GROWTH AND INSTABILITY IN CROP PRODUCTION IN EASTERN INDIA

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1. *Introduction*

The states of eastern India (viz. Assam, Bihar, Orissa and West Bengal) are considered by and large the poverty-ridden regions of India. About 30 per cent of the total rural poor live in these four states. Among these four states, the incidence of rural poor is high in Bihar (14.9 pet cent) and low in Assam (2.0 per cent). It may be noted in this connection that the introduction of new agricultural technology in different parts of India since the mid-sixties have improved the production conditions and conseq-uently the income and employment and yet the states of eastern India fall behind the overall national proformance. For example, these states have experienced drastic falls in per capita production and yield per hectare during the current decades. These states have recorded drastic decline in gross cropped area per person, but have an impressive increase in the number of workers per hectare. The state-wise annual growth rates in the food grain production between 1971-85 fell behind the rate of growth of population in all these states. However, these states with relatively lower level of net irrigated area have relatively higher cropping intensities.

With this background of production conditions in Eastern India this paper attempts to examine empirically whether the pattern of growth in crop production in some states of eastern India (viz. Bihar, Orissa and West Bangal) has recorded any significant change during the period 1950 to 1988. In the rate growth, how does one explain the year to year flutuation resul thereby in instability in agricultural production ? This is a subj which has received wider attention in the country in the rec years in the context of agricultural development strategy across t technologically lagging regions in particular.

The study is divided into three sections. In Section I, w examine the growth rates in production of foodgrains, its constituents and other main cash crop (jute) between different periods along with the corresponding rates of growth in area and productivity. Section II deals with the measure of instability and the trends in instability for the period 1950–88. In Section III, we discuss the relationship between growth and instability for the regions under study and make some concluding observations.

I

2. Growth of Agriculture

2.1 Methodology

For the purpose of analysis of secular trend to the statistical series of agricultural production, yield and acreage for the period 1950-51 to 1987-88, we have fitted three different curves : namely the straight line of the form f_1 (t) a + b t where 'a' positive and 'b' implies a diminishing rate of growth ; the semi-log curve of the form $f_2(t) = a \ (l + r)^t$ implying a constant rate of growth r ; the Gompertz curve of the form $f_3(t) = ab^{c^t}$ which allows for both a diminishing rate of growth when b < 1 and c < 1 and an increasing rate of growth when b > 1 and c > 1. The goodness of fit of a curve has been measured by the statistic D, where D represents the ratio of the Residual Sum of Squares (i.e. the sum of squares of deviations of the observed values from the trend values) to the Total Sum of Squares of deviations of the observed values from the trend values to the Total Sum of Squar--

of the observed values, i.e., $D = \frac{\sum (y_t - y_t^*)^2}{\sum (y_t - \bar{y})^2}$, y_t = observed value, y_t^* = trend value, and $\bar{y}$ = mean value of the y's. Thus, out of three alternative forms of curves, one must choose that form which bears the lowest value of D, indicating thereby the goodness of fit on the fitting of trend curves[1].

2.2 Secular Trend 1950-51 to 1987-88

Presented in Table 1 are the estimates of the best fitted trend equations for some major crops obtained separately for Bihar, Orissa, West Bengal and India as a whole over the period 1950-51 to 1987-88.

We observe from Table 1 that as far as the criterion of lowest D value is concerned, trends in the growth of acreage, output and yield for food crops as a whole in the three states of eastern India give two distinct patterns for period 1950-51 to 1987-88. Thus, in the cases of Bihar and Orissa, linear curve gives the best fit for all the variables (except yield) under study which is consistent with the retardation hypothesis. On the other hand, semi-logarithmic curve provides the best fit for all the variables in the case of West Bengal which confirms that the growth of acreage, output and yield of food crops remained unchange during the entire period of 38 years. Interestingly the results obtained for West Bengal conform with the all-India trends in the growth of output and yield in particular.

Above observations thus suggest a stagnation in the growth of foodgrains output in India mainly because of the diminishing

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1. This methodology was adopted by Rudra (1970, 1982) based on earlier data of agricultural production and was strengthened by us through some fresh results (Chattopadhyay and Bhattacharya 1987). To the best of our knowledge, nobody has till now challenged the test based on the use of 'D' statistic.

rate of growth of cropped area. Although West Bengal gives the similar picture as in the case of India, the other two states of Eastern India (viz. Bihar and Orissa) strongly differ from the all-India trend. The performance of agriculture in these two states is not satisfactory in terms of acreage, output and yield of food crops in general. To take a view in this matter a little more, an analysis of data on acreage, output and yield separately for each major crop seems to be very important.

It is found from the same table (Table 1) that in the case of rice which is the main crop in the states of eastern India, linear trend (which implicity assumes a declining rate of growth) gives the best fit for all the variables and semi-log trend (which implicitly assumes a constant rate of growth) gives the best fit for Orissa and West Bengal for all the variables except acreage in the case of West Bengal. Growth of acreage in the case of rice for West Bengal seems to be declining as the Gompertz curve of the type $b < 1$ and $c < 1$ gives the best fit. It may be noted that the all-India results for rice are fully consistent with the trends of West Bengal and partly of Orissa but not of Bihar All-India trend results relating to rice show that the growth of acreage has been declining and the growth of production and yield remaining unchanged during 1950-51 to 1987-88.

Coming now to the next most important crop wheat, we find from the same table that while the growth of acreage and output for wheat in Bihar and Orissa remained unchanged, the growth of yield rate registered a declining trend. The reverse is true in the case of West Bengal. All-India results, however, largely differ from the results obtained for the states of eastern India. It is seen that at all-India level, growth of wheat production and yield remained constant and the growth of acreage of wheat declined during this period.

An important commercial crop cultivated in eastern India is jute. Declining rate of growth of yield for jute is a phenomenon not only for the states of eastern India but for the country as a whole (Table 1). As a result, although the growth of acreage for jute remained unchanged over time, the growth of output for jute did not register any upward change due to the diminishing rate of growth of yield rate.

Above analysis relating to the growth of agriculture for some major crops in India in general and eastern India in particular rule out any transformation in the production conditions. We do not find any striking result for any crop or for any region under study which provides sufficient ground for supporting breakthroughs in agricuitural production. This amounts to the rejection of the proposition that there has at all been any green revolution over the country. In order to examine this proposition a little more, analysis of data separately for the two periods, namely, the pre-green revolution period (1950-51 to 1966-67) and post-green revolution period (1967-68 onwards) would be useful.[2]

2.3 Growth of Agriculture Before and After Adoption of New Technology

Trend results for the first period (1950-51 to 1966-67), presented in Table 2, show that the trends in the growth of acreage, output and yield for food crops as a whole are more or less consistent with the trends for the entire period (i.e., 1950-51 to 1987-88) for ali the states under study. Thus, for food crops the growth of output and yield declined during the pre-green revolution period in the cases of Bihar and Orissa whereas the growth of acreage remained constant for these two states. All-India trend results are, however, consistent with the hypothesis of constant rate of growth of agricultural output, yield and acreage during the

2. *We have devided the period into two sub-periods in terms of an overall notion of spread of new agricultural technology. In fact, this division may not be applicable for all crops and for all the regions of India. We get such an impression while we attempt to examine the instability questions of the variables which have been discussed in the following section.*

pre-green revolution period and the West Bengal results bear very close resemblance to the all India results.

Coming now to the results for the green revolution period (i.e., between 1968-69 and 1987-88), we find that the same retardation hypothesis regarding the growth of output and yield for food crops can be accepted unambiguously not only for Bihar and Orissa but for West Bengal as well. As a matter of fact, in the green revolution period, straight line provides the best fit in most of the cases of growth of acreage, output and yield for food crops for all the three states of eastern India. For all-India, no difference can be made between the pre- and post-green revolution periods in terms of growth of acreage, output and yield for food crops.

Thus it is clear from the above analysis that there is no major changes in terms of growth pattern with the introduction of new agricultural technology for India in particular and also in the cases of Bihar and Orissa. The break however could be located in the case of West Bengal but only in the case of production and yield of food crops. But this break does not register any upward change of growth of output and yield of food crops All these amount to accepting the proposition that with the introduction of new technology in agriculture, there has not been any structural change in the composition of foodgrains production in eastern India as in India as a whole. Because, with new technology either the trend fitted over the entire period would show an increasing rate of growth or there would have been a break in the trend calling for two separate trend curves to be fitted to the two periods.[3] None of these possibilities were supported by the fitted trend curves for eastern India as well as India as a whole.

Although the growth of agriculture for food crops reveals a smooth trend so as to rule out any transformation in the production conditions, a crop-specific analysis might have to be a somewhat different picture. Our crop-specific trend results, presented in the same tables (Tables 2 and 3), once again rule out any

3. *For an extensive discussion of this point see, Rudra (1982).*

transformation towards the increasing rate of growth of agriculture. In fact, some breaks in the time trends could be located in the cases of wheat and jute for West Bengal, rice for Orissa and wheat for Bihar. But in no cases, the breaks indicate the positive structural transformation in terms of increasing rate of growth. Similar conclusion can be drawn regarding the crop-specific trend results for India as a whole.

To sum up, agricultural growth in the three states of Eastern India and India as a whole, specially foodgrains, has been either stagnant or very marginal over the period 1950-51 to 1987-88. This is clearly due to the fact that the rate of growth of cropped area has been declining over time. Between the three states, West Bengal shows relatively higher overall rates of growth in 38 years in food-grains production (1.78 per cent per annum). Orissa shows relatively poorest rate of growth (0.55 per cent per annum). Somewhat different picture is observed in the case of rice production in these three states. Thus, West Bengal registers highest rate of growth (1.77 per cent per annum) whereas Bihar registers lowest rate of growth (0.67 per cent per annum) in rice production in 38 years. So far as non-food-grains crop jute is concerned, this shows a sustained decrease in the rate of growth in area and yield in respect of all the states. On the whole, it is clear from the analysis that the new technology had hardly any impact in the agrarian sector of eastern India. This is mainly due to the lack of assured irrigation throughout the year in these rainfed and drought prone states. In fact, this growth of agriculture in these states is suspected to have been accompanied by an increase in the instability in agricultural production which has been brought about by the uncertain natural conditions particularly in view of the absence of widespread use of new agricultural technology.

In the light of the problem of agriculture in eastern India discussed above, in the following section, we attempt to measure the extent of instability in crop production in these states.

II

3. Instability in Agricultural Production

3.1 Methodology

A good number of studies have been made on the time trends in the growth of Indian agriculture and on inter-regional variations in the growth of crop production by numerous researchers. However, not much work has been done so far to analyse the growth of agriculture along with the fluctuations of production, area and yield of different crops at the regional level. Some of the recent studies which are notable in this area are Mehra (1981), Hazell (1982), Ray (1987), Dhawan (1987) and Boyce (1987). Most of these studies are at the all-India level and suffer from some serious methodological problems.

The measure which most of the researchers used in analysing instability in crop production was the coefficient of variations (cv) which is defined as the standard deviation of output from its trend divided by the mean level of output (Mehra 1981). The standard errors of the simple (discontinuous) growth rates were sometimes used as a measure of instability. An alternative methodology of assessing changes in instability over time suggested by S.R. Sen (1967) is the 'trough' and 'peak' method.

A crucial drawback of meansuring instability by estimating the variance or coefficient of variation of the variable around the time trend for two separate periods is that it fails to capture the large and frequent fluctuations of the variable concerned. Again, this measure shows only the extent of instability of the variable, and does not give any impression about the trend of instability. That means, the question as to whether the fluctuations are stabilising over the period or the system becoming more unstable, can not be revealed from this kind of measure.

TABLE 1

Estimates of Best Fitted Trend Equation for Different Crops Obtained for Different Regions : 1950-51 to 1987-88

Region with variable	Estimated parameters	Crops			
		Rice	Wheat	All Food Crops	Jute
(1)	(2)	(3)	(4)	(5)	(6)
Bihar					
Acreage		(1)	(2)	(1)	(1)
	a	5123.0247	6.1661	9591.0393	178.6292
	b	3.0392	1.0426	0.4461	−1.2212
	c	—	—	—	—
Production		(1)	(2)	(1)	(2)
	a	3143.1144	5.3411	4893.8027	6.6540
	b	57.6743	1.0819	142.4042	1.0023
	c	—	—	—	—
Yield		(1)	(1)	(1)	(1)
	a	615.4918	343.5849	502.9783	792.8884
	b	10.4714	33.4275	15.0551	9.7844
	c	—	—	—	—

(1)	(2)	(3)	(4)	(5)	(6)
Orissa					
Acreage		(2)	(2)	(1)	(2)
	a	8.2835	1.2648	4128.7371	3.7281
	b	1.0032	1.0907	77.5425	1.0022
	c	—	—	—	—
Production		(2)	(2)	(1)	(2)
	a	7.7721	0.4831	2391.4106	5.3906
	b	1.0190	1.1383	101.9992	1.0159
	c	—	—	—	—
Yield		(2)	(1)	(1)	(1)
	a	6.3984	265.8845	6.3838	929.2724
	b	1.0156	47.5363	1.0121	16.7755
	c	—	—	—	—

Contd.

(1)	(2)	(3)	(4)	(5)	(6)
West Bengal					
Acreage		(3)	(2)	(2)	(2)
	a	5677.0000	3.4016	8.5115	5.6370
	b	0.6656	1.0813	1.0072	1.0181
	c	0.9496	—	—	—
Production		(2)	(2)	(2)	(2)
	a	8.2454	2.7929	8.3662	7.4328
	b	1.0197	1.1276	1.0208	1.0279
	c	—	—	—	—
Yield		(2)	(3)	(2)	(1)
	a	6.8505	2812.7000	6.7624	1073.2146
	b	1.0113	0.1328	1.0135	12.8176
	c	—	0.9399	—	—

(1)	(2)	(3)	(4)	(5)	(6)
All India					
Acreage		(1)	(1)	(3)	(2)
	a	30502.8779	8655.6308	131163.0200	6.4908
	b	301.9688	420.6870	0.6664	1.0065
	c	—	—	0,9033	—
Production		(2)	(2)	(2)	(2)
	a	10.0432	8.6633	11.1220	8.2384
	b	1.0265	1.0599	1.0269	1.0163
	c	—	—	—	—
Yield		(2)	(2)	(2)	(1)
	a	6.6192	6.3852	6.4635	1016.6829
	b	1.0179	1.0328	1.0207	12.4508
	c	—	—	—	—

Note : In this and other two subsequent tables (Tables 2 and 3) figures in brackets indicate the form of the best fitted trend curves against codes : (1) straight line, (2) semi-logarithmio, (3) Gompertz with $b < 1$ and $c < 1$, and (4) Gompertz with $b > 1$ and $c > 1$.

Source: **Area and Production of Principal Crops in India**, Govt. of India (Various Issues).

TABLE 2

Estimates of Best Fitted Trend Equation for Different Crops Obtained for Different Regions : 1950–51 to 1966–67

Region with variable	Estimated parameters	Crops			
		Rice	Wheat	All Food Crops	Jute
(1)	(2)	(3)	(4)	(5)	(6)
Bihar					
Acreage		(1)	(2)	(2)	(2)
	a	5179.5620	6.2977	9.1547	5.1078
	b	-6.9598	1 0206	1.0004	1.0041
	c	—	—	—	—
Production		(1)	(2)	(1)	(2)
	a	2928.6990	5.5498	4686.4180	6.5703
	b	78.8504	1.0436	156.1022	1.0211
	c	—	—	—	—
Yield		(1)	(1)	(1)	(1)
	a	575.3725	484.8889	495.3137	779.2680
	b	14.8380	12.7719	15.9389	15.3694
	c	—	—	—	—

Contd.

(1)	(2)	(3)	(4)	(5)	(6)
Orissa					
Acreage		(2)	(2)	(2)	(2)
	a	8.2258	1.3114	8.3362	3.6811
	b	1.0084	1.0782	1.0153	1.0057
	c	—	—	0.9033	—
Production		(1)	(2)	(1)	(2)
	a	1673.0330	0.7419	1871.7190	5.3190
	b	137.5872	1.0893	157.6904	1.0212
	c	—	—	—	—
Yield		(2)	(1)	(1)	(1)
	a	6.1910	527.9020	477.8431	922.9739
	b	1.0394	9.6945	22.0691	16.3302
	c	—	—	—	—

(1)	(2)	(3)	(4)	(5)	(6)
West Bengal					
Acreage		(1)	(1)	(3)	(1)
	a	3892.4970	50.2810	5687.0000	234.4118
	b	47.2869	0.0815	0.7744	12.6760
	c	—	—	0.8530	—
Production		(2)	(1)	(2)	(1)
	a	8.2549	33.5490	8.3970	1407.8690
	b	1.0179	0.2931	1.0149	107.1600
	c	—	—	—	—
Yield		(2)	(2)	(2)	(1)
	a	6.8929	6.5191	6.8343	1119.6210
	b	1.0068	1.10032	1.0046	9.8411
	c	—	—	—	—

Contd.

(1)	(2)	(3)	(4)	(5)	(6)
All India					
Acreage		(2)	(2)	(3)	(1)
	a	10.2919	9.2170	118142.0000	3438.3160
	b	1.0128	1.0205	0.7427	133.8799
	c	—	—	0.7686	—
Production		(2)	(3)	(2)	(1)
	a	9.9998	12381.4000	11.1174	1049.1840
	b	1.0316	0.4339	1.0266	10.4632
	c	—	0.8498	—	—
Yield		(2)	(2)	(2)	(2)
	a	6.6159	6.5130	6.5059	6.3858
	b	1.0186	1.0150	1.0154	1.0095
	c	—	—	—	—

Note : See note of Table 1.

TABLE 3

Estimates of Best Fitted Trend Equation for Different Crops Obtained for Different Regions : 1967–68 to 1987–88

Region with variable	Estimated parameters	Crops			
		Rice	Wheat	All Food Crops	Jute
(1)	(2)	(3)	(4)	(5)	(6)
Bihar					
Acreage		(1)	(2)	(2)	(2)
	a	5513.6290	6.8268	9.3081	4.5344
	b	-9.4519	1.0210	0.9954	1.0129
	c	—	—	—	—
Production		(1)	(2)	(1)	(2)
	a	3788.8430	6.6586	6380.0710	5.5543
	b	35.4353	1.0374	92.6940	1.0385
	c	—	—	—	—
Yield		(1)	(2)	(1)	(1)
	a	684.9571	6.7395	535.3429	295.3143
	b	7.9910	1.0160	13.9564	25.9977
	c	—	—	—	—

Contd.

(1)	(2)	(3)	(4)	(5)	(6)
Orissa					
Acreage		(2)	(2)	(3)	(2)
	a	8.5091	1.9914	7121.1000	4.0128
	b	0.9955	1.0653	0.7534	0.9926
	c	—	—	0.8980	—
Production		(1)	(2)	(1)	(1)
	a	3914.0710	2.0585	3401.9430	336.1857
	b	6.3045	1.0825	66.2459	0.6759
	c	—	—	—	—
Yield		(1)	(3)	(1)	(2)
	a	784.5429	1912.0000	781.3857	7.0149
	b	5.2985	0.4514	1.8865	1.0083
	c	—	0.7245	—	—

Contd.

(1)	(2)	(3)	(4)	(5)	(6)
West Bengal					
Acreage		(2)	(2)	(1)	(2)
	a	8.4687	5.5332	6411.2570	5.4510
	b	1.0027	1.0111	-8.0617	1.0236
	c	—	—	—	—
Production		(1)	(2)	(1)	(2)
	a	3139.0290	6.3365	4879.6290	6.9974
	b	127.4376	1.0079	108.9113	1.0421
	c	—	—	—	—
Yield		(1)	(2)	(1)	(1)
	a	722.1000	7.7112	745.2714	729.3714
	b	20.6895	0.9968	19.1519	24.3098
	c	—	—	—	—

Contd.

(1)	(2)	(3)	(4)	(5)	(6)
All India					
Acreage		(1)	(3)	(1)	(2)
	a	33343.2900	24874.0000	118071.8000	6.3858
	b	203.0610	0.5754	249.4377	1.0095
	c	—	0.8837	—	—
Production		(2)	(1)	(2)	(2)
	a	10.1101	-11113.3100	11.2036	7.9929
	b	1.0241	1545.9860	1.0241	1.0242
	c	—	—	—	—
Yield		(1)	(2)	(2)	(1)
	a	583.9351	6.4826	6.4313	803.7307
	b	23.3442	1.0300	1.0220	19.6338
	c	—	—	—	—

Note : See note of Table 1.

As to the measure of comparison of two standard errors of the growth rates for two separate periods, it is argued that the standard error estimated for the two periods may be strongly affected by instability throughout the time series and hence cannot be used for inter-temporal comparisons (Boyce 1987).

The method suggested by Sen (1967) is to estimate separate trend for 'peak' and 'trough' years and to assess the instability or stability of the variable in terms of the nature of divergence or convergence of the trend values. The objection against this method is regarding the definition of 'peak' and 'trough' years. It is argued that a small difference in the values of the variable can cause certain year to be excluded or included and any modification of this criteria seems to be a matter of subjective judgement.

Yet another method suggested by Boyce (1987) of testing the changes in instability over time is similar to Glejser's test for heterosc a dasticity and has some very distinctive advantages over the earlier methods discussed above. According to this method, let us define a statistic

$$Z_t = (Q_t - \hat{Q}_t)/\hat{Q}_t$$

where Q_t = observed value at time t and $\hat{Q}_t$ = estimated trend value at time t.

Now either the absolute value of Z_t or if one wishes to put greater weight to larger deviations the square term of the statistic is regressed against time. If the estimated time trend is significantly positive the instability seems to be increasing and if it is found to be negative the instability seems to be decreasing over time. The statistical significance is tested by the corresponding 't' values.

The advantage of this method is that one can use the full set of data for the entire time-period without considering any *a priori* break to measure the changes in instability of the variable. Again, this method can be applied to any functional specification of the growth process. However, the practical problem of this method is that the form of the relationship between $|Z_t|$ and time is not known and that depends on the nature of the scatter diagrams of $|Z_t|$ derived from the fitted relation between Q_t and time. Naturally, an arbitrary specification of the model in finding out the trend value of $|Z_t|$ may be misleading while interpre ing the trend values. Since there are no *a priori* ground to take any specific form one may test different models to obtain the best fitted model. Alternatively, on the basis of a scatter diagram of Z_t the form of the regression has to be decided.

Following the later approach we have, by and large used the measure ($|Z_t|$ and Z^2_t) suggested by Boyce to study the instability of agriculture in eastern India during 1950-51 to 1987-88. The results are presented below.

3.2 Results

In this analysis we did not attempt to break the entire period in two sub-periods as has been done in studying the growth rates presented in Section I of this article. Instead, we have used the entire time-series data without any subjective division of time periods for the reasons described above. As and when a structural break is suspected we have introduced dummy variables to have a better result. In this analysis, we have considered only two types of functional forms viz. linear and semi-log. We have ignored the Gompertz type of relation as it has been found in our earlier results that this functional form does not hold good in most of the cases of growth analysis.

Now, regarding the form of the relationship of $|Z_t|$ and Z_t^2 with time, the nature of the scatter diagrams vindicate for the linear specification to find out the trend value of the test statistics. In some cases we introduced dummy variables (both for intercept and slope) in the linear model and obtained better results. Presented in Table 4 are the results (significant trends only) of our analysis.

It is evident from the figures in Table 4 that instability in area, production and yield of rice and total foodgrains in most of the cases are increasing over time. In West Bengal trend of instability in acreage of rice is negative but the intercept dummy shows a significant upward shift of the magnitude of fluctuations during the post break period. Acreage of total food cultivation in West Bengal become more unstable (in most of the cases) during the later phase of the time series while in the first part of the break the trend is negative but not very significant. Yield instability of both rice and total foodgrain is found to be true for the entire time period resulting thereby in the instability in rice and foodgrains production in the states of eastern India. Instability in area, production and yield of rice and total food crops are much pronounced in Orissa than the other states as in most cases the trend value of the variables are positive and significantly high. When the dummy variables are introduced, the acreage of rice in Orissa shows a declining trend in the post-break period with a significant jump in the magnitude of fluctuations. (This is also true in the case of foodgrains output and yield.)

As to the results of analysis for wheat crop, the post-green revolution enterprise, most of the regions under study show a declining ttend of instability of production and yield which confirms one's expectation. Although instability in acreage of wheat crop in Orissa shows a declining trend, the yield instability seems to be rising in the pre-break period while it is significantly negative in the post-break period.

To sum up, the results of our analysis clearly show the increasing instability in the growth of area, production and yield of food crops and rice in particular in the states of eastern India during the last 38 years. This exercise also confirms the proposition that there has been no break in the production of foodgrains during 1950-51 to 1987-88. (The exception is noticed in the case of Orissa). In Orissa major agricultural break-through in rice and foodgrains production is noticed during the late fifties, much before the introduction of new seed-fertilizer-irrigation technology in different parts of India. This break, however, could not help to reduce the fluctuations of agricultural production during the post-break period. The picture of wheat cultivation is almost same in regard to instability in all the states of eastern India barring West Bengal and India in general.

III

4. Summary and Conclusion

The basic thing which we intend to establish here is that it is not enough to study the agricultural growth without considering the variability of the variables associated with the growth rates. It is sometimes observed that the growth of output of a region or of a country increased at an increasing rate, but this increase has brought in its wake considerable instability in output. This obviously affects the income and employment stability of the country. Thus from the view point of policy implications the growth of agriculture should be viewed in terms of an integrated framework of growth with stability.

With such considerations in mind we have attempted here to study the growth of agriculture in eastern India along with an analysis of fluctuations in foodgrains output and in the output of other major crops. To explain the relationship between growth and instability of agricultural production, an attempt has also been made to study the growth and instability of acreage and yield of the major crops grown in this region.

The results of our analysis provide some interesting insights into the problem. Our foregoing observations suggest that a sharp increase in the growth of agricultural production had not been possible during the period 1950-51 to 1987-88 in eastern India mainly because of the diminishing/constant rate of growth of cropped area of the major crops cultivated in this region. Although the rate of growth of productivity of land in rice seemed

TABLE 4

Measures of instability in terms of $| Z_t |$ and $| Z^2_t |$.

State	Crop	Original variable	Trend specification of original variable	Test Statistics	Trend specification of test statistics	Intercept	Trend	Intercept dummy	Slope dummy
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
West Bangal	Rice	A	Linear	$\| Z_t \|$	Linear[c] with Dummy	0.1038	-0.0014 (-2.06)	0.0453 (3.07)	
				Z_t^2	,,	0.0049	-0.0001 (-1.21)	0.0029 (2.29)	
	Rice	Y	Linear	$\| Z_t \|$	Linear	-0.0305	0.0016 (1.81)		
	Rice	Y	Semi log	$\| Z_t \|$	Linear	-0.0396	0.0017 (2 09)		
	Food	A	Semi log	$\| Z_t \|$	Linear	-0.0364	0.0011 (2.21)		

Contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Food	A	Linear	$\mid Z_t \mid$	Linear	-0.0288	.0010 (2.02)		
	Food	A	Linear	$\mid Z_t \mid$	Linear[f] with Dummy	0.0892	-0.0011 (-1.04)		0.0010 (2.15)
				Z^2_t	,,	0.0081	-0.0001 (-0.85)		0.0001 (1.67)
	Food	Y	Semi log	$\mid Z_t \mid$	Linear	-0.0216	0 0014 (1.87)		
Bihar	Wheat	P	Linear[a] with Dummy	$\mid Z_t \mid$	Linear	0.4602	-0.0040 (-1.76)		
	Wheat	Y	,,	$\mid Z_t \mid$	,,	0.4275	-0.0043 (-2.44)		
				Z^2_t	,,	0.1415	-0.0016 (-1.68)		
	Wheat	Y	Semi log[a] with Dummy	$\mid Z_t \mid$	,,	0.4615	-0.0047 (-2.66)		

Contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Orissa	Rice	A	Linear[b] with Dummy	$\lvert Z_t \rvert$	Linear	-0.0235	0.0007 (1.67)		
	Rice	A	,,	$\lvert Z_t \rvert$	Linear[9] with Dummy (deleting two outlayers at '61 and '62)	0.0075	0.00	0.1655 (2.49)	-0.0017 (-2.04)
				Z^2_t	,,	0.0001	0.00	0.0122 (1.99)	-0.0001 (-1.66)
	Rice	A	Semi log[b] with Dummy	$\lvert Z_t \rvert$	Linear	-0.0244	0.0007 (1.70)		
	Rice	P	Linear[b]	$\lvert Z_t \rvert$	,,	-0.1518	0.0037 (3.52)		
				Z_t^2	,,	-0.0525	0.0010 (3.48)		

Contd.

(1)	(2)	(3)	(4)	(5)	6)	(7)	(8)	(9)	(10)
	Rice	P	Semi log[b] with Dummy	I Z_t I	Linear	0.1696	0.0039 (3.86)		
				Z_t^2	,,	-0.0558	0.0011 (3.67)		
		Y	Linear[b] with Dummy	I Z_t I	,,	-0 0975	0.0028 (2.62)		
				Z_t^2	,,	-0.0367	-0.0007 (2.79)		
		Y	Semi log[b] with Dummy	I Z_t I	,,	-0.1042	0.0029 (2.75)		
				Z_t^2	,,	-0.0390	+0.0008 (+2.88)		
	Wheat	A	Linear[c] with Dummy	I Z_t I	,,	0.3712	-0.0028 (-1.79)		

Contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Z_t^2	,,	0.1176	-0.0011 (-1.64)		
		P	,,	$\mid Z_t \mid$	,,	1.6124	-0.0181 (-2.58)		
				Z_t^2	,,	3.2458	-0.0413 (-1.92)		
Orissa	Wheat	Y	Linear[d] with Dummy	$\mid Z_t \mid$	Linear	0 4181	-0.0041 (2.34)		
				Z_t^2	,,	0.1198	-0.0013 (-1.41)		
		Y	,,	$\mid Z_t \mid$	Linear[g] with Dummy	-0.2653	0.0078 (2.32)		-0.0037 (3.95)
				Z_t^2	,,	-0.2239	0.0047 (2.79)		-0.0018 (-3.93)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Food	P	Linear[b] with Dummy	$\lvert Z_t \rvert$	Linear	-0.0893	0.0026 (2.65)		
				Z_t^2	,,	-0.0328	0.0007 (2.65)		
			Semi log[b] with Dummy	$\lvert Z_t \rvert$	,,	-0.0863	0.0026 (2.68)		
				Z_t^2	,,	-0.0339	0.0007 (2.84)		
		Y	,,	$\lvert Z_t \rvert$	,,	-0.0705	0.0023 (2.00)		
				Z_t^2	,,	-0.0362	0.0007 (2.16)		
			Semi log[b]	$\lvert Z_t \rvert$	,,	-0.0766	0.0024 (2.11)		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Z_t^2	Linear	-0.0384	0.0008 (2.18)		
India	Wheat with Dummy	P	Linear[a]	$\lvert Z_t \rvert$	,,	2.9354	-0.0369 (-3.50)		
				Z_t^2	,,	8.7201	-0.1142 (-2.28)		
		Y	,,	$\lvert Z_t \rvert$	,,	0.2998	-0.0031 (-3.00)		
				Z_t^2	,,	0.0792	0.0009 (-3.50)		

Note : Dummy years corresponding to each superscript. **(contd.)**

(a) D = 0 for 1950-51 to 1967-68
= 0 for other years

(b) D = 0 for 1950-51 to 1959-60
= 1 for other years

(c) D = 0 for 1950-51 to 1972-73
= 1 for other years

(d) D = 0 for 1951 to 1969-70
= 1 for other years

(e) D = 0 for 1950-51 to 1968-69
= 1 for other years

(f) D = 0 for 1950-51 to 1966-67
= 1 for other years

(g) D = 0 for 1950-51 to 1969-70
= 1 for other years.

to be rising over the years in West Bengal and Orissa, the production growth rates of foodgrains and rice remained more or less constant due to the declining rate of growth in area under the food crops. It is further seen that the area under rice and wheat also behaved most erratically in some time-points and in some states (e.g., Bihar and Orissa). As a result a very marginal rate of growth in production of foodgrains and rice in particular is noticed in eastern India during the period of 38 years.

The introduction of new agricultural technology during the late sixties in this region has not helped much to change the growth and instability scenario of eastern India. In fact, in some cases (e.g., Orissa), the growth of foodgrains production seems to have declined during the post-green revolution years and instability is seen to be of much higher magnitude for rice during this period. Again, magnitude of instability seems to be much higher for wheat in most of the states in eastern India during the post-green revolution period. All these evidences amount to this : the new technology in agriculture has not been effective for any major crops (including the commercial crop of this region jute) and for wheat in particular in the states of eastern India.

The poor performance of agriculture in eastern India can be explained in two ways : (i) demographic, and (ii) agrarian backwardness. According to the first factor, the migrations of people from outside India have increased the population pressure in this region resulting thereby in the decrease in the size of viable peasant holdings and a swell in the ranks of the landless population. On the other hand the agrarian backwardness accompanied by the large dependence on rainfall irrigation and the pre-capitalist relations of production particularly in Bihar and Orissa have facilitated the process of pauperisation among the peasantry, in the sense that the rates of accumulation and investment in agriculture have appeared to be very low and hence productivity of land has gone down.

REFERENCES

1. Boyce James K (1987) Agrarian impasse in Bengal : Institutional constraints to technological change. Oxford University Press.

2. Chattopadhyay M, Bhattacharya G (1987) Growth of Indian agriculture : A reappraisal. Indian Journal of Agricultural Economics 42(1) : 67-75.

3. Dhawan B D (1987) How stable is Indian irrigated Agriculture ? Economic and Political Weely 26 September.

4. Hazell Peter B R (1982) Instability in Indian foodgrains production. International Food Policy Research Institute, Washington, Research Report 30, May.

5. Mehra S (1981) Instability in Indian agriculture in the context of the new technology. International Food Policy Research Institute, Washington, Research Report 25, July.

6. Ray S K (1983) An empirical investigation of the nature and cause for growth and instability in Indian agriculture : 1950-80. Indian Journal of Agricultural Economics 38(4) : 459-474.

7. Rudra A (1970) The rate of growth of Indian economy. In : E. G. Robinson and M. Kidron (ed) Economic Development in South Asia, Kandy Conference Proceedings, Macmillan, & London.

8. Rudra A (1982) *Indian agricultural economics : Myths and realities.* Allied Publishers, Delhi.

9. Sen S R (1967) Growth and instability in Indian Agriculture. Agricultural *Situation in India 21 (10).*