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Growth, Instability and Supply Response of Cotton in Andhra Pradesh

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ABSTRACT

Agricultural growth, instability and supply response are the essential characteristics and remained key subjects of intense debate in the agricultural development in India. Since agriculture is dependent on various conditions, the area, production and yield of the crops are subject to significant variations over time. As cotton is the major commercial crop growing in Andhra Pradesh, the present study was conducted to analyze the growth, instability and supply response of area, production and yield of cotton crop in the state for the period of 20 years from 2001-02 to 2020-21. A simple regression growth model, the Cuddy Della Valle instability index and Nerlovian's Supply Response model were considered to assess and analyses the growth, instability and supply response of cotton. The study observed that cotton had positive growth rates in area, production and yield. Moderate instability was observed in the growth pattern of area and yield whereas high instability in production of the cotton in Andhra Pradesh. It is also observed that lagged price, lagged yield, irrigation and lagged area may influence positively on the current year area during the study period.

Key words: Instability, Supply response, Cuddy Della Valle Instability Index, Nerlovian's model.

1. Introduction

India is a developing country where agriculture even at the present time is very important as it provides livelihood for the more than fifty percent of total work force. Agriculture is the lifeline of the Indian economy. The contribution of agricultural sector to the GDP has continued to decline over the years than that of other sectors. As largest private enterprise in India, agriculture contributes nearly about 18-19 per cent of the national GDP in 2022. Andhra Pradesh is one of the major producers of cash crops like Groundnut, Castor, Pulses, Sunflower, Oilseeds, Cotton, and Sugarcane which helps the state to earn huge amounts of revenue. Andhra Pradesh is the fourth highest cotton producing state in India, after Maharashtra, Gujarat and Telangana. It is also a part of the 'Cotton Basket of India'. Cotton is particularly a tropical crop and it can be cultivated in both in kharif and rabi seasons. Cotton crop needs temperature of 21°C to 27°C and rainfall ranging between 50 cm to 80 cm. Cotton grows best on irrigated land in hot climate. Black soils are most suitable for

Cotton crop. The Deccan Plateau region of the state which has the ability to retain moisture is most suitable to grow cotton plants.

Cotton is an important fiber crop grown during Kharif season in the State, mainly as un-irrigated crop. During Kharif, the crop is mostly grown in the areas of Kurnool, Guntur, Krishna, Ananthapuramu, and Prakasam districts. These districts constitute 92.36 percent of the total cropped area under cotton crop in Andhra Pradesh. Area under Cotton during the year 2020-21 was 6.06 lakh hectares which is accounted for 8.18 percent of gross cropped area in the State. The area under the crop was 6.06 lakh hectares during 2020-21 as against 6.57 lakh hectares in 2019-20, recording a decrease of 7.76 percent. The production of Cotton in the State was 16.00 lakh bales of 170 Kgs in 2020-21 (lint) as compared to 25.08 lakh bales in 2019-20 recording a decrease of 36.20 percent. The decrease in production is due to decrease in area during 2020-21. The yield rate of Cotton in the State was 449 kgs/hectare during 2020-21 as against 648 kgs/hectare during 2019-20 showing a decrease of 30.71 percent.

2. Review of Literature

Mahendra, et, al. (2020) calculated the growth rates of area, production and productivity of mungbean (green gram) in Nagaur district of Rajasthan and found that the area under mungbean (green gram) in Rajasthan fluctuated during last forty-one years. The results of compound growth rates are indicated that area, production and productivity of mungbean (green gram) positive. **Shivalika Sood, Hari Singh** (2020) study aims to examine the growth performance of pulses in Rajasthan with collected secondary data from various publications of the state. The trend of area, production and yield of major pulses in Rajasthan were calculated through compound growth rate, instability index and decomposition analysis. Growth rate for area, production and productivity of chickpea was found to be significantly positive. **Jain, Ankur.** (2018) conducted a research study on "Agricultural growth with stability" for a period of 41 years (1970-71 to 2011-12) on area, production and yield under paddy to understand the question of instability in rice production in India. His analysis says that at all India level compound annual growth rate of area, production and yield of rice had been decreasing gradually over the periods.

Md Jaber Rana, et, al. (2021) discussed the growth and instability in area, production and productivity of major spices in Bangladesh for the last 58 years from 1961-70 to 2011-18. The researcher used the semi-log regression to analyse the growth and trends of

major spices in Bangladesh. The Prais-Winsten transformation was used to solve the auto-correlation problems. The Cuddy Della instability index was used to perform the instability analysis. Finally the study found that major spices had low growth rate in area and production. **Kundu. K. K and Parveen Kumar Nimbrayan** (2021) made an attempt to estimate the instability of wheat and rapeseed mustard at national level and then have compared it with Haryana state. The overall period divided into four periods in face of reforms separately and also analyzed jointly. The study identified large variations in growth of area than the production in case of wheat, in case of rapeseed mustard, more instability was observed in the pattern of production. **Sunita et al**. (2019) has made an attempt to examine the instability in the area, production and productivity of barley crop in India and Haryana during three phases i.e., pre-green revolution, green revolution and post green revolution period. The results says that in case of area, the instability is more in the post-green revolution than pre-green revolution period as the focus of the green revolution was mainly on other crops like rice and wheat.

Mohammad Ariful Islam (2020) study has considered the time-series data to examine the structural stability and supply response scenario of cereal food production in Bangladesh and applied the *Nerlovian* supply response model. The study result shows that, lagged area for *aus, boro,* and wheat was positive and statistically significant and noticed that the preceding year area under *aus, boro,* and wheat had a significant influence on land allocation for the next year. **Prasada (2018)** study concentrated to know the supply response of paddy in East Java to various price factors and non-price factors. In this study, the supply response was estimated for paddy in East Java with Nerlove partial adjustment error correction model with the secondary data of paddy harvest areas, grain price, corn price, irrigated land area and rainfall from 1991 to 2015. The study observed that in the short run, paddy supply was significant, but in the long run, the irrigation area was very responsive to paddy supply in East Java.

3. Objective of the Study:

To study the Growth, Instability and Supply Response of area, production and yield of Cotton crop in Andhra Pradesh.

4. Source of Data

The study was based on the secondary data collected from statistical publications and various crop reports of Andhra Pradesh. Data on area, production and yield of Cotton crop

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were collected. The required data for the present study was collected for the period of 20 years from 2001-02 to 2020-21.

5. Methodology

For the attainment of the selected objective, analytical tools are discussed in following sub-sections. The study describes the estimation of growth rates of area, production and yield of Cotton, the model used and variables included in the analysis of production instability and the analysis of acreage supply response function.

(i) Growth Model:

To fulfill the objectives of the present study, the following simple Linear Regression Model has been considered to analyze the Growth and Instability of Cotton crop in Andhra Pradesh.

$$Y = a + bt$$

Here:

Y = Area / Production / Yield.

a is intercept of the function and b is the coefficient of independent variable time 't'

t = Independent variable time

The Linear Growth Rate in percent is calculated as,

$$L.G.R = \frac{\hat{b}}{\bar{Y}} * 100$$

$\hat{b}$ is estimated value of 'b' and tested by student 't'-test statistic

$$t = \frac{\hat{\hat{b}}}{S.E\ (\hat{b})}$$

Where,

$$S.E(\hat{b}) = \sqrt{\frac{\varepsilon\ (Y - \bar{Y})^2}{N}}$$

To determine the Instability in area, output and yield of Cotton, the Co-efficient of Variation (CV) was calculated by the formula

$$C.V. = \frac{\sigma}{\bar{Y}} \text{ x } 100$$

Where: σ = Standard Deviation

$\bar{Y}$ = Mean of Area / Production / Yield

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(ii) Cuddy Della Valle Instability Index Model :

The use of Co - efficient of Variation (CV) as a measure to show the Instability in time series data has some limitations. If the time series data exhibit any trend, the variation measured by CV. i.e., the high value of CV measured the instability. To overcome the limitation of CV Cuddy Della Valle (CDV) Index (1978) has introduced the Instability Index for time series data that is characterized by trend.

To test the Instability the following (CDV Index) measure has incorporated for this study.

CDV Index = $\boldsymbol{C.V} * \sqrt{\boldsymbol{1 - R^2}}$

Where, CV is the Coefficient of Variation in percent, and R^2 is the coefficient of determination from time trend regression adjusted by the number of degrees of freedom. The CDV Index value shows, if less than 15 low instability, 15-30 moderate instability and above 30 high instabilities.

(iii) Supply Response Model:

To know the supply responses of the Cotton crop, the present study adopted the Nerlovian partial adjustment adaptive expectation model. Nerlove introduced the element of dynamism by introducing the concept of distributed lags in the analysis of hectarage (Area Supply Response) of the agriculture crops.

$$A_t = b_0 + b_1 P_{t-1} + U_t \quad \ldots\ldots\ldots (1)$$

Where,

A_t = Desired long − run hectareage

P_{t-1} = Lagged farm harvest price

U_t = Error term

b_0, b_1 are constant and price coefficients respectively

The actual area under the crop was adjusted in proportion to the difference between the long-run desired level of area and actual area under the crop.

$$A_t^* - A_{t-1} = \beta(A_t - A_{t-1}),\ o < \beta \leq 1 \ldots \ldots\ldots (2)$$

β is the coefficient of the adjustment which accounts for the forces which causes the differences between the short-run and long-run supply and price elasticities substituting equation (1) in equation (2), then

$$A_t^* = C_0 + C_1 P_{t-1} + C_2 A_{t-1} + U_t \quad \ldots\ldots\ldots (3)$$

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Where,

$C_0 = b_0\beta$, $C_1 = b_1\beta$, $C_2 = (1-\beta)U_t = \beta V_t$

The equation (3) is helpful in the estimation of short-run and long-run price elasticities and they can be obtained by the following relations:

$$SE = C_1 \frac{\overline{P}_{t-1}}{\overline{A}_t} \qquad \ldots\ldots\ldots\ldots\ldots (4)$$

$$LE = \frac{C_1}{1-C_2}\frac{\overline{P}_{t-1}}{\overline{A}_t}$$

Where,

$\overline{P}_{t-1}$ and $\overline{A}_t$ are the means (averages) of P_{t-1} and A_t^* respectively.

Along with the above said model, the study has been considered another model by introducing risk variables. Then the revised model is as follows-:

$$A_t = b_0 + b_1 P_t^* + b_2 Y_{t-1} + b_3 C V_P + b_4 C V_y + b_5 R_t + b_6 I_t + b_7 D + V_t \quad \ldots\ldots (5)$$

Substituting $P_t = P_{t-1}$ in equation (5), then

$$A_t = a_0 + a_1 P_{t-1} + a_2 Y_{t-1} + a_3 C V_P + a_4 C V_v + a_5 R_t + a_6 I_t + a_7 D + V_t$$

$$A_t^* - A_{t-1} = \beta(A_t - A_{t-1}) + Z_t$$

$$A_t^* - A_{t-1} = \beta A_t - \beta A_{t-1} + Z_t$$

$$A_t^* = \beta_t^* - \beta A_{t-1} + Z_t + A_{t-1}$$

$$A_t^* = \beta_t^* - \beta A_{t-1} + A_{t-1} + Z_t$$

$$A_t^* = \beta_t^* A_t + A_{t-1} - \beta A_{t-1} + Z_t$$

$$A_t^* = \beta A_t + A_{t-1}(1-\beta) + Z_t$$

$$A_t = \beta[b_0 + bP_{t-1} + b_2 Y_{t-1} + b_3 C V_P + b_4 C V_y + b_5 R_t + b_6 I_t + b_7 D + V_t] + A_{t-1}(1-\beta) + Z_t$$

$$A_t = b_0\beta + b\beta P_{t-1} + b_2 \beta Y_{t-1} + b_3 \beta C V_p + b\beta C V_y + b_5\beta R_t + b_6\beta I_t + b_7\beta D + A_{t-1}(1-\beta) + \beta V_t + Z_t \quad \ldots\ldots (6)$$

(or) $A_t = C_0 + C_1 P_{t-1} + C_2 Y_{t-1} + C_3 C V_p + C_4 C V_y + C_5 R_t + C_6 I_t + C_7 D + C_8 A_{t-1} + E_t$

Where,

$$C_0 = b\beta;\ C_1 = \beta;\ C_2 = b_2 B\beta;\ C_3 = b_3 B\beta;\ C_4 = b_4\beta;$$

$$C_5 = b_5\beta;\quad C_6 = b_6\beta;\quad C_7 = b_7\beta;\quad C_8 = b_8\beta;\quad E_t = \beta V_t + Z_t$$

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Where,

Variables are denoted as fallows –
A = Actual area planted under Cotton crop (in 1,000 hectares)
t = 't'th period of production
P_{t-1} = Farm harvest price of Cotton (per quintal) lagged by one year.
Y_{t-1} = Yield of Cotton (Kilograms /Hectares) lagged by one year.
$C V_p$ = Co-efficient of variations of the prices of the Cotton c
$C V_y$ = Co-efficient of variation of yields of Cotton
R_t = Rainfall (in millimeters) for the sowing season for the crop concerned.
I_t = Irrigated area under all crops in 1,000 hectares.
D = Dummy variable
E_t = Stochastic disturbance term.
$C_0, C_1, C_2,$ ----------C_7 are the regression co-efficient.

Equation (6) of Nerlove's model was estimated to know the Supply Response (Area Response) of cotton crop during the study in Andhra Pradesh.

6. 0. Results and Discussions:

6.1. Growth trends of Cotton in Coastal Andhra, Rayalaseema and Entire Andhra Pradesh

In this sub-section, growth trends of area, production and yield of Cotton in Coastal Andhra, Rayalaseema and Entire Andhra Pradesh during the time period from 2001-02 to 2020-21 were examined and presented in table 6.1.

Table 6.1 reflects that there are increasing trends in area of Cotton in Coastal Andhra, Rayalaseema regions and entire Andhra Pradesh at the growth rates of 1.76%, 10.05% and 4.89 per cent every year respectively. This value reveals that on average, 23101.13 hectors of area is increasing every year during the study period in Andhra Pradesh as a whole. The trend values of production are also positive in Coastal Andhra, Rayalaseema and Andhra Pradesh and increase by 4.19%, 13.92% and 6.93 per cent every year respectively. It is also observed from the table that the trend values of yield are positive and significant at 0.05 level. The yield is increasing at 14.72 kgs at 3.67 per cent growth rate every year in Andhra Pradesh as a whole.

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Table 6.1: Linear growth regressions of Area, Production and Yield of Cotton

Region	Area	Production	Yield
Coastal Andhra	Y=239807.78 + 51880.89 * t	Y= 526090.43 + 39279.70 * t	Y=394.55 + 5.44 * t
Rayala seema	Y= -9919.31 + 17912.54 * t	Y= -169794.91 + 51199.15 * t	Y= 111.20 + 13.86 * t
Andhra Pradesh	Y=229888.47 + 23101.43* t	Y= 356295.69+90478.83* t	Y= 246.63 + 14.72*t
Linear Growth Rate (LGR)			
Coastal Andhra	1.76	4.19	1.20
Rayala seema	10.05	13.92	5.40
Andhra Pradesh	4.89	6.93	3.67

6.2. Instability in Area, Production and Yield of Cotton in Andhra Pradesh

The instability of area, production and yield of Cotton in Coastal Andhra, Rayalaseema and Entire Andhra Pradesh during the time period from 2001-02 to 2020-21 are shown in the table 6.2. The coefficient of variation (CV), coefficient of determination (R^2) and CDV Index of Instability were calculated to analyse the Instability in area, production and yield of Cotton.

From the table 6.2, as the calculated the calculated Cuddy Della Velle Index for area in Coastal Andhra (18.28) and for entire Andhra Pradesh (22.89), moderate instability is observed. But in Rayalaseema region the high instability is observed as the value of CDV index is 40.69 of Cotton during the study period. The CDV Index is also calculated as 30.00, 56.98 and 32.22 for the production of Cotton which indicates the high instability during the study period in Coastal Andhra, Rayalaseema and Andhra Pradesh respectively. It is also observed the moderate instability in case of yield of Cotton in Coastal Andhra, Rayalaseema and Andhra Pradesh as whole as the calculated values of CDV index reflect 17.02, 24.43 and 17.27.

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Table 6.2: Instability in area, production and yield of Cotton

Region	R^2			CV			CDV Index		
	A	P	Y	A	P	Y	A	P	Y
Coatal Andhra	0.25	0.41	0.15	21.04	38.89	18.45	18.28**	30.00***	17.02**
Rayalaseema	0.69	0.68	0.63	72.05	100.10	40.21	40.69***	56.98***	24.43**
Andhra Pradesh	0.62	0.62	0.61	36.89	52.13	27.73	22.89**	32.22***	17.27**

(A – Area P – Production Y – Yield)

(* Low Instability ** Moderate instability *** High Instability)

6.3. Estimated supply Response Function of Cotton for Equation- 6 (Nerlovian model)

The estimated coefficients and other related statistics of supply response model (Equation: 6) for Cotton crop were depicted in Table 6.3.

From the Table 6.3, it is observed that the estimated R^2 values show the variation of variables lagged price (Pt_{t-1}), lagged yield ($\mathbf{Y}_{t-1}$), coefficient of variation of lagged price (CVp), coefficient of variation of lagged yield (CVy), Current year rain fall (Rt), Current year source of irrigation (It) and lagged area (At-1) on the current year area (At) of Cotton. According to the Nerlove's Supply response model (equation 6), the estimated regression coefficients of the coefficient of variation of lagged price (CV_p : 0.434), lagged area (A_{t-1}: 0.383), current year irrigation (It; 0.742), rain fall (Rt; 0.112) and coefficient of yield variation (CVy: 0.025) were positive, and they influence the current year area (At) of Cotton positively.

The estimated values of lagged price (P_{t-1}; -0.013) and lagged yield ($\mathbf{Y}_{t-1}$: -0.292), were negative and revealed that price and yield may influence the current year area (At) of Cotton negatively in Coastal Andhra region. In Rayalaseema region, the estimated regression coefficients of lagged price (P_{t-1}; 0.626), the coefficient of variation of lagged price (CV_p : 0.059), lagged area (A_{t-1}: 0.478), current year rain fall (Rt; 0.011) and current year irrigation (It; 0.043) were positive, and they influence the current year area (At) of Cotton positively. The estimated values of coefficient of yield variation (CVy: -0.065) and lagged yield ($\mathbf{Y}_{t-1}$: -0.021), were negative and revealed that yield may influence the current year area (At) of Cotton negatively in Rayalaseema region.

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Table: 6.3
Estimated Coefficients and Other related Statistics of Supply Response Function of Cotton

Regions	Estimated Values									
	b_o	P_{t-1}	Y_{t-1}	CV_p	CV_y	R_t	I_t	A_{t-1}	R^2	F
Coastal Andhra	72656.46	-0.013 (-0.044)	-0.292 (-1.813)	0.434* (3.004)	-0.025 (-0.163)	0.112 (0.837)	0.742* (2.458)	0.383* (2.193)	0.805	7.063*
Rayalaseema	-136764.58	0.626* (3.813)	-0.021 (-0.161)	0.059 (0.624)	-0.065 (-0.645)	0.011 (0.137)	0.043 (0.496)	0.478* (3.493)	0.936	25.224*
Entire Andhra Pradesh	-156229.73	0.140 (0.753)	0.157 (1.211)	0.111 (1.244)	0.179 (1.867)	-0.012 (-0.166)	0.547* (3.384)	0.195 (3.384)	0.947	30.606*

Note: Figures in parentheses are t-values of the estimates.
*Significant at five per cent probability level.

For entire Andhra Pradesh, the estimated regression coefficients of lagged price (P_{t-1}; 0.140), the coefficient of variation of lagged price (CV_p : 0.111), lagged area (A_{t-1}: 0.195), lagged yield (Y_{t-1}: 0.157), current year irrigation (It; 0.547) and coefficient of yield variation (CVy: 0.179) were positive, and they influence the current year area (At) of Cotton positively. The estimated values of rain fall (Rt; -0.012) was negative and revealed that rainfall may influence the current year area (At) of Cotton negatively in entire Andhra Pradesh.

7. Conclusion:

The study has analyzed the growth, instability and supply response of cotton crop in Andhra Pradesh with region-wise analysis. It is observed there were many changes in the growth trends of area, production and yield of cotton in Costal Andhra, Rayalaseema region and entire Andhra Pradesh. The positive growth trends were observed in the area, production and yield of cotton in all the regions of Andhra Pradesh year by year. The study found that the moderate instability in area and yield whereas high instability in case of production of cotton crop in Coastal Andhra, Rayalaseema and entire Andhra Pradesh. The study concluded that the lagged price, lagged yield, current year irrigation and lagged area of cotton are the important positive influencing factors on current year area of cotton cultivation in Andhra Pradesh.

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