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Economic analysis of growth and instability of maize in Odisha

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Abstract
The growth rate analysis is mainly used in economics to know the trend of a particular variable over a period of time and often used for policy analysis. The present study was attempted to examine the annual compound growth rate of area, production and yield of major maize growing districts of Odisha. The secondary data covering the period from 2003 to 2017 were collected from various issues of economic survey of Odisha for computation of growth rate and instability index. The statistical measures like exponential function and Cuddy Della Valle index were used for calculation of growth rate and instability index respectively. The study revealed that Kalahandi district registered the highest growth rate (7.4%) in area followed by Nabarangpur (4.8%), Koraput (4.2%), Rayagada (2.6%) and Keonjhar (-0.1%) districts respectively. Similarly in case of yield parameter, Keonjhar district recorded the highest growth rate (10.3%) followed by Kalahandi (10%), Rayagada (8.1%), Koraput (7.9%) and Nabarangpur (1.9%) respectively. So far as production was concerned, Kalahandi district recorded the highest growth rate in production (17%) followed by Koraput (12%), Rayagada (10.7%), Keonjhar (9.9%) and Nabarangpur (6.6%) respectively. In Odisha the annual compound growth rate of area, yield and production were reported to be 2.8%, 6.3% and 9.2% respectively. Area expansion and yield were the major factors or increased maize production in the state. Therefore, the thrust should be given to increase the area by utilizing the suitable area and to increase the yield through technological advancement, varietal research, and strengthening agro advisory services in Odisha. The computation of instability index confirmed that districts like Keonjhar and Rayagada experienced low level of instability so far as area was concerned. The districts like Nabarangpur and Koraput suffered from medium level of instability. The instability in area was found to be very high in case of Kalahandi district. The instability of yield in Odisha was observed to be low. The districts which showed low instability in yield were Koraput and Rayagada. The moderate level of instability was observed in Nabarangpur district. The instability in production for Nabarangpur, Keonjhar, Koraput, Kalahandi and Rayagada districts were reported to be 27.73, 15.90, 21.54, 55.34 and 26.93 respectively. Moderate instability in production was observed in the state as a whole.

Keywords: maize, growth rate, CDVI

Introduction
Agriculture plays a vital role in agrarian economy like India. Around 54.6 per cent of the population is engaged in agriculture and allied activities (census 2011) and it contributes 17 per cent to the country`s Gross Value Added (current price 2015-16, 2011-12 series). The Indian agriculture is known for fluctuations and instability in its performance. The instability in production and productivity has a cascading effect on the farm economy and has serious implications for food security. In this present context there is a need to transfer of paddy based cropping system to maize based cropping system. Maize (*Zea mays* L.) is an important cereal crop in the world after wheat and rice. The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. It is the most versatile crop with wider adaptability in varied agro-ecologies throughout the year due to its photo-thermoinsensitive and has highest genetic yield potential among the food grain crops (source : DMR). It is the third most important cereal crop in India after rice and wheat. It accounts for around 10 per cent of total food grain production in the country. In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, textile, gum, package and paper industries etc. (Source-www.apeda.gov.in). Maize is grown both in *Kharif* and *Rabi* seasons in India.

The contribution of *Kharif* maize accounts for 83 per cent to the total production in India while *Rabi* maize corresponds to 17% maize area. India ranks 4th in area and 7th in production representing around 4% of world maize area and 2 per cent of total production. Generally, *Kharif* maize suffers from lower productivity (2706 kg/ha) as compared to *Rabi* maize (4436 kg/ha) due to many biotic and abiotic stresses. Over 70 per cent of maize area is grown under rainfed condition. Since 2010, maize productivity in India is expanding over 50kg/ha/year, which is most noteworthy among food crops. Among Indian states, Madhya Pradesh and Karnataka have highest area under maize (15% each) followed by Maharashtra (10 per cent), Rajasthan (9 per cent), Uttar Pradesh (8 per cent), Bihar (7 per cent) and others. Majority of major production in India, approximately 47 per cent is utilised as poultry feed, 13 per cent as livestock feed and food purpose each, 12 per cent for industrial purposes, 14% in starch industry, 7 per cent as processed food and 6 per cent for export and other purposes. During the financial year 2018-19, the maize has been grown in an area of 9.2 million ha with a production of 27.8 million tonnes and productivity of 29.65 q/ha. (Directorate of Economics and Statistics, GoI). Maize is one of the most important cereal crops in the tribal districts of Odisha. It is cultivated in an area of 247.6 thousand ha with an average production of 730 thousand MT and productivity of 2948 kg/ha. (Odisha Economic Survey, 2018-19). It is predominantly cultivated as *Kharif* crop in Ganjam, Gajapati, Keonjhar, Koraput, Nawarangpur, Mayurbhanj and Kalahandi districts of Odisha and considered as second most important crop next to paddy during *Kharif* season in terms of both area and production. Among different districts, Nabarangpur covers the maximum area of 69,270 ha, contributing around 30 per cent of total production. *Rabi* maize accounts only 7 per cent of total area and production of the State. Average *Kharif* maize productivity of Odisha is higher (2098 kg/ha) compared to the national average productivity (2015kg/ha). The *Kharif* maize contributes to the tune of 92 per cent to the total maize production. (RKVY report, 2018-19).The *Rabi* maize is cultivated under irrigated condition, while only 24% of the *Kharif* maize area is grown under rainfed condition. Irrespective of the season, maize is the fourth most important food grain crop with respect to area in the state which is next to rice, mungbean and urdbean.

Materials and Method

For calculation of compound annual growth rate (CAGR) and insability of area, yield and production of maize in Odisha, secondary data were obtained mainly from Directorate of Agriculture and FE, Govt. of Odisha from the period 2003 to 2017. Estimation of CAGR and Instability index were performed using the following analytical techniques

Growth in area, production & productivity was calculated using the following formula

$Y_t = ab^t$ ……. (1)

Where Y = area/ production/ productivity in 1st year, a = intercept, t = year (time period)

(i.e t = 1, 2, 3…..…,n)
b = 1 + r/100,

Where 'r' refers to the percentage rate of compound annual growth rate of area, production, productivity

By taking logarithms both side of the equation (1), it have been reduced to following linear form with log 'Y' as dependent variable and 't' as independent variable

$\text{Log } Y_t = \log a + t \log b$

Putting 'log a' = A and 'log b' = B, then this can be written as

$\text{Log } Y_t = A + B_t$ …….(2)

This is semi log function with time't' as independent variable. Then by using OLS technique, we obtain the following form of equation.

$\Sigma \log Y_t = n A + B \Sigma t$
$\Sigma \log Yt\ t = A \Sigma t + B \Sigma t^2$..... (3)

Where 'n' is the number of observations (years)

By solving equation (3), the values of 'A' and 'B' have been computed. For deriving compound growth rate from the computed regression coefficients, the following procedure has been adopted. When 'B' has positive value, anti-log of 'B' has been obtained and then one was subtracted from anti log value of 'B'. Thereafter the B-1 value has been multiplied by hundred. Thus, it gave the compound growth rate (CGR) of increasing type, when 'B' had negative value, the procedure of calculating CAGR is the same, but the value of growth rate will be negative. This negative CAGR represents the decreasing growth rate over time.

Percentage rate of CAGR can be computed as
r = (b-1) X 100
r = (antilog of ln B- 1)) X 100

Cuddy Della Vella Index

An index of instability was computed to examine the nature and degree of instability in area, production and yield of maize in different districts of Odisha. The co-efficient of variation (CV) was worked out for area, production, and yield to measure the variability. However, simple CV does not explain properly the trend component inherent in the time series data. To overcome this problem, a measure of instability was estimated by using Cuddy Della Valle Index (CDVI) which corrects the coefficient of variations and it is given by

$CDVI = CV * (1-R^2)^{0.5}$ where R^2 is the coefficient of determination from time trend regression
CV= (Standard deviation / mean)*100

Range of CDVI value

0-15: low instability
>15 to <30: medium instability
>30: High instability

Results

Any agricultural policies in general and a crop in particular require the trends and up to date information on area, yield and production. Hence, in this section an attempt has been made to compute the compound annual growth of area, yield and production of major maize growing districts in Odisha (from 2003 to 2017), the result of which are presented in table 1.

Table 1: Compound annual growth rate (CAGR) of area, yield and production of major maize growing districts of Odisha (in % per annum)

Districts	Particulars	CAGR (%)
Nabarangpur	Area	4.8 **
	Yield	1.9
	Production	6.6 **
Keonjhar	Area	-0.1
	Yield	10.3 **
	Production	9.9**
Koraput	Area	4.2 **
	Yield	7.9**
	Production	12**
Kalahandi	Area	7.4**
	Yield	10**
	Production	17**
Rayagada	Area	2.6
	Yield	8.1**
	Production	10.7**
Odisha	Area	2.8 *
	Yield	6.3**
	Production	9.2**

Note- (**) indicates significant at 1% level, (*) indicates significance at 5% level

The district wise per annum CAGR of maize area from table 1 revealed that Kalahandi registered the highest growth rate (7.4%) followed by Nabarangpur (4.8%), Koraput (4.2%), Rayagada (2.6%) and Keonjhar (-0.1%) respectively. In case of Odisha, the CAGR of area was reported to be 2.8% which was statistically significant at 5% probability level.

The district wise per annum CAGR of maize yield revealed that Keonjhar recorded the highest growth rate (10.3%) followed by Kalahandi (10%), Rayagada (8.1%), Koraput (7.9%) and Nabarangpur (1.9%) respectively which were found to be statistically significant at 1% probability level except for Nabarangpur district. In case of Odisha, the CAGR of yield was reported to be 6.3% which was highly significant at 1% probability level.

The district wise per annum CAGR of maize production revealed that Kalahandi recorded the highest growth rate in production (17%) followed by Koraput (12%), Rayagada (10.7%), Keonjhar (9.9%) and Nabarangpur (6.6%) respectively. The growth rate of maize production in the overall study period in Odisha was reported to be 9.2% which was found to be highly significant at 1% probability level.

Instability in area, yield and production of major maize growing districts of Odisha

The instability index indicates the risk involved in cultivating the crop. Instability index of area, yield and production have been presented in table 2.

Table 2: Instability index of area, yield and production of major maize growing districts (in %)

Districts	Particulars	Area (000'ha)	Yield(kg/ha)	Production (000'MT)
Nabarangpur	Mean	52.44	3395	179.72
	CV	25.23	29.51	34.67
	R^2	0.60	0.07	0.35
	CDVI (%)	15.89	28.33	27.73
Keonjhar	Mean	25.32	1663	41.69
	CV	7.92	46.64	44.17
	R^2	0.04	0.88	0.87
	CDVI (%)	8.00	15.85	15.90
Koraput	Mean	21.30	2112.93	47.73
	CV	24.54	34.44	51.30
	R^2	0.59	0.83	0.82
	CDVI (%)	15.7	14.12	21.54
Kalahandi	Mean	14.51	2593.46	42.18
	CV	40.48	45.35	67.49
	R^2	0.32	0.75	0.61
	CDVI (%)	33.19	37.19	55.34
Rayagada	Mean	14.63	2772.46	42.44
	CV	15.85	35.45	44.88
	R^2	0.43	0.70	0.64
	CDVI (%)	11.88	14.18	26.93
State	Particulars	Area (000'ha)	Yield (Kg/ha)	Production (000'tonnes)
Odisha	Mean	233.13	2254.93	542.59
	CV	14.91	26.82	36.81
	R^2	0.60	0.79	0.77
	CDVI (%)	9.39	12.06	17.30

It is evident from table 2 that the mean area, yield and production was found to be the highest in Nabarangpur district, the value of which were reported to be 52.44 thousand hectares, 3395 kg/ha. and 179.72 th.MT respectively while in case of Odisha the same were reported to be 233.13 thousand ha, 2254.93 kg/ha and 542.59 thousand tonnes respectively.

The instability in area was found to be low (9.39%) at the state level. However, district wise analysis confirmed that Keonjhar and Rayagada suffered from low level of instability so far as area was concerned. The instability figure of area in case of Keonjhar and Rayagada were reported to be 8% and 11.88% respectively. The districts like Nabarangpur and Koraput suffered from medium level of instability with values of 15.89 and 15.7% respectively. The instability in area was found to be very high (33.19%) in case of Kalahandi district.

The instability of yield in case of Odisha was observed to be low (12.06%). The districts which showed low instability in yield were Koraput and Rayagada with values of 14.12 and 14.18% respectively. The moderate level of instability was

found in Nabarangpur district. However in case of Kalahandi district, the instability in yield was found to be very high (37.19%). The instability in production for Nabarangpur, Keonjhar, Koraput, Kalahandi and Rayagada districts were reported to be 27.73, 15.90, 21.54, 55.34 and 26.93 respectively. Moderate instability in production was observed in the state as a whole with value of 17.30%.

Discussion

Table 1 indicates the compound annual growth rate of area, yield and production of major maize growing districts of Odisha. The district wise analysis confirmed that highest growth rate of area was observed in case of Kalahandi district whereas the lowest growth rate of area was observed in case of Keonjhar district. The CAGR of area was found to be statistically significant at one% probability level for all the districts except Rayagada and Keonjhar. The reason for significant growth rate in area was mainly due to better relative price in the market. However, insignificant growth rate of area observed in case of Rayagada and Keonjhar was mainly due to shifting of area from maize towards other crops. The result is in line with Bathla (2008) who reported similar result while studying extent of shift in area within the cropping sector in India.

The district wise per annum CAGR of maize yield revealed that Keonjhar recorded the highest growth rate in yield whereas the lowest insignificant growth rate was observed in case of Nabarangpur district. The non-significant growth rate of yield observed in Nabararangpur district was mainly due to lack of location specific high yielding variety with high incidence of disease and pests. The significant growth rate in yield was mainly due to various efforts of the national and state level research projects related to maize, improved package and practices as well as popularisation of high yielding variety seeds. Similar trend was reported by Singh and Singh (1991) [9] and Sinha and Thakur (1993) who observed an increasing trend in yield level in their study. The performance of maize crop in Odisha was better as revealed from the study. The CAGR of maize yield in Odisha was positive and highly significant at one percent probability level.

Maize production registered significant and positive growth rate in all the districts as well as in state. The significant increase in growth rate of production in all the districts was mainly due to yield effect, however in case of Nabarangpur, it was mainly due to area effect which was responsible for increase in growth rate of production. In Odisha, the contribution of yield effect was comparatively higher than that of area effect.

Conclusion

The calculation of per annum CAGR of area, yield and production of maize revealed that majority of the districts of Odisha as well the state itself showed positive growth rate in area except Keonjhar. The positive growth rate observed in case of area was mainly due to better market price while the negative growth rate observed was due to shifting of area from maize towards other crops. The highest CAGR for area was found in Kalahandi district. The district wise per annum CAGR of maize yield revealed that Keonjhar recorded the highest growth rate whereas the lowest was observed in case of Nabarangpur district. The lower growth rate of yield in case of Nabarangpur district was due to lack of location specific high yielding varieties along with incidence of disease and pest. The positive growth rate in yield was mainly due to the coordinated effort of various research institutions, using of high yielding variety seeds and adoption of improved package and practices. The district wise per annum CAGR of maize production revealed that the Kalahandi recorded the highest growth rate in production. The positive significant growth rate observed in case of production was mainly due to interaction of area and yield effect except for Nabarangpur district which was due to area effect only. The calculation of instability index revealed that Odisha had low level of instability in both area and yield meaning that area under maize was stable in the state. The district wise analysis confirmed that Keonjhar and Rayagada showed low instability in area while medium instability in area were observed in case of Nabarangpur and Koraput district and high instability in case of Kalahandi district. In case of yield, low instability was observed in districts like Koraput and Rayagada and high instability in Kalahandi. So far as production was concerned, majority of the districts suffered from moderate instability except Kalahandi.

The growth rate analysis of area, production and productivity over a period of time at state or district level are a major concern for researches as well as policymakers. A careful analysis of the growth rate trend helps the farmers identify the change in cropping and land use pattern under different crops. It further helps the policy makers to devise appropriate policy required for the district or state. The predicted result showed an increase in area, production and productivity of maize in the state. Though the state has shown a noteworthy increase in area, production and yield, still the growth rate is not up to the mark. Therefore, the study recommends for further expansion of area along with supply of better package and practices to derive the desired benefits.

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