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Growth and Stability in Rice Production in Burdwan: A Block Level Study

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Abstract

The study examined growth and stability in rice production in Burdwan whose main food crop is rice. The objective of the study is to measure growth and stability in rice production for major blocks in Burdwan. Growth rates of area, production and productivity have been measured by using kinked exponential trend method. The structural break has selected *a priori* at 2003 for area, production and productivity. The production variability of rice has been measured by using exponential trend line fitted on de-trended statistic. The study depends on secondary data on area, production and productivity for the period 1993-94 to 2012-13. This study period has been divided into two sub-periods viz. early liberalization phase (1993-94 to 2002-03) and matured liberalization phase (2003-04 to 2012-13). The production growth rate of rice is significantly negative for most of the blocks in second sub-period compared to the first sub-period. The production instability of boro rice increases for a few blocks, while production instability of aus and aman either declined or remained constant for most of the blocks in the district.

Keywords: *Growth, Instability, Deceleration Hypothesis*

1. Introduction

The economic condition of Burdwan district mainly depends on the activities of agriculture and allied sector. In the Pre-Independence era agriculture did not play any significant role because the British Government destroyed the agriculture based industries namely, handicrafts and cottage and small scale industries as a result of colonial system of exploitation in the economy. After the Independence the Indian Government started Five Year Planning system and took various policies for development of the Indian agriculture. In late 1960s the green revolution of agriculture in India occurred with the various technological improvements like, introduction of High Yielding Variety seeds, Chemical Fertilizers, Pesticides, new sources of Irrigation, Agricultural Machineries etc, which resulted in large improvement in agricultural production and productivity. After the Green Revolution agricultural sector fulfilled the objective of achieving self-sufficiency in food grains. Rice is the main crop of the district; Burdwan is called the bowl of rice in West Bengal. Total reporting land is 698.76 thousand hectors in the district. The area of rice cultivation is 593.4 thousand hectors and production of rice is 1922.5 thousand tones in this district in 2012-13 (Data are collected from Statistical Handbook). Three types of rice produced in the

district namely, aus, aman and boro. Aman crop captured most of the agricultural land in the district. The irrigation facility is relatively well developed in the district because Damodar Valley Corporation was established in 1953 and there are so many rivers namely, Damodar, Bhagirathi, Barakar, Ajoy, Dwarakeswar, Tamla, Kukua, Kunur, Khari, Banka etc which flow through the district. Further the irrigation facility comes from other sources namely, Deep tube well, Shallow, Wells etc.

We would like to study the patterns of growth and stability in rice production here because in recent time, climate condition changes which causes occurrence of frequent drought or flood in the district and results in hampering production of rice. Further the agricultural growth rate of rice production or productivity in the district is supposed to be saturated in recent year. Again prices of agricultural inputs rise more than agricultural output which results in frequent farmers' suicide. After 2001 more than 800 hundred farmers attempt suicide in West Bengal (NCRB Report 2011). Due to this, probably, the farmers shift their cropping pattern from traditional crops to new crops which may result in declining food security in the district. Further, in a number of agriculturally developed regions deceleration hypothesis is now argued to be set in. Under the circumstances, to know the actual state of the district agriculture, we like to measure its growth and instability in production, area and yield during the post reforms period (more specifically since 1993-94). In early 1990-91 the Indian Government had to face various economic problems and to resolve those problems the government took the policy of economic reforms for improving the economic health of the country. In the reforms period the government adopted and implemented the various polices for improving mainly industrial sector, capital market and financial market, like, reforms on trade and capital flows, new industrial policy, disinvestment and public sector reforms, Financial market reforms (i.e., reforms in banking, insurance and capital market), control of inflation, fiscal correction etc. But during this liberalization period the policy makers did not take any big and serious policy for the betterment of agricultural sector in India. Probably, it has been believed that agricultural sector would develop here with other sectors through push and pull effects. We want to examine in this study whether really that occurred in agriculture here or not.

2. Literature Review

The notable contributions in measuring growth and instability in crop output are Boyce (1984), Saha and Swaminathan (1994), Sawant and Achuthan (1995), Rawal and Swaminathan (1998), Wasim (2002), Parmar (2012), Gupta et.al (2015), Boyal et.al (2015), Ali and Jabbar (2015), Patil and Yeledhalli (2016), Samal et.al (2017), Tewari et.al (2017), Guntukula (2017) etc. The studies of these authors were made in different countries in different periods using different methods for different crops. From the studies conduct in our country, we see that green revelations mainly occurred in 1966 to 1969. Further, the regions of having green revolutions presently experienced declining growth, which actually started from early 1990s. The picture Eastern India is somewhat different. The states of Eastern India experienced growth momentum in agriculture mainly from 1980s. Being a late starter these states also experienced deceleration hypothesis in the growth process of agricultural production during last decade or so, when it was started in Punjab and Haryana in late 1980s. However, we do not get exclusive study in measuring agricultural growth specially giving emphasis on rice production in Burdwan district. The present study has made a modest attempt to cover this gap.

3. Objectives of the study:

1. Whether the agricultural growth patterns of rice (aus, aman and boro) of different blocks in Burdwan vary over time.

2. Whether the stability in production of rice (aus, aman and boro) for different blocks in Burdwan changes during the study period.

4. Data Base and Methodology

We have divided the study period into two sub-periods, viz. early liberalization period (1993-94 to 2002-03) and matured period liberalization (2003-04 to 2012-13) and the cutoff point for two sub-periods is 2003.We have selected 18 major block in the district and taken the secondary level time series data for our study. The block-wise data on area (in hundred hectors), production (in hundred tones), and productivity (in kg per hector) for rice crop (aus, aman and boro) have been collected from different issues of Statistical Handbook of Statistical Bureau of West Bengal during 1993-94 to 2012-13.
Following the study of Boyce (1984) we have chosen the kinked exponential trend equation for measurement of sub-period growth rates on area, production and productivity. We have also measured trend break in the growth of crop outputs to know the relative agricultural performances in the district over two sub-periods. The kinked exponential equation in our study has been used for breaking the time series data into two sub-periods having only one kink.

$$\ln Y_t = a + b_1(D_1 t + D_2 k) + b_2(D_2 t - D_2 k) + u_t$$

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 $D_j = 0$ for sub-period other than j, where j = 1, 2. b_1 and b_2 are parameters. K is the single break point. The significance of growth rate is cheeked by using student t statistics with (n-2) degrees of freedom. We have also checked autocorrelation problem using DW statistics and remove this problem by Cochrane-Orkutt two steps procedure using either first order or second order auto regressive process.

We have used exponential trend fitting method for estimation of instability using de-trend statistic in our study. We have calculated the absolute value of de-trend statistic $|X_t|$ where X_t is the ratio between residual e_t and predicted value $\widehat{Y_t}$. There on $|X_t|$ linear trend is estimated: $|X_t|$ = a+ bt. The parameters a and b have been estimated from this last equation. When b takes significantly positive value, the instability is said to be increasing over time. When b takes significantly negative value, this implies that the instability decreases over time. But when b is found to be insignificant, there will be no change in instability over time.

5. Results and Discussion

5.1. Growth

Table 2 presents that the production growth rate of aus belongs to the category of significantly high growth with value 18.8% at Galsi-II block in the first sub-period. On the other, Ausgram-I is that block whose production growth rate in aus is significantly high with value 20.6% during the second sub-period. Ausgram-II block registered highest negative growth in aus production (-20.9%) in the first sub-period in the district, followed by Bhatar (-15.2%), Burdwan Sadar (-12.3%) and Jamalpur (-8.5%), while in the second sub-period aus production growth rates fluctuate more over blocks in the district. There are many blocks, namely, Bhatar, Kalna-I, Bardwan Sadar, Mangalkote and Jamalpur where we observe significantly negative growth in aus production during the second sub-period. Rest of the other blocks are having insignificant growth in both the sub-periods. The production growth rate of aus took place mainly due to area growth at Galsi-II block during the first-sub-period but in the second sub-period the production growth rate occurred due to both area and productivity growth at Ausgram-I block in the district. Many blocks experienced negative production growth in aus crop mainly due to negative area growth in both the sub-periods (Table 1 and 3).

In case of aman crop, we see (from Table 5) that the production growth rate lies in the category of significantly low but positive at Ausgram-II block with value 4.7% in the first sub-period, followed by Burdwan Sadar with 4.4% and Jamalpur with 4.3%, while Kalna-I (5.3%) block experienced significantly high growth in aman production in the second sub-period. Rest blocks are found to have mainly insignificant growth in aman production in both the sub-periods.

Table 4 and 6 present that the production growth rate in aman took place mainly due to productivity growth for Ausgram-II and Burdwan Sadar block in the first sub-period. Jamalpur is the only block whose production growth increased due to both area growth and productivity growth in the first sub-period. Kalna-I block did not show any clear picture regarding contributions of area and productivity in growth of aman production. The relative contributions of area and productivity are positive but insignificant in this block.

In case of boro crop, we observe (from Table 8) that the production growth rate belongs to the category of significantly positive and high at Bhatar block with value 10.9% in the first sub-period, followed by Katwa-I with 9.4% and Kalna-II block with 6.3%. All other blocks are found to have insignificant growth in boro production. Mangalkote is the only block whose production growth rate in boro is significantly high with positive value 7.5% during the second sub-period in the district. There are 5 other blocks whose growth rates in boro production belong to the category of insignificant in the second sub-period in the district. The production growth rate of boro detoriates for most of the blocks, namely, Galsi-I block (-37.8%), Jamalpur (-30.2%), Memari-II (-19.3%), Ausgram-II (-16.3%), Memari-I (-14.9%), Kalna-II (-8.9%), Monteswar (-7.6%), Burdwan Sadar (-7.1%), Galsi-II (-7.0%), Purbasthali-I (-6.9%), Purbasthali-II (-6.5%) and Kalna-I (-6.1%) in the second sub-period compared to the first sub-period.

Further, Table 7 and 9 present that the growth in boro production took place mainly due to area growth for two blocks, namely, Katwa-I and Bhatar, during the first sub-period. Both area and productivity played significant role for improvement in boro production of Kalna-II block in the first sub-period. Mangalkote block registered positive growth in production mainly due to positive area growth in the second sub-period. In the second sub-period area played negative role for most of the blocks, which resulted to negative production growth in boro for these blocks.

From the estimated trend breaks the production growth rate of rice decreases over time in 13 cases out of total 54 cases. Rest of other cases are found to have constant growth in rice production over time in the district.

5.2. Instability

Table 10 presents that the production instability of aus increases significantly over time in some blocks, namely, Kalna-I, Mangalkote, Jamalpur and Bhatar, while Aushgram-I block has registered significantly declining instability in production over the study period. Rest other blocks, namely, Ausgram-II, Monteswar, Kalna-II, Purbasthali-I, Purbasthali-II, Katwa-I, Katwa-II, Khandaghosh, Memari-I, Memari-II, Galsi-II, Burdwan Sadar are found to have statistically insignificant value of b, i.e., no change of instability in aus production in these block.

In case of aman, we see that the production instability is significantly increasing at Galsi-I block, while Jamalpur block show significantly declining instability in aman production over time. There are 16 other blocks, namely, Ausgram-I, Ausgram-II, Monteswar, Kalna-I, Kalna-II, Purbasthali-I, Purbasthali-II, Katwa-I, Katwa-II, Mangalekote, Khandaghosh, Memari-I, Memari-II, Galsi-II, Bhatar and Burdwan Sadar where we find no change in production instability for aman crop.

Further, the production instability of boro crop significantly increases in some blocks, like, Ausgram-I, Ausgram-II, Monteswar, Jamalpur, Memari-I, Memari-II and Galsi-I, while two other blocks, namely, Kalna-I and Burdwan Sadar have registered declining production instability over the study period. All other blocks, namely, Kalna-II, Purbasthali-I, Purbasthali-II, Katwa-I, Katwa-II, Mangalekote, Khandaghosh, Galsi-II and Bhatar are found to have constant instability in boro production in the district.

Table 1. Estimated Sub-period Growth Rates of Aus Area in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	-6.1 (-0.68)	18.2*** (2.11)	24.3 (1.56)	0.25 [2.42]	2.20
Ausgram-II	-21.0** (-2.25)	-2.3 (-0.20)	18.7 (1.04)	0.40*** [3.77]	2.29
Monteswar	-2.3 (-0.46)	-9.1*** (-1.76)	-6.8 (-0.74)	0.28*** [3.23]	2.19
Kalna-I	2.4 (0.33)	-36.0* (-4.94)	-38.4* (-2.99)	0.68* [17.22]	1.63
Kalna-II	-8.7** (-2.48)	1.1 (0.26)	9.8 (1.43)	0.35** [4.15]	2.54
Purbasthali-I	3.8 (0.31)	-17.3 (-0.91)	-21.1 (-0.76)	0.07 [0.45]	2.35
Purbasthali-II	6.2 (1.70)	-9.6** (-2.57)	-15.8** (-2.41)	0.29*** [3.34]	1.94
Katwa-I	-8.2 (-1.10)	7.5 (0.97)	15.7 (1.16)	0.07 [0.69]	2.03
Katwa-II	-5.2 (-0.39)	39.0 (1.45)	44.2 (1.21)	0.21 [1.23]	1.73
Mangalkote	-2.5 (-0.44)	-23.8* (-4.20)	-21.3** (-2.14)	0.656* [15.24]	1.93
Khandaghosh	-35.8 (-1.84)	3.0 (0.11)	38.8 (0.98)	0.35 [2.15]	2.77
Jamalpur	-10.2* (-3.65)	-12.9* (-4.53)	-2.7 (-0.55)	0.83* [40.48]	2.17
Memari-I	-3.5*** (-2.00)	0.7 (0.37)	4.2 (1.32)	0.23 [2.48]	1.91
Memari-II	0.2 (0.12)	-0.1 (-0.06)	-0.3 (-0.10)	0.00 [0.00]	2.25
Galsi-I	-	-	-	-	-
Galsi-II	17.9** (2.30)	-11.5 (-1.53)	-29.4** (-2.23)	0.35 [2.76]	1.93
Bhatar	-13.0 (-1.64)	-48.6* (-3.31)	-35.6 (-1.74)	0.70* [15.48]	1.56
Burdwan Sadar	-13.7** (-2.60)	-24.3* (-4.21)	-10.6 (-1.08)	0.78* [27.16]	2.27

Source: Author's calculation based on BAES data (1993-94 to 2012-13).

Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 2. Estimated Sub-period Growth Rates of Aus Production in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	-5.7 (-0.61)	20.6** (2.31)	26.3 (1.63)	0.30*** [3.03]	2.18
Ausgram-II	-20.9** (-2.20)	1.5 (0.13)	22.4 (1.22)	0.36*** [3.09]	2.27
Monteswar	-3.5 (-0.48)	-5.8 (-0.78)	-2.3 (-0.17)	0.11 [0.99]	2.49
Kalna-I	-2.1 (-0.27)	-32.2* (-4.19)	-31.1** (-2.23)	0.64* [14.43]	1.50
Kalna-II	-5.1 (-1.34)	1.2 (0.26)	6.3 (0.85)	0.12 [1.11]	2.76
Purbasthali-I	16.8 (1.23)	-19.0 (-0.88)	-35.8 (-1.14)	0.12 [0.78]	2.76
Purbasthali-II	4.9 (0.82)	-5.8 (-0.94)	-10.7 (-0.99)	0.05 [0.50]	1.81
Katwa-I	-6.6 (-0.86)	9.6 (1.29)	16.2 (1.21)	0.10 [0.85]	2.44
Katwa-II	-8.5 (-0.57)	33.8 (1.09)	42.3 (1.01)	0.10 [0.60]	1.69
Mangalkote	-4.6 (-0.83)	-19.7* (-3.51)	-15.1 (-1.53)	0.61 [12.52]	1.96
Khandaghosh	-35.7 (-1.81)	4.6 (0.17)	40.3 (1.00)	0.33 [2.00]	2.77
Jamalpur	-8.5** (-2.42)	-12.0* (-3.29)	-3.5 (-0.53)	0.71* [19.81]	2.23
Memari-I	-0.6 (-0.23)	-0.6 (-0.21)	0.0 (0.00)	0.01 [0.12]	1.80
Memari-II	0.0 (0.01)	1.8 (0.73)	1.8 (0.40)	0.05 [0.41]	2.11
Galsi-I	-	-	-	-	-
Galsi-II	18.8** (2.46)	-9.8 (-1.33)	-28.6*** (-2.22)	0.37*** [3.05]	2.00
Bhatar	-15.2*** (-1.83)	-43.2** (-2.79)	-28.0 (-1.30)	0.67* [13.26]	1.56
Burdwan Sadar	-12.3** (-2.21)	-22.4* (-3.69)	-10.1 (-0.98)	0.73* [20.39]	2.23

Source: Author's calculation based on BAES data (1993-94 to 2012-13).
Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 3. Estimated Sub-period Growth Rates of Aus Yield in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	-0.1 (-0.11)	2.0*** (1.99)	2.1 (1.19)	0.26*** [2.82]	1.62

Ausgram-II	0.1 (0.06)	3.8*** (2.07)	3.7 (1.27)	0.35*** [2.99]	2.29
Monteswar	-1.2 (-0.31)	3.4 (0.84)	4.6 (0.65)	0.04 [0.38]	2.30
Kalna-I	1.1 (0.88)	-0.5 (-0.38)	-1.6 (-0.70)	0.04 [0.40]	1.63
Kalna-II	3.6* (3.25)	0.0 (0.01)	-3.6 (-1.65)	0.51* [8.06]	2.70
Purbasthali-I	10.4 (1.339)	1.6 (0.13)	-8.8 (-0.48)	0.21 [1.51]	2.62
Purbasthali-II	-1.3 (-0.29)	3.8 (0.84)	5.1 (0.64)	0.04 [0.38]	1.90
Katwa-I	-0.1 (-0.19)	1.5 (1.42)	1.6 (0.86)	0.15 [1.42]	1.31
Katwa-II	2.7 (1.65)	-6.9*** (-2.05)	-9.6*** (-2.10)	0.30 [2.22]	2.08
Mangalkote	-2.1 (-1.256)	4.0** (2.34)	6.1*** (2.03)	0.25*** [2.76]	1.26
Khandaghosh	0.2 (0.19)	1.3 (0.84)	1.1 (0.46)	0.13 [0.61]	2.02
Jamalpur	1.6 (1.34)	1.0 (0.78)	-0.6 (-0.30)	0.25*** [2.78]	1.93
Memari-I	2.9** (2.52)	-1.2 (-1.042)	-4.1*** (-1.99)	0.29*** [3.32]	1.54
Memari-II	-0.2 (-0.12)	1.9 (1.47)	2.1 (0.90)	0.15 [1.50]	2.24
Galsi-I	-	-	-	-	-
Galsi-II	0.7 (0.52)	1.5 (1.26)	0.8 (0.41)	0.24 [1.63]	2.18
Bhatar	-2.0 (-1.70)	5.3** (2.38)	7.3** (2.37)	0.30*** [2.90]	2.50
Burdwan Sadar	1.4 (1.39)	1.9 (1.64)	0.5 (0.22)	0.41** [5.31]	1.44

Source: Author's calculation based on BAES data (1993-94 to 2012-13).

Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 4. Estimated Sub-period Growth Rates of Aman Area in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	1.8** (2.20)	0.0 (0.04)	-1.8 (-1.20)	0.32** [3.78]	2.47
Ausgram-II	0.6 (0.60)	1.4 (1.38)	0.8 (0.45)	0.23 [2.46]	2.43
Monteswar	-0.7 (-0.56)	1.1 (0.81)	1.8 (0.77)	0.04 [0.33]	2.15

Kalna-I	0.6 (0.28)	3.0 (1.49)	2.4 (0.69)	0.21 [2.15]	1.35
Kalna-II	-0.1 (-0.15)	0.6 (0.75)	0.7 (0.51)	0.04 [0.35]	1.54
Purbasthali-I	1.4 (0.592)	2.7 (1.12)	1.3 (0.31)	0.18 [1.82]	2.63
Purbasthali-II	-5.2 (-1.67)	0.6 (0.18)	5.8 (1.03)	0.19 [1.88]	2.23
Katwa-I	1.5 (1.21)	0.2 (0.13)	-1.3 (-0.59)	0.13 [1.29]	1.48
Katwa-II	0.1 (0.03)	1.4 (0.60)	1.3 (0.32)	0.03 [0.30]	2.18
Mangalkote	0.7 (-0.72)	1.3 (1.32)	2.0 (1.15)	0.09 [0.88]	2.34
Khandaghosh	1.6** (2.26)	-0.6 (-0.81)	-2.2 (-1.71)	0.25*** [2.75]	2.44
Jamalpur	2.9* (3.06)	1.9*** (1.94)	-1.0 (-0.59)	0.65* [15.31]	2.31
Memari-I	-0.6 (-0.79)	1.6** (2.16)	2.2 (1.67)	0.23 [1.51]	1.80
Memari-II	-4.0* (-3.85)	1.8 (1.63)	5.8* (3.06)	0.49* [7.73]	1.90
Galsi-I	0.4 (0.13)	-4.5 (-1.31)	-4.9 (-0.81)	0.12 [1.16]	2.50
Galsi-II	0.6 (0.87)	-0.6 (-0.80)	-1.2 (-0.94)	0.05 [0.45]	2.40
Bhatar	0.00 (0.01)	-0.2 (-0.20)	-0.2 (-0.12)	0.00 [0.02]	2.71
Burdwan Sadar	1.3 (1.39)	-0.4 (-0.43)	-1.7 (-1.02)	0.12 [1.08]	2.32

Source: Author's calculation based on BAES data (1993-94 to 2012-13).
Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 5. Estimated Sub-period Growth Rates of Aman Production in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	4.7 (1.02)	-2.9 (-0.62)	-7.6 (-0.92)	0.06 [0.52]	2.29
Ausgram-II	4.7** (2.65)	2.1 (1.15)	-2.6 (-0.84)	0.53* [9.07]	1.53
Monteswar	-8.3 (-1.29)	7.1 (1.06)	15.4 (1.32)	0.10 [0.90]	2.48
Kalna-I	0.7 (0.23)	5.3*** (1.74)	4.6 (0.86)	0.25*** [2.73]	1.31
Kalna-II	1.8 (1.17)	-1.0 (-0.62)	-2.8 (-1.00)	0.07 [0.68]	1.67

Purbasthali-I	-2.9 (-0.51)	4.7 (0.81)	7.6 (0.75)	0.04 [0.33]	1.76
Purbasthali-II	-7.7 (-0.96)	5.2 (0.63)	12.9 (0.89)	0.05 [0.46]	2.29
Katwa-I	3.2 (1.69)	1.3 (0.68)	-1.9 (-0.55)	0.31*** [3.59]	1.53
Katwa-II	-1.3 (-0.32)	4.6 (1.09)	5.9 (0.80)	0.07 [0.67]	2.05
Mangalkote	-1.5 (-0.39)	3.0 (0.78)	4.5 (0.66)	0.03 [0.31]	1.88
Khandaghosh	1.7 (1.58)	0.5 (0.46)	-1.2 (-0.61)	0.25*** [2.71]	2.29
Jamalpur	4.3* (3.36)	0.3 (0.21)	-4.0 (-1.74)	0.53* [9.26]	2.43
Memari-I	0.0 (0.02)	1.9 (1.50)	1.9 (0.84)	0.18 [1.76]	1.70
Memari-II	-4.4 (-1.72)	1.3 (0.49)	5.7 (1.24)	0.17 [1.69]	1.85
Galsi-I	0.6 (0.18)	-3.3 (-0.94)	-3.9 (-0.64)	0.06 [0.55]	2.54
Galsi-II	1.5 (1.22)	0.7 (0.57)	-0.8 (-0.35)	0.20 [2.01]	2.34
Bhatar	0.0 (0.00)	1.8 (0.78)	1.8 (0.43)	0.05 [0.46]	2.16
Burdwan Sadar	4.4* (3.52)	-1.2 (-0.91)	-5.6** (-2.47)	0.47* [7.23]	1.58

Source: Author's calculation based on BAES data (1993-94 to 2012-13).
Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 6. Estimated Sub-period Growth Rates of Aman Yield in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	4.1* (4.54)	0.2 (0.21)	-3.9** (-2.39)	0.67* [16.59]	1.78
Ausgram-II	3.2*** (1.97)	0.7 (0.41)	-2.5 (-0.86)	0.32** [3.82]	1.72
Monteswar	-2.2 (-0.56)	1.8 (0.45)	4.0 (0.57)	0.02 [0.17]	2.20
Kalna-I	0.3 (0.20)	2.1 (1.53)	1.8 (0.75)	0.20 [2.10]	1.67
Kalna-II	1.9*** (1.99)	-1.6 (1.56)	-3.5*** (-1.99)	0.20 [2.11]	2.04
Purbasthali-I	-1.1 (-0.25)	1.3 (0.30)	2.4 (0.31)	0.00 [0.05]	1.75
Purbasthali-II	-2.5 (-0.48)	4.7 (0.89)	7.2 (0.78)	0.04 [0.40]	2.26
Katwa-I	1.7	1.1	-0.6	0.33**	1.96

	(1.55)	(1.01)	(-0.28)	[4.04]	
Katwa-II	-1.4 (-0.57)	3.2 (1.26)	4.6 (1.03)	0.09 [0.81]	1.98
Mangalkote	-0.8 (-0.26)	1.8 (0.55)	2.6 (0.45)	0.01 [0.15]	1.84
Khandaghosh	0.1 (0.08)	1.1 (1.38)	1.0 (0.73)	0.16 [1.56]	2.23
Jamalpur	1.8*** (1.75)	-1.7 (-1.60)	-3.5*** (-1.89)	0.18 [1.80]	1.64
Memari-I	0.7 (0.85)	0.3 (0.37)	-0.4 (-0.25)	0.10 [0.94]	1.24
Memari-II	-0.3 (-0.18)	-0.5 (-0.24)	-0.2 (0.03)	0.01 [0.11]	2.07
Galsi-I	0.1 (0.05)	1.4 (1.47)	1.3 (0.80)	0.17 [1.72]	2.36
Galsi-II	1.3 (1.57)	0.9 (1.08)	-0.4 (-0.25)	0.34** [4.27]	2.04
Bhatar	0.00 (0.00)	1.9 (1.06)	1.9 (0.60)	0.09 [0.86]	2.11
Burdwan Sadar	3.1** (2.86)	-0.7 (-0.67)	-3.8*** (-1.97)	0.37** [4.86]	2.18

Source: Author's calculation based on BAES data (1993-94 to 2012-13).
Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 7. Estimated Sub-period Growth Rates of Boro Area in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	-0.6 (-0.07)	-6.4 (-0.82)	-5.8 (-0.42)	0.06 [0.57]	2.79
Ausgram-II	-5.8 (-0.89)	-19.0** (-2.83)	-13.2 (-1.11)	0.52* [8.93]	2.52
Monteswar	5.7*** (2.00)	-6.9** (-2.35)	-12.6** (-2.45)	0.27*** [3.06]	1.50
Kalna-I	4.3 (1.51)	-4.8 (-1.64)	-9.1*** (-1.77)	0.16 [1.58]	1.50
Kalna-II	3.4** (2.15)	-7.6* (-4.63)	-11.0* (-3.82)	0.57* [10.59]	1.47
Purbasthali-I	0.9 (0.55)	-1.1 (-0.69)	-2.0 (-0.69)	0.03 [0.22]	2.25
Purbasthali-II	-1.3 (-0.73)	-6.3* (-3.76)	-5.0 (-1.66)	0.65* [13.13]	2.15
Katwa-I	9.9* (5.95)	1.0 (0.59)	-8.9* (-2.96)	0.79* [30.36]	1.94
Katwa-II	4.5 (1.66)	-0.5 (-0.19)	-5.0 (-1.03)	0.18 [1.84]	1.36
Mangalkote	4.1**	6.8*	2.7	0.72*	1.29

	(2.26)	(3.61)	(0.80)	[21.11]	
Khandaghosh	4.3 (1.27)	0.0 (-0.01)	-4.3 (-0.74)	0.14 [1.18]	2.06
Jamalpur	9.1 (1.22)	-32.5* (-4.25)	-41.6* (-3.09)	0.56* [10.26]	1.83
Memari-I	4.0 (0.95)	-15.7* (-3.66)	-19.7** (-2.61)	0.49* [7.78]	2.33
Memari-II	0.7 (0.26)	-11.5* (-4.00)	-12.2** (-2.42)	0.58* [11.32]	1.22
Galsi-I	12.8 (1.04)	-36.7* (-2.91)	-49.5* (-2.23)	0.36** [4.59]	1.78
Galsi-II	5.6 (1.55)	-7.1*** (-1.92)	-12.7*** (-1.95)	0.20 [1.99]	1.61
Bhatar	10.6** (2.66)	-4.7 (-1.14)	-15.3** (-2.12)	0.31** [3.68]	1.54
Burdwan Sadar	3.4** (2.27)	-6.9* (-4.46)	-10.3* (-3.80)	0.55* [10.07]	2.75

Source: Author's calculation based on BAES data (1993-94 to 2012-13).
Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 8. Estimated Sub-period Growth Rates of Boro Production in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	0.4 (0.04)	-4.6 (-0.55)	-5.0 (-0.34)	0.02 [0.21]	2.66
Ausgram-II	-8.0 (-1.28)	-16.3** (-2.56)	-8.3 (-0.74)	0.53* [9.19]	2.73
Monteswar	3.0 (0.99)	-7.6** (-2.42)	-10.6*** (-1.93)	0.27*** [3.07]	1.63
Kalna-I	4.2 (1.35)	-6.1*** (-1.93)	-10.3*** (-1.85)	0.19 [1.90]	1.43
Kalna-II	6.3* (3.43)	-8.9* (-4.73)	-15.2* (-4.60)	0.59* [11.55]	1.34
Purbasthali-I	3.1 (1.51)	-6.9* (-3.27)	-10.0** (-2.70)	0.40** [5.48]	1.47
Purbasthali-II	-1.0 (-0.46)	-6.5* (-3.20)	-5.5 (-1.50)	0.56* [8.98]	2.29
Katwa-I	9.4* (4.571)	2.5 (1.20)	-6.9*** (-1.84)	0.73* [21.86]	1.93
Katwa-II	4.7 (1.38)	-2.3 (-0.65)	-7.0 (-1.14)	0.10 [0.98]	1.20
Mangalkote	4.3 (1.72)	7.5* (2.92)	3.2 (0.71)	0.62* [13.24]	1.44
Khandaghosh	2.2 (0.69)	1.1 (0.37)	-1.1 (-0.19)	0.08 [0.66]	2.06
Jamalpur	7.5 (0.91)	-30.2* (-3.58)	-37.7** (-2.54)	0.48* [7.46]	1.84

Memari-I	4.1 (0.87)	-14.9* (-3.08)	-19.0** (-2.23)	0.40** [5.39]	2.05
Memari-II	3.6 (1.19)	-19.3* (-6.73)	-22.9 (-4.42)	0.79* [27.73]	1.19
Galsi-I	12.1 (0.96)	-37.8* (-2.94)	-49.9** (-2.20)	0.37** [4.75]	1.82
Galsi-II	4.9 (1.28)	-7.0*** (-1.80)	-11.9 (-1.74)	0.17 [1.67]	1.59
Bhatar	10.9** (2.72)	-6.0 (-1.47)	-16.9** (-2.34)	0.31** [3.72]	1.48
Burdwan Sadar	2.1 (1.08)	-7.1* (-3.60)	-9.2** (-2.64)	0.47* [7.27]	2.02

Source: Author's calculation based on BAES data (1993-94 to 2012-13).
Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 9. Estimated Sub-period Growth Rates of Boro Yield in Burdwan, 1993-94 to 2002-03 and 2003-04 to 2012-13.

Block Name	1st Sub-Period	2nd Sub-Period	Trend Break	R^2	DW
Ausgram-I	-2.1 (-1.03)	2.2 (1.04)	4.3 (1.17)	0.07 [0.68]	1.79
Ausgram-II	-2.0 (-1.21)	2.0 (1.18)	4.0 (1.34)	0.10 [0.91]	2.02
Monteswar	-2.7* (-3.14)	-0.7 (-0.78)	2.0 (1.29)	0.56* [10.18]	2.44
Kalna-I	-1.0 (-0.68)	-0.3 (-0.19)	0.7 (0.29)	0.06 [0.48]	1.60
Kalna-II	3.1*** (1.77)	-2.0 (-1.11)	-5.1 (-1.61)	0.16 [1.58]	2.45
Purbasthali-I	2.4 (1.14)	-6.3* (-2.98)	-8.7** (-2.33)	0.37** [4.71]	1.72
Purbasthali-II	1.1 (0.87)	-1.2 (-0.96)	-2.3 (-1.03)	0.06 [0.54]	1.58
Katwa-I	-0.4 (-0.26)	0.9 (0.63)	1.3 (0.50)	0.02 [0.20]	1.23
Katwa-II	-0.1 (-0.04)	-1.5 (-0.80)	-1.6 (-0.43)	0.06 [0.52]	1.67
Mangalkote	0.4 (0.21)	0.1 (0.06)	-0.3 (-0.08)	0.00 [0.05]	1.79
Khandaghosh	-1.7 (-1.27)	0.5 (0.35)	2.2 (0.90)	0.10 [0.92]	1.55
Jamalpur	-1.4 (-0.64)	1.7 (0.76)	3.1 (0.79)	0.03 [0.32]	1.37
Memari-I	0.3 (0.19)	0.2 (0.11)	-0.1 (-0.04)	0.00 [0.06]	1.62
Memari-II	2.5** (2.31)	-5.5* (-4.95)	-8.0* (-4.10)	0.61* [12.54]	2.09

Galsi-I	-0.5 (-0.35)	-1.7 (-1.11)	-1.2 (-0.43)	0.14 [1.38]	1.95
Galsi-II	-0.7 (-0.49)	0.1 (0.05)	0.8 (0.30)	0.02 [0.16]	2.04
Bhatar	0.4 (0.26)	-1.9 (-1.26)	-2.3 (-0.86)	0.10 [0.96]	1.79
Burdwan Sadar	0.8 (0.60)	-1.5 (-1.13)	-2.4 (-0.97)	0.08 [0.63]	2.39

Source: Author's calculation based on BAES data (1993-94 to 2012-13).
Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level. t- Values are within parentheses and F values are within square bracket.

Table 10. Nature of Instability in Aus, Aman and Boro Production in Major Blocks in Burdwan, 1993-94 to 2012-13

Block Name	Aus		Aman		Boro	
	$\hat{b}$ (Parametric)	Rank correlation (Non-parametric)	$\hat{b}$ (Parametric)	Rank correlation (Non-parametric)	$\hat{b}$ (Parametric)	Rank correlation (Non-parametric)
Ausgram-I	-0.02** (-2.43)	-0.61 (0.00)	0.00 (1.51)	0.48 (0.03)	0.01* (2.92)	0.59 (0.00)
Ausgram-II	0.03 (1.67)	0.76 (0.00)	0.00 (0.10)	0.04 (0.84)	0.00** (2.17)	0.56 (0.01)
Monteswar	0.00 (0.30)	0.18 (0.44)	0.00 (0.06)	0.09 (0.70)	0.00** (2.74)	0.34 (0.14)
Kalna-I	0.03* (3.84)	0.77 (0.00)	-0.00 (-0.44)	-0.01 (0.96)	-0.00*** (-1.89)	-0.31 (0.18)
Kalna-II	-0.00 (-1.08)	-0.38 (0.11)	0.00 (0.20)	0.14 (0.55)	0.00 (-0.45)	-0.06 (0.78)
Purbasthali-I	-0.30 (-0.37)	-0.32 (0.25)	-0.00 (-0.31)	-0.02 (0.92)	0.00 (-0.19)	0.00 (0.99)
Purbasthali-II	-0.00 (-0.79)	-0.26 (0.26)	-0.00 (-0.43)	0.03 (0.88)	0.00 (0.02)	0.11 (0.66)
Katwa-I	-0.01 (-1.23)	-0.37 (0.13)	0.00 (-0.39)	0.01 (0.94)	-0.00 (-1.58)	-0.33 (0.16)
Katwa-II	-0.01 (-0.21)	-0.02 (0.94)	-0.00 (-1.43)	-0.52 (0.02)	-0.00 (-1.16)	-0.25 (0.28)
Mangalkote	0.01* (7.02)	0.90 (0.00)	0.00 (0.14)	-0.02 (0.91)	0.00 (0.54)	0.18 (0.45)
Khandaghosh	0.01 (0.37)	0.39 (0.23)	0.00 (-0.39)	-0.10 (0.67)	-0.00 (-0.39)	-0.15 (0.56)
Jamalpur	0.00** (2.55)	0.53 (0.01)	-0.00*** (-1.86)	-0.38 (0.09)	0.02* (4.95)	0.62 (0.00)
Memari-I	-0.00 (-0.87)	-0.25 (0.29)	-0.00 (-0.87)	-0.23 (0.33)	0.00* (3.28)	0.51 (0.02)
Memari-II	-0.00 (-0.63)	-0.21 (0.37)	-0.00 (-0.49)	-0.14 (0.54)	0.00** (2.52)	0.40 (0.08)

Galsi-I	-	-	0.00** (2.50)	0.52 (0.02)	0.03* (4.66)	0.50 (0.02)
Galsi-II	-0.00 (-0.86)	-0.26 (0.38)	0.00 (-0.57)	-0.18 (0.45)	0.00 (0.51)	0.10 (0.66)
Bhatar	0.08* (3.29)	0.56 (0.02)	0.00 (-0.33)	0.02 (0.90)	0.00 (0.67)	0.13 (0.58)
Burdwan Sadar	0.00 (0.82)	0.18 (0.47)	0.00 (0.87)	0.13 (0.57)	-0.00*** (-1.83)	-0.35 (0.13)

Source: Author's calculation based on BAES data (1993-94 to 2012-13).

Notes: * Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level, $\hat{b}$ is the parameter estimated from $|X_t| = a + bt$.

6. Conclusions

The production growth rate of rice is significantly positive in a few blocks but most of the blocks in the district are having either negative or no growth in production in both the sub-periods. The production instability is also found to be either significantly positive or remains constant for most of the blocks in the district in respect of rice crops. Area is the responsible factor for negative growth in rice crops. In recent time population has increased rapidly but the agricultural land remains more or less constant. As a result of it most of the forest areas and fallow lands have been turned into cultivable agricultural lands. Irrigation facility has also improved and the drought prone areas have come under the new irrigation system. So gross cultivated area is increasing but the production and productivity growth rate of rice are negative or remain constant in recent year. Possibly the farmers change their cropping pattern to new cash crops, due to which the growth rate of area for rice crop remains either negative or constant over time. Productivity growth also remained constant for traditional crops. From this scenario we may come to conclusions that the deceleration hypothesis remains valid in the growth rate of rice crop in the district during the study period.

7. Policy Suggestions

From the foregoing analysis we can suggest the following three policies for the improvement of agricultural sector in general and rice production in particular in the district:

1. The irrigation system is poor in the district. Only 46 percent of agricultural area is under irrigation system and the remaining portion of the agricultural land depends on rainfall. In recent times, weather condition changes due to various types of pollution. As a result, annual average rainfall remains erratic and scantly in the district. The government should take various steps like, establishing new canals, deep tube wells and submersibles, digging ponds and using surface water, promoting drought resistant crops etc. to cope with the vagaries of monsoon and to control the uncertainties in farming.
2. In recent time enormous rise in price of agricultural inputs coupled with more or less constancy in output price leads to deterioration in the economic condition of the farmers. Also the farmers take loan from unorganized sector at a higher rate of interest and often they fall under debt trap. If the government takes various liberal debt policies for providing loans to the farmers at a low rate of interest and promotes co-operative and contract farming, the agricultural condition of the farmers will be better in future.
3. Marketing facility is very poor in the district. There are only 5 Principle markets and 47 regulated sub-markets in the district by which all the regions of the district are not covered. As a result, most of the farmers cannot sell their product at a reasonable price in these markets. They have to sell their products to retailers or pretty traders at a very low price incurring huge loss. If the government establishes many types of new agricultural market facility the farmers will get satisfactory price for their product in future.

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