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## Agricultural Growth And Its Determinants In West Bengal: A Panel Data Analysis

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### Abstract

The present paper examines the growth and instability of yield of the major principal crops across different districts of WB during 1995-2019 and identifies the possible factors that can affect the average yield rate in WB over the study period by using panel data fixed effect regression model. The findings indicates that cropping intensity, rainfall, agricultural wages, fertilizer consumption and IRR play a positive role to raising the average yield rate in agricultural production.

**Keywords:** Cropping intensities, Growth rate, rainfall etc.

### Introduction

West Bengal is considered one of the fastest-growing agricultural states in India, and the agriculture sector remains a major part of its state economy in terms of food security, employment generation, exports and poverty reduction. The state has 2.7% of the nation's total land and produces more than 8% of the country's food production. The state has the leading producer of rice, potato & Jute and supplies around 33% of potato and 66% of jute requirements of the country (Economic review 2016-17). The primary occupation of the rural people in West Bengal is agriculture. About 72% of the country's population is still living in rural areas where the

primary source of income remains agriculture. (Census 2011). In the year 2014-15, agriculture contributed 18.8% to the GSDP of the state. In 2003-04, the cropping intensity in West Bengal was 178 %. It was raised to 189 % in 2017-18. This shows a sign of stagnancy. However, with a successful land reforms programme and implementation of HYV technologies the state attained an important position in the agricultural scenario of the country. In the period 1981-91, **Saha and Swaminathan (1994)** analyzed the growth of agricultural in West Bengal and found that food grains production grew fastest. In terms of food grains, there are two groups: cereals and pulse crops. Rice, wheat and maize are the 3 main cereal crops in the state. The state grows some of the most important cash crops like Jute, potatoes, etc. In 2006 -07, West Bengal contributed 7.4% to the country's food grain production and ranked 4th among major Indian states. In terms of rice production, West Bengal led all major states in rice production and accounted for about 16% of national production.

Several studies have been conducted to examine the issue of growing agriculture in West Bengal and its instability. Saha and Swaminathan (1994) have shown that West Bengal's agricultural output and productivity increased significantly during the decade of the 80s. They estimate that the Indian state's total crop output grew at the fastest rate, which was 6.40% during the eighties, and this remarkable increase has been widespread through the districts of the state. They claim that, in the early 1980s, the state land reforms significantly contributed to a remarkable increase of agriculture production. In the study by Bhattacharyya and Bhattacharyya (2008), they examined some important parameters of the agricultural sector, namely area, production, yield, input use, credit and land reforms. The growth rate of agriculture and productivity in West Bengal has declined since the 1990's, and the same is true of input use. Using district-level data, Anjani Kumar and Rajni Jain (2013) analyzed the growth and instability in Indian agriculture. In both the state and country overall, agricultural productivity varies significantly. The study also showed that modern inputs such as fertilizers, rainfall, irrigation, human resources and transportation contribute to crop sector productivity.

The aforementioned literature indicates that most of the studies have focused on both state and national level, suggesting that district level research is needed. It was also found that previous studies have either focused on just one crop or have only been conducted for a short period of time. It has attempted to cover major crops in West Bengal for a long period of time. India's agriculture is known for its variability and instability. For these reasons, it will be useful to estimate instabilities at the district level for the development of strategies targeting

more vulnerable areas. The varying performance of the crop sector at the district level will also help to understand the linkages between agricultural growth, instability and the factors affecting them.

## Objective of the study

Under this backdrop, this paper intends to explore the following research objectives:

1. To study the growth and instability of yield of major crops across different districts of West Bengal during 1995-2019.
2. To identify the possible factors that can affect the average yield rate in West Bengal during the study period.

In order to make the paper more convenient, it is divided into five sections. Section I discusses data and methodology, while section II examines the inter-district variations in growth performance in principal crops. In section III, we examine the nature and pattern of instability in WB's principal crops across districts. Through the use of panel regression, section IV identifies the major determinants of agricultural growth. Conclusion appear in section V.

### Section I

#### Data sources & Methodology

In the present study, secondary data were collected exclusively from the Statistical Abstracts of the Govt. of WB published by BAES. DES, MOA, Govt. of India is another source

#### Estimation of growth rates

For measuring agricultural growth rate, we consider the following linear form:

$LnY_t = \alpha + \beta t + \mu_t$ , Where  $Y_t$  = output,  $\alpha$  = constant,  $t$  = time (in years),  $\beta$  = Growth coefficient of time &  $\mu_t$  = an error term. The coefficient of time,  $\beta$  is the continuous rate of growth. It closely approximates to the annual compound growth rate. Therefore, the estimates  $\beta$  are presented as growth rates.

Significance of growth rate was judged by Student's t-test

For examining growth performance & Instability of principal crops the period was divided into two parts period I (1995-2007) and period II (2008-2019) and for panel data regression we consider time period 1995-2013.

## Instability analysis

In order to quantify yield instability in time series data, the Cuddy Della Valle Index (CDVI) was utilized. If the data show any trend i.e., if they appear to be scattered around a negative or positive trend line, the variation measured by  $yl$  may have been over-estimated. This method corrects the CV by employing  $\bar{R}^2$ . Thus, the formula suggested by Cuddy Della Valle is given below

$$CDVI = yl \times \sqrt{1 - \bar{R}^2}$$

Where  $yl$  is the coefficient of variation (expressed as a percentage) and  $\bar{R}^2$  is the coefficient of determination.

## Section II

### The Performance of Agricultural Growth in West Bengal:

In estimating the district wise yield growth rate in West Bengal, the main thrust has been given to the crop wise growth rates. The growth rates yield rate of some important crops viz. aus, aman, boro, total rice, wheat, total pulses, are analyzed along with the important cash crops mainly rapeseed, jute and potato. In total, these crops account for more than 70 percent of GCA of the state. The yield growth rates of these crops over two sub-periods (1995-2007 and 2008-2019) are presented in table

Table-1

## District wise growth rate of yield of main crops in West Bengal from 1995 -2019

Districts	Aus		Aman		Boro		Rice		Wheat		Pulses		Potato		Rapeseed	
	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019
Burdwan	1.9	-3.2	1.4	1.3	-0.6	1.6	0.7	1.3	0.9	2.6	-0.1	4.9	0.05	3.1	0.1	2.0
Birbhum	0.5	1.3	2.4	1.4	0.9	1.4	2.2	1.4	0.4	0.8	-1.5	2.7	-3.0	5.5	0.3	0.5
Bankura	1.7	-0.1	1.4	-0.7	-0.6	1.2	1.1	-0.4	-0.1	0.4	2.2	4.9	-1.8	3.9	0.3	1.3
Mednipur	0.8	1.3	1.4	1.5	0.01	2.2	1.9	0.04	1.6	0.7	1.4	0.7	0.05	-2.7	0.1	0.8
Howrah	-2.8	1.8	4.2	3.1	0.8	4.8	2.3	3.5	5.7	0.9	1.0	-3.2	0.8	0.6	1.7	3.2
Hooghly	1.6	1.0	0.6	1.1	0.7	2.0	1.3	1.3	1.8	1.4	-0.9	-0.4	-1.8	4.3	2.2	0.5
N-24 Parganas	3.2	1.3	2.5	1.4	2.3	1.6	1.3	1.3	2.0	-1.7	-0.02	-0.9	-0.7	2.3	2.1	1.8
S-24 Parganas	2.1	2.5	2.9	0.9	1.6	2.9	3.2	1.5	3.1	0.7	0.5	-4.9	-1.0	0.4	3.8	-2.9
Nadia	2.5	2.0	1.9	3.1	0.4	0.8	1.0	1.8	-0.8	0.9	2.2	-2.3	0.6	3.9	0.05	1.4

Murshidab d	2.8	2.4	1.6	1.6	-0.1	1.0	1.5	1.3	-0.8	-0.6	-1.3	0.04	-2.2	5.3	1.7	2.2
Uttar Dinajpur	3.7	5.4	5.6	1.8	-0.4	2.4	2.6	1.8	1.0	-0.3	-0.1	2.6	4.3	1.5	1.2	5.0
Dakshin Dinajpur	2.9	3.3	3.1	2.2	-0.1	1.3	2.8	2.0	1.1	1.4	-3.6	5.1	4.9	2.1	0.1	6.9
Maldha	6.3	4.7	3.5	0.8	1.5	0.9	4.2	0.9	0.9	0.5	4.7	0.7	1.6	2.2	3.2	3.3
Jalpiguri	2.9	0.04	3.0	3.5	-1.3	3.0	3.3	3.7	3.2	0.9	-1.3	3.6	-0.02	4.6	2.5	4.3
Darjeeling	3.5	1.3	4.1	0.7	-3.9	1.6	4.4	0.8	2.4	3.8	0.7	4.6	2.2	0.3	-5.7	0.5
Coochbehr	-0.9	2.2	3.6	4.1	1.0	5.0	3.4	4.2	1.8	2.0	0.8	1.8	-1.9	5.4	-1.4	6.5
Purulia	3.3	1.6	3.9	0.8	0.1	1.1	3.9	1.3	1.8	-0.3	-0.8	3.8	-2.2	-0.3	-1.1	1.1

Source: Authors’ own estimation.

Table-1 reveals that the growth rate of total rice (which include all 3 varieties of rice namely, aus, aman & boro) are positive and significant in all districts except Bankura over the entire period. From period 1995-07 to 2008-19 growth rate increases only five districts namely, Burdwan, Howrah, Nadia, Jalpiguri & Coochbeher and decreases in ten districts for the majority of crops. The yield growth rate of principal rice growing districts like Bardhaman, Birbhum and Midnapore exhibited a declining trend. The highest growth rate was found in Darjeeling district (4.4%) followed by Maldha (4.2%) and Purulia (3.9%) districts during 1995-2007 and during 2008-2019 the highest growth rate found in Cooch Behar district (4.2%) followed by Jalpiguri (3.7%) and Howrah (3.5%). During the whole period, the growth rate of aus, aman & boro has been observed to be positive in most regions. During 2008-2019 potato registered a remarkable growth rate in yield in almost all of the districts. The highest growth rate recorded in Birbhum district

(5.5%) followed by Coochbeher (5.4%), Murshidabad (5.3%) & Jalpiguri (4.6%). In the case of rapeseed & mustared the growth was also positive during 2008-2019. In Dakshin Dinajpur & Coochbehar, where yield growth rate of rapeseed & mustared was grew at 6.9% & 6.5% respectively.

### Section III

#### **Inter-district variation on the nature and pattern of instability in yields of major crops in West Bengal**

Agriculture in India has a history of fluctuating and varying levels of performance. The pattern of index of instability measured by CDVI was examined and reported in table 2.

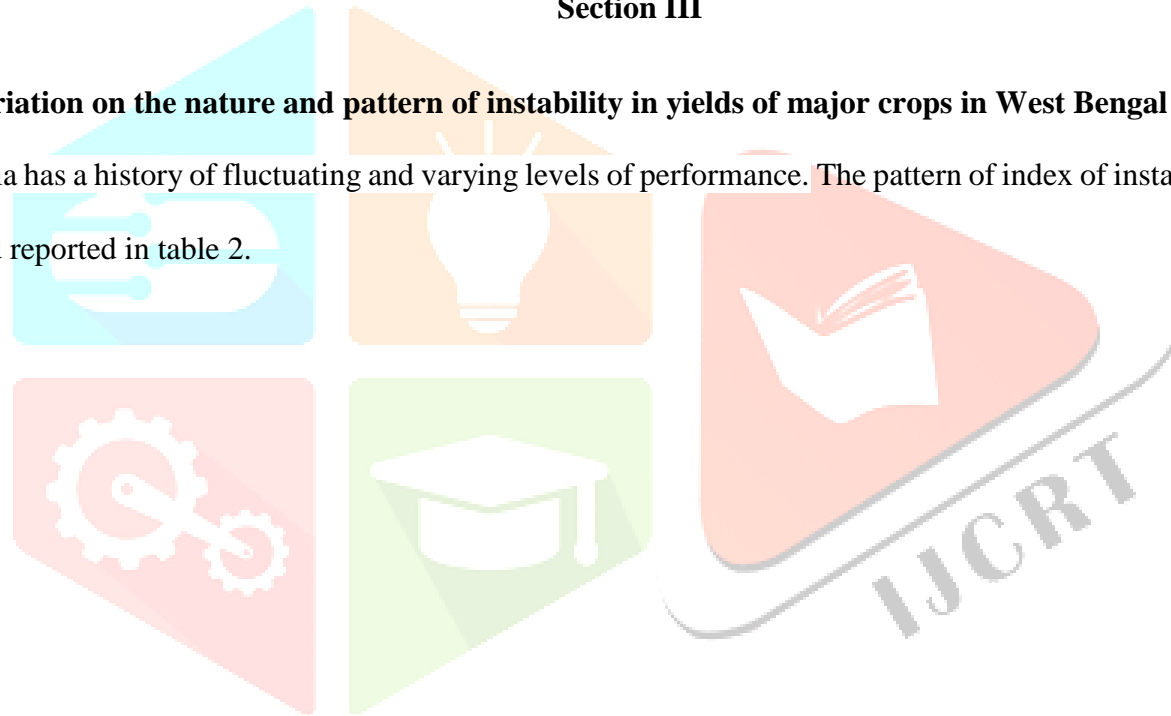


Table-2

## District wise Instability in yield of major crops in West Bengal from 1995 -2019

Districts	Aus		Aman		Boro		Rice		Wheat		Pulses		Potato		Rapeseed	
	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008	1995	2008
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019	2007	2019
Burdwan	11.5	19.8	10.1	5.29	8.76	13.3	4.15	4.82	8.04	11.7	28.5	13.3	15.8	31.6	14.1	9.42
	5	3	9			4				1	0	4	7	9	0	
Birbhum	8.62	10.6	7.59	5.90	8.48	5.83	6.75	5.36	7.46	3.42	12.1	11.0	18.9	23.6	13.1	8.30
		4									3	5	5	2	0	
Bankura	5.48	9.48	6.11	6.58	13.1	8.36	5.18	5.41	15.1	12.9	19.2	15.7	16.1	45.1	17.2	3.42
					0				4	2	6	0	4	1	7	
Mednipur	9.33	9.12	12.0	9.62	13.8	6.94	5.91	6.38	14.6	15.1	1.15	3.72	13.0	21.6	1.19	1.07
			3		8				1	7			7	1		



Howrah	24.9 5	36.8 3	20.0 5	20.4 1	7.13 1	12.6 1	8.38	13.2 6	26.4 2	27.9 5	23.0 3	26.9 0	12.2 6	34.1 8	15.5 9	27.0 9
Hooghly	6.82	13.5 5	11.8 3	3.32	7.04	3.77	3.52	3.21	14.4 3	15.5 0	18.0 7	28.1 1	22.1 9	33.2 7	15.7 5	7.30
N-24 Parganas	15.4 4	5.29	5.61	8.01	17.4 6	4.27	3.64	4.44	8.54	17.4 3	10.4 5	13.4 5	7.71	15.0 1	12.2 8	10.9 9
S-24 Parganas	13.6 7	13.3 1	12.5 3	6.75	6.07	3.95	10.0 9	4.63	11.8 6	20.2 5	13.4 2	17.9 1	13.7 3	14.5 6	20.5 3	41.0 7
Nadia	5.57	6.30	11.2 3	6.50	8.81	2.90	4.82	2.59	7.38	13.3 3	12.4 9	14.8 7	11.7 9	16.2 9	9.96	10.6 8
Murshidab d	12.7 2	5.71	15.1 8	7.24	21.3 8	6.24	7.07	5.68	9.64	11.8 5	14.0 2	16.8 9	17.9 9	21.6 5	12.6 2	11.7 9
Uttar Dinajpur	21.6 5	5.51	14.4 7	10.6 0	11.5 1	8.37	5.83	8.27	10.3 0	7.83	5.87	13.3 0	19.6 9	14.3 0	15.1 4	16.1 1
Dakshin Dinajpur	16.7 6	13.3 6	8.31	5.52	9.72	4.99	6.06	4.47	11.7 7	8.73	24.8 2	18.8 3	14.6 2	14.7 2	19.2 9	11.1 4

Maldha	21.4 8	11.4 3	12.1 2	10.3 0	4.29	7.26	13.4 2	6.80	7.27	8.39	17.6 8	9.79	14.6 3	25.2 7	14.8 4	9.74
Jalpiguri	16.0 5	8.29	8.95	5.52	15.2 7	9.44	8.55	4.81	10.7 6	23.3 0	16.2 4	9.56	21.9 9	10.8 0	15.5 7	10.3 2
Darjeeling	33.3 1	13.8 2	9.37	6.34	16.9 0	11.1 4	11.2 2	6.11	18.5 1	28.2 4	15.6 7	9.56	5.63	12.2 9	39.2 5	48.1 7
Coochbehr	16.3 7	6.63	10.6 2	6.95	9.55	8.90	6.83	6.46	9.47	18.9 6	18.3 2	12.1 1	25.2 2	20.8 8	23.1 5	17.6 7
Purulia	32.1 3	36.9 5	11.2 8	14.8 5	20.4 1	23.2 6	11.3 1	14.8 2	16.2 5	17.6 3	22.8 7	28.6 4	15.4 1	18.0 5	21.1 8	15.1 4

Source: Authors' own estimation.

From Table 2 we see that for aus (36.95), boro (23.26), total rice (14.82) and pulses (28.64), highest instability was found in Purulia district during the second sub-period. It is noticed that the yield under rice was highly variable in South 24 parganas, Maldha, Jalpiguri & Darjeeling districts in phase I and Howrah, Uttar Dinajpur & Purulia districts in phase II. For wheat, highest instability was found in Howrah district (27.95) and lowest instability was found in Birbhum district (3.42) during 2008-2019. The instability in yield for potato has increased in almost all the districts except 3 districts - Uttar Dinajpur, Jalpiguri & Cooch Behar from first sub-period (1995-2007) to second sub-period (2008-19). The estimates of instability for rapeseed have decreased in the majority of districts. For rapeseed the

highest instability was found in Darjeeling district (48.17) and lowest instability was found in Mednipur district (1.07). Thus, in relation to yield fluctuation, there is clear indication of growing inter-district instability of West Bengal in both periods.



## Section IV

### Determinants of the Average Yield Rate in West Bengal Agriculture

The yield rate in West Bengal can be affected by the following factors:

- (1) Average annual rainfall (mm)
- (2) Fertilizers Consumption (Per hectare of GCA)
- (3) Agricultural Credit (Per hectare of GCA)
- (4) Average wage rate in agricultural
- (5) Percentage of GCA under irrigation
- (6) Cropping Intensity.

The following model can be specified to assess the impact of macroeconomic factors on the yield growth in West Bengal agriculture:

$$\text{Ln yield rate}_{jt} = f(\text{Avg rainfall}_{jt}, \text{FC}_{jt}, \text{Ag. Cred}_{jt}, \text{Ag. Wage}_{jt}, \text{IRR}_{jt}, \text{CI}_{jt}) \dots \text{Eq (1)}$$

Where 'j' represents the district,  $j = 1, 2 \dots 17$

And 't' represents the time period,  $t = 1, 2 \dots 19$

We have a balanced panel data model

$\text{Ln yield rate}_{jt}$  = Log of yield rate of the  $j^{\text{th}}$  district in the  $t^{\text{th}}$  period,

$\text{Avg rainfall}_{jt}$  = Average annual rainfall (mm) of the  $j^{\text{th}}$  district in the  $t^{\text{th}}$  period,

$\text{FC}_{jt}$  = Fertilizer consumption of the  $j^{\text{th}}$  district in the  $t^{\text{th}}$  period,

$\text{CI}_{jt}$  = Cropping intensity of the  $j^{\text{th}}$  district in the  $t^{\text{th}}$  period,

$\text{Ag. Wage}_{jt}$  = Average agricultural wage of the  $j^{\text{th}}$  district in the  $t^{\text{th}}$  period,

$\text{IRR}_{jt}$  = Percentage of GCA under irrigation of the  $j^{\text{th}}$  district in the  $t^{\text{th}}$  period,

$\text{Ag. Cred}_{jt}$  = Agricultural credit of the  $j^{\text{th}}$  district in the  $t^{\text{th}}$  period.

In panel regression model, we need to use Fixed Effect Regression Model because our Hausman test supported the estimation of Fixed Effect Model.

Table-3

## Panel result

Explained variable: Inyieldrate <sub>it</sub>			
Explanatory Variable	coefficient	t-Statistics	Prob.
Rainfall	0.003411*	3.918825	0.0001
Fertilizer	0.000424**	2.135265	0.0335
Ag.Credit	1.26*	5.863676	0.0000
Wage rate	0.001010*	3.451538	0.0006
IRR	0.004322*	5.912871	0.0000
CI	0.002225*	7.238490	0.0000
Constant	8.207493*	277.6166	0.0000

$F(17,323) = 14.97969^{**}$   $R^2 = 0.4793$

\* Implies significant at 1% level & \*\* implies significant at 5% level

Source: Authors' own estimation.

The panel data regression results furnished in table 3. Based on the findings, we can make the following conclusions:

From the above table we see that fertilizer has a significant and positive impact on mean yield rate. Fertilizer usage is the most significant factor that accounts for the difference in agricultural productivity between the districts of West Bengal. In West Bengal, rainfall continues to be a crucial factor in determining agricultural productivity and it will have a positive and significant impact on yield rate. We also see that the wage rate is significant and the positive effect on yield. Kundu & Goswamy (2019) have also found the same significant and positive effect of wage rate to yield in West Bengal agriculture. The yield rate is significantly and positively influenced by agricultural credit, IRR and cropping intensity.

## Section V

### Conclusion:

This study identified the key factors influencing the mean yield rate and examined the growth pattern and instability of West Bengal's major crops. With the exception of Bankura district the overall rice yield growth from 1995-07 till 2008-19 was significant and positive. The yield under rice was highly variable in South 24 parganas, Maldha, Jalpiguri & Darjeeling districts in phase I and Howrah, Uttar Dinajpur & Purulia districts in phase II. During 2008-2019 potato registered a remarkable growth rate in yield in almost all of the districts. The highest growth rate was recorded in Birbhum district (5.5%) followed by Coochbeher (5.4%), Murshidabad (5.3%) & Jalpiguri (4.6%). The instability in yield for potato has increased in majority of the districts except 3 districts- Uttar Dinajpur, Jalpiguri & Cooch Behar from the period 1995-2007 to 2008-19. It is interesting to note that in the case of yield fluctuation there is clear indication of growing inter-district instability of West Bengal in both periods. From the result regarding the effect of factors on growth of yield of West Bengal we observed that rainfall, agricultural wage rate, fertilizer consumption, IRR and cropping intensity are significant and positive.

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