03) and matured period liberalization (2003-04 to 2014-15) and the cutoff point for the two sub-periods is 2003. We have selected 16 major districts in the state for our research study. The district-wise data on acreage (in thousands of hectors), production (in thousands of tones), and yield (in kg per hector) for total food grains have been collected from different issues of Statistical Abstract, District Statistical Handbook and the different governmental publications of West Bengal during 1990-91 to 2014-15.

Firstly, we have used the exponential trend equation for estimation of whole period growth rates of area, production and productivity of total food grains for different districts in the states.

$$Yt = AB^t U_t \quad \ldots\ldots\ldots\ldots (1)$$

With natural logarithmic transformation this equation turns into its linear form as follows: $lnY_t = lnA + (lnB)t + lnU_t$

i.e., $y_t = a + bt + u_t$ …… (2)

The log transformation is representing by the small letters. Here compound annual growth rate is measured by 100 × b.

Further, we have also selected the kinked exponential trend equation for estimation of sub-period growth rates on area, production and yield of total food grains, Boyce [6]. The kinked exponential trend equation in our research study has been used for breaking the time series data into two sub-periods having only a single kink.

$$\ln Y_t = a + b_1(D_1 t + D_2 K) + b_2(D_2 t - D_2 K) + u_t \quad \ldots\ldots\ldots (3)$$

where a is the positive intercept term. D_1 and D_2 are the dummy variables. $D_j = 1$ for j^{th} sub-period and $D_j=0$ sub-periods other than j^{th}, where j= 1,2. b_1 and b_2 are the parameters. K is the single break point.

We have used Cochrane-Orkut two steps procedure for correcting it using either first-order or second-order autoregressive scheme.

The instability of food grains area, production and productivity is measured by using Cuddy–Della Valle index.

$$\text{C.D.I} = \text{C.V}\sqrt{1 - R^2} \ldots\ldots\ldots\ldots (4)$$

Where C.V = coefficient of variation and R^2 is the coefficient of determination.

RESULTS AND DISCUSSION

The growth rates of food grains production have been divided into five categories:

I. Significantly low growth which lies between 0 to 3 percent
II. Significantly medium growth which lies between 3 to 5 percent
III. Significantly high growth which lies above 6 percent
IV. Significantly negative growth which lies below 0 percent
V. Statistically insignificant growth

Table 1 Estimated sub-period growth rates of food grains area in West Bengal, 1990-91 to 2002-03 and 2003-04 to 2014-15

District name	Whole period growth	Sub period growth rates[a]		Kinked trend equation	
		1st Sub-Period	2nd Sub -Period	R^2	D. W[c]
Burdwan	0.1 (0.686)	1.5*** (4.790)	-1.1*** (-3.82)	0.591	1.192
Birbhum	0.4 (1.633)	1.2** (2.120)	-3.0 (-0.584)	0.192	1.913
Bankura	-1.2*** (-2.921)	-1.4 (-1.437)	-1.0 (-1.129)	0.273	2.064
Midnapore	-0.2** (2.414)	0.2 (1.447)	0.1 (0.682)	0.202	1.854
Howrah	-0.7*** (-4.138)	-0.4 (-0.878)	-1.0** (-2.791)	0.450	1.884
Hoogly	0.2 (0.833)	0.7 (1.221)	-0.2 (-0.457)	0.129	2.142
South 24 Pargana	-0.4** (2.204)	0.6 (0.850)	-0.7** (2.410)	0.520	1.985
North 24 Parganas	-0.7*** (-5.335)	0.2 (0.616)	-1.5*** (-6.550)	0.733	1.872
Nadia	-0.8*** (-3.126)	0.6 (1.239)	-2.1*** (-4.439)	0.510	1.715
Murshidabad	0.3 (1.075)	1.7*** (3.231)	-1.0* (-2.060)	0.568	1.831
West Dinajpur	0.1 (0.695)	0.8*** (4.095)	-0.8*** (-4.450)	0.050	1.965
Maldah	-1.2*** (-5.688)	-2.0*** (-4.348)	-0.5*** (-1.081)	0.647	1.790
Jalpaiguri	-0.4*** (-3.547)	-0.2 (1.200)	-0.9*** (-4.923)	0.354	1.861
Darjeeling	-1.6*** (-7.750)	-3.2*** (-9.476)	-0.2 (-0.714)	0.875	1.980
Coochbehar	-0.4*** (-2.804)	-0.8** (-2.780)	-0.0 (-0.140)	0.255	1.859
Purulia	-0.7* (-1.754)	-0.8 (-0.895)	-0.5 (-0.642)	0.119	2.011
West Bengal	-0.3** (-2.549)	-0.3 (1.305)	-0.7*** (-3.736)	0.411	2.068

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level. T values are within parentheses

From the (Table 2) it was observed that the production growth rates of total food grains are lies in the category of significantly low growth in the Burdwan district with a value 0.9 percent followed by Birbhum (1.9 percent), Midnapore (1.8 percent), Hoogly (01.3 percent), North 24 Parganas (0.7 percent), South 24 Parganas (0.3 percent), Murshidabad (1.6 percent), West Dinajpur (2.7 percent), Maldah (1.4 percent), Purulia (1.8 percent), Jalpaiguri (2.6 percent) and West Bengal as a whole (1.4 percent) while Coochbehar (3.1 percent) lies in the category of significantly medium growth in the state over the study period. The production growth rates are found to have been significantly negative in Darjeeling (-1.6 percent) while three other districts namely, Bankura, Howrah and Nadia played statistically insignificant results over the study period in the state [7].

In the case of sub-period growth rates, we observe from (Table 2) that the production growth rate belongs to the category of significantly positive and medium in Birbhum district with a value 3.6 percent in the first sub-period, followed by Murshidabad with 3.1 percent, West Dinajpur wkith value 3.5 percent and Purulia district with 3.4 percent, while Coochbehar is only district whose production growth rates is found to be statistically significant with medium value in second sub-period [8-9].

There are 10 other districts namely, Burdwan (2.5 percent), Midnapore (2.7 percent), Hoogly (1.8 percent), Nadia (1.7 percent), Maldah (1.1 percent), Jalpaiguri (2.7 percent), Coachbehar (1.5 percent), South 24Parganas (0.8 percent), North 24 Pargans (2.0 percent) and West Bengal as a whole (2.3 percent) whose growth rates in total foodgrains production

belong to the category of significantly low growth in the first sub-period but in the case of second sub-period, we observe that the 5 number of cases namely, Midnapore (0.9 percent), West Dinajpur (2.0 percent), Maldah (1.6 percent), Jalpaiguri (2.8 percent) and West Bengal as a whole (0.6 percent) played significantly low growth in total food grains production in the state. Darjeeling is the only district whose production growth rate in total food grains is significantly negative with a value -4.7 percent during the first sub-period in the state. There are many districts, namely, Burdwan, Birbhum, Bankura, Howrah, Hoogly, South and North 24 Parganas, Murshidabad and Purulia where we observe constant growth in total food grains production during the second sub-period [10].

The production growth rates of most of the districts, as well as West Bengal as a whole, increased with the productivity growth during the study period. Both area and productivity growth also support increased production growth rates of total food grains in Birbhum, Murshidabad, West Dinajpur and Burdwan during the first sub-period in the state. The production growth rate is significantly negative due to mainly negative area growth [11-12].

Table 2 Estimated sub-period growth rates of food grains production in West Bengal, 1990-91 to 2002-03 and 2003-04 to 2014-15

District name	Whole period growth	Sub period growth rates[a]		Kinked trend equation	
		1st Sub-Period	2nd Sub -Period	R^2	D. W[c]
Burdwan	0.9*** (3.615)	2.5*** (5.066)	-0.5 (-1.044)	0.592	1.752
Birbhum	1.9*** (5.124)	3.6*** (4.672)	0.3 (0.450)	0.636	1.838
Bankura	0.01 (0.043)	1.0 (0.940)	-0.9 (-0.880)	0.100	2.063
Midnapore	1.8*** (7.520)	2.7*** (5.223)	0.9* (1.968)	0.756	2.282
Howrah	0.3 (0.309)	0.7 (0.588)	0.2 (0.177)	0.035	1.876
Hoogly	1.3*** (4.478)	1.8** (2.593)	0.9 (1.388)	0.480	2.114
South 24 Pargana	0.3*** (5.698)	0.8** (2.580)	-0.9 (0.580)	0.659	1.998
North 24 Parganas	0.7*** (2.846)	2.0*** (3.854)	-0.4 (-0.917)	0.449	1.803
Nadia	0.2 (0.834)	1.7*** (2.865)	-1.1* (-1.965)	0.274	1.750
Murshidabad	1.6*** (5.341)	3.1*** (5.011)	0.2 (0.430)	0.554	1.880
West Dinajpur	2.7*** (16.285)	3.5*** (10.02)	2.0*** (6.227)	0.938	2.200
Maldah	1.4*** (6.477)	1.1** (2.234)	1.6*** (3.446)	0.646	1.995
Jalpaiguri	2.6*** (10.027)	2.7*** (4.242)	2.8*** (4.858)	0.825	1.749
Darjeeling	-1.6*** (-3.053)	-4.7*** (-4.839)	1.3 (1.408)	0.551	1.863
Coochbehar	3.1 *** (10.848)	1.5**(2.661)	4.3*** (8.451)	0.837	1.911
Purulia	1.8** (2.699)	3.4** (2.171)	0.4 (0.277)	0.282	2.029
West Bengal	1.4*** (9.584)	2.3*** (8.566)	0.6** (2.287)	0.879	2.021

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level. T values are within parentheses

Table 3 Estimated sub-period growth rates of food grains productivity in West Bengal, 1990-91 to 2002-03 and 2003-04 to 2014-15

District name	Whole period growth	Sub period growth rates[a]		Kinked trend equation	
		1st Sub-Period	2nd Sub -Period	R^2	D. W[c]
Burdwan	0.8*** (6.095)	0.9*** (3.347)	0.7** (2.728)	0.678	1.905
Birbhum	1.5*** (7.809)	2.4*** (5.521)	0.8* (2.029)	0.774	1.804
Bankura	1.2*** (6.783)	2.3*** (7.802)	0.1 (0.382)	0.821	2.139
Midnapore	1.6*** (7.373)	2.2*** (4.991)	0.9* (1.987)	0.703	2.000
Howrah	1.1*** (3.061)	1.0 (1.125)	1.2 (1.546)	0.290	1.685
Hoogly	1.1*** (9.563)	1.1*** (3.838)	1.2*** (4.489)	0.798	2.281
South 24 Pargana	1.3*** (6.587)	0.6** (2.165)	0.8*** (3.564)	0.658	2.001
North 24 Parganas	1.6*** (9.091)	1.7*** (4.059)	1.5*** (3.092)	0.782	1.890
Nadia	1.2*** (8.586)	0.9*** (2.623)	1.6*** (5.076)	0.776	1.837
Murshidabad	1.5*** (9.129)	1.2*** (3.221)	1.7*** (4.819)	0.788	1.776
West Dinajpur	2.5*** (18.193)	2.8*** (8.721)	2.2*** (7.594)	0.904	1.936
Maldah	2.7*** (17.043)	2.9*** (7.713)	2.5*** (7.314)	0.927	1.764
Jalpaiguri	3.1*** (12.137)	2.5*** (4.096)	3.7*** (6.842)	0.874	1.912
Darjeeling	0.2 (0.406)	-1.7 (-1.524)	1.8* (1.866)	0.205	2.008
Coochbehar	3.3*** (14.973)	2.4*** (4.973)	4.0*** (9.148)	0.921	1.821
Purulia	2.5*** (7.178)	4.1*** (5.407)	1.1 (1.624)	0.751	2.186
West Bengal	1.6*** (15.608)	2.0*** (9.043)	1.2*** (5.963)	0.928	1.893

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level. T values are within parentheses

Instability

In our study, the variability has been divided into three categories like low variability, medium variability and high variability on the basis of the value of the Cuddy-Della Valle index. More specifically, observing the empirical results we have categorized the variability as follows:

(a) Low variability ranges between 0 to 6,
(b) Medium variability ranges between 6 to 12 and
(c) High variability implies the value above 12

The production instability of total food grains is found to be in a low category (Table 4) in Murshidabad (3.78) and West Bengal as a whole (3.84) during the study period i.e., 1990-91 to 2014-15. The production instability of total food

grains is found to be in the high category at Bankura (13.35), Howrah (16.01), Darjeeling (16.54) and Purulia (20.89) while 12 other districts, namely, Burdwan (6.88), Birbhum (11.03), (7.08), Hoogly (9.31), Nadia (7.23), West Dinajpur (11.74), Maldah (7.44), Jalpaiguri (9.23), Coochbehar (10.32), North 24 Parganas (7.29), North 24 Parganas (6.85) and West Bengal as a whole (3.84) (11.89) the production instability of total food grains lies in the category of the medium. The productivity instability of food grains in most of the districts belongs to the category of low in the state. The area instability of food grains is found to be in the low category in all the districts except Birbhum, Bankura, Hoogly, Nadia, Murshidabad, Maldah and Purulia [13].

Table 4 Estimated district wise instability of food grains production in West Bengal during 1990-91 to 2014-15

District	Area	Production	Yield
Burdwan	4.37	6.88	4.04
Birbhum	7.92	11.03	6.12
Bankura	11.58	13.35	4.33
Midnapore	2.51	7.08	7.24
Howrah	5.91	16.01	12.83
Hoogly	7.6	9.31	4
South 24 Pargana	4.25	6.85	5.58
North 24 Parganas	3.6	7.29	6.09
Nadia	7.73	7.23	5.23
Murshidabad	6.21	3.78	5.79
West Dinajpur	3.88	11.74	5.84
Maldah	6.55	7.44	5.63
Jalpaiguri	3.66	9.23	8.85
Darjeeling	5.54	16.54	14.78
Coochbehar	4.51	10.32	7.32
Purulia	11.24	20.89	10.93
West Bengal	3.03	3.84	3.22

CONCLUSION

We observe from the study the production growth rate of food grains is significantly positive for most of the districts over the study period. but in the case of sub-period growth rates, we observe that the production growth rates of total food grains are found to have either negative or insignificant growth in the second sub-period compared to the first sub-period in all the respective districts as well as West Bengal as a whole in the state. The area is the more responsible factor for negative growth in food grains production in the state. The production growth rates of food grains in most of the districts mainly increased due to high productivity growth. The production instability of drought-prone districts namely, Bankura, Howrah, Darjeeling and Purulia are also very high in the state. But the production growth rates of developed districts are observed to be low and their instabilities are either low or medium compared to the underdeveloped districts in the state. The production growth rate of total food grains significantly decreased in the second sub-period compared to the first sub-period due to mainly negative area growth from this analysis we may conclude that the cropping pattern changes from food grains to other commercial crops or horticultural crops in the state. In recent times the farmers have been taking a risk for cultivations of high-valued crops and horticultural crops because the government has taken different crop insurance policies which resulted that the farmers shifting their cropping pattern from traditional crops to high-value commercial crops or horticultural crops.

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