Original Research Article

GROWTH AND TREND ANALYSIS OF AREA, PRODUCTION AND PRODUCTIVITY OF COTTON CROP IN THE BALLARI DISTRICT OF KARNATAKA

ABSTRACT

Cotton is the main source of commercial fiber. In India's economy, it is one of the most important cash crops. This study used secondary data to look at the growth in cotton crop area, production, and productivity in the Ballari district of Karnataka over the last 46 years (1970–2016).The findings demonstrated that the cotton crop's area, production, and productivity increased significantly over the study period. In terms of area (2.8 per cent), production (3.3 per cent), and productivity, the Ballari district grew faster (3.0 per cent). To know more about cotton crop acreage, production, and productivity trends in the Karnataka district of Ballari, The quartic model was determined to be the best match among the various polynomial models fitted for the acreage, production, and productivity of the cotton crop in the Ballari district, with an RMSE of 12.9 and an adj.R^2 value of 0.8. The best fit for production was a quartic model with an RMSE of 18.7 and an adj.R^2 value of 0.87, while the best fit for productivity was a cubic model with an RMSE of 50.6 and an adj.R^2 value of 0.8.

KEYWORDS: Ballari district, Growth, Trend, Cotton and Polynomial models.

INTRODUCTION

Cotton is the world's most important natural fiber crop, accounting for more than half of all fibers used in textile production. It is more valuable than synthetic fibers, and it is cultivated in more than 80 nations worldwide. It's the only crop that produces natural fiber, edible oil, and seed by-products for livestock feed. Furthermore, it generates revenue for hundreds of millions of people. It's an agro-industrial crop grown in both developing and industrialized nations. Clothing and home furnishings are made from cotton fibers. Since the industrial revolution in the 17th century, it has played a vital role. It has become a key cash crop in a number of emerging countries, both locally and nationally (Gudeta and Egziabher, 2019). In India, cotton is grown on the largest scale on the globe. It provides the cotton textile industry with the basic raw material (cotton fiber) (Rajan and Palanivel, 2018). It is the most frequently used textile fiber in the world, accounting for 35% of all fiber usage. Cotton was initially cultivated by the people of the Indus Valley civilization approximately 7,000 years back. This civilization is found throughout the northwestern part of the Indian subcontinent, including what is now eastern Pakistan and northern India (Mayilsami and Selvaraj, 2016). Cotton has long been regarded as India's agricultural economy's "non-food backbone" (Sharma, 2015). Because of its prominence in global agriculture and industries, it's also known as "white gold" or the "King of Fibers." Cotton is a cash crop in India that is both significant and profitable (Mohammad, et al., 2018). Cotton farming, trade, processing, manufacturing, and marketing, among other things, employs several million people. It caters to the developing handloom sector in the country. Cotton is used as surgical lint and for a variety of domestic functions in addition to textiles. Paper, cardboard, blotting paper, and other industrial things are made from cotton plant parts. Cotton seeds are a new source of edible oil that has recently gained popular. Cotton farming is a valuable industry that employs millions of people. Cotton production is critical to their financial survival. Cotton yarn, fabric, and clothing are all dependent on its availability. India can earn foreign money by exporting raw cotton and cotton products. Despite having a variety of cotton cultivars and access to technologies, India has not been able to produce a considerable cotton output. Cotton production in the country lags well below that of the world's main producers. Cotton textiles are in high demand around the world. As the world's largest cotton producer, India has a significant opportunity to expand the cotton textile sector and boost the Indian economy in the coming years (Mal and Pandey, 2013). *G. hirustum*, *G. arboretum*, *G. herbaceaum*, and *G. barbadense* are the cultivated cotton species, and India is the only area in the world where they are all grown. The hybrids have progressed the most (Samuel et al., 2013). India is one of the world's most diverse cotton-growing countries, with a wide range of agro-climatic and soil conditions that allow for the production of all cotton cultivars and staple lengths. Cotton is grown in India, China, the US, Pakistan, Brazil, Australia, Uzbekistan, Turkey, Turkmenistan, and Burkina Faso, among other places (Rajan and Palanivel, 2017). Cotton has recently gained popularity in places like Odisha, West Bengal, and Tripura, where it is not traditionally grown. India covers over a third of the world's total cotton land and produces 18% of the world's cotton (Kulkarni et al., 2017). India is first in terms of cotton acreage and production, and seventh in terms of cotton productivity. Cotton is grown over 129.57 lakh hectares in India, yielding 371.00 lakh bales and a 487 kg/ha productivity. The top ten cotton-producing states in India are Gujarat, Maharashtra, Telangana, Karnataka, Andhra Pradesh, Haryana, Madhya Pradesh, Rajasthan, Punjab, and Tamil Nadu (together known as the "cotton basket of India"). They account for more than 95 percent of the country's cotton production. Approximately 65 percent of the cotton crop in the country is grown in rainfed conditions. Cotton is grown over 7.6 lakh hectares in Karnataka, accounting for 7% of the state's total land area. The crop yields 29 lakh bales (about 4% of the country's total) with a yield of 654 kg/ha. Dharwad, Ballari, and Raichur are the major cotton cultivating districts of Karnataka.

METHODOLOGY

Because Ballari is a prominent cotton-growing district in Karnataka, it was chosen as the study area. Secondary sources of data on cotton crop acreage, production, and productivity were collected from Bengaluru's Directorate of Economics and Statistics during a 46-year period (1970–71 to 2015–16) in order to examine cotton's growth and trend.

Statistical models and tools used:

Time-series data from Bengaluru's Directorate of Economics and Statistics was used to estimate linear and compound growth rates for area, production, and productivity for the period 1970-71 to 2015-16. The ordinary least squares method was used to estimate growth rates employing the following analytical tools. To determine the trend in cotton acreage, production, and productivity, appropriate polynomial models were fitted using the ordinary least squares method. The study used both cubic and quartic models.

Growth in a linear formula:

$Y_t = a + b_t + e_t$ This is the linear growth function.

Where, Y_t is the trend value, t is the time in years, a and b are parameters and e_t is the error term

The formula for calculating the linear growth rate (LGR) is:

$$Linear\ growth\ rate\ (LGR\ \%) = \frac{b}{\bar{y}}\ x100$$

Compound growth formula:

$Y_t = ab^t$,This is the compound growth function.

Taking both sides of the log, we get, $Log\ Y_t = loga + t\ log\ b$

Where, Y_t denotes the characteristics, t is the time in years and a and b are constants.

Compound Growth Rate (CGR %) can be written as,

$$\text{CGR (\%)} = (\text{antilog b} - 1)\ \text{x}\ 100$$

Significance of the growth can be determined using the student's t- test, which is defined as

$$\text{t} = \frac{\text{r}}{\text{SE (r)}} \sim \text{t}_{(\text{n}-2)}\ \text{df}$$

Where, n represents the total number of years studied, r is the growth, and $SE(r)$ represents the standard error of the growth.

Co-efficient of Variation (CV):

Cotton crop area, production, and productivity were measured using the co-efficient of variation (CV) in the Ballari district of Karnataka during the time.

$$\text{CV} = \frac{\text{Standard deviation}}{\text{Mean}} \text{x 100}$$

Cubic Model:

It can be written as, $Y_t = a + bt + ct^2 + dt^3 + e_t$

Where, Y_t is the dependent variable (area, production, and productivity), t denotes the independent variable (time in years), e_t denotes the error term, and a,b,c,and d denote constants.

Quartic Model:

It can be written as , $Y_t = a + bt + ct^2 + dt^3 + et^4 + e_t$

Where, Y_t is the dependent variable, which includes area, production, and productivity, t is the independent variable, which includes time in years, e_t is the error term, and a,b,c,d and e are constants.

Model Adequacy Checking:

A model's adequacy refers to its ability to describe the underlying character of the data it receives. The coefficient of determination (R^2) is a statistical tool which can be used to determine whether or not a model is suitable. The R^2 value is the percentage of variance in a data set that a statistical model can account for. It's a statistic for determining how well the assumed model explains the variation of the dependent variable. R^2=RSS/TSS=1-ESS/TSS

The acronyms for error sum of squares are error sum of squares (ESS), regression sum of squares (RSS), and total sum of squares (TSS). The computed R2 value is between 0 and 1.The R^2 score is a measure of how well a model fits the data. The lower the R^2 number, the better the model matches the data. Adjusted R^2 and Root Mean Square Error (RMSE) are also used to assess model fit.

R^2 has been adjusted:

The adjusted R-squared is an R-squared that has been adjusted to account for the number of predictors in the model. Only if the new term improves the model more than would be predicted by chance does the adjusted R-squared rise. R^2=(RSS/df)/(TSS/df)

TSS stands for total sum of squares, and df stands for degrees of freedom. RSS stands for regression sum of squares, TSS stands for total sum of squares, and df stands for degrees of freedom. The significance of the regression coefficient is examined. The significance of the regression coefficient is determined using the F-test statistic.

Root Mean Square Error (RMSE)

Root Mean Square Deviation (RMSD) is a measurement of how much variation in the data the model is not able to apprehend. The RMSE is used as the square root of the mean squared error and is written as

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}\left(Y_t - \hat{Y}_t\right)^2}{n}}$$

Where, Y_t is the observed value, $\hat{Y}_t$ is the forecasted value, and n is the number of observations.

RESULTS AND DISCUSSION

Table 1 shows the rates of growth in cotton crop area, production, and productivity in the Ballari district from 1970-71 to 2015-16. Cotton was observed to have an average area of 70.5 thousand hectares, with a coefficient of variation of 44.7 percent. Over the study period, the linear and compound growth rates were 2.5 percent and 2.8 percent per year, respectively. According to linear and compound rates of growth, the area under cotton in the Ballari district exhibited a favorable, considerable trend. From 1970 to 2015, cotton production averaged 64.5 thousand bales per year, with an 84.6 percent coefficient of variance. The linear and compound growth rates for the study period were 4.0 percent and 3.3 percent per year, respectively. The average cotton productivity in the Ballari district was 232.6 kg/ha from 1970 to 2015, with a coefficient of variation of 48.6%. The linear and compound rates of increase over the study period were 2.97 percent and 3.0 percent, respectively. Cotton productivity has also increased significantly in the Ballari district over the study period. As a result, during the research period, the Ballari district's growth rates for area, production, and productivity increased significantly. Cotton area, production, and productivity all increased in the Coastal Andhra region, Telangana region, and Andhra Pradesh as a whole (Panasa, 2014).

Table 1: Growth for area, production, productivity of Cotton crop in the Ballari district

Ballari district	**Average**	**CV (%)**	**LGR (%)**	**CGR (%)**

Area	70.5	44.7	2.5**	2.8**
Production	64.5	84.6	4.0**	3.3**
Productivity	232.6	48.6	2.97**	3.0**
**** Significance at 1% level**				

Table 2: Parameter estimates of fitted models for Area, Production and Productivity of Cotton in the Ballari										
Ballari District	**Model**	**Parameter estimates**					**R^2**	**Adj. R^2**	**RMSD**	**P Values**
		a	**b**	**c**	**D**	**E**				
Area	**Quartic**	152.0*	-17.0**	1.5**	-0.05**	0.0**	0.8	0.8	12.9	<0.001
Production	**Quartic**	51.7**	-9.5**	1.0**	-0.04**	0.0**	0.9	0.9	18.7	<0.001
Productivity	**Cubic**	51.5**	19.3**	-0.9**	0.02**		0.8	0.8	50.6	<0.001
**** Significant at 1% level, * Significant at 5% level, NS-Non-significant**										

In the Ballari district, time series analysis on cotton crop area, production, and productivity was fitted to various polynomial models, particularly cubic and quartic. When the coefficient of the higher-order polynomial was non-significant, the best fit for the data was a model. The p-value, adj.R^2 value, and RMSE value that were used to select the optimal polynomial model are shown in Table 2. The quartic model was found to be the best fit for the area under cotton in the Ballari district, with an RMSE of 12.9 and an adj.R^2 value of 0.8. The quartic model seemed to have the best fit for production, with an RMSE of 18.7 and an adj.R2 value of 0.9, while the cubic model had the best fit for productivity, with an RMSE of 50.6 and an adj.R^2 value of 0.8. As a result, from 1970 to 2015, the quartic regression model was shown to be the perfect fit with a rising trend in cotton acreage and output in the Ballari district. In terms of cotton productivity, the cubic model was shown to be the best fit for the Ballari district. Additionally, the area, production, and productivity all increased.

CONCLUSION

The current study examined at the growth and trend in cotton crop area, production, and productivity in the Karnataka district of Ballari. For the years 1970–71 through 2015–16, the data is taken from Bengaluru's Directorate of Economics and Statistics. According to the data, the cotton crop's area, production, and productivity all grew significantly over the study period. The Ballari district's acreage, production, and productivity have all increased. To meet the cotton crop's area, production, and productivity, trend equations were utilised, and the best-suited model was selected for future projection. According to the data, the cotton crop's acreage, production, and productivity are all increasing in Ballari. Based on adj.R^2 and RMSE values, the quartic model was chosen as the best fit for cotton production in Ballari. The cubic model was determined to be the most effective for productivity, while the quartic model was proven to be the most effective for production.

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