Forecasting Area, Production and Productivity Growth Trends of Cotton Crop in India

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Abstract**—**Amongst the statistics, a preparatory study was carried out in Tamil Nadu on various growth models in India between 1951 and 2013, including linear, quadratic and cubic for the cotton crop region, production and productivity project. The models included the Linear Trent Model and the Quadratic Trend Model. For the next eight years, this study concluded the cotton production and productivity model. The exploration of the projected period 2013-2020 was presented. The best models foreseen an area of 1.083 (lakh.ha), 5.151 (lakh.bales) production of about 4.404 (lakh.bales) and a 1370 (kg / ha) productivity of 1381(kg / ha) in 2013-20 respectively. The values predicted are very close to actual values and have positively increased because cotton crops are available in Tamil Nadu.

Keywords**—** Trend Model, Area, Production, Productivity, Residual Sum of Square, Mean Square Error

I. Introduction

India is an enormous, heterogeneous country. One study alone could not deal with the many agricultural problems, certainly not enough to make sense. This study was conceptualized through a broad consensus concentrating on strategic issues pertaining to population growth. It focuses on dynamics and productivity growth sources, sustainability of growth and areas that ignore growth potential, all of which are aimed at shaping discussions on strategic priorities and policy actions. The main cotton-producing countries in India are Punjab, Haryan, Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Tamil Nadu and Karnataka. India represented approximately 25% of the world's total area. The production of cotton ranged from 110 to 121 lakh ha during 2014-2015 to 34.81 million bales. India's cotton production fell during 2015-16 to 30.80 million bales, the lowest in the last five years. Due to the pest and fly sucking attack, this drastic reduction in cotton production was particularly in the northern region.

The country was supposed to produce 34,15 million bales in 2016-2017, given the improved weather conditions in the cotton-growing regions of the country (Cotton Advisory Board, 2016). In February 2000, the government of India initiated a' Tech Cotton Mission' to improve production and productivity of cotton through the development of high yields, increase farmers ' income by decreasing farm costs, transfer of technology and better farm practices, cultivation of cotton hybrids, etc. Estimates of area and production are key supporting procedures for the country's decision-making with regard to production, price structures and cotton consumption. In the next decade, increasing global demand for cotton is probably expected to provoke increased production. In this context, the scope of the production of cotton with available resources must in future be known. Various approaches have been used to predict agricultural systems of this kind.

The primary purpose of this research was to focus on past and future cotton production and productivity trends in Tamil Nadu, India, using the appropriate prediction and trend analysis model. The selected growth models can be useful for predicting the future trends by providing an appropriate data summary.

II. Literature Review

India is the world's second largest producer of rice, wheat and maize (Khatkar et al. 2016). Rice, wheat and maize are the main cereal crops in India. In 1965-66 the green revolution probably brought rice and wheat to the surface. In India, the rate of growth for agriculture and allied industries is estimated at 4.1 percent in 2016-17 (Economic Survey 2016-17). Therefore, rice, wheat and maize will play a sustainable role in Indian agricultural growth and food safety. Rice has become a highly strategic and priority commodity for food security in India, mostly in the South and the East, while northern and western countries follow a pattern of wheat and maize. In India, cereal production and food security are at risk from climate change, stagnant yields and environmental degradation.

India is the world's second largest rice producer, one of the largest consumers and 22.3% of world production after China. It is already mainly grown in the East and South, while Punjab is the most productive in India. The government of India has initiated various programs, such as the National Food Security Mission (NFSM) and the Green Revolution in Eastern India (BGREI), to improve rice production and productivity respectively in 2007-08 and 2010-11. After Rice, wheat is India's second biggest source of food grain, accounting for 12 per cent of the global wheat production. For most Indians, it has high calories and a high protein intake (Sahu et al., 2015). It has traditionally been cultivated in northern India's largest fertile and irrigated area. Punjab and Haryana of the northern Indian plains are the market leader in wheat production and Uttar Pradesh is the leader in overall production. In India, three wheat species, namely T, were mainly cultivated. T. Aestivum. Aestivum. Aestivum. Hard and T. Hard and T. dicock. dicocca. dicocum. dicoccum. In certain parts of the country, maize is grown over the years but mainly in the kharif season, with approximately 85 percent of the region covered by the seasonal crops of the kharif (Joshi 2005). Maize is India's third largest cereal crop after rice and wheat. Its share in total food grain production is nearly 9 %. It is called the cereal queen for its highest cereal crop yield potential. It is in fact considered to be one of the most versatile crops, because it has extensive adaptability under various agro-climate conditions. The main maize growing areas are semi-arid to sub-humid and wet regions.

The crops are mainly cultivated in the low-and mid-mountain areas of West and Northeast India. Crop forecasting, irrigated cropland, production and productivity are the essential parameters for setting up aid policy decisions in the fields of food safety, efficient land allocation, technological and environmental issues etc. Use of a correct statistical technique to show the statistical forecast at the desired precision well in advance. The integrated moving average auto return (ARIMA) model is called projections with invariable time series models. The model is also called Box and Jenkin (Box et al., 1976). ARIMA model is one of the most popular prediction methods for the use of observed data with minimum prediction errors in the time series of stochastic model.

Debnath et al. (2013) predict production and cultivation of cotton in India by 2020 through the use of the Autoregressive Integrated Moving Average (ARIMA). Awal et al. (2011) have done their utmost to develop a model explicitly for the short-term rice production of Aus, Aman and Boro in Bangladesh. Iqbal et al. (2005) also used the ARIMA Model to predict the area of wheat and production in Pakistan between 2002 and 2012. Celik (2016) predicted the annual production quantities of certain cereals such as wheat, barley and maize produced in Turkey and the production quantities between 2016 and 2025. Celik (2016) predicted the annual production quantities of certain cereals such as wheat, barley and maize produced in Turkey and the production quantities between 2016 and 2025. Michel et al. (2013) presented eight statistical models that analysed time series yields and compared their ability to predict national and regional wheat yields. Hafner (2003) has submitted a review of the applicability of two general maize, rice and wheat rates to 188 countries to characterize past yield trends and to analyze the relative importance of different trends on a global level. Determine also what factors may be responsible for some countries ' slow growth and yield declines.

III. METHODS AND METHODOLOGY

The present study was carried out in the state of Tamil Nadu in India. Cotton secondary area crop data were collected from the Cotton Corporation of India (CCI) between 1980-11 and 2011-2012. In his study various growth models have been used to estimate the growth rate and to adapt the best model to better predict in the future. Data were analyzed using the software Zaitun. Goodness of fitness statistics subsequently, viz. Highest R, R2 and smaller Square Residual Sum and Mean Square Error measurements also indicate a well-fitting model with predicted model comparisons.

Goodness of fit of Trend analysis Model:

Fitness testing is an essential component of every analysis because our model represents a set of general hypotheses concerning the ecological and observational processes that our data generate. So, if our model "fits" in a certain statistical or scientific meaning, we believe it is consistent with the models hypotheses. More formally, the data are not erratic with the suppositions or the model seems appropriate. If we have sufficient data, we will obviously reject any number of statistical hypotheses. Put another way, we can always develop a model that fits into the model, making it extremely complex. As can be seen by this paradox, it seems to us that simple models that we recognize should usually be preferable, although they are inadequate, for example when they encompass essential mechanisms that are central to our understanding, or if we believe that some of the factors contributing to a lack of adaptation are minor or irrelevant to the scientific context and intended use of the model.

However, the tension is there to obtain fitting models, and this obviously comes at the cost of models easily interpreted, studied and efficiently used. Needless to say, it is often not so easy to perform a fitness test. Moreover, determining whether our goodness-of-fit test is worth anything is never really easy (or particularly convenient). Nevertheless, we recommend attempting to evaluate the fit in real applications as a general rule and offer some basic guidance and some specific guidance on SCR models.

A. Various goodness of fit of Trend analysis Models

The following measure of goodness of fit vis-a-via comparison among different competing model developed. The goodness of fit is examined by using the co-efficient of determination (R^2). Kvalseth examined the different forms of (R^2) available in the literature.

$$R^2 = 1 - \sum (y_i - \hat{y}_i)^2 \sum (y_i - \bar{y})^2$$

This is most appropriate for nonlinear statistical model. It would be used as the coefficient of determination for fit. The potential range of values of this R^2 is well defined with end points corresponding to perfect fit and complete lack of fit, such as $0 < R^2 < 1$, where $R^2 = 1$corresponds to perfect fit and $R^2 \geq 0$ for any reasonable model specification.

B. Residual Sum of Square (RSS)

$$RSS = \sum_{i=1}^{n} (y_i - (\alpha + \beta x_i))^2$$

C. Mean Square Error (MSE)

$$MSE = \sum (x_i - \hat{x}_i)^2 / (n - p)$$

Here n is the total number of observed values and p denotes the number of model parameters. These values are smaller of MSE and RSS better the model. Residual sum of square (RSS) is also known as the sum of square residuals (SSR) or sum of squared errors (SSE) of prediction. It is an amount of the difference between data and an estimated model. Where α the estimated value of the constant is term α and β is the estimated value of the slope coefficient b.

IV. RESULTS AND DISCUSSIONS

This section deals with time series data and estimated trends in Tables and Figures form of Cotton area, production and productivity in Tamil Nadu state. The results revealed that all the values of accuracy measures are highest and smaller in cubic trend model Table 1 (a, b, c)), was selected for forecasting the future trends (Table 2) of cultivated area, production and productivity in Tamil Nadu on the basis of smaller values of accuracy measures.

Table 1a: Growth models of area of Cotton crop in Tamilnadu State

Model	R	R^2	Residual sum of square Error	MSE
Linear	0.722	0.521	6.284	0.202
Quadratic	0.813	0.661	4.451	0.148
Cubic	0.863	0.745	3.338	0.015

Table 1b: Growth models of production of cotton crop in Tamilnadu state

Model	R	R^2	Residual sum of square Error	MSE
Linear	0.290	0.084	31.608	1.019
Quadratic	0.664	0.441	19.316	0.644
Cubic	0.702	0.493	17.512	0.604

Table 1c: trend growth models of productivity of cotton crop in Tamilnadu state

Model	R	R^2	Residual sum of square Error	MSE
Linear	0.913	0.834	260074.3	8389.4
Quadratic	0.664	0.441	157373.1	5245.7
Cubic	0.702	0.493	156873.1	5409.4

Table 2: Projections of area, production and productivity of cotton crop in Tamilnadu state

Year	Area (lakh. ha)	Production (lakh.bales)	Productivity (kg/ha)
2013	1.138	4.404	981
2014	1.194	4.433	1031
2015	1.274	4.485	1082
2016	1.379	4.561	1135
2017	1.510	4.664	1191
2018	1..671	4.795	1248
2019	1.861	4.957	1308
2020	2.083	5.151	1370

Shown in Table 3 results clearly revealed that there is positive increasing trend for area, production and productivity in the Tamil Nadu

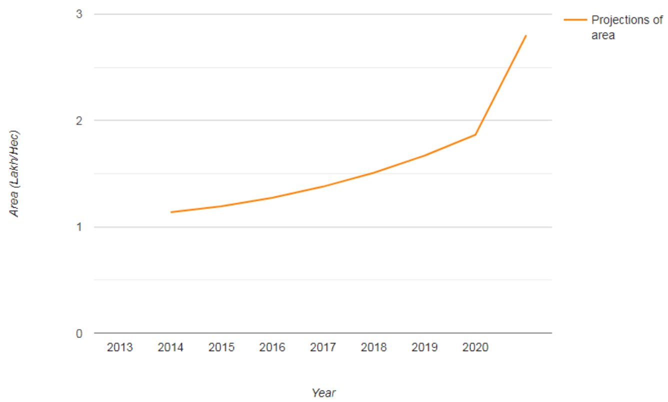

Figure 1. Area of Cotton crop in India

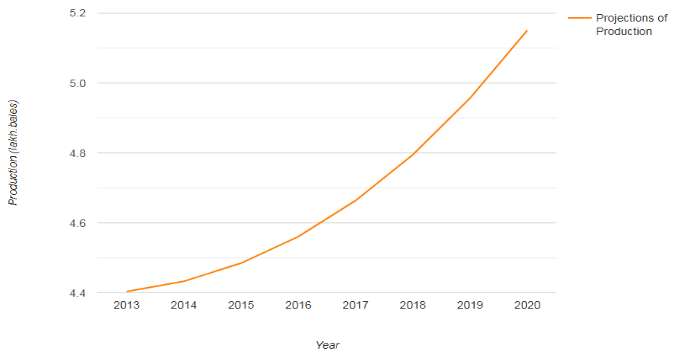

Figure 2. Production of Cotton in India.

V. CONCLUSION

The present study was the regression parameter for calculating the area, production and productivity of cotton crops grown in Tamil Nadu State India. The cotton-cultivated regression model developed in our study was the best suitable model for cubic regression. The world faces growing demand from one of the main forces, namely the continuous improvement of the human population for agricultural production. A number of good research in the trend analysis of important crops has become an hour's demand in respect of their area, production and yield in order to satisfy these increasing demands and ensure food security. The highest R2 was achieved in cotton production (74 %) (49 %) and productivity (90 %), even at the highest R value. The lowest residual square and medium square error were obtained in Table 1(a, b, c) with a minimum value. Tamil Nadu calculated its future cotton area, production and productivity projections by 2020. It was projected to achieve productivity of 2.083 (lakh.ha), 5.151(lakh.bales), and 1370(kg / ha).

References

Box, G. E. P., and Jenkins, G. M., 1976. Time Series Analysis forecasting and control. San Francisco, CA, Colorado State University, Fort Collins, Co.

Debnath, M. K., Bera, K., and Mishra, P., 2013. Forecasting area, production and yield of cotton in India using ARIMA model. Research & Reviews: Journal of Space Science & Technology. 2(1): 16- 20.

Hafner, S., 2003. Trends in maize, rice, and wheat yields for 188 nations over the past 40 years: a prevalence of linear growth. Agriculture. Ecosystems & environment.97 (1): 275-283.

Joshi, P. K., 2005. Maize in India: Production systems, constraints, and research priorities. CIMMYT.

Khatkar B.S., Chaudhary N. and Dangi P., 2016. Production and Consumption of Grains: India. In: Wrigley, C., Corke, H., and Seetharaman, K., Faubion, J., (eds.) Encyclopedia of Food Grains, 2nd Edition, 367-373. Oxford: Academic Press.

Michel, L., and Makowski, D., 2013. Comparison of statistical models for analyzing wheat yield time series. PloS one.8 (10): e78615.

Rachana, W., Suvarna, M., and Sonal, G. 2010. Use of ARIMA Model for Forecasting Pigeon Pea Production in

India, International Review of Business and Finance, 2(1), 97–102.

Sahu, P. K., Mishra, P., Dhekale, B. S., Vishwajith, K. P., and Padmanaban, K., 2015. Modelling and Forecasting of Area, Production, Yield and Total Seeds of Rice and Wheat in SAARC Countries and the World towards Food Security. American Journal of Applied Mathematics and Statistics, 3(1): 34-48.

Prabakaran, K. and Sivapragasam, C. Forecasting Areas and Production of Rice in India Using ARIMA Model, International Journal of Farm Sciences, 4(1): 99-106 (2014). 4.

Payyamozhil, S., Kachi Mohideen, A. Forecasting of Cotton Production in India Using ARIMA Model. Asia Pacific Journal of Research- A peer reviewed International Journal, XLVIII (I): 70-74 (2017). 5.

Sudar Rajan and Palanivel. Time Series Model to Forecast Production of Cotton in India: An Application of ARIMA Model. AE International Journal of Multi-Disciplinary Research, 2(1): 1-9 (2014).