

Growth and Instability in Food Grains Production in Odisha: A district level analysis

*Siba Prasad Samal¹, Dr. Rabi N Patra², Dr. Bijaya Bhusan Nanda³ and Manoj Kumar Das⁴

¹PhD Scholar, Dept. of Economics, Ravenshaw University, Cuttack

²Visiting Professor, Council of Analytical Tribal Studies, Koraput

³Dy Director, Regional Institute of Planning, Applied Economics & Statistic, Odisha, Bhubaneswar

⁴Asst. Professor, Dept. of Economics, Ravenshaw University, Cuttack

Abstract

The present study aims at analyzing the growth and instability of foodgrain production over a 20 years time period from 1995-96 to 2014-15 across the districts. The study compared the growth and instability into two decadal time period i.e. from 1995-96 to 2004-05 and 2005-06 to 2014-15 at the state and district level.

The 1st decadal period 1995-96 to 2004-05 was a gloomy period with total food grains experiencing nil growth. Paddy had only 0.5% growth while other cereals and pulses experienced negative growth. The 2nd decadal period witnessed impressive growth for all the crops and especially for other cereals the growth was phenomenal (7.7%) at the state level. Similarly across the districts production of paddy, other cereals, pulses and total food grains had spectacular improvement in ACGR in the 2nd decadal period. However, some districts have experienced negative growth rates in respect of production of different crops. Instability in the production of total food grain, paddy, other cereals, pulses have reduced in the 2nd decadal period there by implying reduction in the risk of production of foodgrains. However some of the districts still have high to moderate levels of instability.

Keywords: Agriculture, Growth, Instability, Economic Reform, Production, Productivity.

I. INTRODUCTION

The Odisha's economy was predominantly agrarian in nature with agriculture contributing a little higher than 50% share to the total economy of the state in the beginning of the 1st five year plan which gradually reduced to 12.3% in the year 2014-15 as a result of industrialization and growth of service sector. This structural shift in the economy has not been accompanied by commensurate shift in the proportion of agricultural workforce i.e. cultivators and agricultural labourer as percentage of total workers which stood at 50% as per census 2011. Therefore the role of agriculture in Odisha's economy assumes significant importance. The foodgrains production which comprise of Paddy, Other cereals and pulses assumes significant importance for food and nutritional security. Therefore the growth of food

grains production and the instability there in is of paramount importance for the state.

In order to meet the growing demand of agricultural production the farmers have adopted technology intensive practices, use of HYV seeds for achieving higher level of production (Wein Berger and Lumpkin, 2007). However the state of Odisha being vulnerable to the vagaries of weather and climatic conditions the growth in production of crop is liable to substantial variation across time and space. In the early 1990s, the sector was liberalized hoping that confiscating the restriction of export and import of agricultural commodities, imports of agricultural inputs could boost the sector. However, with the advent of modern technology and liberalization, there have been fluctuations in agricultural production rendering an intense debate on agricultural growth and instability in India since it has direct implication for food supply management and macroeconomic stability (Chand and Raju, 2009). There is an obvious need for agricultural growth in India while the increased instability in production instills more uncertainty about sustainability of agricultural growth in India.

Instability in production and productivity of Indian agriculture in relation to green revolution has been intensely studied at aggregate level and there are contradictory views regarding the impact of green revolution on instability. Some studies (Hazell, 1982; Rao, et al, 1988; Larson et al, 2004) have concluded that instability has increased in Indian agriculture during post green revolution period due to adoption of modern technology. The contradictory evidence has been propounded by the studies like Mahendra Dev (1987), and Chand and Raju (2009) who have concluded that the instability has declined during the post green revolution period. Paltasing, K. R. et al (2013) studied growth and instability in subsistence agriculture in Odisha. The study concluded that major crops depicted a distressing picture in two ways. First, incidence of green revolution and subsequently of liberalization have not provided and improvement in agricultural sector. Second, the irrigation development has been very slow and consequently much of the cultivated land is still rainfed in Odisha. This hinders the growth of agriculture on one hand and augment risk on the other. Pattnaik F. et al (2016)

studied the growth performance of major crops in Odisha. The study has concluded that although contribution of technology inputs towards sustainable output growth has been recognised, growth in the yield rate in Odisha agriculture has been generally rather slow and differs regionally due to the differences in geographical area, climate and natural resources. The former study was at the state level while the later is across the physiographic zones. There is a necessity of disaggregated study up to the district level which can highlight deep insights for policy and strategy formulation. The present study aims at analyzing the growth and instability of foodgrains production over a 20 years time period from 1995-96 to 2014-15 across the districts. The objective of the study is to find out clusters of districts with low, moderate and high level of growth and instability of production of foodgrains over the time period. The study further aims to compare the growth and instability into two decadal time period i.e. from 1995-96 to 2004-05 and 2005-06 to 2014-15.

A. Database and Methodology

The study made use of secondary time series data collected from various issues of Odisha Agriculture Statistics, published by Directorate of Agriculture and food production, Odisha. To examine growth and instability of foodgrains across the districts of the state, annual compound growth rates have been calculated for two decadal periods, viz, period I (1995-96 to 2004-05) and period II (2005-06 to 2014-16). Analysis has been made crop wise with respect to production. ACGR for production was estimated as follows:

$$Y_t = Ab^t$$

Where Y_t = Production in tth period.
 $B = 1+r$ and r = Compound growth rate of Y.
 A = Initial year production and
 t = Time in years

After log transformation and estimation of the above function as

$$\ln Y_t = \ln A + t \cdot \ln b,$$

Compound growth rate has been estimated as

$$r = \{ \text{antilog}(\ln b) - 1 \} \times 100$$

Instability Index: Cuddy-Della Valle Index

The instability in production at foodgrains in Odisha was examined by estimating Cuddy-Della Valle Index for production. To measure the instability of economic variables, Cuddy-Della Valle Index (corrected coefficient of variation) is used which considers the long term trend. Therefore, to examine

the extent of risk involved in foodgrains production the instability in the foodgrains production in Odisha was estimated by using Cuddy-Della Valle Index as :

$$I = CV \times (1 - R^2)^{0.5}$$

Where I = Instability index (percent);

CV = Coefficient of variation (percent); from a time trend regression adjusted by the number of degrees of freedom and R = Coefficient of determination.

II. RESULTS AND DISCUSSION

A. Growth of Food Grains Production

Out of the total foodgrains production in Odisha, paddy accounts for 83.3%, other cereals 7.8% and pulses 8.9%. The production of paddy which was 6226.2 thousand MT in the year 1995-96 has increased to 9844.7 thousand MT in the year 2014-15. Production of other cereals increased from 502.9 thousand MT to 922.4 thousand MT. Both these crops have witnessed erratic fluctuations in production during the period. However, the production of pulses which was at a very high level of 1194 thousand MT in 1995-96 suddenly dropped down to 568.7 thousand MT in 1996-97 and became 1056.8 thousand MT in 2014-15. This has also witnessed fluctuations over the period. Total foodgrains' production increased from 7923.2 thousand MT to 11823.9 thousand MT during the same period of course marred by fluctuation (Table 1).

Table 1 : Trend of Production of foodgrains in Odisha (In 000' MT)

| Year | Paddy | Other Cereals | Pulses | Total Foodgrains |
|---------|--------|---------------|--------|------------------|
| 1995-96 | 6226.2 | 502.9 | 1194.0 | 7923.2 |
| 1996-97 | 4437.6 | 340.4 | 568.7 | 5346.7 |
| 1997-98 | 6204.6 | 396.7 | 710.0 | 7311.3 |
| 1998-99 | 5390.5 | 377.1 | 610.7 | 6378.3 |
| 1999-00 | 5187.0 | 424.6 | 654.1 | 6265.7 |
| 2000-01 | 4613.4 | 414.6 | 506.9 | 5534.8 |
| 2001-02 | 7149.0 | 386.8 | 696.8 | 8232.6 |
| 2002-03 | 3243.6 | 342.8 | 458.5 | 4044.9 |
| 2003-04 | 6733.7 | 380.1 | 622.8 | 7736.7 |
| 2004-05 | 6537.5 | 426.2 | 624.6 | 7588.2 |
| 2005-06 | 6963.0 | 463.5 | 794.2 | 8220.6 |
| 2006-07 | 6928.1 | 504.0 | 865.9 | 8298.0 |
| 2007-08 | 7655.0 | 691.1 | 908.3 | 9254.4 |
| 2008-09 | 6916.4 | 723.9 | 994.0 | 8634.3 |
| 2009-10 | 7022.3 | 722.6 | 962.5 | 8707.3 |
| 2010-11 | 6931.2 | 839.3 | 999.4 | 8769.9 |
| 2011-12 | 5895.0 | 800.2 | 920.9 | 7616.1 |
| 2012-13 | 9496.8 | 865.2 | 1036.8 | 11398.8 |
| 2013-14 | 7613.4 | 960.9 | 1058.2 | 9632.5 |
| 2014-15 | 9844.7 | 922.4 | 1056.8 | 11823.9 |

Source : Various issues of Odisha Agriculture Statistics, Directorate of Agriculture and Food Production, Odisha, Bhubaneswar
 MT : Metric Ton

The annual compound growth rate of paddy, other cereals, pulses were 2.8%, 5.5% and 2.8%

respectively. The total foodgrains production as a whole had an ACGR of 2.9%. The insight was the other cereals which were wheat, maize, jawar and bajra etc had experienced double the growth than paddy and pulses. The other important revelation was that the 1st decadal period 1995-96 to 2004-05 was a gloomy period with total foodgrains experiencing nil growth. Paddy had only 0.5% growth while other cereals and pulses experienced negative growth of -0.8% and -4.3% respectively. However in the 2nd decadal period the growth was very impressive for all the crops and especially for other cereals the growth was phenomenal. The paddy and pulses had 2.6% and 2.7% growth respectively while the other cereals had 7.7% growth (Table 2).

Table 2 : Annual compound growth rate of Production in Odisha (In Percentage)

| Crops | Time Period | | |
|------------------|--------------------|--------------------|--------------------|
| | 1995-96 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 |
| Paddy | 2.8 | 0.5 | 2.6 |
| Other Cereals | 5.5 | -0.8 | 7.7 |
| Pulses | 2.8 | -4.3 | 2.7 |
| Total Foodgrains | 2.9 | 0.0 | 3.0 |

Source : Author’s calculation from Odisha Agriculture Statistics (various issues)

B. Growth of Food Grains Production at District Level

Annexure – I provides district wise ACGR of production of paddy, other cereals, pulses and total foodgrains. The growth rates have been analysed for two decadal periods 1995-96 to 2004-05 and 2005-06 to 2014-15. During the 1st decade the minimum ACGR was -2.9% in Deogarh district and maximum ACGR was 3.1% in Boudh district for paddy. The median growth rate was 0.3% with inter-quartile range (IQR) -0.68% to 1.18%. In the 2nd decadal period the minimum growth rate of 6.7% in Ganjam district and maximum growth rate was 9.1% in Deogarh district with a median of 1.9% and IQR -0.68% to 4.95%. This indicated overall improvement in the district level growth of production of paddy in the 2nd decadal period. As many as 17 districts have observed increase in ACGR in the 2nd decadal period. 13 districts namely Balasore, Bhadrak, Boudh, Gajapati, Ganjam, Jajpur, Jharsuguda, Kandhamal, Kendrapara, Keonjhar, Khurda, Mayurbhanj and Nayagarh have observed decline in growth rate during this period.

The growth rate of other cereals was minimum in Puri (-14.8%) and maximum in Nawarangpur (11.9%) during the 1st decade. The median was -3.85% with IQR -5.65% to -0.05%. In the 2nd decadal period the minimum growth was in Kendrapara (-14.4%) and the maximum was in

Sambalpur (25.4%). The median was 7.4% with IQR 4.08% to 11.9%. This implied a spectacular improvement in ACGR across the districts in the 2nd decadal period in comparison to the 1st decadal period. In the 1st decadal period 23 districts had negative ACGR and two had zero ACGR while in the 2nd decadal period 4 districts namely Bhadrak, Boudh, Jagatsinghpur and Kendrapara observed negative growth rate.

During the 1st decadal period production of pulses registered a minimum ACGR of -12.5% in Khurda and maximum of 6% in Gajapati district. The median was -5.5% (IQR= -8.08% to -2.13%). In the 2nd decadal period the minimum ACGR was -8.9% in Malkangiri and maximum was 7.5% in Nuapara. The median ACGR was 3% (IQR= 0.05% to 4.28%). This implied spectacular improvement in growth across the districts in the 2nd decadal period over the 1st one.

Total foodgrains production observed a minimum ACGR of -3.5% in Deogarh district and maximum of 2.8% in Boudh district during the 1st decadal period. The median ACGR was -0.4% (IQR= -1.7% to -0.93%). As many as 17 districts were having negative ACGR during this decade. In the 2nd decadal period the minimum growth rate was -3.5% in Jharsuguda and maximum of 8% in Deogarh. The median was 2.45% (IQR= 0.6% to 4.95%). This indicated remarkable improvement in growth performance in the total foodgrains production across the districts in the 2nd decadal period. However 7 districts namely Bhadrak, Ganjam, Jajpur, Jharsuguda, Kendrapara, Khurda and Nayagarh observed negative growth performance during the 2nd decade.

C. Instability of Food Grains Production

The instability in the production has been measured through Cuddy-Della Valle index. The instability is classified as low for the index value 0-15, moderate for (15-30) and high (>30). At the state level for the entire 20 year period the instability was moderate for total foodgrains, paddy, other cereals and pulses. In the 1st decadal period the instability was higher than the 2nd decadal period. In the 2nd decadal period instability was low for paddy, other cereals, pulses and total foodgrains (Table 3).

Table 3 : Instability of Production in Odisha (In Percentage)

| Crops | Time Period | | |
|------------------|--------------------|--------------------|--------------------|
| | 1995-96 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 |
| Paddy | 17.75 | 23.02 | 14.45 |
| Other Cereals | 17.7 | 12.09 | 7.33 |
| Pulses | 22.07 | 27.13 | 4.6 |
| Total Foodgrains | 16.47 | 21.63 | 11.76 |

Source : Author’s calculation from Odisha Agriculture Statistics (various issues)

District wise instability production of foodgrains in Odisha is presented in Annexure – II. In

the 1st decadal period instability in the production of paddy was moderate in 16 districts and high in 14 districts. However in the 2nd decadal period the instability was low in 3 districts, moderate in 17 districts and high in 10 districts (Table 4).

Table 4 : Classification Districts according to instability in the production of Paddy

| 1995-96 to 2004-05 | | 2005-06 to 2014-15 | | |
|--------------------|---------------|--------------------|------------|------------|
| Moderate | High | Low | Moderate | High |
| Balasore | Angul | Bargarh | Balasore | Angul |
| Bargarh | Bolangir | Bhadrak | Boudh | Bolangir |
| Bhadrak | Boudh | Jagatsinghpur | Cuttack | Deogarh |
| Cuttack | Deogarh | | Dhenkanal | Ganjam |
| Gajapati | Dhenkanal | | Gajapati | Jharsuguda |
| Jajpur | Ganjam | | Jajpur | Kalahandi |
| Kandhamal | Jagatsinghpur | | Kandhamal | Malkangiri |
| Kendrapara | Jharsuguda | | Kendrapara | Nayagarh |
| Koraput | Kalahandi | | Keonjhar | Nowrangpur |
| Malkangiri | Keonjhar | | Khurda | Sundargarh |
| Mayurbhanj | Khurda | | Koraput | |
| Nowrangpur | Nayagarh | | Mayurbhanj | |
| Puri | Nuapada | | Nuapada | |
| Raygada | Sundargarh | | Puri | |
| Sambalpur | | | Raygada | |
| Sonepur | | | Sambalpur | |
| | | | Sonepur | |

Source : Author’s own calculation

Instability in production of other cereals was low in 7 districts moderate in 15 districts and high in 8 districts during the 1st decadal period. In the 2nd decadal period instability was low in 18 districts, moderate in eight districts and high in 4 districts. The instability has reduced in the 2nd decadal period (Table 5).

Table 5 : Classification Districts according to instability

| Other Cereals | | | | | |
|--------------------|------------|---------------|--------------------|------------|---------------|
| 1995-96 to 2004-05 | | | 2005-06 to 2014-15 | | |
| Low | Moderate | High | Low | Moderate | High |
| Bargarh | Angul | Bhadrak | Bargarh | Angul | Balasore |
| Boudh | Balasore | Dhenkanal | Bolangir | Boudh | Bhadrak |
| Cuttack | Bolangir | Jagatsinghpur | Dhenkanal | Cuttack | Jagatsinghpur |
| Gajapati | Deogarh | Jharsuguda | Gajapati | Deogarh | Nowrangpur |
| Mayurbhanj | Ganjam | Kendrapara | Ganjam | Jharsuguda | |
| Puri | Jajpur | Keonjhar | Jajpur | Kendrapara | |
| Sundargarh | Kalahandi | Nayagarh | Kalahandi | Khurda | |
| | Kandhamal | Nuapada | Kandhamal | Sonepur | |
| | Khurda | | Keonjhar | | |
| | Koraput | | Koraput | | |
| | Malkangiri | | Malkangiri | | |
| | Nowrangpur | | Mayurbhanj | | |
| | Raygada | | Nayagarh | | |
| | Sambalpur | | Nuapada | | |
| | Sonepur | | Puri | | |
| | | | Raygada | | |
| | | | Sambalpur | | |
| | | | Sundargarh | | |

Source : Author’s own calculation

As regards the production of pulses in the 1st decadal period in instability was low in one district, moderate in nine, high in 10 districts. In the 2nd decadal period instability was low in 4, moderate in 11 and high in 15 districts. Even though there was improvement in instability during 2nd decadal period, many districts are still having moderate to high instability in the production of pulses (Table 6).

Table 6 : Classification Districts according to instability

| Pulses | | | | | |
|--------------------|------------|------------|--------------------|------------|------------|
| 1995-96 to 2004-05 | | | 2005-06 to 2014-15 | | |
| Low | Moderate | High | Low | Moderate | High |
| Jagatsinghpur | Bargarh | Angul | Bargarh | Bhadrak | Angul |
| | Bolangir | Balasore | Bolangir | Boudh | Balasore |
| | Boudh | Bhadrak | Ganjam | Gajapati | Cuttack |
| | Gajapati | Cuttack | Jagatsinghpur | Kandhamal | Deogarh |
| | Ganjam | Deogarh | | Keonjhar | Dhenkanal |
| | Kandhamal | Dhenkanal | | Mayurbhanj | Jajpur |
| | Keonjhar | Jajpur | | Nowrangpur | Jharsuguda |
| | Mayurbhanj | Jharsuguda | | Puri | Kalahandi |
| | Sundargarh | Kalahandi | | Sambalpur | Kendrapara |
| | | Kendrapara | | Sonepur | Khurda |
| | | Khurda | | Sundargarh | Koraput |
| | | Koraput | | | Malkangiri |
| | | Malkangiri | | | Nayagarh |
| | | Nayagarh | | | Nuapada |
| | | Nowrangpur | | | Raygada |
| | | Nuapada | | | |
| | | Puri | | | |
| | | Raygada | | | |
| | | Sambalpur | | | |
| | | Sonepur | | | |

Source : Author’s own calculation

As regards total foodgrains production, 20 districts were having moderate and 10 districts were having high instability during 1st decadal period. In the 2nd decadal period the instability was low in 4, moderate in 19 and high in 7 districts.

The 2nd decadal period even though characterised reduction in instability of foodgrains production a lot of districts have moderate to high instability (Table 7).

Table 7 : Classification Districts according to instability

| Total Foodgrains | | | | |
|--------------------|------------|--------------------|---------------|------------|
| 1995-96 to 2004-05 | | 2005-06 to 2014-15 | | |
| Moderate | High | Low | Moderate | High |
| Balasore | Angul | Bargarh | Balasore | Angul |
| Bargarh | Bolangir | Koraput | Bhadrak | Bolangir |
| Bhadrak | Boudh | Raygada | Cuttack | Boudh |
| Cuttack | Deogarh | Sonepur | Deogarh | Dhenkanal |
| Gajapati | Dhenkanal | | Gajapati | Ganjam |
| Jagatsinghpur | Ganjam | | Jagatsinghpur | Jharsuguda |
| Jajpur | Jharsuguda | | Jajpur | Nayagarh |
| Kandhamal | Kalahandi | | Kalahandi | |
| Kendrapara | Nayagarh | | Kandhamal | |
| Keonjhar | Nuapada | | Kendrapara | |
| Khurda | | | Keonjhar | |
| Koraput | | | Khurda | |
| Malkangiri | | | Malkangiri | |
| Mayurbhanj | | | Mayurbhanj | |
| Nowrangpur | | | Nowrangpur | |
| Puri | | | Nuapada | |
| Raygada | | | Puri | |
| Sambalpur | | | Sambalpur | |
| Sonepur | | | Sundargarh | |
| Sundargarh | | | | |

Source : Author’s own calculation

III. MAJOR FINDINGS

Other cereals which comprised of wheat, maize, jawar and bajra etc had experienced double the growth than paddy and pulses. The other important revelation was that the 1st decadal period 1995-96 to 2004-05 was a gloomy period with total food grains experiencing nil growth. Paddy had only 0.5% growth while other cereals and pulses experienced negative growth. The 2nd decadal period witnessed impressive growth for all the crops and especially for other cereals the growth was phenomenal (7.7%).

Across the districts production of paddy, other cereals, pulses and total food grains experienced spectacular improvement in ACGR across the districts in the 2nd decadal period. However, some districts have experienced negative growth rates in respect of production of different crops. These districts need attention.

Instability in the production of total food grain, paddy, other cereals, pulses have reduced in the 2nd decadal period there by implying reduction in the risk of food grain production. However some of the districts still have high to moderate levels of instability that requires attention.

The poor performance of growth during the 1st decadal period was attributed to manifestation of vagaries of natural calamities like super cyclone in 1999-2000, severe drought in 2002-03 and low investment on agriculture during this period. On the other hand the better performance of growth in the 2nd decadal period was achieved because greater focus by Government both center and state by way of launching several schemes of the programs like NFM, RKVY etc. Besides various state agricultural policies were also implemented for the development of agriculture. Focus was given on input management, agricultural research and education, creation of irrigation potential and promotion of agricultural entrepreneurship agricultural marketing technology up gradation etc. This has also resulted in the reduction of the instability of food grain production in the State.

IV. CONCLUSION

Growth of foodgrains production is important for sustainable food and nutrition security of the growing population of Odisha. Besides instability of moderate and high nature needs to be curtailed to reduce uncertainty in the foodgrains production. Therefore high growth rate coupled with low instability is a pre requisite for the state for sustainable development. The findings of the study is encouraging in the sense that the paddy, other cereals, pulses and total food grains have better compound growth rate over the 2nd decadal period from 2005-06 to 2014-15 at the state level. This period has also experienced reduced instability in the production of these foodgrains crops. Many districts have experienced improved growth rate and reduced instability in these foodgrains production. Nevertheless the study has identified many districts with negative growth rate, reduced growth rate and moderate to high instability in these foodgrains production. The paper has listed out those districts crop wise. Strategic intervention of the Government in those districts is required to first track the pace of agricultural development.

REFERENCES

[1] Bhalla, G.S. and Singh, G. (2009) Economic liberalization and Indian agriculture: A state-wise analysis. Economic and Political Weekly. 54 (52): 34-44.
 [2] Bhattacharya, S. and Bhattacharya M. (2007) Agrarian impasse in West Bengal in the liberalization era. Economic and Political Weekly. 42(52): 65-71.
 [3] Chand K., Mathhur V. C. and Kumar S. 2001. An Economic Inquiry into Growth and Instability of India’s

Agricultural Exports. Vol. 35(1) 25-30. <http://agricoop.nic.in>.

[4] Chand, R. (2001) Emerging trends and issues in public and private investments in Indian agriculture: A state wise analysis. *Indian Journal of Agricultural Economics*. 56(2): 161-184.

[5] Chand, R. (2003) Government Intervention in Foodgrain Markets in the Changing Context. Policy Paper No. 19. National Centre for Agricultural Economics and Policy Research, New Delhi.

[6] Chand, R. and Raju, S. S. (2009) Instability in Indian agriculture during phases of technology and policy. *Indian Journal of Agricultural Economics*, 64(2): 187-207.

[7] Das, P. S. (1978) Growth and Instability in crop output in Eastern India. *Economic and Political Weekly*, 13(41): 1741-1748.

[8] Hazel, P. B. R. (1982) Instability in Indian Foodgrains Production. Research Report No. 30, International Food Policy Research Institute, Washington D. C.

[9] Lenka, J. (2010) Crop diversification in Orissa: An econometric analysis. In: *Current Issues in Indian Agriculture*, Eds: J. Lenka. Serials Publication, New Delhi.

[10] Mahendradev, S. (1987) Growth and instability in foodgrains production: An interstate analysis. *Economic and Political Weekly*, 22(39): A82-A92.

[11] Mehra Shakuntala, (1981), Instability in India agriculture in the context of new technology Research Report 25, Washington D. C. International Food Policy Research Institute.

[12] Mohanty. S., Pattanaik. F. and Patra. R.N. (2013) Agricultural diversification in Odisha during post reform period. *Agricultural Situation in India*, 70(6):5-14.

[13] Paltasingh, K. R. and Goyari, P. (2013) Analysing growth and instability in subsistence agriculture of Odisha: Evidence from major crops. *Agricultural Economics Research Review*, 26 (Conference Number): 67-78.

[14] Paltasingh, K. R. and Goyari, P. and Mishra, R. K. (2012) Measuring weather impact on crop yield using aridity index: Evidence from Odisha. *Agricultural Economics Research Review*, 25(2): 205-2016.

[15] Pattanaik. F. and Nayak, N. C. (2010) Experiences of structural transformation in Odisha. *Indian Journal of Regional Science*, 43(1): 17-26.

[16] Pattanaik. F. and Nayak, N. C. (2014) Agricultural growth in Odisha during 1970-2008: An analysis. *Journal of Applied Economics*, 13(1): 1-19.

[17] Roa, C. H. H., S. K. Ray and K Subbarao (1988): *Unstable Agriculture and Droughts: Implications for Policy*, Vikas Publishing House.

[18] Sihmar, Rakesh (2014), Growth and Instability in Agricultural Production in Haryana: A District level analysis. *International Journal of Scientific Research Publications*, Vol. 4, Issue 7: 1-12.

[19] Subrahmanyam, S. and Satya Sekhar, P. (2003) Agricultural growth: Pattern and prospects. *Economic and Political Weekly*, 38(12/13): 1202-1211.

[20] Weinberger, K. and Lumpkin, T. (2007) Diversification into horticulture and poverty reduction: A research agenda. *World Development*, 35(8): 1464-1480.

| Annexure I : District wise Annual Compound Growth Rate of Production of Foodgrain in Odisha | | | | | | | | |
|---|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Districts | Paddy | | Other Cereals | | Pulses | | Total Foodgrain | |
| | 1995-96 to 2004-05 | 2005-06 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 |
| Angul | 1.1 | 1.8 | -6 | 13.8 | -4.8 | 3.8 | -0.2 | 2.7 |
| Balasore | 3 | 0.9 | -9.8 | 6.8 | -3.3 | -0.7 | 2.6 | 0.9 |
| Bargarh | 0.6 | 4.8 | -2.1 | 3.7 | -6.2 | 4.8 | 0.3 | 4.8 |
| Bhadrak | 2.3 | -2.9 | -12.9 | -5.7 | -7.5 | -6.9 | 1.8 | -3.1 |
| Bolangir | 1 | 6.2 | 1.2 | 7.1 | -2.8 | 7.4 | 0.5 | 6.9 |
| Boudh | 3.1 | 2.6 | 1.8 | -1.2 | 1.2 | -0.2 | 2.8 | 2.2 |
| Cuttack | -0.5 | 1.1 | -5.7 | 9 | -0.9 | -0.3 | -0.7 | 1 |
| Deogarh | -2.9 | 9.1 | -7 | 2.3 | -7.3 | 0 | -3.5 | 8 |
| Dhenkanal | -0.7 | 3.7 | -3.1 | 6.7 | -8 | 4.2 | -1.9 | 3.8 |
| Gajapati | 0.8 | -2.5 | 1.7 | 8.3 | 6 | 0.2 | 1.8 | 1.3 |
| Ganjam | 1.2 | -6.7 | 0.7 | 4 | -1.6 | 4.2 | 0.7 | -2.2 |
| Jagatsinghpur | 1 | 2 | -14.1 | -4.3 | -6.3 | 3 | 0 | 2.1 |
| Jajpur | -2.2 | -2.3 | -0.6 | 9.4 | -9.4 | 2.8 | -3.1 | -1.4 |
| Jharsuguda | 0 | -4.8 | -4.9 | 11.9 | -5.6 | 2.1 | -0.7 | -3.5 |
| Kalahandi | 1.7 | 7.7 | 0 | 22.9 | 0.3 | -0.4 | 1.3 | 7.1 |
| Kandhamal | 0.7 | -0.6 | -5.3 | 5.2 | -3.2 | 2.2 | -1.2 | 1.2 |
| Kendrapara | -0.4 | -0.7 | -5.5 | -14.4 | 5.2 | 0.5 | 0.2 | -0.5 |
| Keonjhar | 2.6 | 1.4 | -4.9 | 12.7 | -5.4 | 4.9 | 1 | 2.8 |
| Khurda | -1.8 | -3.3 | -10 | 4.3 | -12.5 | 0.5 | -3 | -2.6 |
| Koraput | 1.7 | 2.9 | -3.8 | 7.7 | -8.1 | 3 | -0.6 | 4.3 |
| Malkangiri | 0.1 | 2.8 | -0.2 | 11.9 | -9.5 | -8.9 | -0.7 | 3.5 |
| Mayurbhanj | 2.6 | 0.6 | 0 | 3.1 | -5.4 | 3.7 | 2.1 | 0.9 |
| Nayagarh | 0.5 | -2.6 | -1.1 | 11.9 | -9.5 | 4.6 | -1.8 | -0.6 |
| Nowrangpur | -0.4 | 5.7 | 11.9 | 4.6 | -3.8 | -6.1 | 1.4 | 5 |
| Nuapada | -0.6 | 5 | -5.2 | 13.2 | -10.3 | 7.5 | -2.3 | 6.1 |
| Puri | -1.9 | 0 | -14.8 | 14.3 | -5.6 | 6.9 | -2.2 | 0.5 |
| Raygada | 0 | 6.2 | 0.5 | 7.1 | -1.8 | 4.3 | -0.2 | 6.3 |
| Sambalpur | -0.7 | 2.7 | -4.7 | 25.4 | -9.6 | 3.8 | -1.4 | 3.1 |
| Sonepur | -1.3 | 7.6 | -3.9 | 12.9 | -1.9 | 4.4 | -1.4 | 7.5 |
| Sundargarh | -1.6 | 7.4 | -3.3 | 8.5 | -10.1 | 4.1 | -2.5 | 7.1 |
| Min | -2.9 | -6.7 | -14.8 | -14.4 | -12.5 | -8.9 | -3.5 | -3.5 |
| Max | 3.1 | 9.1 | 11.9 | 25.4 | 6 | 7.5 | 2.8 | 8 |
| Q1 | -0.68 | -0.68 | -5.65 | 4.08 | -8.08 | 0.05 | -1.7 | 0.6 |
| Q2 (Median) | 0.3 | 1.9 | -3.85 | 7.4 | -5.5 | 3 | -0.4 | 2.45 |
| Q3 | 1.18 | 4.95 | -0.05 | 11.9 | -2.13 | 4.28 | 0.93 | 4.95 |

Source : Author's calculation from Odisha Agriculture Statistics (various issues)

| Annexure II : District wise Instability of Production of Foodgrains in Odisha | | | | | | | | |
|---|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Districts | Paddy | | Other Cereals | | Pulses | | Total Foodgrains | |
| | 1995-96 to 2004-05 | 2005-06 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 | 1995-96 to 2004-05 | 2005-06 to 2014-15 |
| Angul | 47.61 | 41.37 | 24.88 | 21.87 | 49.59 | 34.1 | 42.41 | 39.54 |
| Balasore | 27.72 | 17.83 | 28.68 | 41.02 | 75.38 | 81.4 | 27.75 | 28.24 |
| Bargarh | 20.86 | 10.71 | 12.5 | 12.52 | 17.2 | 8.42 | 20.01 | 11.26 |
| Bhadrak | 26.02 | 11.29 | 31.19 | 51.43 | 33.49 | 27.87 | 25.96 | 20.11 |
| Bolangir | 53.76 | 38.91 | 16.65 | 7.46 | 25.73 | 7.04 | 47.81 | 36.86 |
| Boudh | 47.18 | 25.17 | 13.93 | 15.1 | 25.47 | 24.4 | 42.4 | 40.77 |
| Cuttack | 27.13 | 24.64 | 12.36 | 17.13 | 30.65 | 31.24 | 24.6 | 24.26 |
| Deogarh | 38.84 | 38.08 | 18.93 | 26.48 | 30.84 | 41.05 | 34.78 | 26.58 |
| Dhenkanal | 41.73 | 23.99 | 30.8 | 9.8 | 57.2 | 31.02 | 39.86 | 33.38 |
| Gajapati | 23.71 | 28.87 | 8.8 | 2.5 | 24.02 | 29.28 | 15.72 | 16.18 |
| Ganjam | 37.45 | 46.73 | 17.7 | 4.57 | 28.16 | 13.97 | 32.41 | 32.37 |
| Jagatsinghpur | 31.64 | 13.06 | 30.69 | 41.65 | 13.16 | 7.43 | 27.05 | 23.2 |
| Jajpur | 29.14 | 22.16 | 21.84 | 11.36 | 31.16 | 38.16 | 28.76 | 29.96 |
| Jharsuguda | 41.47 | 44.74 | 30.85 | 20.65 | 41.04 | 39.73 | 39.97 | 38.28 |
| Kalahandi | 34.72 | 30.05 | 18.24 | 3.12 | 36.44 | 36.14 | 31.81 | 22.85 |
| Kandhamal | 27.47 | 16.3 | 15.99 | 8.57 | 25.96 | 23.06 | 20.36 | 19.23 |
| Kendrapara | 25.32 | 20.05 | 61.18 | 29.59 | 38.67 | 41.14 | 24.91 | 24.81 |
| Keonjhar | 34.49 | 19.42 | 33.15 | 13.96 | 27.2 | 17.85 | 29.98 | 24.95 |
| Khurda | 32.2 | 23.88 | 21.51 | 24.9 | 33.64 | 56.27 | 29.6 | 29.13 |
| Koraput | 17.55 | 21.93 | 24.31 | 11.12 | 48.09 | 39.31 | 15.68 | 11.73 |
| Malkangiri | 29.46 | 31.15 | 19.92 | 7.98 | 60.62 | 50.44 | 24.55 | 22.08 |
| Mayurbhanj | 24.53 | 23.29 | 11.88 | 9.37 | 24.89 | 15.07 | 23.51 | 24.14 |
| Nayagarh | 44.86 | 33.35 | 30.32 | 8.07 | 30.45 | 35.43 | 38.75 | 39.72 |
| Nowrangpur | 26.78 | 30.92 | 26.56 | 37.96 | 42.38 | 16.2 | 22.25 | 18.05 |
| Nuapada | 45.56 | 28.72 | 33.58 | 8.72 | 48.07 | 35.66 | 38.45 | 29.58 |
| Puri | 22.28 | 17.49 | 10.03 | 14.79 | 31.23 | 28.44 | 21.13 | 21.98 |
| Raygada | 26.16 | 23.79 | 26.74 | 13.22 | 48.6 | 37.98 | 25.27 | 14.58 |
| Sambalpur | 29.13 | 24.44 | 18.75 | 10.96 | 35.76 | 26.55 | 28.16 | 25.42 |
| Sonepur | 19.76 | 21.18 | 24.8 | 21.49 | 38.22 | 17.07 | 19.02 | 12.33 |
| Sundargarh | 32.23 | 31.95 | 14.81 | 4.31 | 19.16 | 22.15 | 27.14 | 20.4 |

Source : Author's calculation from Odisha Agriculture Statistics (various issues)