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Growth and instability of food grains production of India and West Bengal

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ABSTRACT

The present study is an attempt to examine the growth and instability in food grains production both at the country as well as state level (West Bengal) for the period ranging from 1950 to 2006 and also to find out the impact of modern crop production practices designated as green revolution technology occurred during mid –sixties on the same. The study revealed that India attained an overall growth rate of area, production and productivity of 284.22, 3028.02 and 22.29 percent and their corresponding instability measured in terms of adjusted co-efficient of variation were accounted to be 2.91, 0.36 and 0.05 percent respectively. The state West Bengal witnessed acceleration at the rate of 29.29, 224.08 and 29.37 percent associated with the variability of 3.14, 01.47 and 1.90 percent respectively at the same order. In spite of experiencing a marginal set back in area under total food grains during post revolution period, production growth rate had become almost doubled in India due to almost two times higher productivity rise compared to pre-revolution period. In West Bengal, food grains production rose by 275.64 percent as a result of combined effect of rise in area and productivity by 13.95 and 39.28 percent respectively which were far ahead of that achieved prior to adoption of new technology. Both the country and state gained more stability in production and productivity front, but the fluctuation of above parameters were recorded to be higher at country level in comparison to the state although the state experienced a higher rate of growth. Higher rise in food grains production in India might be attributed to spectacular response of cereals mainly rice and wheat, more specifically wheat, to intensive use of inorganic sources of inputs coupled with the introduction of high yielding varieties and at the state level, it was might be due to outstanding performance of rice and to some extent wheat in the productivity frontier. Status of pulses, another major component of total food grains, remained more or less static in India and in case of West Bengal, area and production registered a negative growth rate in spite of remarkable improvement in productivity i.e. technological revolution in agricultural sector bypassed pulses, although the crops achieved more stability in productivity and production compared with regime of traditional crop production system. The concrete inference as regard to the relationship between growth and instability cannot be established from the present study.

Key words: Co-efficient of variation, green revolution, growth rate, instability index

Growth and instability in agricultural production have become a matter of great concern from the view point of long term food security of the country. Instability associated growth not only hampers the agricultural development, but also casts aspersion on the economic health of the country like India where agriculture still constitutes a sizeable proportion of the gross domestic product of the country. So, it is always desirable to maintain higher rise in farm production with minimum variability in order to achieve sustained economic growth. Sometime, it is argued that high growth rate is associated with higher degree of instability i.e. instability is a consequence of growth (Hazell, 1982). Again, variability in production affects both producers and consumers along with intermediaries involved in the movement of products through price fluctuations. Instability in agriculture and food production is also important for food management and macroeconomic stability (Chand and Raju, 2009). Although natural factors are mainly responsible for fluctuations in agriculture in developing countries like India, influence of technological factors cannot be over ruled. However, the impact of new technology on instability in agriculture and food production has not been quite clear and has remained a matter of concern (Chand, 2010). Some past studies in this regard presents conflicting views. Instability in agricultural production has a direct relationship with the adoption of new technology (Mehra, 1981, Hazell, 1982; Ray, 1983, Rao et. al. 1988; Larson, 2004). On the other hand, some studies on the possible impact of green revolution technology on variability in agricultural production reports somewhat different opinions. So, it is difficult to believe the hypothesis of positive relationship between high growth rate and instability in agricultural sector. The study on association between trends in instability and unadjusted growth rates for the period 1960-61 and 1984-85 shows a significant negative relationship between growth and instability in food grains productions (Mahendradev, S. 1987). So, the studies represent contradictory views as regard to the assumed relationship between growth rate and fluctuation in agricultural production. Under this back drop, the present study is an attempt to examine the association between growth rate and instability in food grains production at both the country as well as state level (West Bengal) for the period 1950-06. The study will cover only food grains crops and its major constituents on ground of the visible impact of modern technology on food grains production at both level. The specific objectives of the study are presented as follows:

a) To estimate growth rate of area, production and productivity of food grains as well as its

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major constituents at the country as well as state level for the period 1950-06.

b) To examine the impact of modern crop production technology on growth and instability of food grains productions and

c) To find out individual crops responsible for growth and instability in food grains production.

MATERIALS AND METHODS

To measure growth rate and instability in area, production and productivity of food grains and its major constituents at the country and state level, necessary secondary data has been collected from Fertilizer Statistics of India published by Fertilizer Association of India and Economic Review and Statistical Abstracts of West Bengal published by Directorate of Agriculture, Govt. of West Bengal for the period stretching from 1950-51 to 2005-06. The entire study period has been divided into two phases – pre-green revolution period ranging from 1950-51 to 1963-64 and post –green revolution period covering 1965-66 to 2006-06 in order to compare the growth and instability between before and after the adoption of modern crop production technology packaged with high yielding varieties of seeds, fertilizers, insecticides, irrigation etc. Growth rate of area, production and productivity has been estimated by using linear growth rate technique represented as follows:

$y = a + bt$ where, y means area / production / productivity , ' a' indicates intercept,

' b ' represents co-efficient , ' t ' stands for time period .

Generally co-efficient of variation is used for estimation of nature and degree of instability of a parameter. But simple co-efficient of variation does not explain properly the trend component inherent in the time series data (Hasan et al., 2008). So, coefficient of variation around trend rather than around mean should be a better measure of variability (Guddy and Della, 1978) and constructed as follows

$$CV_t = CV\sqrt{1 - R^2}$$

$$and\ CV = \frac{\text{Standard Deviation} * 100}{\text{Mean}}$$

Where, CV_t stands for instability index, CV presents co-efficient of variation and R^2 indicates coefficient of determination.

RESULTS AND DISCUSSION

At the outset, we will examine the growth rates and instability in area under food grains as well as major components of food grains i.e. total cereals and pulses separately for two sub-periods and also for the entire study period both at country and state level (Table -1). During first half, the country registers a staggeringly high growth rate of 1498.35 percent with minimum variability of only of 0.37 percent whereas the state experiences a moderate growth of 64.37 percent having instability of only 0.92 percent. But the country suffers a loss in area marginally by 0.66 percent and the state West Bengal records a rise in area of only 13.95 percent and their corresponding variability grows by 3.19 and 3.14 percent respectively during the period ranging from 1965-66 to 2005-05. So, in short, post green revolution period marks with reduction in growth rate of area and high variability. Although, both the state and country maintains a positive growth rate of 284.22 and 29.29 percent associated with 2.91 and 3.16 percent instability index respectively over the entire study period.

Table 1: Growth and instability of area under food grains of West Bengal and India for periods 1950-64, 1965-06 and 1950-06

Crops	Period	India		West Bengal	
		Growth rate	CV_t	Growth rate	CV_t
Total Cereals	1950-64	1106.24 (10.36)*	0.21	49.75 (7.66)*	1.02*
	1965-06	14.14 (-0.33)	3.47	30.21 (9.56)*	2.39*
	1950-06	285.42 (6.99)*	2.30	41.11 (9.36)*	1.75*
Total Pulses	1950-64	382.16 (6.18)*	1.12	13.98 (4.64)*	4.67*
	1965-06	-1.03 (-0.08)	4.45	-14.76 (-17.12)*	5.42
	1950-06	5.69 (0.63)	6.06	-10.9 (-13.17)*	9.33
Food-grains	1950-64	1498.35 (8.65)*	0.37	64.73 (8.65)*	0.92
	1965-06	-0.66 (0.01)	3.13	13.95 (4.45)*	3.40
	1950-06	284.22 (6.09)*	2.91	29.29 (11.8)*	3.14

Significant at 5% level of significance

The table also represents the growth and variability of area under two components of food grains i.e. total cereals and total pulses for two sub-periods both at state as well as country level. The objective is mainly to find out the source of high growth and instability in food grains area. The country marks a remarkably high growth of 1106.24 percent associated with low variability (0.21%) for period 1950-64 and declines drastically to 14.14 percent with 3.47 percent fluctuation during second

half. The overall rice area under total cereals is accounted to be 285.82 percent with instability of 2.30 percent lower than that of period 1965-06. The state West Bengal experiences a similar trend as that of India as a whole, but with lesser magnitudes. The area under pulses of India follows the same pattern as regard to increase in area, but corresponding instability estimates observe to be higher over whole time period (6.06%) in comparison to that of two sub-periods. West Bengal performs miserably in the second sub-period which drives down the state to score negative growth in area estimated for period 1950-07. The growth of pulses area not only shows deterioration but also associates with higher instability. So, the negative and reduced rate of rise of food grains area at country and state level respectively coupled with wide fluctuation might be the result of appallingly poor performance of pulses during post green revolution period. Inquest for identifying the potential contributors to the growth and instability of food grains area via total cereals, the same for major components of total cereals e.g. *Aus*, *Aman* and *Boro* constituting total rice and wheat for West Bengal and rice, wheat, jowar, bajra and maize in case of India has been estimated separately for all three periods (Table -2).

Table 2: Growth and instability of area of components of total cereals of West Bengal for periods 1950-64, 1965-06 and 1950-06

Crops	1950-65		1965-06		1950-06	
	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t
Aus	5.65 (2.29)**	7.20	-11.65 (-11.19)*	7.20	-2.77 (-3.22)*	22.40
Aman	41.25 (8.15)*	1.66	2.76 (1.86)***	3.66	9.29 (7.15)*	3.19
Boro	-0.10 (-2.53)	21.04	37.69 (-25.43)*	19.87	28.46 (-21.5)*	10.45
Total Rice	48.8 (6.92)*	1.25	30.27 (10.03)*	2.36	36.89 (-19.97)*	1.58
Wheat	-0.29 (-0.97)	23.02	2.20 (-2.25)**	30.88	6.13 (-7.89)*	29.14
Total Cereals	49.75 (-7.66)*	1.02	30.21 (-9.56)*	2.39*	-19.36	1.75

Among total rice of West Bengal, *Aman* registers a high growth rate of 41.25 percent with negligible variation of only 0.66 percent followed by *Aus* with corresponding value of 05.61 and 7.2 percent that accelerates the total rice area to grew 48.8 percent annually for the period 1950-65 in spite of witnessing a negative growth rate of *Boro* measuring 0.10 percent coupled with wide variability of 21.04 percent. Highly unstable negative growth rate of wheat fails to pull down or even arrest the rise in total cereals growth might be due to better performance of area under minor cereals grown in West Bengal. During post revolution regime, the state witnessed a strikingly higher increment in area under *Boro* rice measuring 37.69 percent with associated high variability of 19.87 percent followed by *Aman* (2.76%) that raised the total rice area to 30.27 per cent with corresponding variability of 2.36 percent in spite of gross decline in area under *Aus* by 11.65 percent. Adoption of modern technology helped wheat area to grow by 2.20 percent annually, although associated with wide fluctuation (30.88%).

As a whole, the state registers a rise in area under total cereals by 30.21 percent during second half which is less by 19.54 percent but also less stable compared to the former. The cumulative effect of the two sub-periods has clearly reflected in the overall area growth of all major components of total cereals of West Bengal. Remarkable performance of *Boro* (28.46%) in association with positive growth of *Aman* (9.29%) and wheat (6.12%) influences the total cereals area to rise by 41.10 percent and higher level of variability associated with *Boro* and wheat area do not disturb the stability of cereals area growth that was estimated to be 1.75 percent.

In case of India, area under rice, wheat, bajra and maize rose by 424.98, 307.34, 90.12 and 108.37 percent and their corresponding instability index values were estimated to be 2.82, 1.13, 0.21 and 4.76 percent respectively during traditional crop cultivation regime. High negative growth rate of jowar (12.59%) associated with high fluctuation (10.59%) could not check the rise in total cereals area, although associated with high stability (Table-3). In the post revolution period, area under cereals like rice, wheat and maize maintained positive growth with lower magnitudes compared to ex-ante and variability ranged between 1-4 percent except wheat area (9.39%). Although, the country suffered a huge set back in terms of area growth but the major concern

was the rise in instability value which moved from 2.1 to 3.47 percent. Overall better performance of area under rice, wheat and maize in both periods pushed the country to attain a high growth of 280.42 percent with instability index of 2.3 percent. So the modern crop production technology has benefited both the state and country in terms of maintaining positive growth rate in area, but the state seemed to be slightly ahead of the country from stability point of view in all three study periods.

Table 3: Growth and instability of area of components of total cereals of India for periods 1950-64, 1965-06 and 1950-06

Crops	1950-64		1965-06		1950-06	
	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t
Rice	424.98 (11.38)*	2.82	161.06 (7.26)*	1.85	229.12 (15.71)*	6.28
Wheat	307.34 (7.24)*	1.13	297.47 (15.54)*	9.39	337.34 (29.07)*	5.05
Jowar	-10.59 (-0.11)	10.59	-243.55 (-18.88)*	0.72	-156.03 (-10.95)*	3.51*
Bajra	90.12 (2.09)	4.76	-84.38 (-9.44)*	2.02	-36.5 (64.74)*	6.48*
Maize	108.37 (13.51)*	0.21	39.66 (8.53)*	2.19	58.24 (17.52)*	1.25
Total Cereals	1106.24 (10.36)*	2.1	14.14 (0.33)	3.47	285.4 (26.99)*	2.30

Table 4: Growth and Instability of productivity and production of components of total food grains of West Bengal and India for periods 1950-64, 1965-06 and 1950-06

Crops	Period	Productivity				Production			
		India		West Bengal		India		West Bengal	
		Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t
Total Cereals	1950-64	13.85 (8.37)*	0.66	9.25 (-1.77)	7.24	2049.68 (10.85)*	0.73	97.60 (3.24)*	5.86
	1965-06	32.36 (35.74)*	0.16	38.37 (21.37)*	0.67	3325.70 (28.41)*	0.31	282.40 (21.63)*	0.78
	1950-06	26.63 (33.21)*	0.49	28.91 (19.82)*	1.80	2954.26 (38.28)*	0.33	229.17 (24.08)*	1.48
Total Pulses	1950-64	3.89 (-0.78)	20.27	-19.20 (-2.59)**	14.62	267.61 (1.85)**	17.03	-5.30 (-0.89)	25.05
	1965-06	3.09 (6.43)*	4.54	4.34 (5.87)*	6.15	90.54 (5.27)*	6.57	-6.77 (-12.55)*	3.37
	1950-06	1.90 (5.25)*	10.18	1.75 (3.20)*	16.48	65.79 (4.70)*	12.08	-5.57 (-10.63)*	7.13
Food-grains	1950-64	12.13 (6.39)*	1.25	5.44 (-1.25)	7.62	2353.51 (9.23)*	0.77	96.58 (3.11)*	5.89
	1965-06	27.14 (33.63)*	0.18	39.28 (22.34)*	0.62	3422.06 (26.65)*	0.35	275.64 (20.82)*	0.83
	1950-06	22.29 (32.18)*	0.05	29.37 (19.81)*	1.90	3028.02 (36.16)*	0.36	224.08 (23.63)*	1.47

Next to area, we will examine the trend in productivity in determining the pattern of productions of food grains. Table -4 clearly discerns that development and adoption of new technology in farm sector has made definite improvement in productivity of food grains both at country as well as state level. Not only that, it has also helped to achieve higher level of stability compared to the regime of traditional crop production practices. The cumulative impact of two sub-periods has prominently reflected as regard to growth and instability at both levels in the present study. Break-up of food grains into total cereals and

total pulses more or less behave in the same manner as shown by food grains in the same count.

As the horizontal expansion of food grains has come to a halt, vertical rise i.e. raising productivity level is seemed to be only reality to augment production .Productivity growth rate shows a positive trend in all periods at all levels(Table-5 & 6). Prior to introduction of improved technology, rise in yield in the state records more than two and half percent lower compared to that of India but less stable. But the state has made a quantum jump exceeding country level growth with higher stability. Over the entire period, the country and state, register an increase in growth of 22.29 and 29.57 percent respectively with marginal variability of only 0.05 and 1.90 percent in the same order. Now, as total cereals and pulses constitute the total food grains, it is relevant to find out the source of high productivity rise in food grains.

From this table, it is also clear that higher growth of total cereals, both in India and West Bengal effect food grains productivity to grow at a rate of 13.85 and 9.25 during period 1950-64 and 32.36 and 38.37 percent respectively during 1965-06. Variability has also come down from 0.66 to 0.16 and from 7.24 to 0.67 percent in the same order. Over all, the country as well as state witnesses an increase in productivity of 26.63 and 28.91 percent with corresponding fluctuation of 0.49 and 1.8 percent respectively. On the other hand, total pulses has maintained a steady growth rate with reduced variability in case of India and the state, West Bengal uplifts the productivity level from staggeringly high negative growth of 19.20 during 1950-64 to 4.34 percent during the period 1964-06 and stability also increases by 8.47 percent. In short, impact of modern technology conspicuously reflects manifold rise in productivity of total cereals with higher stability but not too much on pulses except deceleration in instability as compared to former period and between crops, pulses are subject to high vulnerable in terms of variability.

Table 5: Growth and instability of productivity and production of components of total cereals of West Bengal for periods 1950-64, 1965-06 and 1950-06

Crops	Productivity						Production					
	1950-64		1965-06		1950-06		1950-64		1965-06		1950-06	
	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t
Aus	3.55 (-1.06)	8.04	34.11 (15.59)*	18.64	24.04 (14.84)*	4.16	6.95 (-1.92)	11.93	2.24 (-1.28)	17.79	6.13 (6.36)*	13.32
Aman	10.77 (-1.76)	7.96	33.86 (15.75)*	14.9	24.54 (14.36)*	3.45	89.37 (3.30)*	5.91	146.81 (14.93)*	1.77	111.24 (16.36)*	2.81
Boro	16.6 (3.97)*	3.09	27.27 (5.64)*	6.37	44.29 (13.35)*	5.27	1.33 (3.29)*	15.03	120.98 (21.8)*	1.6	90.37 (19.43)*	7.83
Total Rice	9.90 (-1.82)	7.29	24.40 (16.65)*	1.43	28.87 (15.85)*	3.16	98.78 (3.27)*	5.97	276.50 (19.93)*	1.04	212.96 (20.30)*	2.3
Wheat	-11.65 (-1.42)	15.17	15.45 (3.64)*	12.99	32.76 (10.24)*	10.85*	98.78 (3.27)*	5.97	276.50 (19.93)*	1.04	212.96 (20.30)*	2.3
Total Cereals	9.25 (-1.77)	7.24	38.37 (21.37)*	0.67	28.91 (19.82)*	1.8	97.60 (3.24)*	5.86	282.40 (21.63)*	0.78	229.17 (24.08)*	1.48

For outstanding performance of total cereals, credit mainly goes to remarkable rise in productivity growth of total rice (*Aus*, *Aman* and *Boro*) and wheat in case of West Bengal and rice, wheat, jowar, bajra and maize in India (Table -5 and 6). The state West Bengal experiences a slower yield growth of 9.90 percent with high instability (7.9%) in the first sub-period in comparison to that of next sub-period where the corresponding figure was 24.40 percent and instability of yield rise has come down to 1.43 percent. Further, break –up total rice into three categories namely, *Aus*, *Aman* and *Boro* shows a direct relationship between growth and instability. Relatively better performance of *Aus* during post revolution period over *Aman* and *Boro* might be the result of inability of traditional cultivation practices to extract full potentiality of *Aus* rice during period 1950-64. Amazing impact of technological development on wheat manifests in galloping rise in yield rate from a negative magnitude of 11.65% to as high as 15.45 percent with higher stability, although the crop registers a growth of 12.76 percent accompanied by 10.85 percent instability over entire study period.

Table-6: Growth and Instability in productivity and production of components of Total Cereals of India for periods 1950-64, 1965-06 and 1950-06

Crops	Productivity						Production					
	1950-64		1965-06		1950-06		1950-64		1965-06		1950-06	
	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t	Growth rate	CV_t
Rice	28.27 (9.01)*	5.95	31.38 (24.82)*	4.03	25.73 (27.56)*	0.67	1330.59 (13.74)*	0.35	1526.16 (23.30)*	0.56	1319.79 (31.02)*	0.6
Wheat	10.73 (3.21)*	7.72	45.15 (30.45)*	2.61	45.62 (38.02)*	0.39	373.0 (27.6)*	1.57	1607.28 (35.21)*	0.24	1399.27 (37.33)*	0.65
Jowar	16.76 (3.38)*	9.23	8.51 (8.81)*	4.07	7.47 (11.92)*	3.98	238.7 (4.62)*	3.87	-36.43 (-1.67)	16.86	18.75 (-1.3)	17.23
Bajra	5.17 (2.59)**	6.7	10.44 (6.36)*	12.45	8.57 (99.56)*	8.78	81.52 (2.73)**	8.87	73.19 (3.41)*	22.12	79.10 (6.73)*	14.57
Maize	27.48 (8.46)*	10.02	24.00 (13.79)*	1.84	21.17 (19.56)*	1.65	198.55 (12.43)*	0.59	220.55 (13.51)*	2.67	195.77 (21.11)*	1.9
Total Cereals	13.85 (8.37)*	0.66	32.36 (35.74)*	0.16	26.63 (33.21)*	0.49	2049.68 (10.85)*	0.73	3325.70 (28.41)*	0.31	2954.26 (38.28)*	0.33

Whereas in India, rice experiences a marginal improvement in productivity as well as stability during last sub-period and the crop maintains a steady rise by achieving a rate of 25.75 percent with 0.67 percent variability over the period 1950-06.Tremendous direct effect of improved technology has helped wheat to uplift productivity level almost five and half times over traditional system of cultivation and variability also come down from 9.23 to 2.61 percent. Other two cereals, namely jowar and maize, have gained more stability at the cost of marginal deceleration in productivity growth and bajra performs moderately by raising growth from 5.17 to 10.44.The adjusted co-efficient of variation measuring fluctuation moves up to 12.45 from a very low level or 6.7 percent recorded during 1950-64.

The effect of area and productivity growth of food grains conspicuously has reflected in production front at both level. Adoption of green revolution generated crop cultivation practices has propelled food grains production to increase manifold at the country level and the state also experiences high growth rate with reduced fluctuation. This galloping increase in food grains production might be attributed to the spectacular performance of cereals, particularly, rice in case of West Bengal and rice and wheat, specifically outstanding response of wheat to new technology associated with lower level of variability. The enhancement of production stability in comparison to ex-ante can be treated as a definite improvement during ex-post. But pulses, another important constituent of total food grains, has failed to harvest the benefit of modern crop production techniques resulting lower positive growth in terms of area, production and productivity compared with pre-revolution period in case of India and in West Bengal, the crops has performed miserably in all periods heading towards further marginalization. The one valid explanation may be the acute food crisis at that time demanded immediate intervention to achieve self –sufficiency in food production and so all efforts including private and public sector research and development programmes were directed towards augmentation of stable food production.

The study clearly reveals that food grains production has achieved tremendous momentum during the regime of technology induced modern crop production practices in place of traditional system. Outstanding performance in productivity front of major cereals has made the country to achieve near self – sufficiency in food grains production. Higher food grains production growth rate at the country level has been propelled by miracle performance of total cereals, more specifically rice and wheat and for the state West Bengal, only rice (particularly *Aman* and *Boro*) catapulted food grains productions to such a peak. The study also indicates that the benefit of new technology does not remain confine within the ambit of production; it has also manifested in the deceleration of fluctuation in production to a larger extent that might be attributed to the lesser dependence of crop production on natural factors. But a definite inference as regard to relationship between growth and instability can not be established from the present study. Increase in production at a diminishing rate faced by the country as a whole and gross

deceleration in pulses production growth witnessed by the state West Bengal seems that the technological revolution in farm sector bypassed pulses crops which can be substantiated by the fact that high deficit in food production at that time necessitates urgent strategies to augment food production within a very short time to ensure food security for ever increasing population. But the benefit of green revolution experienced by pulses has manifested in the rise of stability in production compared to period before adoption of new technology.

REFERENCES

Chand, R. 2000. Trade Liberalisation, Agricultural prices and net – social welfare in India. Key note paper in *Third Asian Conf. Agril. Econ.*, 18-20 Oct. Jaipur.

Chand. R and Raju, S. S. 2008. Instability in Indian agriculture during different phases of technology and policy. *Indian J. Agri. Econ.*, 64, pp. 283-88.

Coddy and Della V. 1978. Measuring the instability of time series data. Oxford *Bulletin of Economics and Statistics*, Feb.

Dev. Mahendra S. 1987. Growth and instability in food grains production : An interstate analysis, *Econ. and Political Weekly*, 22, A 82-92.

Hazell, Peter B.R. 1982. Instability in Indian food grains productions, Research Report No -30, International Food Policy Research Institute, Washington, D.C.

Larson, D.W. Jones, F., Pannu R.R., and Sheokand, R. S. 2004. Instability in Indian Agriculture –A Challenge to the Green Revolution Technology, *Food Policy*, 29, p 257-73.

Mehra, S. 1981. Instability in Indian Agriculture in the context of the New Technology, Research Report No. 25, International. Food Policy Research Institute, Washington, D.C., USA.

Rao, C.H.H., Ray, S.K., and Subba Rao, K. 1988. Unstable Agriculture and Droughts – Implications for Policy. Vikas Publishing House Pvt. Ltd., New Delhi.

Ray, S.K. 1983. An Empirical Investigation of the Nature and C*Aus*es for Growth and Instability in Indian Agriculture : 1950-80, *Indian J. Agri. Econ.*, 38, P. 459-74.

Sharma, H.R., Singh, K. and Kumari, S 2006. Extent and Source of Instability in Food grains Productions in India. *Indian J. Agri. Econ.*, 61, pp. 648-66.