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Rice production in Telangana: growth, instability and decomposition analysis

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ABSTRACT

One of the objectives of the study is to assess the growth of rice sector in Telangana and growth rate is the measurable indicator for assessing the growth. The present study was conducted to assess the growth rates and instability in the area, production, and yield of rice in Telangana. Also, the relative contribution of area and yield to change in output was estimated by decomposition analysis. The study is based on secondary data for a period of 30 years i.e., 1990-91 to 2019-20. The secondary data were obtained from various publications of the Directorate of Economics and Statistics, Government of India and Directorate of Rice Development, Patna. For this study, the whole period (1990-91 to 2019-20) is divided into three sub-periods to have a period-wise examination of growth and instability patterns of the area, production, and productivity of rice and the sub-periods were as follows: period I (1990-91 to 1999-2000), period II (2000-01 to 2009-10) and period III (2010-2011 to 2019-20), and overall period (1990-91 to 2019-20). Compound Growth Rates were used to calculate the growth rates. The instability in area, production, and yield was measured with Cuddy Della Valle Index and Coppock's Instability. The study revealed that the growth rates for Telangana in the overall period were positive for the area, production, and yield (2.1%, 3.7%, and 1.5% respectively). The Cuddy Della Valle Index for the overall period registered higher, medium, and low instability for production (35.1), area (26.4), and yield (7.6) respectively. Coppock's Instability indices revealed that the degree of instability for area and production was higher during period III in comparison to periods I and II. One of the major reasons for this could be the increased area under rice in period III, because of the assured irrigation due to the completion of many major and minor irrigation projects and revival of tanks under Mission Kakatiya in Telangana. The decomposition analysis for the overall period (1990-91 to 2019-20) revealed that the area effect was highly responsible for the production variability (46.1 percent) in Telangana. The area effect in enhancing rice production increased over some time. Since the scope to further increase the area under rice cultivation is limited, the focus should be on the improvement of the yield to meet the future demand for rice.

Key words: *Rice, Telangana, growth rates and decomposition analysis*

INTRODUCTION

Rice is the staple food for more than half of the world's population and is grown in an area of about 162 million hectares worldwide, and 755 million tonnes of paddy is harvested each year. Of this, Asia accounted for 90% of the production and consumption and 86% of the area in 2019-20. (http://www.fao.org/faostat 2020). Rice provides up to 60 percent of the daily energy requirement and therefore is crucial for food and nutritional security (Nirmala et al., 2019)

India has the world's largest area of 44 million hectares under rice with the production of 118 million tonnes in 2019-20. India stands as the second-largest producer in the world which accounts for 23.5 percent of global rice production next only to China. India is both the world's second-largest producer and consumer of rice. Rice accounts for 41 percent of total food grain production occupying 35 percent of the food grain area

of the country and continues to play a key role in the national food and livelihood security system (Nirmala et al., 2021). Telangana has a productivity of (3649 kg ha^{-1}) (Agricultural statistics at a glance 2020).

Rice production has increased significantly in Telangana; it continues to dominate as a major crop produced in the state and has seen a prominent increase in production in recent years. Rice is the predominant crop in Telangana, accounting for 50.3 percent (4.12 mha) of the total gross cropped area in 2020-21, up from 26.6 percent in 2014-15. In contrast, production accelerated by 29.9% from 19.3 million tons in 2019-20 to 25.1 million tons in 2020-21. It marked the state as one of the national leaders in paddy production.

Keeping this in view, the present paper is an attempt to examine the growth and instability in the area, production, and yield of rice crop in Telangana and also to assess the contribution of area, yield, and their interaction to growth in the production of rice.

MATERIALS AND METHODS

The present study is based on secondary data. Time-series data related to the area, production, and yield of rice in Telangana for the period of 30 years *i.e.*,1990-91 to 2019-20 have been collected from publications of the Directorate of Economics and Statistics, Govt. of India (https://eands.dacnet.nic. in/), Directorate of Rice Development, Patna, Bihar (https://drdpat.bih.nic.in//). For lucidity, the study period is divided into three sub-periods to have a period-wise examination of growth and instability patterns of the area, production, and productivity of rice and the sub-periods were as follows: period I (1990-91 to 1999-2000), period II (2000-01 to 2009-10) and period III (2010-2011 to 2019-20) and overall period (1990-91 to 2019-20).

Compound Annual Growth Rate (CAGR): Compound annual growth rate is calculated to study the growth pattern in the area, production, and productivity of rice in Telangana.

The growth rate was estimated using an exponential trend model.

$$Y = ab^t$$

Where, Y = area/ production / yield

a = intercept,

b = regression coefficient,

t = time in years

From the estimated function, the compound annual growth rate percentage (r %) can be expressed as

CAGR (r) = (Antilog of b - 1) x 100

Where,

r = Compound Annual Growth Rate (%)

Instability index

Instability means deviation from the "trend". In agriculture, instability is an inherent characteristic due to weather conditions, seasonal variation in area, yield, and production of crops from year to year. Instability analysis can be studied using three measures of instability *viz*., Coefficient of Variation, Cuddy-Della Valle index, and Coppock's index. The use of coefficient of variation as a measure to show the instability in any time series data has some limitation. If the time series data exhibit any trend, the variation measured by CV can be overestimated. Hence, present study applies the Cuddy Della Valle Index and Coppock instability index for measuring the instability. Cuddy Della Valle index attempts to de-trend the CV by using coefficient of determination. Coppock's instability index is a close approximation of the average year to-year percentage variation adjusted for trend and the advantage is that it measures the instability in relation to the trend in prices. Thus, two better measures *viz*., Coppock's instability index and Cuddy Della Valle index were used to capture instability in rice area, production and yield.

Cuddy- Della Valle Index (CDVI)

CDVI was originally developed by Cuddy and Valle (1978) for measuring the instability in time-series data that is characterized by trends. The estimable form of the equation is as follows:

$$\text{Cuddy-Della Valle Index (CDVI)} = C.V \times \sqrt{1 - R^2}$$

Where,

C.V. = Coefficient of Variation

R^2 = ESS/TSS *i.e.*, ratio of explained variation to total variation.

ESS = Variation explained by explanatory

variable.

TSS = Total Variation

The present study includes the ranges of Cuddy- Della Valle Index suggested by Rakesh Sihmar (2014) are given as follows:

- Low instability = between 0 to 15
- Medium instability = > 15 to < 30
- High instability = >30

Coppock's Instability Index (CII)

$$\text{Coppock's instability index} = \text{Antilog}\left(\sqrt{\text{V log - 1}}\right) \times 100$$

$$\text{V log} = \frac{\Sigma\left[\log \frac{X_t + 1}{X_t} - m\right]^2}{N}$$

Where Xt = Area/production/yield of rice in year t

N = number of years minus one (*i.e.*, $N = n^{-1}$)

m = Arithmetic means of the difference between the log of X_t and X_{t+1}, X_{t+2}, etc.

The CII analysis was used to measure percentage variation from year to year.

Decomposition analysis:

Decomposition analysis is used to measure the relative contribution of area and yield towards the total production changes of rice. This has been worked out using the formula recommended by Palanisami, Paramisivam, and Ranganathan (2002).

$$P_t - P_0 =$$

$$A_0 (Y_t - Y_0) + Y_0 (A_t - A_0) + (A_t - A_0)(Y_t - Y_0)$$

$$\Delta P = A_0 \Delta Y_t + Y_0 \Delta A_t + \Delta A \Delta Y$$

Production = Yield effect + Area effect + Interaction effect

Where,

P, A, and Y represent production, area, and yield.

'0' represents the base period and 't' represent current period.

Thus, the total change in production can be decomposed into three components *viz*., yield effect, area effect, and the interaction effect due to change in yield and area.

RESULTS AND DISCUSSION

Telangana is the rice bowl of South India. The area under rice has increased from 1.3 million hectares to 3.2 million hectares during the period 1990-20. Similarly, the yield has increased from 2.4 t ha^{-1} to 3.7 t ha^{-1} during the above mentioned period.

The data presented in Table 1 depicts the area, production, and yield of rice in Telangana during the period 1990-91 to 2019-20. It was observed that the

Table 1. Area, production and yield of rice in Telangana from 1990-91 to 2019-20.

S. no.	Year	Area (Million hectares)	Production (Million Tonnes)	Yield (Tonnes ha^{-1})
1	1990-91	1.3	3.2	2.4
2	1991-92	1.3	2.9	2.2
3	1992-93	1.1	2.3	2.1
4	1993-94	1.0	2.3	2.3
5	1994-95	1.1	2.7	2.5
6	1995-96	1.1	2.6	2.4
7	1996-97	1.3	3.1	2.4
8	1997-98	0.8	1.7	2.2
9	1998-99	1.5	4.2	2.7
10	1999-00	1.2	3.0	2.4
11	2000-01	1.5	4.4	2.8
12	2001-02	1.3	3.6	2.7
13	2002-03	1.0	2.0	2.1
14	2003-04	1.0	2.9	2.8
15	2004-05	0.9	2.2	2.5
16	2005-06	1.5	4.4	3
17	2006-07	1.5	4.3	2.8
18	2007-08	1.4	4.4	3.1
19	2008-09	1.7	5.4	3.1
20	2009-10	1.1	3.3	2.9
21	2010-11	2.0	6.5	3.3
22	2011-12	1.8	5.1	2.9
23	2012-13	1.4	4.6	3.2
24	2013-14	2.0	6.6	3.3
25	2014-15	1.4	4.5	3.2
26	2015-16	1.0	3.0	2.9
27	2016-17	1.7	5.2	3
28	2017-18	2.0	6.3	3.1
29	2018-19	1.9	6.7	3.4
30	2019-20	3.2	11.9	3.7

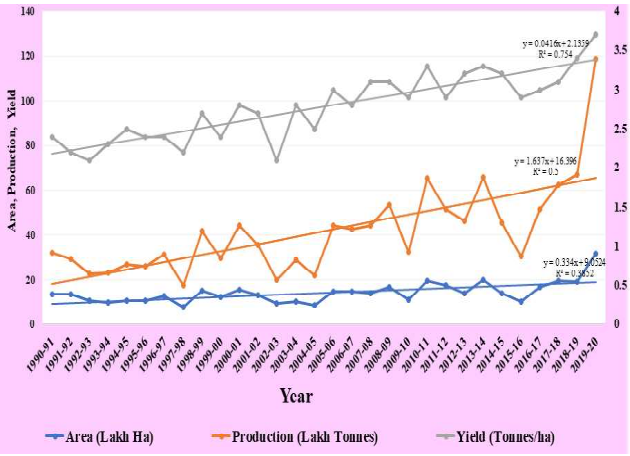

Fig. 1. Trends in area, production, and yield of rice in Telangana from 1990-91 to 2019-20.

production of rice in Telangana has increased from 3.2 million tonnes in 1990-91 to 11.9 million tonnes in 2019-20. The increase in production was approximately 3.7 times whereas the area of rice has increased from 1.3 million hectares in 1990-91 to 3.2 million hectares in 2019-20. Similarly, yield also has increased throughout the study period *i.e.*, 2.4 tonnes ha^{-1} in 1991 to 3.7 tonnes/ha in 2019-20. It is observed from the data that from the year 2015-16 to 2019-20 there is an even increase in the area, production, and yield of rice. The increase in the area can be attributed to assured irrigation due to the completion of many major and minor irrigation projects and the revival of tanks under 'Mission Kakatiya' in Telangana. With assured irrigation more land was brought under rice cultivation in the last five years. Enhancement in the production of rice in Telangana can be attributed to irrigation facilities, favourable rainfall, investment support provided by the government through the 'Rythu bandhu' scheme, quality seed and good management practices followed by the farmers.

Compound annual growth rates

The district-wise compound annual growth rates of area, production, and yield of rice in Telangana for three periods and the overall study period have been examined and are presented in Table 2. Analysis across districts revealed that the compound annual growth rates of area, production, and yield are fluctuating throughout the three periods.

During the period I, the highest growth rate was recorded in Adilabad for production (4.6) and yield (4.8). The growth rate for the area was highest in the Khammam district. However, it was observed from the results that in period I both positive and negative growth rates were found across districts for the area, production, and yield. Due to better irrigation facilities and good drainage system, where water is aerated quickly in the fields, the growth rate of Karimnagar was positive and significant at 1 percent level for yield (3.5***).

During period II, Nalgonda registered the highest growth rate in area and production (7.0* and 9.4* respectively) and Nizamabad has the highest growth rate in yield (5.0*) which was found positive and significant at 10 percent level. The highest decline

Table 2. CAGR of area, production and yield of Rice in Telangana from 1990-91 to 2019-20.

District	Particular	Period I	Period II	Period III	Overall period
Adilabad	Area	-0.2	-3.5	7.9*	1.7**
	Production	4.6	-1.8	10.2*	4.5***
	Yield	4.8	3.1	4***	2.7***
Karimnagar	Area	-0.3	1.6	5.2	3.3***
	Production	3.3	3	6.4	4.7***
	Yield	3.5***	1.3	1.1	1.4***
Khammam	Area	0.9	0.5	0.1	0.4
	Production	1.7	2.7	2.8	1.9***
	Yield	0.8	2.2	2.6**	1.5***
Mahabubnagar	Area	0.2	1.5	2	2.4***
	Production	-0.1	3.3	3.2	3.9***
	Yield	-0.3	1.8	1.1	1.4***
Medak	Area	-1.1	-0.5	-5.2*	0.5
	Production	0.4	1.7	-4.3	3***
	Yield	1.5	2.3	0.9	2.5**
Nalgonda	Area	-1.2	7*	6.9*	2.4***
	Production	-1.4	9.4*	8.1*	3.3***
	Yield	-0.2	2.3*	1.1	0.9***
Nizamabad	Area	0.3	0.7	4.2	2.8***
	Production	1.5	5.7	4.8	5.4***
	Yield	1.2	5*	0.6	2.5***
Rangareddy	Area	-1.6	-4.2*	1.6	-0.3
	Production	-1.8	-2.9	4.9	0.6
	Yield	-0.3	1.4	3.3***	0.9***
Warangal	Area	0.4	-0.5	4.5	2.8***
	Production	0.4	-0.1	5.9	4.4***
	Yield	0.02	0.4	1.4	1.6***
Telangana	Area	-0.2	1.5	3.5	2.1***
	Production	0.8	3.7	4.7	3.7***
	Yield	1	2.1*	1.1	1.5***

***Significant at 1% level, **Significant at 5% level, * Significant at 10% level

in growth was observed for the production of the Rangareddy and Adilabad districts in comparison to the period I. The compound growth rate of area (4.2*) in Rangareddy district was negative and statistically significant at 10 percent level. This may be due to the diversion of rice area to other commercial crops and non-agricultural purposes.

During period III, Adilabad recorded positive and significant growth rates for the area (7.9*), production (10.2*) at 10 percent level while for yield (4***) significant at 1 percent level of significance. In this period almost all districts registered a positive growth rate for the area, production and yield except Medak which has shown a negative but significant growth rate at a 10 percent level of significance for the area (-5.2*) and a negative and non-significant growth rate for production (-4.3) The yield growth rate of Khammam was positive and statistically significant at 5 percent level of significance, while the growth rate of area (6.9*) and production of Nalgonda was positive and statistically significant at 10 percent level of significance.

During the overall period the compound growth rates of area, production and yield were positive and statistically significant (except Khammam and Medak which were positive but statistically not significant) in almost all districts except the area of Rangareddy (-0.3) which was found to be negative and statistically non-significant. The highest growth rate for production was recorded in Nizamabad (5.4***) followed by Karimnagar (4.7***), Adilabad (4.5***), and Warangal (4.4***) which were positive and statistically significant at 1 percent level. The highest growth for the area was found in Karimnagar (3.3***) followed by Warangal (2.8***) and Nizamabad (2.8***) which were also significant at 1 percent level. The highest growth rate for yield was found in Adilabad followed by the Nizamabad district and were significant at 1 percent level of significance.

Examining Telangana as a whole, the period I growth rates for the area, produc,tion and yield of rice was -0.2, 0.8, and 1.0 percent respectively. During the period I yield growth was the main source of production. In period II all three components were positive and yield (2.1*) was found significant at 10 percent level of significance. In period II, period- III the growth rates of area, production, and yield of Telangana reveal positive and higher growth than in period-I. This could be due to increased irrigation facilities in the state. During period III, the growth rates of area (3.5), production (4.7), and yield (1.1) were positive but statistically non-significant. The yield peaked till period II and after it has shown declined growth in period III. In the overall period compound growth rate for the area (2.1***), production (3.7***), and yield (1.5***) of Telangana registered positive and significant growth at the 1 percent level of significance. The compound growth rates of area, production, and yield of rice in Telangana were positive in all the periods except in the area during Period I.

Instability index

The level of instability cannot be detected by focusing solely on growth rates. Growth rates will simply explain

Table 3. Cuddy- Della Valle Index for area, production, and yield of rice.

District	Particular	Period I	Period II	Period III	Overall period
Adilabad	Area	19.4	21.3	40.0	36.8
	Production	40.5	33.1	49.6	54.7
	Yield	29.0	17.8	10.9	19.6
Karimnagar	Area	25.2	35.6	34.3	35.7
	Production	29.6	41.0	38.4	42.2
	Yield	8.1	11.1	6.0	8.4
Khammam	Area	13.7	23.4	25.9	20.4
	Production	20.2	28.9	30.7	26.8
	Yield	9.5	13.9	8.5	10.5
Mahabubnagar	Area	33.2	22.4	30.9	28.3
	Production	46.2	28.7	43.0	39.9
	Yield	17.3	10.0	11.4	12.5
Medak	Area	18.2	22.2	21.6	23.4
	Production	28.6	30.4	28.9	33.7
	Yield	13.4	12.5	10.5	11.7
Nalgonda	Area	17.4	27.0	31.0	32.2
	Production	20.2	29.9	33.8	37.3
	Yield	6.3	8.4	6.0	7.1
Nizamabad	Area	19.7	30.1	33.9	34.7
	Production	30.8	38.6	39.9	46.2
	Yield	13.2	16.4	11.8	13.9
Rangareddy	Area	21.2	20.3	25.0	24.5
	Production	21.6	26.0	30.8	29.5
	Yield	5.1	9.4	6.6	8.7
Warangal	Area	29.9	23.0	26.7	27.1
	Production	37.9	29.9	30.9	34.0
	Yield	16.7	10.8	8.6	11.4
Telangana	Area	19.8	22.8	29.1	26.4
	Production	24.4	29.2	36.3	35.1
	Yield	6.5	9.7	7.2	7.6

the rate of growth over time, whereas instability will determine whether the growth performance for the variable under study was stable or unstable over time. In this study, the level of instability in the area, production, and yield of rice was determined by using Cuddy-Della Valle Index and Coppock's Instability Index.

Cuddy Della Valle Index

It is evident in Table 3 that during the period I, the highest instability for area and production has been found in the Mahbubnagar district while Adilabad registered high instability in yield. Low instability for the area (13.7) was recorded in Khammam while production (20.2) recorded low instability in Khammam and Nalgonda districts. Medium instability in the area and production has been found in most districts. The area has been found low and medium unstable in all districts whereas in the case of production, instability varies from low to high and yield has been found less unstable in the majority of districts. The instability of Telangana for the area, production and yield was found to be medium(19.8),, medium(24.4) and low(6.5) respectively.

During period II, high instability for the area and production was recorded in Karimnagar (35.6 & 41.0 respectively) followed by Nizamabad (30.1 & 38.6 respectively). Low instability for yield was registered in Nalgonda (8.4) district followed by Rangareddy (9.4), Mahbubnagar(10.0), and Karimnagar (11.1) respectively. The instability varies from 20.3 to 35.6 percent, 26.6 to 41.0 percent for the area and production respectively which are in medium to the highly unstable range, and 8.4 to 17.8 percent for yield which is low to medium unstable in period II. The instability of Telangana for the area (22.8) and production (29.2) was found to be medium unstable and yield (9.7) has shown low instability.

In period III the high instability index for the area registered in Adilabad (40.0) followed by Karimnagar, Nalgonda and Nizamabad while production is highly unstable in Adilabad (49.6), followed by Mahbubnagar (43.0), Nizamabad (39.9) and Karimnagar (38.4) respectively. Yield has shown low instability in Karimnagar and Nalgonda (6.0). The area has shown medium to high instability (21.6 to 40.0%), production showed a similar pattern of medium to highly unstable (28.9 to 49.6%) and yield varies from 6.0 to 11.8% which is less unstable. The instability of Telangana for the area, production, and yield are 29.1, 36.3, and 7.2 respectively.

Table 4. Coppocks Instability Index for the area, production, and yield of rice.

District	Particular	Period I	Period II	Period III	Overall period
Adilabad	Area	45.86	47.63	54.96	51.26
	Production	60.08	53.85	60.23	65.69
	Yield	51.79	45.20	45.89	52.38
Karimnagar	Area	47.77	56.05	53.46	57.75
	Production	49.97	62.45	56.14	65.18
	Yield	42.09	41.51	39.28	42.83
Khammam	Area	42.20	46.90	46.50	45.20
	Production	44.92	52.29	48.43	50.24
	Yield	40.45	43.55	41.26	43.77
Mahabubnagar	Area	50.16	46.10	48.90	51.66
	Production	56.16	49.86	53.67	60.17
	Yield	43.01	41.00	41.12	44.00
Medak	Area	44.14	45.56	47.99	46.39
	Production	47.75	51.01	50.42	55.44
	Yield	42.08	42.53	40.81	47.16
Nalgonda	Area	43.35	53.10	53.17	53.17
	Production	44.58	57.67	55.30	57.55
	Yield	39.09	41.08	39.32	40.89
Nizamabad	Area	44.58	50.18	54.05	54.93
	Production	50.46	58.55	60.53	68.99
	Yield	42.06	46.59	41.75	48.10
Rangareddy	Area	44.91	45.78	47.96	46.81
	Production	45.20	47.79	51.51	48.68
	Yield	38.65	40.87	41.33	41.34
Warangal	Area	50.79	46.21	49.25	53.20
	Production	52.90	50.37	51.54	60.96
	Yield	43.75	41.07	40.45	44.41
Telangana	Area	44.66	46.31	49.17	49.64
	Production	46.56	50.86	52.33	56.48
	Yield	39.40	41.45	39.68	42.87

During the overall period, high instability for the area (36.8) and production (54.7) was found in the Adilabad district. The instability for area varies from 20.4 to 36.8%, for production varies from 29.5 to 54.7% and for yield varies 7.1 to 19.6%. Telangana registered higher, medium, and low instability for production (35.1), area (26.4), and yield (7.6) respectively.

Coppock's Instability Index

The results of Coppock's instability analysis of the area, production, and yield of rice are presented in Table 4 and are discussed period wise including the overall

period. The instability analysis revealed that in the period I higher instability for the area was observed in Warangal (50.79) whereas production and yield were highly instable in the Adilabad district (60.08 and 51.79 respectively). The lowest Instability was shown in Khammam district for the area (42.20), whereas for production low instability was found in Nalgonda (44.58) followed by Khammam (44.92) and for yield, the district observed was Rangareddy (38.65). In period II, the Karimnagar district showed the highest instability for the area (56.05) and production (62.45) respectively. Highest instability for yield was registered in the Nizamabad district (46.59). Low instability for the area was registered in Khammam district (45.56) followed by Rangareddy (45.78). Similarly, the Rangareddy district recorded low instability in production (4.79) and yield (40.87) respectively.

In period III Adilabad district registered a high level of instability for area and yield (54.96 &45.89 respectively) followed by Nizamabad (54.05 & 41.75 respectively) whereas high instability for production was found in Nizamabad district followed by Adilabad. A low level of instability was recorded by Khammam district for the area (46.50), production (48,.43) and for yield low instability registered in Karimnagar (39.28) followed by Nalgonda (39.32).

In the overall period, Karimnagar has shown higher instability for the area component (57.75). In the case of production and yield components, the highest instability was found in Nizamabad (68.99) and Adilabad (52.38) respectively. The low level of instability registered in Khammam, Rangareddy and Nalgonda for the area (45.20), production (48.68), and yield (40.89) respectively.

The instability analysis for the Telangana state revealed that the production component was highly instable for all study periods followed by the area component. The yield component has shown high instability in the overall period compared to other

Table 5. Decomposition analysis in area, production, and yield of rice in Telangana (1990-91 to 2019-2020).

District	Particular	Period I	Period II	Period III	Overall period
Adilabad	Area effect	-4.2	257.1	71.2	30.3
	yield effect	106.5	-204.9	16.1	31.5
	Interaction effect	-2.3	47.8	12.7	38.2
Karimnagar	Area effect	-28.8	47.9	81.0	51.6
	yield effect	137.5	46.6	12.4	19.5
	Interaction effect	-8.7	5.5	6.6	28.9
Khammam	Area effect	30.2	33.0	30.9	26.6
	yield effect	67.0	60.2	63.5	58.3
	Interaction effect	2.8	6.9	5.5	15.1
Mahabubnagar	Area effect	40.8	38.1	61.0	53.1
	yield effect	63.8	56.2	31.4	26.4
	interaction effect	-4.6	5.8	7.6	20.5
Medak	Area effect	-274.7	-21.7	131.3	-10.2
	yield effect	415.6	125.3	-41.4	118.9
	interaction effect	-40.9	-3.6	10.1	-8.7
Nalgonda	Area effect	101.7	66.8	84.8	66.2
	yield effect	-1.8	21.5	8.7	16.0
	interaction effect	0.2	11.7	6.5	17.8
Nizamabad	Area effect	-15.2	-3.9	83.0	42.3
	yield effect	116.7	105.6	12.1	24.6
	interaction effect	-1.5	-1.7	4.9	33.2
Rangareddy	Area effect	94.5	128.0	36.6	2.5
	yield effect	6.3	-38.4	54.1	96.5
	interaction effect	-0.8	10.4	9.3	0.9
Warangal	Area effect	9.7	6.2	77.3	54.0
	yield effect	89.2	93.4	16.5	20.5
	interaction effect	1.2	0.4	6.2	25.5
Telangana	Area effect	-79.8	34.1	71.0	46.1
	yield effect	188.2	59.7	21.2	28.5
	interaction effect	-8.5	6.3	7.8	25.4

periods. The Instability indices revealed that the degree of instability for area and production was higher during period III (49.17 and 52.33 respectively) in comparison to period I (44.66 and 46.56 respectively) and II (46.31 and 50.86 respectively). In the overall period production registered the highest instability (56.48) followed by area and yield with instability indices of 49.64 and 42.87 respectively.

Decomposition analysis

Decomposition analysis is used to study the contribution of area, yield, and their interaction effects on the variability of production. The source of production growth was decomposed into three effects *i.e.*, area, yield, and interaction effect. Examining Table 5, results revealed that in the period I yield effect was found to be a positive and major contributor to production of rice in almost all districts except for Nalgonda which has a negative yield effect (-1.8) and Rangareddy though showed positive yield effect (6.3) area is the major contributor of production of rice in both the districts. It is evident from the study that during period-I area effect contributing to the increase in rice production is highest in Nalgonda (101.7 percent) followed by Rangareddy (94.5percent), whereas the change in production due to yield effect was recorded highest in Medak (415.6 percent) followed by Karimnagar (137.5 percent). The contribution of interaction effect was observed highest in Adilabad (44 percent) followed by Nizamabad (33 percent). In contrast to the high positive yield effect, Medak has shown a high negative area effect (-274.7 percent) on the production of rice.

In period II area effect was found to be positive in almost all districts except for Medak which is negative whereas interestingly yield effect was found to be positive and a major contributor to the production of rice in the Medak district (125.3). The contribution of area (257.1) to the production of rice was found high in the Adilabad district, in contrast, the yield effect was found to be negative(-204.9). The interaction and yield effect were also found positive in almost all districts.

It is evident from table 5 that in period III, the area, yield and interaction effect was found to be positive in all districts except the Medak which has a negative yield effect. The area effect was more responsible for production in period III in most of the districts and was shown a higher area effect (131) by the Medak district. The yield was a major source of production in Khammam (63.5) in comparison to other districts.

In the overall period area, yield and interaction effect were found to be positive as observed in period III except Medak in which yield (118.9) was a positive and high profound contributor to the production but area (-10.2) and interaction effect (-8.7) were found to be the negative source of production of rice. The area effect was found high in the Nalgonda district (66.2). In this study period, the yield was the main source of production.

Examining the results of area, yield and their relative contribution to production in Telangana it was found that in the overall period, the area effect of Telangana was highly responsible for the production variability *i.e.*, 46.1 percent, and the yield and interaction effect accounts for 28.5 percent and 25.4 percent production variability, respectively. Study shows that in Telangana during the period I and II the yield effect (188.2 and 59.7 respectively) was the major source of rice production while interestingly the area effect (71.0) was dominating for rice production during period III than the yield effect.

CONCLUSION

The study revealed that the growth rates for Telangana in the overall period were positive for the area, production, and yield (2.1%, 3.7%, and 1.5% respectively). The Cuddy Della Valle Index for the overall period registered higher, medium, and low instability for production (35.1), area (26.4), and yield (7.6) respectively. Coppock's Instability indices revealed that the degree of instability for area and production was higher during period III in comparison to the periods I and II. One of the major reasons for this could be the increased area under rice in period III, because of the assured irrigation due to completion of many major and minor irrigation projects and revival of tanks under Mission Kakatiya in Telangana. Also, annual rainfall has significantly exceeded normal levels in the last two years and has recorded rainfall of 1033 mm in 2019-20 and 1078 mm in 2020-21. This, combined with the government's investment in irrigation infrastructure, has driven increased agricultural output. (Socio-economic outlook 2021, DES, Govt. of Telangana). The

decomposition analysis for overall period (1990-91 to 2019-20) revealed that the area effect was highly responsible for the production variability (46.1 percent) in Telangana. The area effect in enhancing the rice production increased over a period of time. Since the scope to increase the area under rice cultivation is limited, the focus should be on the improvement of the yield to meet the future demand for rice.

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