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ANALYSIS OF TREND IN AREA, PRODUCTION AND PRODUCTIVITY OF COTTON CROP IN THREE DISTRICTS OF NORTHERN TELANGANA ZONE

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ABSTRACT:

Attempts have been made to examine the trends and forecasting in area, production and productivity of Cotton crop in three districts of Northern Telangana Zone. Linear and compound growth rates were calculated for this purpose. Ten growth models were fitted to the area, production and productivity of Cotton crop and best- fitted model for future projection was chosen based upon least Residual Mean Square (RMS) and significant AdjR^2. Besides, the important assumption of randomness of residuals was tested using one sample run test. The reference period of study was from 1979-80 to 2012-13 and it was carried out in three districts of Northern Telangana Zone.

KEY WORDS: *Analysis, Production, Cotton, Northern Telangana zone.*

INTRODUCTION:

Cotton is one of the important fiber and cash crops in India and plays a dominant role in the industrial and agricultural economy of the country. Cotton has been in cultivation in India for more than five thousand years**.** The major cotton producing countries are USA, China, India, Pakistan, Uzbekistan, Egypt, Argentina, Australia, Greece, Brazil and Turkey. These countries contribute about 85 per cent to the

global cotton production. Current estimates for world production are about 25 million tonnes or 110 million bales annually, accounting for 2.5% of the world's arable land. China is the world's largest producer of cotton, but most of this is used domestically. India ranks first in the world in respect of area with about 8 million hectares under cotton cultivation and fourth in total seed cotton production. The largest producers of cotton are China and India, with annual production of about 34 million bales and 27 million bales respectively.

In India cotton crop is grown throughout the country. However, there are nine major cotton producing states, *viz*., Punjab, Haryana, Rajasthan, Madhya Pradesh, Maharashtra, Gujarat, Telangana, Karnataka and Tamil Nadu. The states of Gujarat, Maharashtra and Telangana are the major producers of cotton in India, accounting for 68 per cent of the country's total output. India is currently the world's second largest exporter of cotton. In India, Telangana ranks 3rd in area and production, and 6th in productivity. Cotton is one of the major traditional commercial crops grown in Telangana state. The advent of new cotton hybrids and revolution of Bt cotton technology coupled with suitable agro-climatic conditions have contributed for significant rise in area, production and productivity of cotton in the state. In Telangana, major cotton growing districts are Adilabad, Karimnagar, Warangal, Khammam and Nalgonda and these districts cover about 84 per cent of the total cotton area.

Area, production and productivity of cotton in Telangana is area under cotton crop has increased in Telangana over a period of time continuously with the introduction of Bt cotton and also favorable market prices. Cotton area has increased from 11.6 lakh hectares in 2009-10 to 18.1 lakh hectares in 2012-13. During the above period, the cotton production and yields were increased from 23.3 lakh bales to 40.6 lakh bales and 342.5 Kg/ha to 380.6 Kg/ha respectively. However, in 2011-12 cotton production and productivity has witnessed a drastic decline to around 22.9 lakh bales and 246.7 kg/ha respectively because of severe drought resulted due to deficit rainfall.

In Telangana the area under cotton during 2012-13 was 18.1 lakh hectares with a production and productivity of 40.6 lakh bales and 380.6 Kg/ha respectively. Cotton production may be due to higher growth rates of area and productivity because of extended area under new hybrids and higher levels of fertilizer use **(**www.indianstat.com**).**

Telangana was a part of Andhra Pradesh till 1 June 2014. It has become separate state on 2 June 2014. The Telangana state attained significant acceleration in agricultural growth in the first phase of green revolution (decade of 70's). The second phase of green revolution (decade of 80's) maintained the growth rate which was attained in the first phase. This achievement was due to the shifts in crops and cropping system from low valued coarse cereals and millets to high valued commercial crops such as cotton. In the 90's, the state experienced a steep decline in agricultural

growth. All the major crops rice, cotton and maize registered a significant decline in the growth of output (Reddy, 2001). Areas under rice, cotton and maize crops have substantially increased. A drastic reduction in the areas of maize occurred largely due to the availability of rice and cotton at subsidized prices in the public distribution system. Even the food preferences in the rural areas shifted largely in favor of rice. The global prices are also influencing the crop scenario. (Source: United Telangana: Vision 2020).

Growth models are useful in drawing inferences like the exact relationship between time and growth, the rate of growth at each point of time, the turning points in the growth, growth rates are considered as the best indices of growth. Parthasarathy and Suryanarayana (1976) analyzed regional growth rates of area, production and productivity of major food-grain crops in pre-green and green revolution periods in the selected districts of Andhra Pradesh. They computed linear growth rates and used standard deviation and coefficient of variation to study the stability or variability of area, production and productivity of certain crops. They concluded that there existed regional variations in the growth rates of area, production and productivity which could be attributed due to shifts in cropping pattern under the improved yield, increasing technology and adoption of high yielding varieties. Chattopadhyay and Das (2000) estimated growth rates and performance of agriculture in West Bengal particularly during the left front rule in the state. After making necessary adjustments in the data they found that the rate of growth of agricultural production in West Bengal during the left front rule has been certainly higher than that during the pre-left front. Navadkar *et al*. (2004) stated that the area under fruits and vegetables in Himachal Pradesh increased by 3.1 and 1.5 % per annum whereas the production rose by 2.6 and 4.4 % annually. The annual increase in area and production of vegetables in India is 1.1 million tonnes per hectare respectively and the productivity rose from 10.5 million tonnes per hectare during the last 10 years period. Tuteja (2006) stated that all India pulse production grew at the rate of 0.7 % per annum from 1980-81 to 2001-02. The growth in area was found almost stagnant as where yield increased at a slow rate at around one %. The pre economic reforms period with 1.9 % per annum growth in pulse production in India was far better than the post reforms period with negative growth of 0.3 % per annum.

The present study is based on 34 years of data i.e., from 1979-80 to 2012-13 of Cotton in three districts of Northern Telangana Zone. The linear growth rate (LGR) and compound growth rate (CGR) for the crop characteristics i.e., area, production and productivity of Cotton crop in three districts of Northern Telangana Zone are estimated by fitting the following functions, the analysis of the data has been carried out by using data on area production and productivity obtained from web site: www.indian**stat.com**..

MATERIALS AND METHODS:

Methodology for the estimation of growth rates

The study was based on 34 years of data i.e., from 1979-80 to 2012-13. Keeping the objectives in view, linear growth rate (LGR) and compound growth rate (CGR) for the crop characteristics i.e., area, production and productivity of Major crops in three districts of Northern Telangana Zone i.e., Adilabad, Karimnagar and Nizamabad were estimated by fitting the following functions.

Methodology for fitting the trend equations

The trend equations were fitted by using different growth models. Growth models are nothing but the models that describe the behavior of a variable overtime. The growth models taken under consideration here are as follows.

Linear function

A linear model is one in which all the parameters appear linearly.

The mathematical equation is given by

$$Y_t = a + bt$$

Where

Y_t is the dependent variable i.e., area, production and productivity

t is the independent variable, time in years

a and b are the constants

The constants ‘a’ and ‘b’ are estimated by applying the Ordinary Leasts Square approach.

Logarithmic function

This model shows very rapid growth, followed by slower growth

The mathematical equation is given by

$$Y_t = a + b \ln(t)$$

Where,

Y_t is the dependent variable i.e., area, production and productivity

t is the time in years, independent variable

‘a’ and ‘b’ are constants

The constants ‘a’ and ‘b’ are estimated by applying the Ordinary Least Squares approach.

Inverse function:

Inverse curve shows a decreasing growth.

Inverse fit is given by the equation

$$Y_t = a + b/t$$

Where,

Y_t is the dependent variable i.e., area, production and productivity

t is the independent variable, time

'a' and 'b' are parameters

The parameters can be estimated by the method of Ordinary Least Squares (OLS).

Quadratic function:

This function is useful when there is a peak or a trough in the data of past periods.

Quadratic fit is given by the equation

$$Y_t = a + bt + ct^2$$

Where,

Y_t is the dependent variable i.e., area, production and productivity

t is the independent variable, time in years

a, b and c are constants

The constants can be calculated by applying the method of ordinary least squares approach.

Cubic function:

This function is useful when there is or has been, two peaks or two troughs in the data of past periods.

Cubic fit or third degree curve is given by the equation:

$$Y_t = a + bt + ct^2 + dt^3$$

Where,

Y_t is the dependent variable i.e., area, production and productivity

t is the independent variable, time in years

a, b, c and d are parameters

The parameters are calculated by ordinary least squares technique.

Compound function:

This function is useful when it is known that there is or has been, increasing growth or decline in past periods

Compound fit is given by

$$Y_t = ab^t$$

Or $\ln Y_t = \ln a + t \ln b$

Where,

Y_t is the dependent variable, area, production and productivity

t is the independent variable, time in years

a and b are parameters or constants

The constants can be obtained by using ordinary least squares technique.

S-curve:

S-curve fit is given by

$Y_t = Exp\ (a+b/t)$

or $\ln Y_t = a + b/t$

Where,

Y_t is the dependent variable, area, production and productivity

t is the independent variable, time in years

a and b are parameters or constants

Ordinary Least Squares (OLS) method can be applied to estimate the parameters of the model.

Growth function:

The fit is given by

$Y_t = Exp\ (a + bt)$

or $\ln Y_t = a + bt$

Where,

Y_t is the dependent variable, area, production and productivity

t is the independent variable, time in years

a and b are parameters or constants

The constants are obtained by ordinary least squares technique.

Power function:

The fit is given by the equation

$Y_t = at^b$

or $\ln Y_t = \ln a + b \ln(t)$

Where,

Y_t is the dependent variable, area, production and productivity

t is the independent variable, time in years

a and b are parameters or constants

The constants are calculated by ordinary least squares technique.

The fit is similar to exponential fit, but produces a forecast curve that increases or decreases at different rate.

Exponential fit:

If, when the values of t are arranged in an arithmetic series, the corresponding values of y form a geometric series, the relation is of the exponential type.

The function of this type can be given by

$Y_t = a\ Exp\ (bt)$

or $\ln Y_t = \ln a + (bt)$

Where,

Y_t is dependent variable i.e., area, production and productivity

t is independent variable, time in years

a and b are constants

The constants are calculated by ordinary least squares technique

Methodology for the estimation of future projections

The future projections of area, production and productivity of major crops in three districts of Northern Telangana Zone up to 2020 AD were estimated upon the best fitted growth model used for fitting the trend equations.

Methodology for the best fitted model

The choice of the trend equation amongst the available alternatives is very crucial. Many researchers use coefficient of multiple determination, R^2 or adjusted R^2 ($\overline{R}^2$) as the criterion of model selection.

$$R^2 = \frac{EXPLAINEDVARIATION}{TOTALVARIATION} = \frac{\sum_{i=1}^{n}(\tilde{Y}_i - Y)^2}{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}$$

$$Adj R^2 = (\overline{R^2}) = R^2 - \left[\frac{K-1}{N-K}\right](1 - R^2)$$

Where,

K is the number of constants in the equation

N is the total number of observations

It was observed that R^2 is not enough to examine goodness of fit of a model (Reddy, 1978). So in addition to adj R^2, the residual mean square (RMS) which will also measure the accuracy in forecasting is the best criterion to choose a model from among the alternatives.

$$\text{Residual mean square} = \frac{\Sigma(y_i - \hat{y}_i)^2}{\text{Residual degrees of freedom}}$$

In the present study, the model with least residual mean square (RMS) and significant adj R^2 was considered to be the best fitted model.

Before choosing a model, one should be certain that the disturbance term satisfies all the conditions of randomness, non-autocorrelation, homoscedasticity and normality. In the present

study, an attempt has been made to verify the most important assumption of randomness of residuals.

Test for randomness of residuals:

Non-parametric one sample run test can be used to test the randomness of residuals. A *run* is defined as a succession of identical symbols in which the individual scores or observations originally were obtained. For example, suppose a series of binary events occurred in this order:

++++ - - + - - - ++ - + -

This sample of scores begins with a run of four pluses. A run of two minuses follows, then comes another run of one plus and then a run of three minuses and so on. The total runs in the above example are 8.

If very few runs occur, a time trend or some bunching owing to lack of independence is suggested and if many runs occur, systematic short period cyclical fluctuations seem to be influencing the scores.

Let 'n_1', be the number of elements of one kind and 'n_2' be the number of elements of the other kind in a sequence of $N = n_1 + n_2$ binary events. For small samples i.e., both n_1 and n_2 are equal to or less than 20 if the number of runs r fall between the critical values, we accept the H_0 (null hypothesis) that the sequence of binary events is random otherwise, we reject the H_0.

For large samples i.e., if either n_1 or n_2 is larger than 20, a good approximation to the sampling distribution of r (runs) is the normal distribution, with

$$Mean = \mu_r = \frac{2n_1n_2}{N} + 1$$

$$\text{Standard deviation} = \sigma_r = \sqrt{\frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1+n_2)^2(n_1+n_2-1)}}$$

Then, H_0 may be tested by $$Z = \frac{r - \mu_r}{\sigma_r}$$

The significance of any observed value of Z computed from the above formula may be determined by reference to the Standard Normal Distribution table..

RESULT AND DISCUSSION:

Adilabad:

In Adilabad the average area under Cotton during the study period (1979-80 to 2012-13) was 178.3 thousand hectares. The coefficient of variation recorded for the study period was 36.69 percent and the linear and compound growth rates recorded during the study period were 2.8 and 2.6 per cent per annum respectively. The area of Cotton in Adilabad exhibited a positive trend and it was found

significant at 1%levelof significance in the compound growth rate and linear growth rate. The average production of Cotton during the study period (1979-80 to 2012-13) was 210.08 thousand tones with a coefficient of variation of 99.80 per cent. The linear growth rate and compound growth rate recorded for the study period were 8.4 and 9.7 per cent per annum respectively. The production of Cotton in Adilabad exhibited a positive trend and has been increasing significantly during the study period and the increase was significant at 1% level of significance of linear growth rate and compound growth rate. Regarding the productivity in Adilabad, the average yield of Cotton during the study period (1979-80 to 2012-13) was 170.8 kg/ha, with the coefficient of variation of 70.15 per cent. The linear and compound growth rates during the study period were 6.03 and 7 per cent respectively. The productivity of Cotton also had exhibited a positive trend during the study period in Adilabad and was significant at 1% level of significance at linear growth rates and compound growth rate. As a whole, the growth rates of production were higher than growth rates of area and productivity.

The future projections of area, production and productivity of Cotton in Adilabad region by 2020 AD were calculated and the results were presented in the Table 2. Area under Cotton in Adilabad region was projected by using Cubic function which was found to be best for this purpose as it had significant Adj $R^2$and also fulfilled the assumption of randomness of residuals. The area under Cotton projected by Cubic function by 2020 AD would be 702 thousand hectares which as in increasing trend. Regarding the production of Cotton, Cubic function was found to be the best model for future projections by 2020 AD as it has the significant Adj $R^2$and also satisfied the assumption of randomness of residuals. The projected production would be increasing at 1290 thousand bales by 2020 AD. Productivity of Cotton was projected by using Cubic function which has least RMS, significant Adj $R^2$and also has showed significant runs. The future projection for productivity of Cotton also is in increasing trend and it would be 420 kg/ha by 2020.AD.

Karimnagar:

The average area under Cotton during the study period (1979-80 to 2012-13) was 72.7 thousand hectares. The coefficient of variation recorded for the study period was 102.79percent and the linear and compound growth rates recorded during the study period were 9.1 and 15.6 per cent per annum respectively. The area of Cotton in Karimnagar exhibited a positive trend and it was found significant at 1%level of significance in the compound growth rate and linear growth rate. The average production of Cotton during the study period (1979-80 to 2012-13) was 143 thousand tones with a coefficient of variation of 110.76 per cent. The linear growth rate and compound growth rate recorded for the study period were 9.4 and 18.2 per cent per annum respectively. The

production of Cotton in Karimnagar exhibited a positive trend and has been increasing significantly during the study period and the increase was significant at 1% level of significance of linear growth rate and compound growth rate. Regarding the productivity in Karimnagar, the average yield of Cotton during the study period (1979-80 to 2012-13) was 268.4 kg/ha, with the coefficient of variation of 52.15 per cent. The linear and compound growth rates during the study period were 3.5 and 5.4 per cent respectively. The productivity of Cotton also had exhibited a positive trend during the study period in Karimnagar and was significant at 1% level of significance at linear growth rates and compound growth rate Growth rates of area, production and productivity of the Cotton crop for the study period (1979-80 to 2012-13) in Karimnagar were shown in the table4. As a whole, the growth rates of production were higher than growth rates of area and productivity.

The future projections of area, production and productivity of Cotton in Karimnagar region by 2020 AD were calculated and the results were presented in the Table 5. Area under Cotton in Karimnagar region was projected by using Cubic function which was found to be best for this purpose as it had significant Adj R2 and also fulfilled the assumption of randomness of residuals. The area under Cotton projected by Cubic function by 2020 AD would be 508 thousand hectares which as in increasing trend. Regarding the production of Cotton, Cubic function was found to be the best model for future projections by 2020 AD as it has the significant Adj R2 and also satisfied the assumption of randomness of residuals. The projected production would be increasing at 840 thousand bales by 2020 AD. Productivity of Cotton was projected by using Cubic function which has lest RMS, significant Adj R2 and also has showed significant runs. The future projection for productivity of Cotton also is in increasing trend and it would be 2178kg/ha by 2020.AD.

Nizamabad:

The average area under Cotton during the study period (1979-80 to 2012-13) was 12 thousand hectares. The coefficient of variation recorded for the study period was 50.99percent and the linear and compound growth rates recorded during the study period were 2.9 and 3.6 per cent per annum respectively. The area of Cotton in Nizamabad exhibited a positive trend and it was found significant at 1%level of significance in the case of compound growth rate and linear growth rate. The average production of Cotton during the study period (1979-80 to 2012-13) was 16.4 thousand tones with a coefficient of variation of 89.8 per cent. The linear growth rate and compound growth rate recorded for the study period were 6 and 8.4 per cent per annum respectively. The production of Cotton in Nizamabad exhibited a positive trend and has been increasing significantly during the study period and the increase was significant at 1% level of significance of linear growth rate and

compound growth rate. Regarding the productivity in Nizamabad, the average yield of Cotton during the study period (1979-80 to 2012-13) was 193.9 kg/ha, with the coefficient of variation of 56.21 per cent. The linear and compound growth rates during the study period were 4 and 5.2 per cent respectively. The productivity of Cotton also had exhibited a positive trend during the study period in Nizamabad and was significant at 1% level of significance at linear growth rates and compound growth rate Growth rates of area, production and productivity of the Cotton crop for the study period (1979-80 to 2012-13) in Nizamabad were shown in the table 7. As a whole, the growth rates of production were higher than growth rates of area and productivity.

The future projections of area, production and productivity of Cotton in Nizamabad region by 2020 AD were calculated and the results were presented in the Table 8. Area under Cotton in Nizamabad region was projected by using Cubic function which was found to be best for this purpose as it had significant Adj R2 and also fulfilled the assumption of randomness of residuals. The area under Cotton projected by Cubic function by 2020 AD would be 43.8 thousand hectares which as in increasing trend. Regarding the production of Cotton, Cubic function was found to be the best model for future projections by 2020 AD as it has the significant Adj R2 and also satisfied the assumption of randomness of residuals. The projected production would be increasing at 62.5 thousand bales by2020 AD. Productivity of Cotton was projected by using Linear function which has lest RMS, significant Adj R2 and also has showed significant runs. The future projection for productivity of Cotton also is in increasing trend and it would be 374kg/ha by 2020.AD.

CONCLUSIONS:

The present investigation has been undertaken to evaluate the growth in area, production and productivity of Cotton crop in three districts of Northern Telangana Zone. An attempt has been made to fit the trend equations to the area, production and productivity of the Cotton crop and best fitted model was chosen for the purpose of future prediction by 2020. The analysis has been taken for three districts of Northern Telangana Zone. The time series data pertaining to the area, production and productivity of selected Cotton crop in Three districts of Northern Telangana Zone were collected from the Directorate of Economics and Statistics (DES) Hyderabad for the period of 34 years i.e., from 1979-80 to 2012-13 and also from the District chief planning office at District head Quarters. The linear growth rates and compound growth rates for the study period of 1979-80 to 2015-16 were estimated by fitting the linear function and compound function to the area, production and productivity of Cotton crop, respectively. The models fitted to the time series data of area, production and productivity were linear, logarithmic, inverse, quadratic, cubic, compound, S-curve, growth, power and exponential. The most important assumption of

randomness of residuals was tested by using one sample run test. The model which showed relatively the least residual mean square (RMS), significant Adj R^2 and significant runs were chosen for the purpose of future projection by 2020A.D.

Area of Cotton in Adilabad showed a increasing growth pattern during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from -0.102 in case of inverse and 0.929 in case of cubic function, almost all the models Adj R^2 values were significant at 5% level of significance. The Production of Cotton in Adilabad showed a systematic growth pattern during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from 0.103 in case of inverse and 0.897 in case of cubic function. Almost all the models Adj R^2 values were significant at 5% level of significance, Except inverse, it was significant at 1% level of significance ,only linear ,Logarithmic, inverse and power function satisfied the assumption of randomness of residuals. The Productivity of Cotton in Adilabad showed a increasing trend during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from 0.134 in case of inverse and 0.777in case of compound function respectively. Almost all the models Adj R^2 values were significant at 5% level of significance, except inverse, model Adj R^2values were significant at 1% level of significance but only, Logarithmic, inverse, cubic and power function satisfied the assumption of randomness of residuals.

Area of Cotton in Karimnagar showed a increasing growth pattern during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from -0.153 in case of inverse and 0.946 in case of cubic function, Almost all the models Adj R^2 values were significant at 5% level of significance, but only inverse function Adj R^2 value was significant at 1% level of significance, all the models are satisfied the assumption of randomness of residuals. The Production of Cotton in Karimnagar showed a increasing decrease growth pattern during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from 0.133 in case of inverse and 0.832 in case of compound, growth, exponential function. Almost all the models Adj R^2 values were significant at 5% level of significance, except inverse, it was significant at 1% level of significance. All growth models were satisfied the assumption of randomness of residuals. The Productivity of Cotton in Karimnagar showed a increasing decrease trend during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from 0.274 in case of inverse and 0.635in case of power function respectively. Almost all the models Adj R^2 values were significant at 5% level of significance, except quadratic remaining all growth models were satisfied the assumption of randomness of residuals.

Area of Cotton in Nizamabad showed a increasing decrease growth pattern during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from 0.151 in case of

inverse and 0.430 in case of power function, Almost all the models Adj R^2 values were significant at 5% level of significance, but only inverse function Adj R^2 value was significant at 1% level of significance, except quadratic remaining all the growth models are satisfied the assumption of randomness of residuals. The Production of Cotton in Nizamabad showed a increasing decrease growth pattern during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from 0.126 in case of inverse and 0.561 in case of compound, growth and exponential function. Almost all the models Adj R^2 values were significant at 5% level of significance, except inverse, it was significant at 1% level of significance. All the growth models were satisfied the assumption of randomness of residuals. The Productivity of Cotton in Nizamabad showed a increasing decrease trend during the study period of 1979-80 to 2012-13. The Adj R^2 values for all the models were ranging from 0.121 in case of S-curve and 0.491in case of linear function respectively. Almost all the models Adj R^2 values were significant at 5% level of significance but inverse, S-curve models Adj R^2values were significant at 1% level of significance. Except quadratic remaining all growth models were satisfied the assumption of randomness of residuals.

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Table 1. Growth Rates in Area, Production and Productivity of Cotton Crop in Adilabad

Adilabad (%)	Area	Production	Productivity
Linear	2.8**	8.4**	6.03**
Compound	2.6**	9.7**	7**
C.V	36.69	99.80	70.15

Table 2. Growth models of Area, Production and Productivity of Cotton crop in Adilabad

AREA										
Model	**Linear**	**Logarithmic**	**Inverse**	**Quadratic**	**Cubic**	**Compound**	**Power**	**S-curve**	**Growth**	**Exponential**
AdjR2	0.578*	0.337*	0.102*	0.791*	**0.929***	0.678*	0.448*	0.172*	0.678*	0.678*
RMS	1804.44	2835.69	3842.16	894.56	**303.35**	1551.4904	3727.50519	1525.98	2646.66	1525.759705
Runs	7	3	3	8	**12**	7	3	7	5	7
PRODUCTION										
AdjR2	0.707*	0.41*	0.103**	0.882*	**0.897***	0.854*	0.63*	0.206*	0.854*	0.854*
RMS	12890	25929	39429	5205.72	**4512.703**	5878.7156	42452.1432	6211.36	22599.5	6218.15071
Runs	5	3	6	14	**16**	19	5	19	13	19
PRODUCTIVITY										
AdjR2	0.726*	0.482*	0.134**	0.758*	**0.763***	0.777*	0.594*	0.18*	0.777*	0.777*
RMS	3933.37	7445.42	12435.96	3469.86	**3398.68**	3567.9609	12676.7906	3554.97	5985.24	3559.311991
Runs	14	7	7	18	**20**	18	9	18	15	18

Table 3. Future Projections of Area, Production and Productivity of Cotton crop in Adilabad

Year	Area ('000'ha)	Production ('000'tonn)	Productivity(kg/ha)
2013-14	425.8	799.2	384.3
2014-15	469.8	881.2	391.9
2015-16	518.0	969.2	398.2
2016-17	570.7	1063.6	403.1
2017-18	628.0	1164.4	406.5
2018-19	690.2	1272.0	408.3
2019-20	702.0	1290.0	420.0

Table 4. Growth Rates in Area, Production and Productivity of Cotton crop in Karimnagar

Karminagar (%)	Area	Production	Productivity
Linear	9.1**	9.4**	3.5**
Compound	15.6**	18.2**	5.4**
C.V	102.79	110.76	52.20

Table 5. Growth models of Area, Production and Productivity of Cotton crop in Karimnagar

AREA										
Model	**Linear**	**Logarithmic**	**Inverse**	**Quadratic**	**Cubic**	**Compound**	**Power**	**S-curve**	**Growth**	**Exponential**
AdjR2	0.787*	0.5*	0.153**	0.913*	**0.946***	0.881*	0.909*	0.531*	0.882*	0.881*
RMS	1127.28	2646.31	4482.91	459.96	**284.15**	1000.28	4733.33	1004.43	1086.04	1007.03
Runs	5	3	5	6	**10**	5	5	5	7	5
PRODUCTION										
AdjR2	0.721*	0.456*	0.133**	0.816*	**0.82***	0.832*	0.779*	0.358*	0.832*	0.832*
RMS	7013.188	13652.56	21762.06	4618.59	**4523.16**	11762.933	26254.22	11477.463	8694.2089	11490.407
Runs	11	7	5	12	**11**	11	7	11	7	11
PRODUCTIVITY										
AdjR2	0.435*	0.511*	0.274*	0.571*	**0.556***	0.512*	0.635*	0.351*	0.512*	0.512*
RMS	11100.8	9599.62	14256.08	8435.08	**8716.24**	16138.619	13228.837	15926.231	10310.514	15925.788
Runs	7	12	9	13	**4**	11	7	11	10	11

Table 6. Future Projections of Area, Production and Productivity of Cotton crop in Karimnagar

Year	Area ('000'ha)	Production ('000'tonn)	Productivity(kg/ha)
2013-14	304.8	543.4	1787.4
2014-15	337.6	593.2	1860.8
2015-16	372.9	646.3	1935.5
2016-17	411.0	702.9	2011.3
2017-18	451.9	763.1	2088.4
2018-19	495.8	827.0	2166.7
2019-20	508.0	840.0	2178.0

Table 7. Growth Rates in Area, Production and Productivity of Cotton Crop in Nizamabad

Nizamabad (%)	Area	Production	Productivity
Linear	2.9**	6**	4**
Compound	3.6**	8.4**	5.2**
C.V	50.99	89.88	56.21

Table 8. Growth models of Area, Production and Productivity of Cotton crop in Nizamabad

AREA										
Model	**Linear**	**Logarithmic**	**Inverse**	**Quadratic**	**Cubic**	**Compound**	**Power**	**S-curve**	**Growth**	**Exponential**
AdjR2	0.306*	0.339*	0.151**	**0.341***	0.369*	0.404*	0.43*	0.187*	0.404*	0.404*
RMS	26.236	25.33	32.1	**24.905**	23.85	28.330851	31.635244	28.370403	25.150531	28.364599
Runs	4	5	5	**1**	4	5	7	5	5	5
PRODUCTION										
AdjR2	0.441*	0.344*	0.126**	0.432*	**0.496***	0.561*	0.547*	0.238*	0.561*	0.561*
RMS	121.522	142.642	190.256	123.624	**109.732**	118.45982	205.85529	119.12373	138.99241	119.10078
Runs	5	7	7	9	**5**	11	7	9	7	9
PRODUCTIVITY										
AdjR2	0.491*	0.404*	0.156**	0.474*	0.485*	0.356*	0.337*	0.121**	**0.356***	0.358*
RMS	6055	7090	10031	6246.4	6120.38	6376.5761	10206.613	6366.2862	**6584.5553**	6365.3001
Runs	15	15	9	17	15	13	5	13	**15**	13

****Significant at 1% level**

***Significant at 5% level**

Table 9. Future Projections of Area, Production and Productivity of Cotton crop in Nizamabad

Year	Area ('000'ha)	Production ('000'tonn)	Productivity(kg/ha)
2013-14	29.8	32.0	330.2
2014-15	32.0	36.3	338.0
2015-16	34.3	41.1	345.8
2016-17	36.9	46.6	353.6
2017-18	39.7	52.6	361.4
2018-19	42.7	59.3	369.2
2019-20	43.8	62.5	374.0