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RESEARCH NOTES

Growth Decomposition of Foodgrains Output in West Bengal: A District Level Study

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I

INTRODUCTION

Decomposition of output growth is not a new concept in the field of agricultural growth analysis. Still, it has its usual importance to the researchers and policy makers for identifying the root causes of high and low growth of agricultural output. Basically decomposition analysis is a post-Independence phenomenon. This paper attempts a component-wise analysis of the growth of foodgrains output valued at constant prices for the state of West Bengal and its districts during the time period 1970-71 to 1999-2000. One additive decomposition model without any arbitrary residual term has been developed in a double kink linear framework. The factors identified for output decomposition are area, yield and cropping pattern. The reason behind the use of additive model is the nature of the growth trends (double kink linear). The decomposition model with the interaction term has certain disadvantages as it either underestimates or over-estimates the pure effect of the variable. In the multiplicative framework, consistent decomposition model without any interaction term has been introduced for the first time by Jamal and Asad (1992), but to the best of our knowledge, no such attempt has been made in the additive framework. Consistent decomposition of output growth with the appropriate additive model without any interaction term is the modest attempt of the present work.

The planning of the paper is as follows. After the brief introduction of Section I, an overview of literature is presented in Section II. Section III discusses the methods of analysis. Results of decomposition model and discussion thereon are presented in Section IV, while Section V summarises the findings of the study.

II

OVERVIEW OF LITERATURE

There are different models and concepts of growth decomposition. Broadly these can be categorised into two schemes: (i) Additive Scheme, (ii) Multiplicative

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Scheme. Additive schemes are used to decompose the absolute growth rate (dQ) and for relative growth (dQ/dt) decomposition, multiplicative schemes are used.

Under additive schemes the first systematic study came from Minhas and Vaidyanathan (1965). They decomposed the change in value of gross output into four components in the following manner:

$$P_t - P_0 = (A_t - A_0) \Sigma w_i c_{i0} y_{i0} + A_t \Sigma w_i c_{io} (y_{it} - y_{io}) A_t \Sigma w_i y_{io} (c_{it} - c_{io}) + A_t \Sigma w_i (y_{it} - y_{io})(c_{it} - c_{io}) \quad \ldots (1)$$

where P_t, A_t, c_{it}, y_{it} are respectively the value of output, gross cropped area, cropping pattern, yield at time period t and w_i is constant price weight. Subscript '0' values are the base period values of the same components. The first three components of Minhas and Vaidyanathan scheme [(Equation (1)] measure the contribution of area, yield, and cropping pattern, respectively, in the absolute change in value of gross agricultural output. The last term is the interaction effect of yield and cropping pattern change. A positive interaction term implies a shift of agricultural production in favour of high yielding crops. This study showed that for the country as a whole, approximately 45 per cent of additional output was accounted for increase in area, more or less the same proportion for yield increase and only 8 per cent accounted for change in the cropping pattern.

Kaul (1966) used the same four factor additive model of Minhas and Vaidyanathan (1965) to study the growth of agricultural production of Punjab. The four-factor model of growth decomposition was further extended to seven-factor model by Minhas (1966). Here the new added terms were interaction of area-yield, area-cropping pattern, area-cropping pattern and yield.

Sagar (1977) also decomposed the gross agricultural output at prevalent prices into seven components, three gross components (area, yield, price) and four interactions (area-price, area-yield, yield-price and area-price-yield). Introduction of current price was the new addition of Sagar's (1977) work.

Narain (1977) made another new addition in this field by introducing locational component in the decomposition of agricultural productivity. There were three gross components in his model, viz., yield, cropping pattern and locational component. A positive locational component indicates a shift in crop location from low productivity region to high productivity region. His analysis showed that the locational effect on the average yield was significant but from time to time it was changing in magnitude.

To measure the contribution of the technological factors, viz., irrigation, fertiliser and high-yielding varieties towards increase in overall agricultural production Sagar (1978) further decomposed the Minhas-Vaidyanathan's (1965) yield component into four components. The main components are irrigation, fertiliser and high-yielding varieties. The fourth term is the unexplained yield growth rate. The results showed that 66 per cent of yield component of the productivity growth was being explained by the three technological factors and among them fertiliser was the largest contributor (30 per cent). The contributions of irrigation and high-yielding varieties were 18 and 15 per cent, respectively.

Kurosaki (2002) proceeded through three steps, first, decomposition of gross output into two components area and productivity, then decomposition of productivity into three components yield, crop shift and the residual effect and lastly, yield into three components pure yield effect, static land reallocation effect and dynamic land reallocation effect. The static effect become more positive when the area under crops whose yields were initially high increases relatively and the dynamic shift effect becomes more positive when the area under dynamic crops increases relative to the area under non-dynamic crops.

For studying the relative contribution of the three factors viz. area, yield and their interaction Dashora *et al.* (2000), Sarkar and Chakraborty (2002) also split the aggregate crop output using seven-factor additive model.

In the field of multiplicative analysis Parikh's study (1966) was the pioneering one. Dayal (1966) also used the same multiplicative model in his growth analysis. Formulation of this model is as follows:

$$\frac{\sum y_{ti} A_{ti} P_{0i}}{\sum y_{0i} A_{0i} P_{0i}} = \frac{A_t}{A_0} \frac{\sum y_{ti} R_{ti} P_{0i}}{\sum y_{ti} R_{0i} P_{0i}} \frac{\sum y_{ti} R_{0i} P_{0i}}{\sum y_{0i} R_{0i} P_{0i}} \qquad \text{.... (2)}$$

where y, A, P, R stand for yield, area, prices and cropping pattern, respectively. This model indicates that output index is nothing but a product of the index of area, cropping pattern and yield. In Parikh-Dayal's model there is no interaction term. Explaining the importance of the interaction term in the multiplicative model, Minhas (1966) split up the ratio of final and base year production into three factors, area, yield and one interaction term. The area and yield effects are the same in both the models. The third item that is the interaction term is the product of two elements, the crop pattern at final year yields and the inverse of the crop pattern at base year yields.

A major study was conducted by Bhalla and Alagh (1979) covering 289 districts over the period 1962-65 to 1970-73 in India with a new multiplicative model. Their study found out that among high growth districts the yield effect was the predominant factor of output growth, among medium-growth districts, yield effect was not the dominant factor, rather area change and cropping change had more strong influence. Their study also considered the interaction term.

In discussing the problems of interaction or residual term in multiplicative model Jamal and Asad (1992) observed "the interpretation of such decomposition poses several problems, especially when the residual effects are large. Then in fact the decomposition really does not provide any useful information to the policy makers, it tells only ambiguous nature of changes". They formulated a decomposition model without residual term. But their model is unlike the model of Parikh-Dayal (1966) model where also the residual term was absent. Again Parikh's model was inconsistent in the use of the index number. Jamal and Asad (1992) consistently introduced some new indices in the analysis that can be considered as the substitute element of the residual terms. Each effect (e.g., yield effect) has been represented by a Generalised Ideal Index constructed by taken the Geometric Mean of the corresponding Laspayer's Index (using base year values as weight), Paasche's Index (using terminal values as weight) and an index representing interaction between base and terminal year.

III

METHODOLOGY

Type and Sources of Data

The main sources of data for this paper are from the various issues of *Economic Review and Statistical Abstract* published by Government of West Bengal. The data used for this study are the state and district level output, yield, area and harvest prices of the different foodgrains. *Aus* rice, *aman* rice, boro rice, wheat, barley, gram and other pulses are considered in the foodgrain items. The average farm harvest price of the three normal years (1987, 1988, 1989) has been taken here as constant price weight. As the harvest price for the other pulses are not directly available, an estimate on the basis of price ratio to similar crops has been made for the present analysis.

The study has been done for the time period of 1970-71 to 1999-2000. Green revolution, though it started in the mid-sixties in the Punjab, Haryana, etc., came a little later in the eastern region, in West Bengal, mainly in the early seventies. This is why the present study began from the year 1970-71. The study ended at 1999-2000, since at the time of data collection the data were available up to 1999-2000, in view of average publication lag of two years in the official publications.

Components of Growth

At the constant price weight the value output can broadly be decomposed into two components: (i) area and (ii) productivity. Again productivity consists of two items (i) yield and (ii) cropping pattern or inter-crop reallocation. In case of individual crop there is no difference between yield and productivity. So ultimately the components of growth considered for output decomposition in the present study are area, yield and cropping pattern effects. In general, explanation of the area component takes into account the rate of growth of gross cropped area that includes the impact of change both in the net sown area and cropping intensity. In this connection it is important to mention that as far as West Bengal's land structure is concerned little scope exists for the extension of new land and maximum area growth reflects the increase in cropping intensity. The yield component measures the impact of change in output per hectare. Cropping pattern change implies to what extent area is shifted from a low yield crop to a high yield crop.

The specific objectives and the corresponding hypotheses of this study are as follows: (1) To decompose sub-period-wise the output growth into area, yield and cropping pattern effects in West Bengal for the period of 1970-71 to 1999-2000 and (2) To find out if there is a sharp change in the effects of different components on absolute growth of output consistent with its profile.

Hypotheses

H1. Yield growth would be the most dominant component of foodgrains output growth.

H2**.** There would be a linear influence of time on each component of absolute growth of output.

H3. There would be sharp changes in the profile of yield, area and cropping pattern effects on absolute growth of output.

IV

MODEL

It is already mentioned that an attempt has been made here to construct an appropriate additive decomposition model without any residual term. From the trend selection[1] it is found that the linear model with double kink, positive the first one in the year of 1983-84 and negative the second in 1991-92 [Table 4], gives the best fit. The linear model with two kink looks like the following:

Double Kink Linear Model

$$V_t = a_1 + b_1 D_1 t + b_2 (D_2 t + D_3 K_2) + b_3 (D_3 t - D_3 K_2) + u_t \qquad \ldots. (3)$$

a_1, b_i, c_i are the parameters estimated on the basis of observed data, t is the time period, D_js are the dummy variables and

$D_j = 1$ for the j-th sub-period, $\quad$ i,j = 1, 2,3
$\quad = 0$ otherwise.

u_t is the disturbance term. K_1 and K_2 are the two break points. For simplicity the value of 't' has been assumed to be zero at the first trend break and therefore t = 8 at K_2.

At the district level in most of the cases the double kink linear model gives the best fit.[2]

To test the level of significance of the trend breaks the following equation, which are the modified form of equation 3 have been used.

Model for Trend Breaks Testing

$$V_t = a_1 + b_1 t + b_2^* t(D_2 + D_3) + b_3^* (D_3 t - KD_3) + \mu_t \qquad \ldots. (4)$$

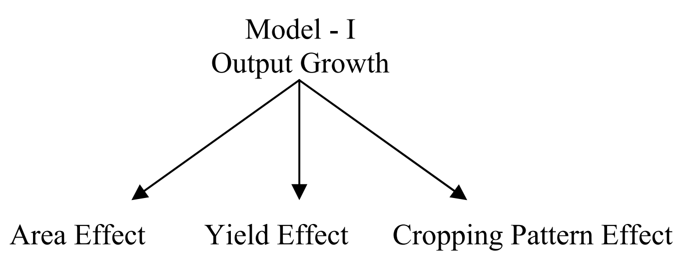
Here b_1^*, b_2^* indicate the differences between b_1 and b_2, b_2 and b_3, of equation 1 respectively. The time coefficients b_2 and b_3 of the Double Kink Linear model

(Equation 3) being replaced by $(b_1 + b_1^*)$ and $(b_1 + b_1^* + b_2^*)$ respectively, the new parameters b_1^* and b_2^* indicate the difference in growth rates between sub-period I and II and sub-period II and III respectively.

Model for Decomposition

As mentioned above the three components, viz., area, yield and cropping pattern have been considered in the present study for output decomposition. The effect of each component is evaluated using, as weights, different combinations of base and terminal years values of the other two components. In fact for each crop and each effect the weight is the arithmetic mean of three terms. The first two terms represent the base year and terminal year values of the products of the two remaining components and the third term is the average of the products obtained by alternately taking the base year value of one remaining component and the terminal year value of the other remaining component. It may be noted, this third term is also an interaction term in the language of Jamal and Asad (1992) but this is not the Minhas (1966) type of residual. In fact such a 'pooled-partial-effect-term' is not required in this scheme to ensure an identity, since it has an in-built balancing system.

The model constructed for the present study is as follows:



Output Growth

$$= A_t \Sigma\, w_i\, c_{it}\, y_{it} - A_0\, \Sigma\, w_i\, c_{i0}\, y_{i0} \qquad \ldots (5)$$

Area Effect

$$= 1/3[(A_t - A_0)\{\Sigma w_i\, c_{io}\, y_{io} + \Sigma w_i\, c_{it}\, y_{it} + 1/2\, \Sigma\, w_i\, c_{io}\, y_{it} + \Sigma w_i\, c_{it}\, y_{io}\}] \qquad \ldots (6)$$

Yield Effect

$$= 1/3\, A_0\, \Sigma w_i\, (y_{it} - y_{i0})\, c_{i0} + 1/3\, A_t\, \Sigma w_i\, (y_{it} - y_{io})\, c_{it} + 1/6\, A_0\, \Sigma w_i\, (y_{it} - y_{i0})\, c_{it} + 1/6\, A_t\, \Sigma w_i\, (y_{it} - y_{i0})\, c_{i0} \qquad \ldots (7)$$

Cropping Pattern Effect

$$= 1/3\, A_0\, \Sigma wi\, (c_{it} - c_{i0})\, y_{i0} + 1/3\, A_t\, \Sigma wi\, (c_{it} - c_{i0})\, y_{it} + 1/6\, A_0 \Sigma wi\, (c_{it} - c_{i0})\, y_{it} + 1/6\, A_t \Sigma wi\, (c_{it} - c_{i0})\, y_{i0} \qquad \ldots (8)$$

The variables and notations used in this model are

At = $\sum_i a_{it}$ = Gross area under foodgrains,

a_i is the area under i-th crop,

$y_{it} = V_{it}/A_t$ = yield of i-th crop,

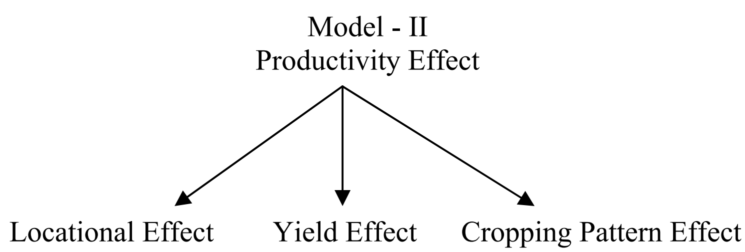
$c_{it} = a_{it}/A_t$ = share of the i-th crop in gross cropped area all at time t.

w = Constant price weight.

The subscripts '0' and 't' refer respectively to the base and 't' th period. Subscript 'i' is used for the i-th crop (i = 1,2 …. 7).

In output decomposition, under linear framework, the effect of each component (yield, cropping pattern, area) measures the output growth due to that particular component. For example, here yield effect indicates the output growth due to growth in yield.

The time reversal and factor reversal test by Fisher Ideal Index number has been already extended by Jamal and Asad (1992) in the context of their Generalised 'Ideal' index interpreted as the geometric mean of three indices: Laspayer's (L), Paasche's (P) and Interaction (I) between base and terminal year values. The additive counterpart of these steps are satisfied by the linear decomposition models suggested by us in the present study.



Time Reversal Test (Model I)

$$E_{01}^{v} + E_{10}^{v} = A_t \sum w_i c_{it} y_{it} - A_0 \sum w_i c_{i0} y_{i0} + A_0 \sum w_i c_{i0} y_{i0} - A_t \sum w_i c_{it} y_{it} = 0 \qquad \text{…. (9)}$$

In the additive framework this test implies as the time periods are interchanged one gets the effects which are equal in magnitude but opposite in sign $(E_{01}^{V} = -E_{10}^{V})$.

Factor Reversal Test (Model I)

$$E^A + E^y + E^C = E^V = A_t \Sigma w_i c_{it} y_{it} - A \Sigma w_i c_{i0} y_{i0} \qquad \text{…. (10)}$$

where E stands for effect, V, A, y, c indicate the output, area, yield and cropping pattern respectively.

V

RESULTS AND DISCUSSION

Foodgrains output growth (valued at constant prices- average for the years 1987, 1988 and 1989) in West Bengal and its districts over the last three decades from 1970-71 to 1999-2000, have been decomposed following Model-I, where the output is decomposed into three components, viz., area, yield and cropping pattern. The growth of each component has been estimated by regression method (OLS).

Trend selections[2] show that not only in the case of output, but also in the case of area, yield and cropping pattern, double kink linear (DKL) model gives the best fit in majority of the districts and the state as a whole, despite some component-wise variation across the districts. However, even for those districts and those components, for which the best fit is given by some other functional form, the DKL form fits reasonably well. Therefore, for the sake of uniformity DKL trend has been uniformly used for all the constituent components. The state level trends of output and its components are graphically presented in Figure 1. The significant values of Adj R^2 in the DKL trend of the components (Table 1) establish the linear influence of time on each of the items. Kink in linear form indicates an abrupt rise in the rate of absolute growth. Consistent with double kink model there are three sub-periods in the study. The first sub-period is from 1970-71 to 1982-83, second from 1983-84 to 1990-91 and the third from 1991-92 to 1999-2000.

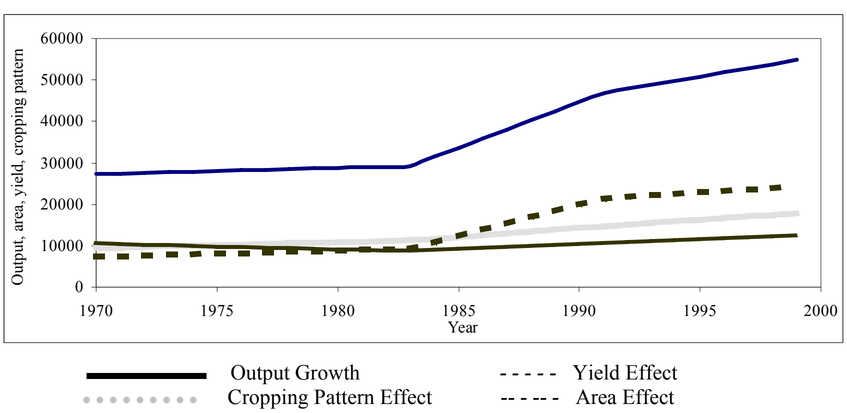


Figure 1. Double Kink Linear Trends of Output and Its Components

The results of this three-way decomposition of output growth under the double kink linear framework denoting three sub-periods separately have been presented in Table 1 for the state and in Table 3 for the districts.

TABLE 1. DECOMPOSITION OF ABSOLUTE OUTPUT GROWTH IN WEST BENGAL

(Rs. million per annum)

(1)	Sub-period I (2)	Sub-period II (3)	Sub-period III (4)	$\bar{R}^2$ (5)	DW (6)
Output growth	147.78	2208.79	988.48	0.93	2.07
	(156.69)*	(235.72)*	(292.11)*		
Area effect	-139.69	255.57	230.74	0.49	1.29
	(62.26)*	(93.67)*	(116.07)**		
Yield effect	149.86	1522.75	363.04	0.89	2.11
	(130.59)	(196.46)*	(243.46)*		
Cropping pattern effect	140.03	430.50	394.70	0.95	2
	(35.91)*	(54.03)*	(66.95)*		

Notes: 1. Figures in parentheses are the Standard Error.
2. ** and * Significant at 5 and 1 per cent level, respectively.

Output Growth

The output column of Table 1, 2 and 3 for the state and for each district gives the relative and absolute growth rates. So far as relative output growth rates are concerned, all but four districts (Burdwan, Howrah, Nadia and Malda) and the state as a whole registered the growth rate of below 1 per cent (Tables 2, 3) during sub-period I. During the second sub-period all the districts witnessed the relative growth rate of above 4 per cent per annum except for the district of Jalpaiguri (2.45 per cent). In the state of West Bengal the growth rates was observed at 5.86 per cent during this sub-period. The performance of sub-period III was not as good as sub-period II but it was not as poor as the first sub-period. Six (Burdwan, Birbhum, Hooghly, Murshidabad, West Dinajpur and Jalpaiguri) out of fifteen districts of the state under study indicated a growth of more than 2 per cent and the state growth rate was 1.96 per cent per annum.

TABLE 2. DECOMPOSITION OF RELATIVE OUTPUT GROWTH IN WEST BENGAL

(per cent per annum)

(1)	Sub-period I (2)	Sub-period II (3)	Sub-period III (4)
Output growth	0.54	5.86	1.96
	(100)	(100)	(100)
Area effect	-0.51	0.68	0.46
	(-94.53)	(11.57)	(23.34)
Yield effect	0.54	4.04	0.72
	(99.38)	(68.94)	(36.73)
Cropping pattern effect	0.51	1.14	0.78
	(95.15)	(19.49)	(39.93)

Note: Figures in parentheses are the percentage share of the items to relative output growth.

TABLE 3. DISTRICT WISE DECOMPOSITION OF ABSOLUTE AND RELATIVE OUTPUT GROWTH IN WEST BENGAL

(Rs. million per year)

Components	g_1	g_2	g_3	$\bar{R}^2$	DW
(1)	(2)	(3)	(4)	(5)	(6)
		Darjeeling			
Output growth	0.19 (0.08)	11.64* (4.1)	-16.90* (-6.4)	0.41	1.92
Area effect	0.78 (0.32)	6.49* (2.26)	-13.38* (-4.8)	0.59	1.35
Yield effect	-0.15 (-0.06)	5.69** (1.98)	-4.13 (-1.49)	0.10	1.75
Cropping pattern effect	-0.44 (-0.18)	-0.543 (-0.14)	0.612 (0.11)	0.13	0.88
		Jalpaiguri			
Output growth	-14.46 (-1.18)	29.99** (2.45)	25.73 (2.09)	0.33	2.01
Area effect	3.95 (0.32)	-10.05 (-0.82)	0.055 (0.004)	-0.007	0.99
Yield effect	-17.70 (-1.44)	36.93* (3.01)	28.69 (2.34)	0.48	2.34
Cropping pattern effect	-0.71 (-0.06)	3.11** (0.26)	-3.02 (-0.25)	0.03	0.95
		Cooch Behar			
Output growth	8.89 (0.78)	62.17* (4.2)	-11.05 (0.67)	0.79	1.88
Area effect	7.47 (0.65)	13.73** (0.92)	-20.00**(-1.21)	0.26	1.44
Yield effect	-1.07 (-0.09)	45.13 * (3.01)	-0.190 (-0.01)	0.70	1.78
Cropping pattern effect	2.4** (0.22)	3.31** (0.27)	9.23**(0.55)	0.74	1.95
		West Dinajpur			
Output growth	13.59 (0.72)	112.84* (4.6)	215.55* (6.16)	0.77	1.84
Area effect	8.65 (0.46)	-4.69 (-0.19)	41.94* (1.09)	0.32	1.48
Yield effect	2.34 (0.12)	69.39** (2.76)	157.96* (4.48)	0.63	1.88
Cropping pattern effect	2.60 (0.14)	48.14* (2.03)	15.66* (0.59)	0.94	2.17
		Malda			
Output growth	18.92* (1.44)	108.09* (5.9)	10.87 (0.46)	0.93	2.28
Area effect	-25.13* (-1.9)	26.74* (1.43)	-36.82* (-1.55)	0.52	1.19
Yield effect	30.16* (2.28)	59.82* (3.2)	18.08 (0.76)	0.94	1.94
Cropping pattern effect	13.89* (1.06)	21.54* (1.27)	29.60*(1.25)	0.94	1.94
		Murshidabad			
Output growth	1.78 (0.08)	161.78* (5.8)	108.24*(2.69)	0.86	2.09
Area effect	-14.08 (-0.59)	-30.6 ** (-1.05)	41.90* (1.03)	0.36	1.75
Yield effect	-0.382 (-0.02)	129.66* (4.3)	34.84 (0.86)	0.79	1.87
Cropping pattern effect	16.241* (0.69)	62.71* (2.15)	31.5* (0.8)	0.98	1.70
		Hooghly			
Output growth	-3.33 (-0.20)	109.84* (5.2)	63.29* (2.2)	0.85	2.44
Area effect	-12.76** (-0.75)	18.18** (0.86)	31.67* (1.11)	0.53	2.22
Yield effect	9.821 (0.58)	76.54* (3.64)	11.68 (0.41)	0.81	2.49
Cropping pattern effect	-0.385 (-0.03)	15.11* (0.7)	19.92* (0.68)	0.76	2.89
		Nadia			
Output growth	40.07* (2.6)	179.53* (6.9)	48.23* (1.39)	0.95	1.63
Area effect	-15.24* (-0.98)	17.79 (0.67)	20.77 (0.59)	0.17	1.37
Yield effect	19.00** (1.24)	95.83* (3.6)	-15.27 (-0.44)	0.87	2.33
Cropping pattern effect	36.00* (2.34)	65.91* (2.63)	42.73* (1.24)	0.96	1.56
		Burdwan			
Output growth	35.796 (1.07)	257.77* (5.48)	264.5* (3.96)	0.92	2.07
Area effect	-14.80 (-0.44)	29.02 (0.61)	152.13* (2.24)	0.77	1.87
Yield effect	40.1* (1.18)	182.12* (3.81)	35.31 (0.52)	0.90	1.77
Cropping pattern effect	10.41(0.33)	46.63* (1.05)	77.13* (1.2)	0.84	2.21

(Contd.)

TABLE 3. *(Concld.)*

Components	g_1	g_2	g_3	$\bar{R}^2$	DW
(1)	(2)	(3)	(4)	(5)	(6)
		24 Parganas			
Output growth	26.42 (0.64)	375.29 (9.09)	23.48 (0.57)	0.89	1.71
Area effect	-0.99 (-0.02)	36.61* (0.89)	38.61* (0.93)	0.70	1.08
Yield effect	-0.22 (-.005)	295.95* (7.16)	-57.37* (-1.39)	0.81	1.91
Cropping pattern effect	27.63* (0.67)	42.73* (1.04)	42.24* (1.03)	0.91	1.53
		Howrah			
Output growth	12.56 (1.9)	52.20 (7.89)	-13.46 (-2.04)	0.78	1.55
Area effect	2.7 (0.41)	20.95* (3.17)	-6.57 (-0.99)	0.69	1.69
Yield effect	8.27** (1.25)	6.23 (0.94)	-4.8 (-0.73)	0.22	1.82
Cropping pattern effect	1.59(0.24)	25.02* (3.78)	-2.09 (-0.32)	0.91	1.71
		Midnapore			
Output growth	13.59 (0.34)	419.00* (7.23)	103.55 (1.28)	0.89	2.33
Area effect	-16.8** (-0.42)	64.73* (1.10)	53.04* (0.65)	0.81	2.00
Yield effect	17.77 (0.44)	280.39* (4.77)	7.36 (0.09)	0.76	2.29
Cropping pattern effect	12.68** (0.32)	73.874* (1.36)	43.16* (0.54)	0.91	1.91
		Bankura			
Output growth	-5.147 (-0.29)	207.23 *(7.84)	52.51 (1.41)	0.85	2.33
Area effect	-17.651* (-0.96)	47.19* (1.76)	-4.51 (-0.12)	0.54	2.07
Yield effect	6.657 (0.36)	147.56* (5.49)	53.57** (1.43)	0.85	2.16
Cropping pattern effect	5.847* (0.31)	12.47* (0.59)	3.451 (0.01)	0.83	2.37
		Birbhum			
Output growth	-9.97 (-0.47)	110.24 (4.06)	131.34*(3.7)	0.73	1.49
Area effect	-28.62* (-1.29)	3.19 (0.12)	74.42* (2.11)	0.50	1.91
Yield effect	7.534 (0.34)	97.98* (3.53)	48.50* (1.38)	0.78	1.49
Cropping pattern effect	11.12 (0.48)	9.07 (0.41)	8.43 (0.21)	0.56	1.89
		Purulia			
Output growth	4.62 (0.05)	67.81* (4.33)	14.75 (1.48)	0.62	2.43
Area effect	-14.65* (-1.30)	34.03* (2.17)	-2.26 (-0.12)	0.48	2.68
Yield effect	18.45* (1.64)	33.35** (2.13)	13.58 (0.72)	0.59	2.30
Cropping pattern effect	0.82 (-0.29)	0.43 (0.03)	3.4** (0.88)	0.31	1.69

Notes: 1. Figures in parentheses are the relative growth rates.
2. Effect of each component represents the rate of growth of output caused by a change in that component and therefore measured in the same unit of Rs. million per year as output growth itself.
3. ** and * Significant at 5 and 1per cent level, respectively.

Yield Effect

In both absolute and relative growth decomposition, for most of the districts and the state as a whole, the maximum portion of the output growth in the first as well as in the second sub-period was explained by the yield growth. However, just like the output growth, yield growth was very poor in most of the districts during the first sub-period and remarkable improvement occurred during the 1980s in most of the cases. The state level sub-period wise relative growth rates of yield were 0.54 per cent, 4.04 per cent and 0.72 per cent respectively (Table 2).

At the state level, during the first sub-period, yield growth alone accounted for almost 100 per cent of the output growth and the corresponding shares being 68.94 per cent and 36.73 per cent during the second and third sub-periods respectively. So over the years, the importance of yield effect on output growth showed a declining trend in West Bengal.

So far as the districts are concerned during sub-period I, six out of fifteen districts remain above the state level yield growth (Table 3). The maximum growth rate was observed in the district of Malda at 2.28 per cent level annually. In the next sub-period, i.e., in sub-period II, the best performance was experienced by the districts of 24 Parganas, the growth rate of yield being 7.16 per cent per annum. In almost all the districts, the yield growth explained almost 70 per cent of the output growth during the 1980s. During the last sub-period the trend of yield growth was almost in the same direction of output growth for most of the cases. The West Dinajpur district was the only district which registered high yield growth at the level of 4.48 per cent per annum during the third sub-period after registering 2.76 per cent growth rate in the previous sub-period.

On the whole, the performance in terms of yield growth was poor in the Eastern Himalayan region as a whole and district of Darjeeling in particular.

Cropping Pattern Effect

Though the yield growth was the main engine, the growth rate of cropping pattern and area also increased during the second sub-period. Cropping pattern effect indicating its contribution to output growth showed gradual improvement in its importance to the foodgrains output growth in West Bengal. Among all the components, change in cropping pattern within the foodgrains group was the most important one during the third sub-period at the state level contributing as much as 39.9 per cent (Table 2) to the output growth though in terms of absolute or relative growth rate it was less than that of second sub-period (Table 1 and 2). At the district level the growth of cropping pattern in all the three sub-periods in most of the districts remained either below 1 per cent or even negative. However, for the district of Nadia it was as high as 2.34 per cent per annum. Just like the state as a whole, during the last sub-period, in the districts of Nadia, Malda, Purulia, Darjeeling and Cooch Behar maximum output growth came from the cropping pattern effect. It is definitely a good sign that over the years the shift of crop has taken place more towards high yielding crops. The fall of output growth despite this welcome shift is really a cause of concern for West Bengal.

In West Bengal the cropping pattern was solely guided by the yield behaviour and was the second most important factor in the decomposition analysis during the time period 1970-71 to 1999-2000. During the second sub-period the cropping pattern effect was also seen high as compared to the other sub-periods though its percentage contribution was the highest in the third sub-period. Among the season-wise competing crops in West Bengal like *boro* paddy and wheat crop the cropping pattern was in favour of *boro* paddy during the period 1982-83 to 1990-91. The yield ratios of *boro* paddy and wheat during the two years were found to be 1.29 and 3.34 respectively and that of gross cropped area were 1.14 and 1.52 per cent respectively.

Area Effect

Area effect, which was negative in the first sub-period at the state level, explained 11.60 per cent and 23.47 per cent of output growth during the second and third sub-periods respectively. The state level relative area growth rates increased from -0.51 per cent to 0.68 per cent per annum between first and second sub-periods, and decreased to 0.46 per cent during the third sub-period.

During the 1970s almost all the districts and the state as a whole excluding the districts of Howrah, West Dinajpur, Jalpaiguri, Darjeeling and Cooch Behar, the area effect was negative. From crop-wise data it was found that the fall was specifically in the case of pulses. During 1970-71, the area under total pulses was 669.5 thousand hectares and decreased to 407.3 thousand hectares during 1982-83. However, as mentioned above during second and third sub-periods area growth rates were positive at the state level, but it was not because of any improvement in the area under pulses, rather because of area increase under *boro* rice. Area growth was positive and high in most of the districts during the 1980s. Not only the area effect, but also the other components of the districts with a few exceptions showed decreasing trend during the third sub-period as compared to the second. However, exceptionally good area growth was observed in the districts of Burdwan and Birbhum at the level of 2.24 per cent and 2.11 per cent per annum respectively.

Dominance of Yield effect

The overall analysis of output decomposition indicates that the yield effect was the dominant component in explaining the growth rates in West Bengal in the first and second sub-periods. Both in terms of absolute and relative growth rates from the first to the second sub-period, noticeable improvement in the growth of yield was found in the state. However, during the third sub-period a sharp decline was noticed in yield effect. In percentage terms its contribution was reduced from around 68 per cent in the second sub-period to 36 per cent in the third, with the cropping pattern effect now coming in the limelight. Thus the results support the hypothesis (H1) of dominance of yield growth for the first two sub-periods though not for the third sub-period.

Trend Breaks of the Components

It was already mentioned that in the double kink linear (DKL) trend of output two kinks, first one in 1983-84 and second one in 1991-92 were significant in positive and negative direction respectively for the state of West Bengal.[3] The same DKL model has also been used for analysing the growth rates and trend breaks of the three components (area, yield, cropping pattern) of output decomposition (Figure 1). The results show (Table 4) the performance of all the three factors was the same for the first kink, i.e., positive and significant. But in the second break the components behave differently. In all the cases the magnitude of the break was negative but it was significant only for the yield effect.

TABLE 4. TREND BREAKS OF THE COMPONENTS IN WEST BENGAL

(Rs. million per annum)

Component (1)	First trend break (2)	Second trend break (3)
Output growth	2,061.01 (353.52)*	-1,220.32 (475.95)*
Area effect	395.27 (140.48)*	-24.84 (189.13)
Yield effect	1,357.86 (294.64)*	-1,159.68 (396.69)*
Cropping pattern effect	289.88 (81.03)*	-35.80 (109.09)

Notes: 1. Figures in parentheses are the standard error.
2. ** and * Significant at 5 and 1 per cent level, respectively.

VI

CONCLUSION

After a long period of stagnation West Bengal registered a significant improvement in the foodgrains production during 1980s. The decomposition of output growth by a newly constructed additive model that has no arbitrary residual term, under the double kink linear framework, shows that the remarkable improvement of the 1980s output growth in West Bengal was mainly because of the improvement in the yield growth. The growth rates of other two factors, viz., area and cropping pattern also increased during 1980s but in percentage terms their contributions were only around 11 per cent and 20 per cent respectively.

This high yield growth of foodgrains in West Bengal during 1980s is partly because of institutional reforms and partly due to technological factors (Saha, 1996). During 1980s under the Left Front Government some institutional and technological advancements took place in West Bengal, which seem to be the root cause of significant improvement in the eighties though still it is debatable. However, this remarkable growth rate was not sustained for a long time. A sudden fall in the 1990s has been again a matter of concern to the researchers and policy makers. The new institutional set up is still continuing, still a sharp fall in the yield and therefore in output growth was noticed in the last decade (third sub-period). A decline has also been noticed in the growth rates of area and cropping pattern but the extent were not that much serious. Again their contributions to total output growth in percentage terms doubled during this period. A detailed study in this field is yet to come. May be the existing reform practice has reached its saturation. Now in a state like West Bengal where the output growth of foodgrains is explained at a maximum level by the growth of its yield, this type of fall in its growth is not desirable rather alarming. There is a limit to any reform practices and it is not possible to sustain the steady growth of yield unless further technological breakthrough takes place. New thinking, new reforms, etc. are very much necessary to give a new dimension to the yield growth in West Bengal in the present decade.

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NOTES

1. To find out the best fitted trend[2] equation and thereupon the growth trend of the different components linear, exponential, log-quadratic and parabolic model both in their simple and kink forms have been tested through $\bar{R}^2$, DW, and 'C' test. Though XR^2 is the most common and powerful measure of goodness of fit, it is not strictly comparable for the trend equations with different forms of dependent variables. In the present study, after the rejection of the models with the problem of autocorrelation, with non-significant coefficient of the quadratic term, if any, without any significant evidence of trend break at either kink and non significant coefficient of the quadratic term, if any in double kink cases, comparison have been done in between linear and parabolic forms (both simple and kink) and in between exponential and log quadratic forms (both simple and kink) on the basis of XR^2. After this selection the final selection has been made with the 'C' test. Unlike XR^2, 'C' (Chattopadhyay and Bhattacharya, 1986) can be used to compare between the different functional forms (y, log y etc.).

2. Detailed results of trend selection are available with the authors. They are included in a related paper on growth profile which has been communicated to *Economic and Political Weekly*.

3. District-wise results of standard errors, trend breaks are available with the authors but not reported on the consideration of the size of the paper.

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