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Trend and Instability Index Analysis in Paddy Crop Area, Productivity and Production across District in Andhra Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Paddy is the important, food grain, cereal crop, and staple food crop of India. India ranks second in production of paddy after China. This establishes the pressing need for the study of vulnerability and trend of paddy cultivation and productivity in India. Andhra Pradesh being one of the largest producers of paddy, the compound growth rate and instability in area, productivity and production of paddy in Andhra Pradesh was assessed after the remainder of the state of undivided Andhra Pradesh after bifurcation in 2014 with the jurisdiction of four Rayalaseema and nine Coastal Andhra districts. In this study, we have analyzed the trend & carried out instability index analysis in paddy crop area, productivity and production across district of Andhra Pradesh to explicate the trend in extent paddy cultivation and paddy productivity, district wise Cuddy-Della Valle-Instability Index (%) for the paddy cultivating area from 1991-92 to 2018-19, using the data collected from Directorate of

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Economics and Statistics, Andhra Pradesh. We assessed district wise Cuddy-Della Valle-Instability Index (%) in paddy productivity from 1991-92 to 2018-19 and found that in Andhra Pradesh, the area of paddy cultivation, paddy productivity output has changed in the study area over the time. Between 1991-92 and 2018-19, the overall paddy growth rate of the area showed a decline of 0.5%. And growth rate of paddy productivity was 1.31% while the increase of production was 0.74%, which can be attributed to the negative impacts arising out of changing weather patterns.

Keywords: Instability index; paddy cultivation; paddy productivity; growth rate; weather.

1. INTRODUCTION

Paddy is a crop cultivated primarily under irrigation that requires plenty of water. Due to climate change, the effects of severe occurrences of emergencies such as floods, droughts, floods and hailstorm all exacerbated and are threatening national and global food security. World projected rice acreage would be around 163.1 million hectares with productivity 3.48t/ha to reach 567.3 million metric tonnes by 2030 [1]. In India, rice was cultivated on 44 million ha and total production of rice close to 96 million tonnes [2]. India requires at least 130 million tonnes of rice to satisfy the increasing food demand by 2030 [3]. Millions of people derive livelihoods and jobs from labor intensive paddy farming. Technologies of the Green Revolution improved production across the world. Increase in the production from the irrigated cultivation can be attributed to increased use of fertilizer and plant protection chemicals. The demand of land for the urbanization and industrialization affected in stopping of expansion of paddy cultivation area [4]. India is the world's second largest in area but rice productivity in country is about 3.6t/ha which is below world average 4.5t/ha. In rice productivity, Andhra Pradesh is third in the country. The Uttar Pradesh (13.12%) and the Haryana area was the largest proportion in 2018-19 and the smallest proportion (3.30%). West Bengal had the biggest share of production in 2018–19 (13.9%), while Madhya Pradesh was the lowest share (4.50%) [5]. Recent rice production estimates indicate a lower productivity in Andhra Pradesh (3,733 kg/ha) than several rice-producing states such as Punjab (4,132 kg/ha), Tamil Nadu (3,748 kg/ha). Even though India has achieved tremendous growth from 37.70% in 1950 to 60.13% in 2015, about 90% in the area under irrigation proportion of rice produced in India is consumed domestically [6]. Having high in carbohydrates content paddy meets the nutritional needs by 30% in calories [7]. The burgeoning population in Andhra Pradesh is the main cause of ever greater rice consumption. In Andhra Pradesh, we examine the paddy area, production and productivity trends. In the five agro-climate zones of North coastal zone, Godavari zone, Krishna zone, Southern zone and Scarce rainfall zone, Andhra Pradesh, the growth rates were explained for two time periods.

The inevitable expansion of industrialized urban complex, unabated population explosion, need for food security and vulnerability through the changing weather necessitates for investigating the trend, vulnerability and instability in the paddy cultivation. This study is an attempt to analyze the trend, vulnerability and instability in the paddy cultivation and to the extent of cultivated area so as to assist target suitable strategies to improve rice production and productivity in the selected study area of Andhra Pradesh state.

2. LITERATURE REVIEW

[8] The research was carried out to investigate growth trends, patterns and degree of instability in rice crop areas, production and productivity in the state of Andhra Pradesh, in the period between 1959-60 and 2013-14 over a period of five-and-a-half decades. In calculating the yearly growth rate and instability, the compound growth rate and the coefficient of variation were used. Rice area, production and productivity rose respectively by 25, 201 and 138% in this period. During this period, the districts were classified and divided according to average rice productivity into various groups. Many districts changed from extremely low productivity to high productivity throughout the research period. 17 districts had a very low productivity (<1 500 kg/ha) during the 1960s and 13 districts have great productivity (> 3000 kg/ha), respectively, during the 2010s. The contribution from various productivity groups in Andhra Pradesh to state paddy productivity was estimated in the period 2014-19 and found that 52 percent of production had been provided by 3 high productivity group districts (> 6.000 kg/ha). The yearly rates for area, production and productivity growth in 2010s are 4.08, 4.02 and 1.21. Over the last five and a

half decades, growth rates in production and productivity are higher than growth in the area. Originally researched Production and area of instability were higher than productivity. The rate of yearly growth and production and area instability is higher in 2010. In 2010 Adequate crop planning must be started, sustainable practices must be strengthened so that growth may remain and instability is reduced in areas and production.

[9] The research evaluated the results of Haryana and India rice production over 47 years). The quantitative analysis uses only secondary data to estimate linear and exponential functions. The research shows favorable developments for Haryana and India in the area, output and rice yields. At state and national level, the output of rice was primarily boosted because of an expansion in the area. On triennial basis, similar findings are found. In Haryana, rice crop output and yield throughout the whole research term and for five sub-periods except P-V yields have showed positive growth rates. The general trend in rice crop production in India has been comparable to that in Haryana; rates of growth have been positively achieved throughout the study and five sub periods, while negative rates of rice crop growth have been seen in P-IV and P-V rates.

[10] Andhra Pradesh State, widely known as "India's rice bowl," has enormous agricultural potential. While the bulk of the people (62%) rely on agricultural operations for their livelihood, it accounts for only 27,84% of the national Gross Domestic Product and grows at 6,2%. (2018-2019). the face of its agricultural growth continues to affect Andhra Pradesh substantially. The research seeks to establish growth and instability using time series data from rice in the paddy area, production and productivity. The research shows that in Andhra Pradesh year after year, the paddy acreage, output and yield are declining. The study of instability reveals clearly that the area, the production and the yield of paddy are quite unstable.

[11] Rice is Keralites' basic meal. Kerala's climate is suitable for growth of wetland paddy. However, throughout the years the paddy land of Kerala has fallen. This decadal decline was somewhat changed by the Kerala Conservation Act of 2008 on paddy and wetlands. In this research, the Bai-Perron test showed that the area, production and productivity structural ruptures may be linked to the conservation act in 2007-08 and 2009-10. The yearly compound rate of increase was detected as negative for area and output. The area growth decreased before and after the break, although after the break (-2.52 percent) the rate declined lower than the pre-break period (-4.40 percent). As for output, thus over the whole time, productivity has shown a positive growth rate. Production instability was significant after the interruption date, but the region instability remained almost same both before and after the interruptions. For predicting, an exponential model of growth was used. There was a decreasing tendency in the projected area and output by 2030. The findings predicted for the region indicated that in another 12 years there would be a decrease of about 36.444 hectares. The output will also fall to 3,70,795 tonnes.

[12] In the form of a decrease in the Gross State Domestic Production share, and marketing of agriculture, agriculture in Kerala has experienced major structural changes. Over a period of time, the gross area grown and the net area planted in the state have fallen. The changes in land use patterns as a large conversion of paddy fields to cash crops and to non-agricultural uses have resulted in Kerala's food insecurity. They also have caused numerous difficulties in the state on the social, the environment and the environment. The main competitor crops of paddy, coconut and rubber, have been occupying the paddy land for a lion share over a period. In Kerala, the area of paddy production and its growth rate has declined steadily, with the greatest negative growth in the 1990s. There would have been a much greater decrease in paddy output without a positive return change. In the Kollam District and in the lowest Palakkad district over the period 1980-81 through 2011-12 the greatest negative growth rate is observed in the area under paddy. Kollam district and Alappuzha district have the lowest negative growth rates in paddy output. In all districts, however, the overall paddy production growth rates are favorable. The impact on paddy output in all districts is negative while the effect on yield is positive. Despite the greatest negative impact on the region of Kottayam and its interaction effect, there has been an enhanced paddy output due to its highest yield effect. The research finds that the lack of an efficient land use strategy has caused to food insecurity in Kerala, and the rapid loss of farming and agriculture.

[13] In India, stable agricultural growth has been a cause for worry. To understand rice production instability in India, the article examines the 41-year (1970-71 to 2011-12), area, production, and

yield statistics under paddy. The study revealed that the yearly growth rate of the area, production and yield of rice at all levels of India was positive but was progressively decreasing over the periods. Throughout the last decade (2000-01 to 2011-12), rice area, production and production instability has increased in all of India. The potential causes for an increase in instability were low irrigated area percentage of the crop area, declining seed and manure usage, and other agricultural inputs. In the period after the reform (1990-91 to 2016-17) the instability rose with wholesale paddy prices across different states, while the price of farm paddy decreased with instability.

[14] This research investigated district-level patterns in Indian agriculture for development and instability and found unique characteristics and driver of productivity increase in districts. The productivity of the agricultural sector in both the nation as a whole and within a state has been very variable between districts. Different crop industry performance has highlighted the necessity for regional differentiation strategies to ensure sustained, inclusive agricultural development in a state and thus in the nation. The productivity instability persists and the volatility in the various areas varies widely. A major support to stabilizing measures such as insurance should be sought aggressively to minimize the effects of persistent instability. The district level data analysis showed that contemporary inputs have a vital role to play in increasing agricultural sector production. The most significant input was the usage of fertilizers. As the other important drivers of agricultural production, alongside fertilizer uses, precipitation, irrigation, irrigation supply, improved human resources and road connection have emerged. These findings show that it is important to utilize contemporary inputs and carefully manage rainfed water, especially in areas with poor production.

3. MATERIALS AND METHODS

3.1 Data

The study pertains to paddy growing district and the state. 27 year's time series data have been collected from Andhra Pradesh, Directorate of Economics and Statistics (https://des.ap.gov.in). Area, Productivity and Production of paddy at district-level statistics from agricultural year 1991-92 to 2018-19. The data are divided into period-I, 1991-92 to 2004-05, period-II, 2005-06 to 2018-19. Therefore, there are two groups. The objective of this study is to determine the Compound Annual Growth Rate (CAGR) and the Cuddy-Della Valle index in Andhra Pradesh state, area, productivity and production.

The Compound Annual growth rate (CAGR) compound was determined using the following time series in area, productivity and production data in accordance with the following equation.

$$\ln Y = a + bt \quad (1)$$

Where, Y defines the time series data of area, productivity and production of Paddy,

't' is the trend term
'a' is the constant coefficient.
'b' is the slope coefficient,

Which assesses relative change in Y in the value of explanatory variable 't' to provide absolute change.

The growth rate for a compound is determined using the:

$$CGR = [\text{antilog } b - 1] * 100 \quad (2)$$

Equation (1) was calculated using the technique Ordinary Least Square (OLS). The t-test was used to assess the significance of 'b.' this equation assumes that a change in agricultural production would rely on the previous year's output.

If yt denotes the observation (e.g., agricultural production, productivity, or area) at time t and r is the compound growth rate, model employed for estimating r is based on Eq. (1):

$$yt = y0 (1 + r) t \quad (1)$$

The usual practice is to assume a multiplicative error-term exp (e) in Eq. (1) so that the model may be linearized by means of logarithmic transformation, giving Eq. (2):

$$\ln (yt) = A + Bt + e \quad (2)$$

where, A = ln (y0), and B = ln (1 + r). Eq. (2) is then fitted to data using "method of least squares" and goodness of fit is assessed by the coefficient of determination R^2.

Finally, the compound growth rate is estimated by Eq. (3):

$$r^{\wedge} = \exp(B^{\wedge}) - 1 \quad (3)$$

3.2 Cuddy-Della Valle Index (Instability Index)

The Cuddy Della Valle Index and the Variation Official are divided by average by two techniques, which are used for measurement of variability in the instability of data analytical time series. For this research, the Cuddy-Della Valle Index offers similar results for the area instability, productivity and crop paddy production predicted.

Cuddy-Della Valle Index (Ix) was calculated as follows:

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

R^2 is the corrected coefficient of determination of the log linear trend function that fits the time series. If the F-test is significant at 5 per cent level of significance, then the Index is calculated by using R^2. When test statistics is not significant or R2 < 0 (the value of R2 is lies between 0 to 1; in the above log-log function, R^2 cannot be negative), then CV is chosen to measure instability index.

4. RESULTS AND DISCUSSION

4.1 Trend in Area, Productivity and Production

4.1.1 Trend in Paddy Area

A study of interest to assess zonal differences, in the paddy productivity and production in the Andhra Pradesh, area of five agro-climate regions in the Northern coastal zone, Godavari zone, Krishna zone, Southern zone and Scarce rainfall zone areas was conducted to achieve an effective planning of regions, productivity and production with an understanding of zonal differences and productive areas. Zonal changes arise in the Table 1 area.

Andhra Pradesh has seen a little decline in the paddy area. Paddy area dropped from 24.8 lakhs hectares during period I (1991–92 to 2004–05) to 24.00 lakhs hectares during period II (2005-06 to 2018-19). The Compound Annual growth rate (CAGR) was just –0.567%. There are zonal differences in the area under paddy throughout Andhra Pradesh. Vizianagaram and Visakhapatnam have shown negative growth in the North coastal zone, except for Srikakulam, with low growth rates. In Vizianagaram and Visakhapatnam district showed a negative growth rate of 0.12 and 0.065 percent. Principally due to water deficiencies, lack of labor, insufficient irrigation tanks and decreased tank area irrigation, etc.

The area was somewhat decreased in the Godavari region of the two districts, East and West Godavari and the growth rate was negative. Paddy area dropped significantly from 3.87 and 4.32 lakhs hectares in period I (1991-92 to 2004-05), to 3.85, and 4.12 lakhs hectares in period II in the East Godavari and West Godavari (2005-06 to 2018-19).

With respect to Krishna zone, Krishna and Guntur in the area under paddy cultivation have decreased somewhat whereas in the other district like Prakasam the area of rice has suffered significant losses.
The Nellore area has clearly witnessed strong development in area whereas negative growth has seen in the Chittoor and Kadapa districts. In the paddy zone Nellore displays considerable growth. The area of paddy in Nellore, for instance, has risen from 2.0 lakhs hectares to 2.3 lakhs hectares in period I (1991-92 to 2004-05) to period II (2005-06 to 2018-19).

It is clear, in Kurnool district in the scarce rainfall region were growing significantly. The area under paddy in Kurnool has significantly increased where as negative growth has seen in Anantapur. For instance, the paddy area in Kurnool was increased from 7.0 lakhs hectares to 9.1 lakhs hectares during periods I (1991-92 to 2004-05) in period II (2005-06 to 2018-19).

4.1.2 Trend in Paddy productivity

The productivity level rose from 4,236 kg/ha to 4,997 kg/ha in Period I (1991-92 to 2004-05) in Period II (2005-06 to 2018-19). (The report's Table 2). While productivity increases continuously not just in the state but throughout the district, significant variations occur across districts. High productivity districts are Nellore (5184 kg/ha) West Godavari (5181 kg/ha) East Godavari (4,993 kg/ha), Guntur (4,963 kg/ha), Krishna (4,867 kg/ha) and Prakasam (4,829 kg/ha). Nellore has the greatest productivity among member states, followed by West Godavari (5181 kg/ha) and East Godavari (4993 kg/ha) with a productivity output of 5184 kg/ha. In Andhra Pradesh, an annual paddy return was reported by CAGR of 1.31% between 1991–92 and 2018–19. While the paddy growth rate in Indian agriculture was good, the pattern of development varied significantly across areas.

Table 1. Trend in Paddy area across districts in Andhra Pradesh (ha)

District	Period-I 1991-92 to 2004-05	Period- II 2005-06 to 2018-19	Overall Period 1991-92 to 2018-19
North Coastal Zone			
Srikakulam	194029	202254	198142
	-1.17	1.26	0.23
Vizianagaram	124883	122321	123602
	-1.042	0.895	-0.12
Visakhapatnam	102474	101981	102228
	-1.894	1.418	-0.065
Godavari Zone			
East Godavari	387863	385506	386684
	-0.18	-0.016	-0.056
West Godavari	432617	412174	422396
	-0.635	-0.733	-0.428
Krishna Zone			
Krishna	357167	308556	332861
	-3.401	-3.325	-1.613
Guntur	287237	270583	278910
	-2.229	-4.116	-1.203
Prakasam	123496	101912	112704
	-4.916	-8.685	-3.052
Southern Zone			
Nellore	209015	238188	223601
	-1.556	-1.131	0.346
Chittoor	84344	56164	70254
	-5.747	-0.976	-2.868
Kadapa	59728	54402	57065
	-2.12	-2.416	-1.03
Scarce rainfall zone			
Anantapur	50485	39412	44949
	-1.656	-4.222	-2.04
Kurnool	76029	106995	91512
	-1.043	-1.017	1.625
Andhra Pradesh	2489365	2400449	2444907
	-1.685	-1.415	-0.567

The district analysis shows that all districts had a positive annual CAGR over a period of 27 years. The positive rise in yield in most districts so offset the losses in paddy output during the last years, as paddy acreage shrinks. The main yield effect may be attributed to high technology, current varieties, fertilizer application and agro climatic variables. Increasing the yearly composite paddy growth for Nellore, for example, is mainly attributable to the increased usage of technology such as high yield semi dwarf's crop and crop production after three crop seasons and seasonal planning and low productivity (2386 kg/ha) in Visakhapatnam district. The productivity of paddy in Chittoor grew positively by 2.22% a year. In Andhra Pradesh, positive yields are helping to at least maintain paddy production.

4.1.3 Trend in Paddy production

In Andhra Pradesh, paddy output has improved significantly over the years. Total paddy output in Andhra Pradesh rose from 105.0 lakhs tonnes in Phase I (1991-92 to 2004-05) to 112.19 lakhs tones in Period II (2005-06 to 2018-19). The Green Revolution and wider use of technology such as new paddy, fertilizer and production facilities have led to a 13.5 % shift in paddy output. The growth rate of paddy output in Andhra Pradesh was 0.74% per year (Table 3).

It is demonstrated that there are various implications on overall output for the behavior and production situation in all paddy producing areas in the state. The output of paddy across

Andhra Pradesh has risen considerably. In Krishna and the Southern regions (2005-06 to 2018-19), there has been a slight decrease compared with the previous period in the Andhra Pradesh output in Krishna, Guntur and Prakasam during the second period. There have also begun to be good paddy growth and significant increases in paddy production in the other areas, including the North Coastal, Godavari, the Southern (Nellore) and scarce rainfall (Kurnool). The increase in paddy output in the restricted rainfall area was substantial and beneficial for Kurnool. However, it was mainly due to the substantial prediction of the fall of 1.24% in the growth rate. Rice output has also grown substantially in the countries of eastern and northern India. In period II in East Godavari, Nellore, Kurnool has shown continuous increase in output from 17.6, 9.15 and 3.13 lakhs tonnes I (1991-92 to 2004-05) to 20.87, 14.25 and 5.63 lakhs tonnes (2005-06 to 2018-19). But Nellore's unprecedented 14.25 tonnes lakhs increase is the most interesting.

4.1.4 Instability in Paddy area, productivity and production

The fourth biggest paddy grower is Andhra Pradesh. The paddy area, productivity and production variations have been observed such that instability is captured in the paddy area, productivity and production and the outcome is Table 4. In comparing the area district instability indices, for I and II period, the Kurnool indices (21.9,17.7), Kadapa (22.9, 19.2), Visakhapatnam (13.1,10.5) and Vizianagaram (8.9,6.8), respectively. While there is greater instability throughout the period in Prakasam, Guntur, Nellore, Chittoor.

Table 2. Trend in Paddy productivity across districts in Andhra Pradesh (kg/ha)

District	Period-I 1991-92 to 2004-05	Period-II 2005-06 to 2018-19	Overall Period 1991-92 to 2018-19
North Coastal Zone			
Srikakulam	3069	3275	3172
	-0.456	1.146	0.269
Vizianagaram	2958	3765	3361
	-1.092	2.608	1.491
Visakhapatnam	2145	2627	2386
	0.504	1.7	1.392
Godavari Zone			
East Godavari	4568	5419	4993
	3.514	2.051	1.637
West Godavari	4889	5473	5181
	2.826	1.996	1.22
Krishna Zone			
Krishna	4484	5249	4867
	0.657	1.986	1.161
Guntur	4703	5223	4963
	0.906	2.07	0.899
Prakasam	4214	5443	4829
	1.424	0.617	1.682
Southern Zone			
Nellore	4380	5988	5184
	1.556	1.591	2.104
Chittoor	3502	4933	4218
	0.476	2.458	2.227
Kadapa	3897	4133	4015
	-0.887	2.51	0.481
Scarce rainfall zone			
Anantapur	3660	4095	3877
	2.087	-0.707	0.808
Kurnool	4063	5268	4665
	1.231	0.963	1.707
Andhra Pradesh	4236	4997	4617
	1.727	1.673	1.31

Table 3. Trend in Paddy production across districts in Andhra Pradesh (lakhs tonnes)

District	Period-I 1991-92 to 2004-05	Period-II 2005-06 to 2018-19	Overall Period 1991-92 to 2018-19
North Coastal Zone			
Srikakulam	5.982	6.634	6.308
	-1.62	2.421	0.504
Vizianagaram	3.726	4.646	4.186
	-2.123	3.526	1.369
Visakhapatnam	2.227	2.711	2.469
	-1.4	3.142	1.327
Godavari Zone			
East Godavari	17.694	20.87	19.282
	3.33	2.033	1.581
West Godavari	21.093	22.494	21.793
	2.173	1.248	0.785
Krishna Zone			
Krishna	16.067	16.036	16.051
	-2.766	-1.404	-0.471
Guntur	13.537	13.954	13.746
	-1.343	-2.131	-0.315
Prakasam	5.253	5.503	5.378
	-3.563	-8.122	-1.422
Southern Zone			
Nellore	9.155	14.254	11.704
	-0.025	0.441	2.458
Chittoor	2.979	2.773	2.876
	-5.298	1.458	-0.704
Kadapa	2.341	2.204	2.272
	-2.989	0.032	-0.554
Scarce rainfall zone			
Anantapur	1.87	1.619	1.745
	0.397	-4.898	-1.248
Kurnool	3.132	5.638	4.385
	0.175	-0.064	3.36
Andhra Pradesh	105.055	119.336	112.196
	0.013	0.234	0.736

In terms of the productivity, the instability rate for paddy-makers in the district of Chittoor (13.1, 4.7), Nellore (8.8, 4.0), Kurnool (12 and 7.9), Anantapur (11.9, 8.2), Visakhapatnam (20.3, 16.7), Vizianagaram (17.1, 14.0) continuously decrease and the level of stability improvement during the periods of I and II in seven districts, such as Prakasam (13.1 and 4.7). While it exhibits greater instability over period, Srikakulam, Guntur, East Godavari, Kadapa, West Godavari and Krishna. In view of the aspects of production the instability has declined in all the periods which implies for states such as Anantapur (35.4, 22.2), Kurnool (31.6.18.9), Kadapa (26.9,19.8), Visakhapatnam (28.7, 21.8), Vizianagaram (31.7 17.8), Krishna (18.4 and 15.7), Prakasam (29.6, 27.7). Other than Srikakulam, Guntur, East Godavari ad Nellore, the stability of which declined throughout the period.

The area instability percent index in Andhra Pradesh (9.01, 6.36), productivity (4.5, 6.5) and production (11.0, 7.3) have improved P1 in yield to P2 with reduced area instability and production with a little increase in productivity instability [2].

For Andhra Pradesh, throughout the whole period the area (8.98), productivity (5.8) and output (9.5) are more stable and provide moderate levels of instability.

Table 4. Andhra Pradesh district wise cuddy-della valle-instability index (%) in Paddy area 1991-92 to 2018-19

District	Period-I 1991-92 to 2004-05	Period-II 2005-06 to 2018-19	Overall Period 1991-92 to 2018-19
Srikakulam	6.8	6.0	7.9
Vizianagaram	8.9	6.8	8.7
Visakhapatnam	13.1	10.5	13.2
East Godavari	7.9	7.6	7.7
West Godavari	8.4	8.1	8.2
Krishna	12.7	11.8	14.6
Guntur	13.0	17.2	17.3
Prakasam	20.8	27.4	28.0
Nellore	8.2	12.4	13.2
Chittoor	21.1	24.5	25.5
Kadapa	22.9	19.2	21.7
Anantapur	26.8	21.1	25.1
Kurnool	21.9	17.7	23.1
Andhra Pradesh	9.01	6.36	8.98

Table 5. Andhra Pradesh district wise cuddy-della valle-instability index (%) in Paddy productivity 1991-92 to 2018-19

District	Period-I 1991-92 to 2004-05	Period-II 2005-06 to 2018-19	Overall Period 1991-92 to 2018-19
Srikakulam	12.2	24.9	20.1
Vizianagaram	17.1	14.0	17.6
Visakhapatnam	20.3	16.7	16.7
East Godavari	10.3	11.9	12.3
West Godavari	7.8	8.9	9.9
Krishna	8.8	9.3	9.6
Guntur	8.0	11.9	10.9
Prakasam	13.1	4.7	9.6
Nellore	8.8	4.0	7.2
Chittoor	10.9	4.3	10.0
Kadapa	14.1	15.6	16.2
Anantapur	11.9	8.2	11.2
Kurnool	12.7	7.9	10.5
Andhra Pradesh	4.5	6.5	5.8

Table 6. Andhra Pradesh district wise Cuddy-Della Valle-Instability Index (%) in Paddy Production 1991-92 to 2018-19

District	Period-I 1991-92 to 2004-05	Period-II 2005-06 to 2018-19	Overall Period 1991-92 to 2018-19
Srikakulam	16.3	25.9	23.3
Vizianagaram	21.7	17.8	22.5
Visakhapatnam	28.7	21.8	26.2
East godavari	13.1	13.6	14.1
West godavari	11.7	11.4	12.2
Krishna	18.4	15.7	18.3
Guntur	17.8	20.3	19.8
Prakasam	29.6	27.7	34.6
Nellore	14.7	15.1	18.3
Chittoor	28.6	28.1	31.7
Kadapa	26.9	19.8	24.5
Ananthapur	35.4	22.2	32.0
Kurnool	31.6	18.9	28.4
Andhra Pradesh	11.0	7.3	9.5

5. SUMMARY AND CONCLUSION

The performance of area, productivity, and production of paddy in Andhra Pradesh has been studied. In Andhra Pradesh, the area, productivity and paddy output have changed in areas in districts. Between 1991-92 and 2018-19, the overall growth rate of paddy area showed a decline of 0.5%. The growth rate of paddy productivity was 1.31% while the increase of output was 0.74%. Impact on some agricultural returns in the former state of Andhra Pradesh, to avoid negative impacts due to poor weather and available coping mechanisms, the adaptation and mitigating measures must be begun. Modifications in crop patterns, the installation of climatic information systems, land use changes, crops diversification, new tolerant species development, insurance and improved irrigation are amongst many ways of adaptation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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