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A study on growth and instability of Jowar and Green gram in Guntur district of Andhra Pradesh

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Abstract

Guntur district in Andhra Pradesh is a key agricultural area known for its significant crop production. Agricultural growth and instability have been central themes of debate in India's agricultural economics literature as instability is considered an inherent feature of agriculture. This study examines the growth and instability of Jowar and Green gram crops in Guntur district of Andhra Pradesh. The entire study period was divided into two sub periods from 1998 to 2010 and from 2011 to 2023. Through use of SPSS and R software, the study identified the variations in the growth patterns of area and production of Jowar and Green gram and further revealed that instability levels differ across these parameters throughout the study period.

Keywords: Jowar, green gram, growth and instability

Introduction

Agriculture has historically been the cornerstone of India's economy and continues to be a major force in driving the country's socioeconomic development. Even today it provides livelihood opportunities to nearly 45 to 65% of the population and makes a notable contribution to the national GDP though its share has gradually declined with the growing dominance of industry and services.

In Guntur district of Andhra Pradesh, out of a total geographical area of 2.447 lakh hectares about 2,19,548 hectares are under cultivation (Guntur district, A.P). The district's agricultural significance is further highlighted by its diverse crop base particularly the large-scale production of tobacco chilli maize cotton and pulses which firmly establishes its role in shaping India's agricultural profile.

Jowar commonly known as sorghum is an important heat resistant coarse cereal crop in India making it highly suitable for semi-arid and rainfed regions. The crop covers an area of approximately 13 thousand hectares with an annual production of around 82 thousand tonnes and an average yield of 6304 kg per hectare (Directorate of Economics and Statistics, Government of A.P). This highlights its relevance in dryland farming systems and its contribution to sustainable agriculture in the region.

Green gram commonly known as moong dal is a significant pulse crop in India recognised for its nutritional richness particularly in protein and dietary fibre. Green gram is often grown in rotation with crops like paddy or maize contributing to improved soil fertility due to its nitrogen fixing properties. In Guntur district, green gram covers an area of approximately 10 thousand hectares with an annual production of 12 thousand tonnes and a yield of 1236 kg per hectare (Directorate of Economics and Statistics, Government of A. P). This emphasises its importance in sustainable farming and rural livelihood security.

The behaviour of the data series was first explored using descriptive statistics. Further analysis included Simple Annual Growth Rate and Compound Annual Growth Rate to capture yearly and long term growth trends. Instability was also assessed using the Cuddy Della Valle Index ensuring a comprehensive understanding of variability in the dataset. Keeping in view the importance of these selected crops the present study has been undertaken to analyse the area and production of Jowar and Green gram.

Materials and Methods

Data pertaining to production of Jowar and Green gram in Guntur were collected for period of 26 years as during 1998-2023, from secondary sources (Directorate of Economics and Statistics). Descriptive statistics are typically distinguished from inferential statistics, as it is simply described what is or what the data shows. In this present study selected descriptive measures viz., mean, standard deviation, minimum, maximum, skewness, kurtosis, coefficient of variation and Simple Growth rate were used to explain behaviour of each series.

Simple growth rate per month (SGR) had also been calculated by using the following formula, as to determine the growth per year during the study period.

$$SGR(\%) = \frac{X_t - X_0}{X_0 \times n} \times 100$$

where X_t is the value of the series for the last period and X_0 is the value of the series for first period and n is the total number of periods (Vishwajith *et al.* 2014)^[9].

Compound Annual Growth Rates

In the present study, compound annual growth rate (CAGR) was calculated as to determine the growth of major crops in Guntur (Kumareswaran *et al.*, 2022)^[8]. In order to estimate the CAGR, the exponential time trend equation is

$$Y_t = a b^t \rightarrow (1)$$

Where, Y_t = Actual values of major crops in year t
 t = year (which takes value 1, 2 n) and
 'a' (Intercept) and 'b' (Regression Coefficient) are parameters to be estimated.

The above equation (1) is transformed in to Log linear form and it is written as $\log Y_t = \log a + t \log b \rightarrow (2)$

The equation (2) is estimated by ordinary least square technique (OLS) and the Compound growth rate (g) is then calculated as shown below

$$g = (b-1) \times 100$$

Where,

g = estimated compound growth rate in percent per

annum and

b = anti log of b

Instability Index

Instability index is a simple analytical technique to find out the fluctuation or instability in any time series data. To examine the extent of variability in area and production, the Cuddy-Della Valle Index was employed in the study. The simple coefficient of variation (CV) is usually overestimates the level of instability in time-series data, as the data is characterized by long term trends; whereas the Cuddy-Della Valle index corrects the coefficient of variation (Cuddy and Della Valle, 1978). The Cuddy Della Valle index (CDVI) is calculated as follows:

$$\text{Index of Instability} = CDVI = CV \sqrt{1 - \bar{R}^2}$$

Where,

CV = Coefficient of Variation

$\bar{R}^2$ = Adjusted coefficient of determination

The ranges of CDVI (Dudhat *et al.*, 2017)^[5] are given as follows:

- Low instability = between 0 and 15
- Medium instability = greater than 15 and lower than 30
- High instability = greater than 30

In the present study, entire study period was divided in to "Period-I" and "Period-II", as to understand the decadal scenario. Further, selected tools such as Descriptive statistics, simple annual growth rate, compound annual growth rate and instability index were also calculated to Period-I and Period-II, in addition to the entire study period.

1. **Period-I:** 1998-2010
2. **Period-II:** 2011-2023
3. **Total Period:** 1998-2023

Results and Discussion

The univariate data on Area and Production of Jowar in Guntur district for the period 1998-2023 were examined for the existence of outliers using Grubb's test. Table 1 showed that the two periods of the study (Period-I, Period-II), in addition to the entire period from 1998 to 2023.

Table 1: Descriptive statistics, Growth rates and Instability for Area and Production of Jowar in Guntur district of Andhra Pradesh.

Crop	AREA ('000 ha)			Production ('000 tonnes)		
	Period-I	Period-II	Total	Period-I	Period-II	Total
Jowar						
Mean	11.62	7.26	9.53	9.14	7.39	8.30
Standard Deviation	2.07	1.79	2.92	2.18	2.12	2.29
Kurtosis	2.31	3.60	1.75	1.80	3.50	2.07
Skewness	-0.68	0.60	0.04	0.16	1.16	0.51
Minimum	7.57	4.34	4.34	5.96	5.50	5.50
Maximum	14.08	11.36	14.08	12.58	12.38	12.58
SAGR (%)	-1.17	0.55	-1.49	6.37	1.11	1.09
CAGR (%)	-2.40	3.00	-2.90	3.50	0.10	-0.80
CV (%)	17.79	24.67	30.70	23.88	28.64	27.55
CDVI	15.89	22.78	22.20	20.06	28.62	27.08

It was confirmed that there were no significant outliers were detected from Grubb's test in all the three cases of Period-I (1998-2010), Period-II (2011-2023) and Total Period

(1998-2023). Several statistical measures such as descriptive statistics, Simple Annual Growth Rate (SAGR), Compound Annual Growth Rate (CAGR) and Cuddy Della Valle

Instability Index (CDVI) were applied to understand the basic behaviour of the data series. It was identified that the Area under Jowar Production during the entire period had ranged from 4.34 to 14.08 ('000 ha) with an average of 9.53 ('000 ha). It was estimated a compound growth rate (CAGR) of nearly-2.90% per annum and where simple growth rate (SAGR) of nearly-1.49% per annum. Instability index of Cuddy-Della Value Index was observed as 22.20, which indicated the moderate instability over the study period as per Akula *et al.* (2022) ^[1]. Similarly, the mean values of Period-I and Period-II were 11.62 ('000 ha), 7.26 ('000 ha) with CAGR of-2.40%, 3.00% and SAGR of-1.17%, 0.55%per annum respectively. Instability index (CDVI) was recorded as 15.89 and 22.78 for Period-I and Period-II respectively. From the results, it was concluded that Area under Jowar Production during all the periods were moderately stable.

Similarly, descriptive statistics were also calculated for Jowar Production. It was observed that Jowar Production during the entire study period had distributed between 5.50 to 12.58 ('000 tonnes) with an average of 8.30 ('000 tonnes). It had recorded a compound growth rate (CAGR) of-0.80% and simple growth rate (SAGR) of 1.09% per annum. Instability index of Cuddy-Della Valle Index was observed as 27.08, which indicated the moderate instability over the study period as per Kondeti *et al.* (2024) ^[7]. Similarly, the mean values of Period-I and Period-II were 9.14 ('000 tonnes), 7.39 ('000 tonnes) with SAGR of 6.37% and 1.11% per annum respectively. Instability index (CDVI) was reported as 20.06 and 28.62 for Period-I and Period-II respectively. From these results, it was understood that the Jowar Production during all three periods were moderately stable.

Table 2: Descriptive statistics, Growth rates and Instability for Area and Production of Green Gram in Guntur district of Andhra Pradesh.

Crop	Area ('000 ha)			Production ('000 tonnes)		
	Period-I	Period-II	Total	Period-I	Period-II	Total
Greengram						
Mean	3.56	9.44	6.50	1.55	10.22	5.88
Standard Deviation	2.92	2.23	3.93	1.28	4.87	5.63
Sample Variance	8.53	4.97	15.46	1.63	23.72	31.72
Kurtosis	7.35	1.79	1.53	4.26	2.06	1.91
Skewness	2.24	-0.27	0.16	1.57	-0.42	0.67
Minimum	1.35	5.64	1.35	0.45	1.75	0.45
Maximum	12.28	12.41	12.41	4.74	16.80	16.80
SAGR (%)	-3.31	2.50	9.44	-1.67	66.25	54.54
CAGR (%)	-7.90	4.40	6.40	-8.30	13.10	12.50
CV (%)	81.92	23.63	60.46	82.64	47.66	95.74
CDVI	78.80	17.42	42.91	77.51	29.51	53.80

From the Table 2. It was confirmed that there were no significant outliers were detected from Grubb's test in all the three cases of Period-1 (1998-2010), Period-II (2011-2023) and Total Period (1998-2023).

From Table 2. It was also identified that the Area under Green gram Production during the entire period had distributed between 1.35 to 12.41 ('000 ha) with an average of 6.50 ('000 ha). It was estimated a compound growth rate (CAGR) of nearly 6.40% per annum and where simple growth rate (SAGR) of nearly 9.44% per annum. Instability index of Cuddy-Della Value Index was observed as 42.91, which indicated the high instability over the study period as per Dudhat *et al.* (2017) ^[5]. Similarly, the mean values of Period-I and Period-II were 3.56 ('000 ha), 9.44 ('000 ha) with CAGR of-7.90%, 4.40% and SAGR of-3.31%, 2.50%per annum respectively. Instability index (CDVI) was recorded as 78.80 and 17.42 for Period-I and Period-II respectively. From the results, it was concluded that Area under Green gram Production during Period-I was highly unstable than Period-II.

Similarly, descriptive statistics were also calculated for Green gram Production as shown in Table-2. It was observed that Green gram Production during the entire study period had distributed between 0.45 to 16.80 ('000 tonnes) with an average of 5.88 ('000 tonnes). It had recorded a compound growth rate (CAGR) of 12.50% and simple growth rate (SAGR) of 54.54% per annum. Instability index of Cuddy-Della Valle Index was observed as 53.80, which indicated the high instability over the study period as per Ansari *et al.* (2022) ^[2]. Similarly, the mean values of Period-I and Period-II were 1.55 ('000 tonnes), 10.22 ('000 tonnes) with SAGR of-1.67% and 66.25% per annum respectively.

Instability index (CDVI) was reported as 77.51 and 29.51 for Period-I and Period-II respectively. From these results, it was understood that the Green gram Production for Period-I was highly unstable than Period-II.

Conclusions

The study examined the growth and instability of area and production of Jowar and Green gram in Guntur district of Andhra Pradesh during the period from 1998 to 2023 by dividing it into two sub periods. The results reveal clear differences in growth performance and stability between the two crops. Jowar recorded steady growth with moderate instability across both sub periods and the overall period. Lower variability and instability indices indicate that Jowar production remained relatively stable which may be attributed to its adaptability to local agro climatic conditions and suitability to rainfed farming systems. In contrast green gram exhibited higher variability particularly during Period I reflecting greater sensitivity to climatic and market related factors. However a noticeable reduction in instability during Period II suggests improvements in cultivation practices and production management in recent years. Overall the findings highlight the need for crop specific strategies especially for Green gram to reduce instability and enhance sustainable agricultural growth in Guntur district.

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