

Chapter-V

Agricultural Growth: Variability and Instability in Production and Productivity of Foodgrains and Non-Foodgrains in West Bengal

5.1 Introduction

The preceding chapter attempted to examine the dominance of rice in agricultural production, especially foodgrain production in West Bengal. Therefore, rice demands a deeper probe. In this connection, the present chapter deals with the changing share of aman, aus and boro to total rice production, absolute change in their productivity over the periods, the growth in production, area and productivity of aus, aman, boro, in pre-defined different sub-periods, viz. sub-period I (1970-71 to 1979-80); sub-period II (1980-81 to 1989-90); sub-period III (1990-91 to 1999-2000); sub-period IV (2000-01 to 2008-09). In the periodic analysis, variability in production, area and productivity at state level have taken into consideration in this chapter. Further, to note that growth rate in production and productivity of foodgrain as well as rice has been taken declining since 1990-91 and the decline becomes more prominent since 2000-01. It has further been attempted has also been made to identify the nature of acceleration or deceleration of production of foodgrain, rice and wheat at the state level as well as at district level in pre-defined sub-periods and for the whole period. An analysis has also been carried out to understand the nature and extent of growth in production, area and productivity, variability in the sub period growth rates of production and productivity as well as the changing dynamics in the trend of growth rates of production and productivity of foodgrain and non-foodgrain in West Bengal since 1970-71 to 2008-09. The present chapter makes an attempt to study the impact of weather variable such as rainfall on production of different crops, and to differentiate the growth rates of crops.

5.2 Methodology of the Study

The following statistical techniques and tools are used in this chapter.

5.2.1 Growth Measurement over Sub-Periods

Kinked Exponential model has again been used here to study the sub-period growth rates of production, area and productivity for aman, aus and boro rice and also for select non-foodgrains.

5.2.2 Acceleration and Deceleration in Growth Rates

The acceleration or deceleration (or constants) of growth and/or growth rates or changes in the growth rates of any major components has also been measured. The method followed here has also been undertaken and explained in Chapter-III.

5.2.3 Weather Adjusted Growth Rates

A question is raised in various growth literature that the extent to which growth as estimated earlier could be due to exceptionally good rainfall or weather conditions or does the rainfall¹ factor could impact the production level of agricultural output.

An attempt has been made in this study to develop an improved and updated weighting scheme in constructing a rainfall index for foodgrains.

Unadjusted and weather adjusted growth rates in foodgrains production have been estimated by using the following log-linear functions, respectively.

$$\ln y_t = a + bt \quad (1)$$

$$\ln y_t = a + ct + d \ln w_t + u_t \quad (2)$$

Where y_t is the foodgrain production, w_t is the production rainfall or weather index, coefficient b in equation (1) gives the unadjusted trend growth rate and coefficient c is the weather adjusted trend growth rate, while coefficient d can be interpreted as the weather elasticity of production with respect to rainfall. This equation has been estimated using the index of total agricultural output for all districts.

5.2.4 Measuring Instability of Growth in Agricultural Production

An analysis of fluctuations in agricultural production, apart from growth, is of importance for understanding the nature of food security at the regional level. Instability² is considered as the flip side of stability measures and it deals with the extent and nature of fluctuations in agricultural production.

In this study, the method followed by Boyce (1987), Saha and Swaminathan (1994) and Mahendradev (1987) have been used to measure the instability in production. Similar method has been adopted for the calculation of districtwise instability coefficients of production of foodgrains, rice, wheat, pulses and other cereals for the period 1970-71 to 2008-09. Based on actual value of production for the period 1970-71 to 2008-09, an exponential trend line was

fitted and exponential growth rate has been calculated. Predicted values are calculated for the successive periods from 1970-71 to 2008-09.

The difference between the actual values and predicted values, crop output are calculated and the differences are expressed as the percentage of the predicted value (see Boyce, *op.cit.*: 273).

$$z_t = \frac{Y_t - \hat{Y}_t}{\hat{Y}_t}$$

Y_t = Actual output at period t

\hat{Y}_t = Predicted value of output at period t.

The square of these percentage deviations are calculated and regressed against time. The estimated coefficient of time (t) is considered as instability coefficient. If the estimated coefficient on time is positive, it may be considered that the instability has increased and if the coefficients assume negative values then it can be said that instability has decreased. The t-stat of the coefficient indicates the strength of the trend.

5.3 Aus, Aman and Boro in West Bengal

In West Bengal, one normally finds three principal rice growing seasons. During spring season, from late-April to July, aus is grown. With the onset of monsoon in June (kharif season), aman is cultivated and it ends in October and November with the harvest of aman rice. During winter, in rabi season (beginning in November), boro is cultivated and generally in March the harvest process starts. In the dry rabi season, irrigation helps or allows farmers to switch from relatively low-yielding unirrigated crops to higher yielding irrigated crops (Boyce, 1987:11).

In terms of percentage of production and area under cultivation of rice in West Bengal (Table 5.1), aman has overwhelming domination in terms of production and area under cultivation. In 1970-71, more than 75 percent rice production in the state was alone contributed by aman and more than 75 percent area under cultivation of rice was utilised for growing aman rice. It was continued to increase till 1980-81 and there after a fall in contribution of aman to total rice production as well as area under cultivation was observed. In 2000-01, the share of aman production to total rice production and area under cultivation as percentage of area under rice production reached the lowest level but an upsurge in share of production and area was

observed between 2000-01 and 2008-09. So far as aus is concerned, it has never been a major contributor to the rice production in the state, its share to total rice production as well as area under cultivation as percentage of area under total rice production consistently declined since 1970-71. In 2008-09, the percentage share of aus to total rice production and area under aus as percentage of total area under aus stood at mere 4.02 percent and 4.95 percent respectively.

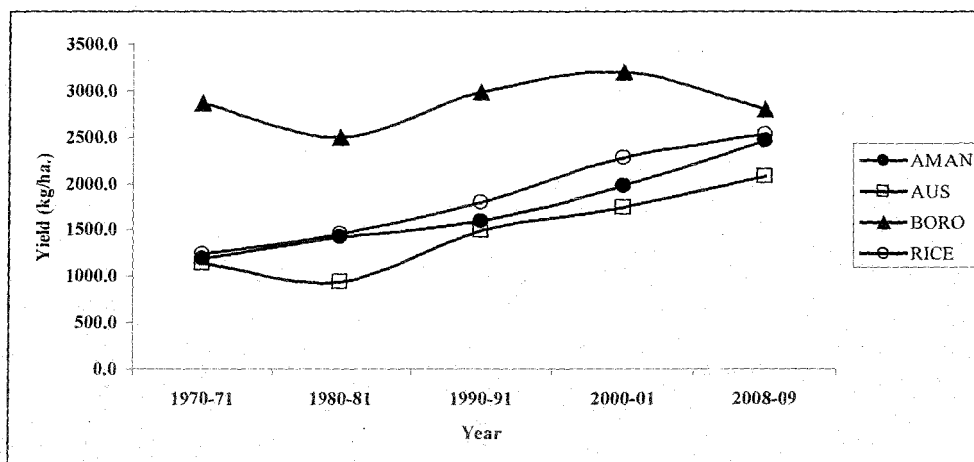
The fall in percentage share of aman and aus to total rice production and total area under rice, especially after 1980-81, were compensated by the rise in production as well as area under cultivation of boro. In comparison to 1980-81, production increased by 1.6 times and area under cultivation of boro increased almost four times. Boro is primarily a high-yielding variety and needs to be supported by irrigation. Comparison of productivity or yield of aman, aus and boro reveals that during 1970-71, the productivity of aman and aus was much lower in comparison to boro rice. But a close look suggests that productivity of aman and aus gradually increased over the periods while for boro, the yield increased and reached a peak (3020 kg/ha) in 2000-01, thereafter it started declining. But from 1970-71 to 2008-09, the productivity of boro remained much higher in comparison to the productivity of aman and aus.

Table 5.1: Production and Area under cultivation of Aman, Aus, Boro as percentage of Production and Area under cultivation of Rice in West Bengal

Year	Aman	Aus	Boro	Aman	Aus	Boro
	Production (in percentage)			Area (in percentage)		
1970-71	76.46	14.82	8.72	80.11	16.13	3.76
1975-76	75.93	10.88	13.18	78.16	15.93	5.91
1980-81	79.89	8.64	11.48	81.42	11.88	6.69
1985-86	73.78	8.74	17.48	80.40	9.51	10.09
1990-91	65.78	8.69	25.53	74.09	10.50	15.42
1995-96	64.06	7.19	28.75	71.94	8.58	19.49
2000-01	58.19	5.53	36.29	66.96	7.25	25.79
2005-06	67.94	4.17	27.89	71.12	4.98	23.90
2008-09	67.00	4.02	28.98	68.85	4.93	26.23

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Figure 5.A: Yield (kg/ha) of Aman, Aus, Boro and Rice in West Bengal from 1970-71 to 2008-09



Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

5.3.1 Trends in Production, Productivity and Area under Cultivation of Aman, Aus, Boro in West Bengal

The exponential growth rates vis-à-vis compound annual growth rates during 1970-71 to 2008-09 (Table 5.2) reveals that production of aman grew at an annual rate of 2.4 percent per annum while aus achieved negative and insignificant rate and boro grew at a phenomenal rate of 6.3 percent and is statistically significant at 1 percent level (as per T-stat). For aman, growth in area turned out to be insignificant, for aus it achieved high negative value and for boro, growth in area was found to be 5.8 percent per annum. In productivity frontier, both aman and aus grew at exponential rates of 2.4 percent and 2.8 percent respectively, where as, the growth in productivity of boro was much less and it was a mere 0.5 percent. Therefore, the picture so emerged suggests that growth in production for Aman was primarily driven by the growth in productivity where as for boro, growth in area became the driving force. For aus, declining area under cultivation has offset the positive impact of growth in productivity and hence growth in production became negative and insignificant.

It has been observed that the estimated growth rates in each sub-period may be higher or lower than that in the period as a whole and therefore, to calculate the exponential growth rate simultaneously for four sub-periods, viz. sub-period I (1970-71 to 1979-80), sub-period II (1980-81 to 1989-90), sub-period III (1990-91 to 1999-2000) and sub-period IV (2000-01 to 2008-09), kinked exponential model has been used here also.

In sub-period I, growth in production, productivity and area under cultivation achieved positive values (less than 1 percent) but remained statistically insignificant. For aus, growth

in production, area and productivity achieved negative growth rates and these rates are statistically significant at 1 percent level. So far as boro is concerned, in the first sub-period, it achieved positive growth rates of production, area and productivity but they remained statistically insignificant. And as a cumulative impact, we observed that in the growth rate for rice for the first sub-period was meagre and statistically insignificant.

Table 5.2: Exponential Growth and CAGR in Production, Area and Productivity of Aman, Aus, Boro and Rice in West Bengal

	Production	Area	Productivity	Production	Area	Productivity
	Exponential Growth			CAGR		
Aman	2.4 (13.0)*	0.1 (1.0)	2.4 (15.2)*	2.03	0.08	1.95
Aus	-0.1 (-0.5)	-2.9 (-18.7)*	2.8 (13.8)*	-1.07	-2.61	1.58
Boro	6.3 (18.8)*	5.8 (17.2)*	0.4 (2.4)*	5.67	5.74	-0.07
Rice (Total)	3.0 (17.1)*	0.5 (8.1)*	2.5 (17.9)*	2.39	0.48	1.90

*T Stat are shown in parenthesis, * Significant at 1 percent level*

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

In sub-period II, a trend break was observed for the growth in production and productivity of Aman and for area and production of boro. In comparison to sub-period I, the growth rate in production and productivity of aman was increased by 2.8 percent and 3.1 percent respectively in sub-period II. Growth in area for aman remained at less than 1 percent and also statistically insignificant, and therefore, growth in production was primarily attributed to growth in productivity. For aus, there was impressive rise in growth in production that took place in sub-period II. In fact, growth in production increased by 10 percent in comparison to sub-period I, and it was solely driven by the growth in productivity. As a matter of fact, growth in area under aus was negative and statistically significant during sub-period II. Again, in comparison to sub-period I, growth rate in production and area under cultivation for boro increased by 7.9 percent and 9.6 percent respectively in sub-period II, which is phenomenal by any yardstick. However, growth in productivity of boro was negative. Therefore, impressive growth in production of boro was achieved through area expansion. In sub-period III and IV aman experienced decline in growth in production and productivity although in sub-period III a marginal increase in growth of area has been observed. For aus, a decline in growth in production and productivity and area were observed, however, the decline in growth in production in sub-period-IV and decline in growth in area in sub-periods III and IV were quite substantial and significant. Drastic fall in growth in area was the

obvious reason for a significant fall in growth in production of rice. In case of boro, though a very high growth rate in production was maintained, 8.8 percent and 6.1 percent respectively in sub-period III and IV, therefore, in comparison to sub-period II, a sharp decline has been observed. A significant decline in area has also been observed. In addition, growth in productivity remained at low level and also found to be statistically significant. Therefore, the spurt in growth in production and area that was observed in sub-period-II for boro could not be sustained in sub-period III and IV.

Table 5.3: Kinked Exponential Growth in Production, Area and Productivity of Aman, Aus and Boro in West Bengal for (1970-71 to 1979-80), (1980-81 to 1989-90), (1990-91 to 1999-2000) and (2000-01 to 2008-09)

	Sub-period Exp. Growth / Crop	Sub-period I (1970-71 to 1979-80)	Sub-period II (1980-81 to 1989-90)	Sub-period III (1990-91 to 1999- 2000)	Sub-period IV (2000-01 to 2008-09)	Trend break I	Trend break II	Trend break III	DW	R ²
Aman	Production	0.8	3.6	3.0	2.6	2.8	-0.6	-0.4	1.6	0.8
	T Stat	(0.7)	(3.5)*	(7.0)*	(9.4)*					
	Area	0.2	0.1	0.2	0.0	-0.1	0.1	-0.3	2.0	0.2
	T Stat	(0.7)	(0.4)	(1.8)**	(-0.3)					
	Productivity	0.5	3.5	2.9	2.7	3.1	-0.6	-0.3	1.7	0.9
	T Stat	(0.5)	(4.1)*	(8.2)*	(11.5)*					
Aus	Production	-5.8	4.1	2.4	0.6	10.0	-1.7	-1.8	1.0	0.5
	T Stat	(-4.7)*	(3.8)*	(5.2)*	(2.0)**					
	Area	-2.5	-1.7	-2.4	-3.1	0.8	-0.7	-0.7	1.2	0.9
	T Stat	(-2.9)*	(-2.2)*	(-7.4)*	(-15.0)*					
	Productivity	-2.6	4.8	4.4	3.5	7.4	-0.4	-0.9	1.1	0.9
	T Stat	(-3.1)*	(6.6)*	(14.5)*	(17.7)*					
Boro	Production	1.9	9.8	8.8	6.5	7.9	-1.1	-2.3	1.7	0.9
	T Stat	(1.2)	(6.9)*	(14.5)*	(16.7)*					
	Area	1.8	11.4	8.2	6.1	9.6	-3.2	-2.1	1.7	0.9
	T Stat	(1.1)	(8.0)*	(13.8)*	(15.9)*					
	Productivity	0.2	-1.5	0.6	0.4	-1.7	2.1	-0.2	1.7	0.3
	T Stat	(0.2)	(-1.7)***	(1.5)	(1.5)					

*T stats are shown in parenthesis, *Significant at 1% level, ** Significant at 5% level, ***Significant at 10% level*

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Table 5.4: Variability in Production, Area and Productivity of Aman, Aus and Boro in West Bengal in Four Sub-Periods (1970-71 to 1979-80), (1980-81 to 1989-90), (1990-91 to 1999-2000) and (2000-01 to 2008-09)

		Sub-Period I (1970-71 to 1979-80)		Sub-Period II (1980-81 to 1989-90)		Sub-Period III (1990-91 to 1999-2000)		Sub-Period-IV (2000-01 to 2008-09)	
		MEAN	C.V	MEAN	C.V	MEAN	C.V	MEAN	C.V
Aman	Production	4782.9	9.7	5920.9	21.6	7926.7	8.0	9428.1	9.4
	Area	4034.3	4.7	4114.6	2.6	4246.7	1.9	4060.3	4.9
	Productivity	1185.8	8.4	1439.2	20.2	1866.2	7.5	2312.2	6.7
Aus	Production	736.0	21.4	714.7	22.7	839.7	7.8	671.7	14.6
	Area	805.1	11.5	637.2	10.8	498.9	12.5	332.5	15.3
	Productivity	914.2	15.2	1121.6	18.4	1683.2	6.9	2020.1	5.6
Boro	Production	822.4	24.0	1515.0	40.6	3433.9	22.1	4396.7	5.6
	Area	298.2	23.2	542.8	34.4	1122.8	19.0	1433.6	4.2
	Productivity	2757.8	8.7	2791.5	7.9	3058.4	4.6	3068.3	4.9

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

In measuring the variability of production, area and productivity of aman, aus and boro in four sub-periods, coefficient of variations were calculated and compared (Table 5.3). Variability in production for aman increased substantially in sub-period II in comparison to sub-period I and declined significantly in sub-period III and increasing marginally in sub-period IV. Now a sharp rise in variability in production for aman in sub-period II was primarily caused by the rise in variability in productivity while the fall variability in production in sub-period III was caused by the fall in both variability of production and productivity. A rise in variability in production of aman in sub-period IV was caused by rise in variability in area under cultivation. Variability in production for aus marginally increased in sub-period II in comparison to sub-period I and it was primarily caused by the rise in variability in productivity. In sub-period III variability in aus production significantly declined and it was caused by the decline in variability in productivity of aus. Rise in variability in production of aus in sub-period IV was due to rise in the variability of area under cultivation for aus. In case of boro, variability in production registered a significant rise in sub-period II in comparison to sub-period I and this was primarily caused by the huge rise in variability in area under cultivation. In sub-period III and IV variability in production was consistently declined and this occurred because of variability in area and productivity where both had declined. Thus it is evident that sub-period II contains highest variability for aman, aus and boro but for boro it is gradually moving towards stability because of consistent fall in coefficient of variations in sub-periods III and IV, while for aman and aus stability has been marginally disrupted in sub-period IV.

5.4 Districtwise Acceleration and Deceleration in Growth in Production of select Foodgrains in West Bengal from 1970-71 to 2008-2009

It has been shown that from 1990-91, growth rate in production of foodgrain, and rice have started falling. The euphoria of high growth in the 1980s slowly dissipated. Therefore, districtwise and cropwise long term acceleration or deceleration of growth in production of major foodgrains needs to be measured. On the basis of these results it can be verified that the high growth in production of foodgrains achieved during the eighties would be sustained or not. From Table 5.5, 5.6, 5.7 and 5.8 one may comment on the nature of acceleration or deceleration in growth in production of foodgrain, rice, wheat and pulses that are taking place among the districts of West Bengal as well as for the state as a whole from 1970-71 to 2008-09. For the state as whole, acceleration in growth rate in production in foodgrain is continuing and the acceleration is significant at 1 percent level. Among the districts, acceleration in growth in foodgrain was observed for Birbhum, Midnapore, Hoogly, Murshidabad, West Dinapur, Jalpaiguri, Cooch Behar and Purulia and for all these districts rate of acceleration is significant at 1 percent level. We also observed that for these districts coefficient of time (t) as well as coefficients of time square (t^2) both are positive. For the districts of Burdwan, Bankura, Howrah, 24 Parganas, Nadia, Malda and Darjeeling, coefficients of time (measures the exponential growth rate) are positive but coefficients of time square are found to be negative which implies that growth rates are falling over time.

For rice, growth in production has shown acceleration (increasing over time) for the districts of Birbhum, Hoogly, West Dinajpur, Jalpaiguri, Cooch Behar and Purulia. The districts of Burdwan, Bankura, Midnapore, Howrah, 24 Parganas, Nadia, Murshidabad, Malda and Darjeeling have registered positive growth in production but growth rates are falling over time. Deceleration in growth in rice production was also observed for the state of West Bengal. The notable feature is that major rice producing districts Burdwan, Birbhum, Bankura, Midnapore, Murshidabad and 24 Parganas are facing deceleration in growth in foodgrain production. In spite of the fact that wheat contributes a small share in foodgrain production and also occupies a small percentage of area under cultivation as percentage of area under foodgrain in the state, most of the districts achieved negative growth in production of wheat but we observe that only Jalpaiguri, Darjeeling and Cooch Behar are showing deceleration and rest of the districts as well as the state as a whole are showing acceleration in the growth in wheat production. In case of pulses, from 1970-71 to 2008-09, only Darjeeling achieved positive and significant growth rate and rest of the districts achieved negative growth in production. However, long term acceleration (also statistically significant)

was achieved by Burdwan, Midnapore, Hoogly, 24 Parganas, Nadia, Murshidabad and Malda. Deceleration in growth in production was observed for the districts of Bankura, Howrah, West Dinajpur, Jalpaiguri, Darjeeling, Cooch Behar and Purulia. The state of West Bengal also showed acceleration in growth in production in pulses from 1970-71 to 2008-09. It needs to be clarified that for foodgrain and rice, the coefficients of time (t) are positive i.e., exponential growth rates for all the districts are found to be positive, therefore, the districts which are having negative coefficients for time square (t^2), imply that growth rates are falling over time but that does not necessarily mean that there is retardation or deceleration in growth in the strict sense, because to have such results coefficients of time (t) as well as time square (t^2) both have to be negative, which is not the case for foodgrain and rice.

Table 5.5: Districtwise Acceleration or Deceleration in Foodgrain Production from 1970-71 to 2008-09

Districts	Exp. Growth	Coef (T^2)	P VALUE
Burdwan	2.8 (14.8)*	-0.00013	0.00*
Birbhum	2.4 (10.2)*	0.00061	0.00*
Bankura	2.7 (9.3)*	-0.00014	0.00*
Midnapore	3.0 (13.8)*	0.00004	0.00*
Howrah	2.6 (9.7)*	-0.00066	0.00*
Hoogly	2.2 (11.5)*	0.00022	0.00*
24 Parganas	2.6 (12.5)*	-0.00031	0.00*
Nadia	3.0 (14.4)*	-0.00067	0.00*
Murshidabad	2.6 (13.3)*	0.00034	0.00*
West Dinapur	3.0 (19.5)*	0.00046	0.00*
Malda	2.5 (16.4)*	-0.00022	0.00*
Jalpaiguri	1.3 (7.1)*	0.00057	0.00*
Darjeeling	1.1 (3.4)*	-0.00145	0.00*
Cooch Behar	2.0 (12.9)*	0.00013	0.00*
Purulia	2.7 (8.0)*	0.00056	0.00*
West Bengal	2.6 (15.8)*	0.00004	0.00*

T stats are shown in parenthesis

Significant at 1% level, ** Significant at 5% level, *Significant at 10% level*

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Table 5.6: Districtwise Acceleration or Deceleration in Rice Production from 1970-71 to 2008-09

Districts	Exp. Growth	Coef (T ²)	P VALUE
Burdwan	3.1 (16.5)*	-0.00027	0.00*
Birbhum	2.9 (12.4)*	0.00024	0.00*
Bankura	2.9 (10.0)*	-0.00019	0.00*
Midnapore	3.2 (14.5)*	-0.00001	0.00*
Howrah	3.0 (10.4)*	-0.00076	0.00*
Hoogly	2.6 (13.1)*	0.00003	0.00*
24 Parganas	2.8 (13.1)*	-0.00039	0.00*
Nadia	4.4 (18.4)*	-0.00121	0.00*
Murshidabad	3.9 (14.0)*	-0.00009	0.00*
West Dinapur	3.4 (16.5)*	0.00035	0.00*
Malda	3.1 (18.0)*	-0.00054	0.00*
Jalpaiguri	1.2 (6.1)*	0.00064	0.00*
Darjeeling	0.6 (2.1)*	-0.00007	0.04**
Cooch Behar	2.2 (11.8)*	0.00012	0.00*
Purulia	2.9 (8.4)*	0.00060	0.00*
West Bengal	3.0 (16.9)*	-0.00009	0.00*

T stats are shown in parenthesis

Significant at 1% level, ** Significant at 5% level, *Significant at 10% level*

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Table 5.7: Districtwise Acceleration or Deceleration in Wheat Production from 1970-71 to 2008-09

Districts	Exp. Growth	Coef (T ²)	P VALUE
Burdwan	-6.9 (-11.6)*	0.00254	0.00*
Birbhum	-0.7 (-1.4)	0.00379	0.17
Bankura	-2.5 (-3.4)*	0.00057	0.00*
Midnapore	-1.7 (-2.4)*	0.00150	0.02**
Howrah	-7.5 (-6.9)*	0.00433	0.00*
Hoogly	-11.0 (-13.5)*	0.00215	0.00*
24 Parganas	-1.4 (-2.9)*	0.00105	0.01**
Nadia	0.2 (0.4)	0.00001	0.70
Murshidabad	1.3 (4.4)*	0.00057	0.00*
West Dinapur	1.2 (3.3)*	0.00053	0.00*
Malda	2.9 (8.7)*	0.00014	0.00*
Jalpaiguri	5.0 (4.7)*	-0.00292	0.00*
Darjeeling	3.2 (3.1)*	-0.00271	0.00*
Cooch Behar	0.7 (0.9)	-0.00178	0.37
Purulia	-1.3 (-1.3)	0.00082	0.21
West Bengal	0.2 (0.5)	0.00089	0.62

T stats are shown in parenthesis

Significant at 1% level, ** Significant at 5% level, *Significant at 10% level*

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Table 5.8: Districtwise Acceleration or Deceleration in Pulses Production from 1970-71 to 2008-09

DISTRICT	Exp. Growth	T stat	Coef (T ²)	P VALUE
Burdwan	-6.3 (-8.0)*		0.00115	0.00*
Birbhum	-0.3 (-0.9)		0.00250	0.39
Bankura	-8.2 (-17.5)*		-0.00156	0.00*
Midnapore	-2.6 (-6.3)*		0.00035	0.00*
Howrah	-9.6 (-10.6)*		-0.00156	0.00*
Hoogly	-8.2 (-9.2)*		0.00281	0.00*
24 Parganas	-2.3 (-5.8)*		0.00116	0.00*
Nadia	-1.9 (-5.6)*		0.00035	0.00*
Murshidabad	-2.7 (-8.0)*		0.00145	0.00*
West Dinapur	-5.3 (-7.9)*		-0.00144	0.00*
Malda	-2.5 (-5.8)*		0.00002	0.00*
Jalpaiguri	-1.2 (-2.3)*		-0.00045	0.03**
Darjeeling	1.7 (3.5)*		-0.00022	0.00*
Cooch Behar	-0.2 (-0.6)		-0.00018	0.57
Purulia	-1.1 (-2.2)*		-0.00031	0.03**
West Bengal	-2.5 (-10.3)*		0.00065	0.00*

T stats are shown in parenthesis

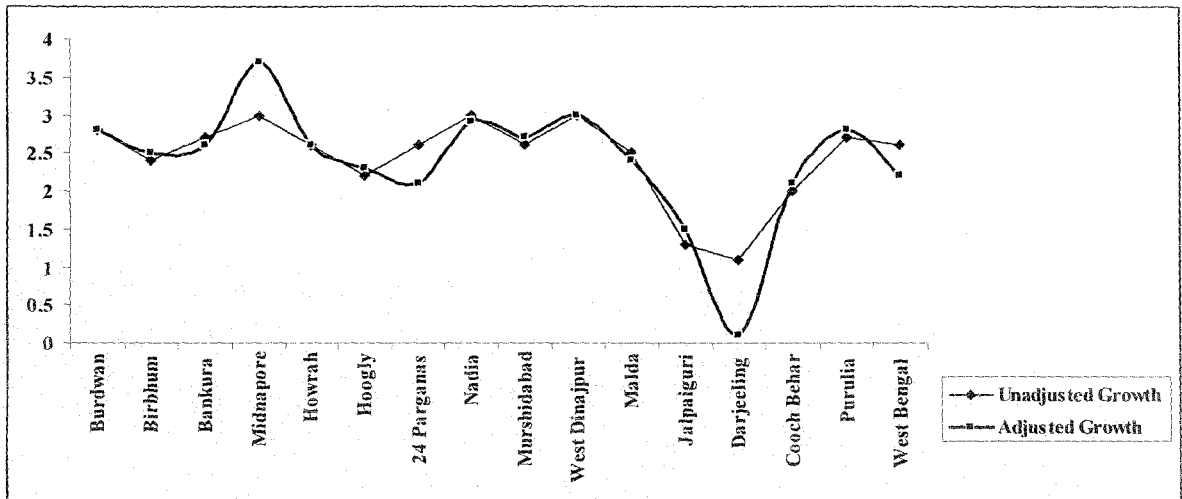
*Significant at 1% level, ** Significant at 5% level, ***Significant at 10% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

5.5 Weather Adjusted Growth Rate

In this study, rainfall data are collected for all the districts from the year 1972, instead of 1970, due to non-availability of data. For this, an index of rainfall (defined here as actual rainfall as a percentage of normal rainfall) is included in the exponential growth equation. Figure: 5.B, which gives a plot of the rainfall index along with de-trended actual foodgrain production, shows that the index has a close relationship with the actual foodgrain production.

Figure 5.B: Districtwise Weather Adjusted and Unadjusted Growth Rates of Foodgrain Production in West Bengal from 1970-71 to 2008-09



Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

The tracking of fluctuations in production is somewhat better for the district like Midnapore and worse for district like Darjeeling and 24 Parganas with the improved index calculated in this study indicating great impact of bad weather on lowering foodgrain production in Darjeeling and 24 Parganas, and that of good weather on raising foodgrain production in Midnapore.

Table 5.9: Districtwise Weather (Rainfall Index) Adjusted Growth Rate and Exponential Growth rate in Foodgrain Production (1970-71 to 2008-2009)

Districts	Unadjusted Growth	Adjusted Growth	Weather elasticity of production (foodgrain)
Burdwan	2.8 (14.9)*	2.8 (10.6)*	0.0 (0.2)
Birbhum	2.4 (9.5)*	2.5 (8.9)*	0.2 (1.3)
Bankura	2.7 (9.4)*	2.6 (7.3)*	0.2 (1.3)
Midnapore	3.0 (14.0)*	3.7 (10.8)*	-0.2 (-1.9)**
Howrah	2.6 (9.1)*	2.6 (6.6)*	0.1 (0.7)
Hoogly	2.2 (11.4)*	2.3 (10.6)*	0.0 (0.1)
24 Parganas	2.6 (12.3)*	2.1 (5.2)*	0.2 (1.5)
Nadia	3.0 (12.8)*	2.9 (12.0)*	0.4 (2.6)*
Murshidabad	2.6 (13.0)*	2.7 (10.8)*	0.0 (0.1)
West Dinajpur	3.0 (17.6)*	3.0 (11.8)*	0.1 (1.3)
Malda	2.5 (16.2)*	2.4 (11.7)*	0.1 (1.8)**
Jalpaiguri	1.3 (6.4)*	1.5 (7.2)*	-0.1 (-0.5)
Darjeeling	1.1 (2.7)*	0.1 (0.0)	0.7 (2.7)*
Cooch Behar	2.0 (13.0)*	2.1 (13.5)*	0.1 (1.2)
Purulia	2.7 (7.8)*	2.8 (6.8)*	0.2 (1.0)
West Bengal	2.6 (16.0)*	2.2 (9.5)*	0.3 (3.5)*

T stats are shown in parenthesis

** Significant at 1% level, ** Significant at 5% level.*

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

But overall the result of growth estimates in Table 5.9 shows that weather elasticities were insignificant in all but the three districts (Midnapore, 24 Parganas, and Darjeeling). The estimates of growth did not change substantially when adjustments for weather were made. In other words, the growth performance of the last four decades in foodgrain production cannot be explained solely in terms of unusually good or bad weather conditions. The weather

adjusted growth rates being insignificant for most of the districts over the last four decades has been validated by the study of Saha and Swaminathan (1994).

5.6 Growth Instability in Production and Productivity of Select Foodgrains

Nature of instability of districtwise production and productivity for foodgrain, rice, wheat and pulses and other cereals has been presented in Table 5.10 and Table 5.11.

Table 5.10: Districtwise Measures of Instability Coefficients of Production of Various Crops in West Bengal from 1970-71 to 2008-09

	Foodgrain instability coefficient	Rice instability coefficient	Wheat instability coefficient	Pulses instability coefficient	Other Cereals instability coefficient
Burdwan	-5.2 (-1.0)	-5.9 (-1.1)	30.6 (1.0)	30.6 (0.7)	-10.5 (-0.5)
Birbhum	-20.5 (-1.2)	-18.0 (-0.9)	-49.4 (-3.0)*	3.4 (0.1)	47.6 (1.0)
Bankura	-29.1 (-1.3)	-29.7 (-1.2)	56.8 (1.3)	20.8 (0.7)	-24.0 (-0.7)
Midnapore	-7.8 (-0.7)	-7.6 (-0.7)	-7.7 (-0.1)	28.5 (0.9)	10.03 (0.2)
Howrah	-22.9 (-0.5)	-12.1 (-1.2)	39.6 (1.2)	25.3 (2.4)*	-12.5 (-1.8)**
Hoogly	-1.2 (-0.1)	-4.6 (-0.4)	50.3 (2.7)*	57.4 (2.5)*	-20.7 (-0.8)
24-Parganas	-11.9 (-1.6)	-14.2 (-1.8)**	-31.9 (-0.7)	8.6 (0.1)	-15.3 (-0.5)
Nadia	-6.3 (-0.9)	-11.2 (-1.5)	-68.3 (-2.2)*	-17.4 (-1.1)	12.5 (1.5)
Murshidabad	-5.3 (-0.6)	-0.5 (0.0)	-6.1 (-0.9)	35.0 (1.1)	58.0 (1.4)
West Dinajpur	-4.4 (-1.6)	-6.8 (-1.7)	-43.2 (-2.3)*	-41.1 (-1.0)	47.8 (0.7)
Malda	1.3 (0.6)	2.8 (0.8)	-18.2 (-1.3)	61.3 (0.9)	12.1 (1.0)
Jalpaiguri	-10.9 (-1.7)***	-12.0 (-1.4)	-24.6 (-2.9)*	32.5 (0.3)	10.9 (0.1)
Darjeeling	-9.0 (-0.2)	-8.2 (-0.9)	-46.0 (-1.7)***	-36.9 (-1.3)	24.1 (0.4)
Cooch Behar	-1.0 (-0.4)	-4.9 (-0.9)	-97.9 (-2.5)*	-19.7 (-0.8)	25.6 (1.3)
Purulia	-39.3 (-0.8)	-37.9 (-0.8)	-59.4 (-1.6)	-12.4 (-0.2)	-46.0 (-0.6)
West Bengal	-7.4 (-1.1)	-8.6 (-1.2)	-16.4 (-1.8)**	-2.7 (-0.2)	34.8 (2.1*)

T stats are shown in parenthesis

* Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

While analysing the instability coefficients, we observe that instability of foodgrain production between 1970-71 and 2008-09 has declined for Burdwan, Birbhum, Bankura, Midnapore, Hoogly, 24 Parganas, Nadia, West Dinajpur, Darjeeling, Cooch Behar, Purulia, Howrah and for the state but instability coefficients are not statistically significant. In

Jalpaiguri district, the decline in instability in foodgrain production was found to be statistically significant at 10 percent level. Only for district of Malda, instability has increased over time but instability coefficient was not found to be statistically significant. For rice, the results remained almost the same as foodgrain. Decline in instability in rice production is statistically significant at 10 percent level only for the district of West Dinajpur. The instability scenario of wheat production is a substantially different from rice. Decline in instability was proved to be statistically significant for Birbhum, West Dinajpur, Jalpaiguri, Darjeeling, Cooch Behar and for West Bengal. Decline in instability remained statistically insignificant for Midnapore, 24 Parganas, Nadia, Murshidabad, Malda and Purulia.

Table 5.11: Districtwise Measures of Instability Coefficients of Productivity of Various Crops in West Bengal from 1970-71 to 2008-09

	Foodgrain instability coefficient	Rice instability coefficient	Wheat instability coefficient	Pulses instability coefficient	Other Cereals instability coefficient
Burdwan	-3.9 (-2.1)*	-4.5 (-2.3)*	1.2 (0.1)	25.7 (2.7)*	33.7 (0.6)
Birbhum	-13.9 (-1.8)**	-12.8 (-1.1)	-0.7 (-0.3)	-5.0 (-0.6)	28.4 (1.2)
Bankura	-17.8 (-1.4)	-18.9 (-1.4)	37.2 (1.4)	23.8 (3.3)*	28.2 (0.3)
Midnapore	-5.2 (-0.8)	-6.1 (-0.8)	-2.5 (-0.2)	24.8 (3.3)*	-20.5 (-0.2)
Howrah	-13.1 (-1.6)	-18.5 (-1.8)**	-12.2 (-0.1)	25.6 (0.8)	4.0 (0.1)
Hoogly	-9.0 (-3.5)*	-11.0 (-3.5)*	35.9 (1.8)**	28.8 (2.5)*	30.7 (1.3)
24-Parganas	-11.5 (-2.0)**	-13.6 (-2.2)*	-2.0 (-0.3)	-0.3 (-0.1)	-17.3 (-1.3)
Nadia	-4.9 (-1.7)***	-6.6 (-1.90)**	-2.9 (-0.6)	0.4 (0.1)	-39.3 (-0.6)
Murshidabad	-5.2 (-1.2)	-10.9 (-1.3)	-0.8 (-0.2)	12.1 (1.2)	46.1 (1.3)
West Dinajpur	-4.8 (-1.8)**	-4.2 (-1.6)	-36.5 (-0.9)	-16.28 (-1.0)	29.0 (0.4)
Malda	-1.5 (-1.2)	-2.2 (-1.2)	-14.5 (-2.3)*	15.5 (1.0)	40.3 (0.7)
Jalpaiguri	-8.3 (-1.3)	-8.0 (-1.1)	-16.0 (-1.4)	3.5 (0.4)	13.8 (0.1)
Darjeeling	0.7 (0.0)	-3.1 (-0.5)	2.1 (0.1)	1.1 (0.2)	31.5 (0.3)
Cooch Behar	-3.0 (-1.3)	-5.2 (-1.3)	-5.7 (-0.9)	22.9 (2.7)*	27.7 (1.1)
Purulia	-31.0 (-1.0)	-33.6 (-1.1)	4.2 (0.2)	39.6 (1.0)	-17.4 (0.0)
West Bengal	-5.2 (-1.4)	-6.2 (-1.4)	-2.0 (-0.8)	-12.1 (-1.2)	36.7 (1.6)

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

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Instability in wheat production increased over time for Burdwan, Bankura, Howrah and Hoogly. For Hoogly, the increase in instability in wheat production also became statistically significant. Finally, for pulses production, instability over time has increased (though remained statistically insignificant) for Burdwan, Birbhum, Bankura, Midnapore, 24 Parganas, Murshidabad, Malda and Jalpaiguri. Instability was also increased for Howrah and Hoogly and instability coefficients for these two districts also became statistically significant. Districts of Nadia, West Dinajpur, Darjeeling, Cooch Behar, Purulia as well as the state of West Bengal have shown a decline in instability (though remained statistically insignificant) in pulses production.

5.7 Trends in Production and Productivity of Non-Foodgrains in West Bengal

Mention has been made on the trend in growth in production, productivity and area of foodgrains in West Bengal as well as for the districts of West Bengal from 1970-71 to 2008-09. We have also estimated the growth in select foodgrains for the districts of West Bengal. Most of our trend analysis has not only considered the whole period of our study i.e. 1970-71 to 2008-09 but also for four sub-periods viz. 1970-71 to 1979-80, 1980-81 to 1989-90, 1990-91 to 1999-2000 and 2000-01 to 2008-09. We find it imperative to carry on similar exercise for non-foodgrains also and for which the analysis has been confined to state level. Non-foodgrains crops like potato, jute, sugarcane, Rapeseeds and mustard, linseed, linseed plus other oilseeds among the various non-foodgrains grown in West Bengal. First attempt is made to see the percentage of area utilised to grow various non-foodgrains and how these percentages are changing over time. Then we try to find out cropwise kinked exponential growth in production, area and productivity of various non-foodgrains in West Bengal have been keeping undertaken the total period of study as well as for pre-defined four sub-periods. Measuring the nature of acceleration and deceleration of growth in production and productivity and area for select non-foodgrain items is also attempted along with measurements of a production variability of various non-foodgrains into its various components. To measure the extent of variability of production, area and productivity for various non-foodgrains, coefficient of variations are also taken into consideration.

5.7.1 Changes in Percentage of Area under Various Non-Foodgrains in West Bengal from 1970-71 to 2008-09

It is observed from the Table 5.12, that, area under major non-foodgrains crops as percentage of total cropped area in West Bengal has increased over time. In comparison to 1970-71, the area under major non-foodgrain as percentage of total cropped area in West Bengal almost

became double and reached around 20 percent of total cropped area in West Bengal. It also shows that non-foodgrains are gaining importance among the farmers of West Bengal. Among various non-foodgrains grown in West Bengal major area under cultivation were used for jute, oilseeds, Rapeseeds and mustard and potato. A look at the figures of area utilisation (Table 5.13) during 1970-71, reveals that the highest percentage of area (48.1 percent) was utilised for the cultivation of jute among the various non-foodgrains grown in West Bengal. Around 20 percent of the area under non-foodgrain was allocated for the cultivation of oilseeds and around 13 percent of the area was utilised for the cultivation of Rapeseeds and mustard. Cultivation of potato occupied around 8 percent of area under total foodgrains production in West Bengal. Around 5 percent of the area was utilised for the cultivation of sugarcane.

In course of time, the area allocation under different non-foodgrains underwent a change. As time progressed jute started losing its relevance and especially since 1985-86, the area under jute cultivation was consistently falling. In 2008-09, the area under jute cultivation fell to 31.8 percent of total area under non-foodgrain. Similar trend was also visible for sugarcane. Mere 1 percent area under non-foodgrain was utilised for sugarcane cultivation. Potato proved to be more attractive option for the farmers and in comparison to 1970-71, the area under potato as percentage of total area under non-foodgrain registered three fold increase in 2008-09. Area under Rapeseeds and mustard in spite of experiencing fluctuation in some years increased over time. In comparison to 1970-71, the area under Rapeseeds and mustard as percentage of total area under non-foodgrain almost doubled in 2008-09. Area under total oilseeds also steadily increased over time and in comparison to 1970-71, the area under total oilseeds as percentage of total area under non-foodgrain almost got doubled in 2008-09. Though area under linseed declined steadily but area under other oilseeds increased consistently and pulled up the total area under oilseeds.

It needs to be mentioned that increase in area under cultivation for a particular crop does not necessarily suggest that production and productivity shall increase also. Again, growth in production may simultaneously be increased due to the increase in growth in productivity as well as increase in growth in area. To validate or invalidate this statement we computed exponential growth in production, area and productivity for a select non-foodgrains for the whole period of our study (1970-71 to 2008-09) as well as for four sub-periods, viz. sub-period I (1970-71 to 1979-80), sub-period II (1980-81 to 1989-90), sub-period III (1990-91 to 1999-2000) and sub-period IV (2000-01 to 2008-9) by using kinked exponential model.

Table 5.12: Area under Various Non-foodgrains as percentage of Total Cropped Area in West Bengal from 1970-71 to 2008-09

Year	1970-71	1980-81	1990-91	2000-2001	2008-09
Potato	0.96	1.62	1.42	2.77	3.47
Jute	5.98	8.53	6.59	5.73	7.83
Sugarcane	0.56	0.20	0.38	0.20	0.31
Rapeseeds & Mustard	1.59	1.83	4.94	5.86	5.04
Linseed plus Other Oilseeds	0.88	2.60	1.77	2.19	3.55
Total	9.97	14.78	15.1	16.75	20.2

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Table 5.13: Cropwise Area as percentage of Total Area under Non-foodgrain in West Bengal

Year	Potato	Jute	Sugarcane	Rapeseeds & Mustard	Lin Seed	Linseeds plus Other Oilseeds	Other Oilseeds	Total Oilseeds	Total Area under Non-Foodgrain
1970-71	7.7	48.1	4.5	12.8	5.2	7.1	1.9	19.9	100.0
1975-76	13.9	41.3	3.6	11.8	8.1	12.8	4.7	24.6	100.0
1980-81	9.5	50.4	1.2	10.8	5.6	15.4	9.8	26.2	100.0
1985-86	9.8	51.9	0.9	16.4	3.5	9.9	6.4	26.3	100.0
1990-91	14.5	37.2	0.9	28.1	0.6	10.0	9.4	38.2	100.0
1995-96	18.1	36.5	1.2	23.2	1.1	12.0	10.9	35.2	100.0
2000-01	18.0	36.8	1.3	26.2	0.7	9.8	9.1	36.0	100.0
2005-06	20.7	32.6	0.9	24.6	0.4	13.0	12.6	37.6	100.0
2008-09	21.1	31.9	1.0	22.5	0.3	15.9	15.7	38.4	100.0

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

5.7.2 Kinked Exponential Growth in Production of Select Non-Foodgrains

It has been observed (Table 5.14) that between 1970-71 and 2008-09, potato grew at an impressive rate of 5.78 percent and this growth rate is also statistically significant at 1% level. Now looking at four sub-periods, growth rate became negative in sub-period II (1980-81 to 1989-90) and registered an overwhelming increase during sub-period III (1990-91 to 1999-2000). In sub-period III a net addition of 7.95 percent was made to the growth rate in production of potato in comparison to sub-period II. Though in sub-period IV, growth rate in production remained impressive but a decline has also been observed.

Table 5.14: Kinked Exponential Growth in Production in West Bengal for (1970-71 to 2008-09), (1970-71 to 1979-80), (1980-81 to 1989-90), (1990-91 to 1999-2000) and (2000-01 to 2008-09) of Select Non-Foodgrains

Crop/Year	Total Period (1970-71 to 2008-09)	Sub-Period I (1970-71 to 1979-80)	Sub-Period II (1980-81 to 1989-90)	Sub-Period III (1990-91 to 1999-2000)	Sub-Period IV (2000-01 to 2008-09)	Trend Break- I	Trend Break- II	Trend Break- III	DW	R ²
Potato	5.78 (15.1)*	3.17 (5.7)*	-0.37 (4.4)*	7.58 (9.9)*	5.98 (10.8)*	-3.54	7.95	-1.6	1.7	0.93
Jute	3.17 (15.7)*	4.2 (3.2)*	2.3 (2.0)*	3.1 (6.5)*	2.9 (9.3)*	-1.9	0.8	-0.2	1.8	0.88
Sugarcane	-0.37 (-0.7)	-5.31 (-1.8)***	-4.24 (-1.7)***	-0.18 (-0.1)	0.45 (0.7)	1.07	4.0	0.63	0.9	0.32
Rapeseeds & Mustard	7.58 (12.3)*	6.58 (2.5)*	18.26 (7.8)*	9.78 (10.0)*	7.31 (11.6)*	11.7	-8.5	-2.5	1.2	0.91
Linseeds plus Other Oilseeds	5.98 (16.0)*	11.63 (5.7)*	5.57 (3.1)*	4.58 (6.0)*	4.88 (10.0)*	-6.1	-1.0	0.3	1.9	0.91

T stats are shown in parenthesis

Significant at 1% level, ** Significant at 5% level, * Significant at 10% level*

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Jute, one of the premium cash crops of West Bengal grew at a modest rate above 3 percent per annum between 1970-71 and 2008-09. However, looking at growth figures in various sub-periods, jute production attained highest growth rate in sub-period I and in subsequent sub-periods growth rates remained lower than sub-period I but it showed an increase in sub-period III over sub-period II and again declined in sub-period IV. The growth experience of sugarcane production continued to remain bleak from 1970-71 to 2008-09 and in four sub-periods. The growth rate in sugarcane production has either remained negative and significant or positive but less than unity and statistically insignificant. Conversely, Rapeseeds and mustard showed spectacular growth in production. From 1970-71 to 2008-09, the growth rate in production for Rapeseeds and mustard remained as high as 7.58 percent and a huge increase has been observed in sub-period II, where a net addition of 11.7 percent in growth rate in production took place. In two subsequent sub-periods, though growth rates have substantially declined but still it remained very high. In comparison to other non-foodgrains, highest rate of growth in production was achieved by Rapeseeds and mustard. Linseed and other oilseeds also grew at an impressive rate from 1970-71 to 2008-09 and highest growth rate in production was achieved during sub-period I and thereafter growth rates declined substantially in subsequent sub-periods.

5.7.3 Kinked Exponential Growth in Productivity of Select Non-Foodgrains

Growth in productivity is one of the major contributing factors for the growth in production. In case of potato growth rate in productivity from 1970-71 to 2008-09 was not much very impressive at 1.1 percent per annum though significant at 1 percent level. In sub-period I, highest growth in productivity was achieved by potato and there after the growth rate started declining. In sub-period II, and III growth rates though positive but was significant at 5 percent level and in sub-period IV growth rate in productivity became insignificant. The growth rate in productivity for jute for the total period of our study (1970-71 to 2008-09) was found to be 2 percent per annum, and highest growth rate was achieved during sub-period I (3.7 percent), however for rest of the subsequent sub-periods (II, III and IV) growth rates were either negative and insignificant or positive and insignificant. For sugarcane, growth scenario of productivity was also not that encouraging. For the whole period of our study sugarcane grew at an exponential rate of 1.1 percent.

Among four sub-periods, growth rate was found to be insignificant in sub-period I, in sub-period II growth rate increased to 2 percent and in sub-period III and IV growth rates were reduced to 1.4 percent and 1.5 percent. Rapeseeds and mustard achieved productivity growth rate of 2.6 percent per annum for the period between 1970-71 and 2008-09. Impressive growth rates in productivity were achieved during sub-period I and II, however, the growth rates declined in sub-period III & IV. Linseeds and other oilseeds grew at 3 percent per annum from 1970-71 to 2008-09. Growth rate in productivity for linseeds and other oilseeds remained insignificant during sub-period I, however, a turn around was observed in sub-period II, when a net addition of 5.45 percent was achieved. It has also been observed that growth rates remained satisfactory during sub-period III and IV but it declined by more than 1 percent in sub-period III and IV (Table 5.15).

Table 5.15: Kinked Exponential Growth in Productivity of West Bengal for (1970-71 to 2008-09), (1970-71 to 1979-80), (1980-81 to 1989-90), (1990-91 to 1999-2000) and (2000-01 to 2008-09) of Select Non-Foodgrains

Crop/Year	Total Period (1970-71 to 2008-09)	Sub-Period I (1970-71 to 1979-80)	Sub-Period II (1980-81 to 1989-90)	Sub-Period III (1990-91 to 1999-2000)	Sub-Period IV (2000-01 to 2008-09)	Trend Break- I	Trend Break- II	Trend Break- III	DW	R ²
Potato	1.1 (3.5)*	3.6 (2.3)*	2.6 (1.8)**	1.7 (2.8)**	0.4 (1.1)	-1.08	-0.89	-1.25	1.8	0.5
Jute	2.0 (19.3)*	0.6 (1.0)	3.2 (5.8)*	2.5 (11.0)*	2.2 (14.9)*	2.6	-0.7	-0.3	1.9	0.9
Sugarcane	1.3 (8.1)*	0.1 (0.1)	2.0 (2.3)*	1.4 (3.7)*	1.5 (6.4)*	1.9	-0.6	0.1	1.6	0.7
Rapeseeds & Mustard	2.6 (10.6)*	4.5 (4.4)*	5.7 (6.2)*	2.8 (7.3)*	2.2 (8.7)*	1.2	-2.9	-0.7	2.0	0.9
Linseeds plus Other Oilseeds	3.0 (12.7)*	0.4 (0.3)	5.9 (4.9)*	4.3 (8.5)*	3.3 (10.2)*	5.5	-1.5	-1.0	1.6	0.9

T stats are shown in parenthesis

* Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

5.7.4 Kinked Exponential Growth in Area of Select Non-Foodgrains

From the analysis it is evident above that for most of the non-foodgrains, growth rate in production was not solely influenced by growth rate in productivity and therefore growth rate in area must have contributed positively to the growth in production of various non-foodgrains. If we look at the figures of growth rate in area under various non-foodgrains (Table 5.16) we observe that for the whole period of our study as well as in the four sub-periods, the growth in area remained much higher than growth rate in productivity and therefore, the growth in area had stronger influence to enhance growth in production of potato in West Bengal. For jute growth in area was highest during sub-period I and for sub-period II and III growth rates of area either remained very low and insignificant or negative. In sub-period IV, growth rate in area though remained at less than 1 percent but was found to be statistically significant. The growth in sugarcane had remained negative for the whole periods as well as for the four sub-periods. Rapeseeds and mustard however, showed impressive growth in area for the whole period and in four sub-periods. Phenomenal growth in area (12.5 percent) was achieved during second sub-period, i.e. between 1980-81 and 1989-90. In sub-period III and IV, decline in growth in area was observed, in spite of which growth rates remained very impressive (more than 5 percent). Therefore, if the growth in production in sub-period I was driven by growth in productivity then in sub-period II and

onwards, growth in production was driven by both growth in area and growth in productivity. However, growth in area had stronger impact on growth in production in comparison to growth in productivity. In case of linseeds and other oilseeds, growth in production was primarily influenced by growth in area in sub-period I but from sub-period II and onwards growth in area had slowed down, therefore growth in productivity played a dominant role in enhancing the growth in production.

Table 5.16: Kinked Exponential Growth in Area of West Bengal for (1970-71 to 2008-09), (1970-71 to 1979-80), (1980-81 to 1989-90), (1990-91 to 1999-2000) and (2000-01 to 2008-09) of Select Non-Foodgrains

Crop/Year	Total Period (1970-71 to 2008-09)	Sub-Period I (1970-71 to 1979-80)	Sub-Period II (1980-81 to 1989-90)	Sub-Period III (1990-91 to 1999-2000)	Sub- Period IV (2000-01 to 2008-09)	Trend Break-I	Trend Break-II	Trend Break- III	DW	R ²
Potato	4.7 (27.5)*	6.3 (6.9)*	4.2 (5.2)*	4.7 (13.7)*	4.1 (18.5)*	-2.1	0.5	-0.6	1.5	1.0
Jute	1.1 (5.9)*	3.6 (3.1)*	-0.9 (-0.9)	0.6 (1.3)	0.6 (2.3)*	-4.5	1.5	0.1	1.2	0.6
Sugarcane	-1.6 (-3.5)*	-5.4 (-2.2)*	-6.2 (-2.8)*	-1.5 (-1.6)	-1.1 (-1.7)***	-0.8	4.7	0.5	1.0	0.5
Rapeseeds & Mustard	4.9 (12.0)*	2.0 (1.1)	12.5 (7.5)*	6.9 (9.9)*	5.1 (11.4)*	10.5	-5.6	-1.8	1.1	0.9
Linseeds plus Other Oilseeds	2.9 (7.7)*	11.3 (6.2)*	-0.3 (-0.2)	0.3 (0.4)	1.6 (3.6)*	-11.6	0.6	1.3	1.5	0.8

T stats are shown in parenthesis

* Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

5.7.5 Acceleration and Deceleration in Growth in Production, Productivity and Area of Select Non-Foodgrains in West Bengal from 1970-71 to 2008-09

Acceleration and deceleration of growth in production, productivity and area under cultivation of some important non-foodgrains (Table 5.17, 5.18 and 5.19) grown in West Bengal for 1970-71 to 2008-09 have been taken in consideration. As has been already stated above that if the coefficient of time square (t^2) in a log-quadratic model becomes positive then growth over time is increasing or accelerating and if it becomes negative then growth over time is falling. Among four non-foodgrains, growth in production of potato, jute and Rapeseeds and mustard achieved positive and significant values but rate of change in growth rate with respect to change in time became negative during 1970-71 to 2008-09. For sugarcane, growth rate in production though found to be insignificant, the coefficient of time square was positive implying that growth rate over time has accelerated. Similar results were

achieved for growth in productivity as well as growth in area for all non-foodgrains crops while the sugarcane rest of the crops have shown deceleration.

Table 5.17: Acceleration and Deceleration in Production of select Non-Foodgrains in West Bengal from 1970-71 to 2008-09

Crop	Exp. Growth	Acceleration or Deceleration (Coefficient of t ²)	DW	R ²
Potato	5.78 (15.1)*	-0.00174 (23.3)*	0.8	0.86
Jute	3.17 (15.7)*	-0.00023 (-1.2)	1.8	0.86
Sugarcane	-0.37 (-0.7)	0.001809 (4.2)*	0.5	0.01
Rapeseeds & Mustard	7.58 (12.4)*	-0.00241 (-5.5)*	0.4	0.81

T stats are shown in parenthesis

*Significant at 1% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Table 5.18: Acceleration and Deceleration in Productivity of select Non-Foodgrains in West Bengal from 1970-71 to 2008-09

Crop	Exp. Growth	Acceleration or Deceleration (Coefficient of t ²)	DW	R ²
Potato	1.1 (3.5)*	-0.001285 (-5.9)*	1.8	0.5
Jute	2.0 (19.3)*	-0.000062 (-0.6)	1.9	0.9
Sugarcane	1.3 (8.1)*	0.00028 (1.9)**	1.6	0.7
Rapeseeds & Mustard	2.6 (10.6)*	-0.001068 (-6.5)*	2.0	0.9

T stats are shown in parenthesis

*Significant at 1% level, ** Significant at 5% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

Table 5.19: Acceleration and Deceleration in Area under Cultivation of select Non-Foodgrains in West Bengal from 1970-71 to 2008-09

Crop	Exp. Growth	Acceleration or Deceleration (Coefficient of t ²)	DW	R ²
Potato	4.7 (27.5)*	-0.00045 (-3.0)*	1.4	1.0
Jute	1.1 (5.9)*	-0.00017 (-0.9)	1.1	0.5
Sugarcane	-1.6 (-3.5)*	0.001528 (3.9)*	0.80	0.4
Rapeseeds & Mustard	4.9 (12.0)*	-0.00134 (-4.1)*	0.50	0.9

T stats are shown in parenthesis

*Significant at 1% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

5.7.6 Instability in Production and Productivity of Select Non-Foodgrains in West Bengal from 1970-71 to 2008-09

Finally, the question whether instability in production and productivity of some major non-foodgrains in West Bengal has been increasing or decreasing over time (from 1970-71 to 2008-09) needs to be explained. It has been unfurled that instability coefficients of production for potato, sugarcane and linseeds and other oilseeds are positive and instability coefficient for potato is statistically significant at 1 percent level and for linseeds and other oilseeds at 10 percent level. Therefore, instability in production for these crops has increased over time, while for jute, Rapeseeds and mustard it has declined since the instability coefficients for these crops assumed a negative value (though statistically insignificant). We achieved similar results for instability in productivity for the aforementioned non-foodgrains (Table 5.20).

Table 5.20: Extent of Instability in Production and Productivity of Select Non-foodgrains in West Bengal from 1970-71 to 2008-09

Crop	Instability coefficient for Production	Instability coefficient for Productivity
Potato	41.5 (2.25)*	54.40 (2.39)*
Jute	-15.7 (-1.53)	-4.16 (-2.04)*
Sugarcane	17.4 (0.63)	9.59 (2.89)*
Rapeseeds & Mustard	-20.3 (-0.95)	-4.59 (-0.88)
Linseeds and Other Oilseeds	10.9 (0.48)	22.86 (1.72)***

T stats are shown in parenthesis

* Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level

Source: Calculation based on data collected from various volumes of West Bengal Economic Review, Government of West Bengal

5.8 Conclusion

The empirical exercise undertaken in this chapter adequately reveals that rice is the catalyst that augments or diminishes the growth in production of foodgrain in West Bengal. During the 1970s, growth in production, productivity and area under cultivation of aman and boro grew at abysmally low rates, while aus registered negative growth in production, area under cultivation and productivity. As cumulative impact, the growth rate for rice remained negligible during the 1970s resulting in a low rate of growth in foodgrain production causing stagnation in West Bengal agriculture. During 1980s, a trend break was observed in foodgrain production in West Bengal alleviating long spell of agricultural stagnation. This turn around was caused by the spectacular rise in growth in production of aman aus and boro. Importantly, in the post-1980s, growth in production of aman and aus were primarily driven

by the growth in productivity while growth in production of boro was achieved through massive growth in area. Notwithstanding the fact that boro is high productivity crop and its absolute productivity is much higher than aman and aus, the growth in productivity remained negative during the decade of 1980s. During the decade of 1990s and in the post 1990s aman experienced decline in growth in production and productivity, for aus a decline in growth in production and productivity and area was observed, and in case of boro, though a high very high growth rate in production was maintained but a sharp decline in growth in area has also been observed. Moreover, growth in productivity for boro remained at low level. As a result the spurt in growth in production and productivity of rice and foodgrain was observed during 1980s could not be sustained in the decade of 1990s and in subsequent years.

As the decline in growth became discernible, the pace of change in growth rate would provide us to judge the long term impact on agrarian scenario in West Bengal and her districts. It has been seen that districts of Birbhum, Midnapore, Hoogly, Murshidabad, West Dinajpur, Jalpaiguri, Cooch Behar and Purulia have experienced acceleration of growth in foodgrain, for the districts of Burdwan, Bankura, Howrah, 24 Parganas, Nadia, Malda and Darjeeling growth rates over times experienced deceleration

Inspite, the growth in production is showing acceleration for the districts of Birbhum, Hoogly, West Dinajpur, Jalpaiguri, Cooch Behar and Purulia, the worrying point is that major rice producing districts Burdwan, Bankura and Midnapore, Murshidabad and 24 Parganas are facing deceleration in growth in foodgrain production. The state of West Bengal also showed acceleration in growth in production between 1970-71 and 2008-09. It needs to argue that though the growth rates are falling over time but that does not necessarily mean that there is retardation or deceleration of growth in the strict sense in order to have such results coefficients of time (t) as well as time square (t^2) both have to be negative, which is not the case for foodgrain and rice in particular.

The impact of rainfall on growth in production has significance only for the districts of Darjeeling and 24 parganas and Midnapore and the rest of the districts as well as the state as whole seem to be insulated from the vagaries of rain fall. Coming to the issues of long term stability or instability in foodgrain and rice production in the state and districts, it may be observed that instability of foodgrain and rice production from 1970-71 to 2008-09 has declined for Burdwan, Birbhum, Bankura, Midnapore, Hoogly, 24 Parganas, Nadia, West Dinajpur, Darjeeling, Cooch Behar, Purulia, Howrah, Jalpaiguri and for the whole state as well. Only in the district of Malda, instability has increased over time.

Shifting our focus from foodgrain to non-foodgrain, it is observed that the area under major non-foodgrains in West Bengal almost became double and reached closer to 20 percent of total cropped area in West Bengal in last thirty eight years. It also shows that non-foodgrains are gaining more importance among the farmers of West Bengal.

Among various non-foodgrains grown in West Bengal major area under cultivation were used for jute, oilseeds, Rapeseeds and mustard and potato. As time progresses, jute started losing its relevance and especially since 1985-86, the area under jute cultivation was consistently falling. Similar trend has also been observed for sugarcane. Potato proved to be more attractive option for the farmers in West Bengal and area under cultivation almost got trebled since 1970-71 to 2008-09. Area under Rapeseeds and mustard in spite of experiencing fluctuation in some years increased over times. Though area under linseed was declined steadily, the area under other oilseeds has consistently increased and pulled up the total area under oilseeds. Potato also registered an impressive growth in production, however growth became pronounced during the decade of 1990s. The growth in production of potato primarily pulled up by the growth in area under potato for the reason that the growth in productivity for potato remained low. Jute, one of major cash crops of West Bengal grew at modest rate above 3 percent per annum from 1970-71 to 2008-09, but it remained highest in the decade of 1970s and has primarily driven by growth in productivity, however, it became susceptible to fluctuation and failed to attain the growth rate in 1970s in the subsequent years. The growth in sugarcane production continued to remain bleak in West Bengal and it never peaked up. Conversely, Rapeseeds and mustard showed spectacular growth in production and a massive increase was achieved during the decade of 80s and growth in productivity as well as area together played a dominant role in this regard. Linseed and other oilseeds also grew at an impressive rate from 1970-71 to 2008-09 and highest growth rate in production was experienced during the decade of 70s, but it started declining thereafter. Especially after 1980s growth in productivity became quite strong and influence of area got dissipated for linseed and other oilseeds. However, the empirical results find that during the whole period of study i.e. 1970-71 to 2008-09, potato, jute, mustard and Rapeseeds experienced deceleration of growth in production, area and yield while sugarcane experienced acceleration. On the issue of stability vis-à-vis instability of production it was observed that production instability has been increasing over time for potato, sugarcane and linseeds and other oilseeds while for jute and Rapeseeds and mustard registered decline.

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¹ In a study mentioned earlier, Saha and Swaminathan (1994) have shown that there was no statistically significant effect of rainfall on agricultural production in West Bengal during 1980s, despite the fact that there was good rainfall in most of the years over the period {(Dutta Roy (1994))}. The rainfall index for four different seasons (i.e. southwest monsoon, post-monsoon, winter and pre-monsoon) of a year was first used by Cumming and Ray (1969) to construct an all India rainfall index based on cropping pattern and estimates of area and production in different divisions and states of India. Later the estimation procedure of rainfall index was refined and extended by Ray (1976, 1983). The variability in the productions of crops may change significantly across the districts depending on the nature of rainfall (Saha and Swaminathan, *op.cit.*). But the variability's of productivity and production of crops in different districts of West Bengal can be better understood if emphasis has been given to decadal growth rates of the districts of the major crops.

² A number of attempts have been made to examine the extent of instability in crop production. Measurement of instability has primarily been evolved as a related issue to the growth measurement exercise in agriculture. Many notable scholars who emphasised on this particular issue are Reddy (1978), Srinivasan (1979), Vaidyanathan (1980), Sen (1967), Das (1978), Rath (1980), Alagh and Sharma (1980), Rao *et al.*, (1980), Bandhopadhyay (1981), Mehra (1981), Hazell (1982), Ray (1983), Dhawan (1983), Mahendradev (1987), Boyce (1987), Hanumantha Rao *et al.*, (1988), Saha and Swaminathan (1994), Chattopadhyay (2001) etc.

While measuring instability in agricultural production, broadly two techniques are mostly used: summary measure and trend measure. The summary measure of instability was used by Barkar *et al.*, (1981), Mehra (1981), Hazell (1982), Ray (1983), Dhawan (1983), Mahendradev (1987), Hanumantha Rao *et al.*, (1988), etc. But in general these summary measures has been criticized on the following grounds: i) These measures could not fully encompass the necessary information on the change of instability over time ii) Again measures based on year to year fluctuations are generally get influenced by the short time variations than the long term variations and the conclusion on instability can easily be manipulated simply by adding or removing one or two years having strong outliers in a period.

Many scholars prefer to use the trend measures of instability instead of summary measures. We get two broad categories of trend measures. The first one is to estimate separate trends (linear or exponential) for 'peak' and 'trough' years and to see whether these two trends are converging, meaning thereby increasing instability over time. For selecting peaks and troughs there are mainly three criterion) the usual local maxima and minima definitions, used by Sen (1967), Das (1978), etc. This criterion has also been criticised because a small output differences can cause certain years to be included or excluded. To overcome these difficulties, in the recent studies [Boyce (1987), Mahendradev (1987), Saha and Swaminathan (1994), etc.,] another trend measure of instability has been used by fitting the time trend (linear or exponential) on the statistic of instability and observing the sign of slope parameter with statistical significance. In comparison to Mahendradev statistic, Boyce statistic is more reliable as, being the detrend statistic; it captures all sorts of variations (namely seasonal, cyclical and irregular variations) in the agricultural production.

Some studies considered the nature of association between growth and instability, along with their measurements, either from the simple visual inspection of the movements of the estimated results on growth rates and summary measures/nature (convergence or divergence) of instability over different sub-periods [Sen (1967), Mehra (1981), Hazell (1982), Ray (1983) etc.,] or by regressing instability levels and trends against growth rates cross-sectionally over different crops and regions. However, the regression method appears to be better than other one since it is amenable to statistical analysis and inferences.