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TREND ANALYSIS IN COTTON AREA FOR JUNAGADH DISTRICT OF GUJARAT

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ABSTRACT

Cotton is mainly a rainfed crop in Gujarat. About 54 per cent of the state's production comes from Surendranagar, Rajkot, Vadodara, Ahmadabad and Sabarkantha districts. Gujarat state accounts 17.10 lakh hectare area in 1960 and increases up to 30.6 lakh hectare area during year 2014-2015. The research was carried out on the polynomial (linear, quadratic and cubic) models were fitted on original data as well as three, four and five year moving averages data. The Autoregressive Integrated Moving Average (ARIMA) models were fitted to original time series data. The data from year 1960-61 to 2006-07 were used for model fitting and remaining year for testing the forecast. In polynomial models, the most suitable model was selected on the basis of adjusted R^2, significant regression coefficient, root mean square error, mean absolute error, normality and randomness of residual's (Run test) distribution. The different ARIMA models (p, d, q) were judged on the basis of autocorrelation function (ACF) and partial autocorrelation function (PACF) at various lags. All the coefficients of determination (Adj. R^2) were significant in all models of all data approach and it was maximum (75.9 percent) in third degree polynomial models on five year moving average approach. ARIMA (0, 1, 1) fulfilled all criteria for selection of model to explain the trend of cotton area in Junagadh district.

Keywords: *AR, MA, ARIMA, hapiro and wilk test, run test, polynomial model, autocorrelation function.*

INTRODUCTION

Cotton is grown in the nine major states in three different zones. About 54 per cent of the state's production comes from Surendranagar, Rajkot, Vadodara, Ahmadabad and Sabarkantha districts.

Gujarat state accounts 17.10 lakh hectare area in 1960 and increases up to 30.6 lakh hectare area during year 2014-2015. Production of cotton crop increases 36.78 lakh bales to 125 lakh bale from year 1960 to 2014-2015. Productivity of cotton crop increases from 86 kg/hectare to 707 kg/hectare from year 1960 to 2014 -2015. (Anon., 2015 b). The observation on these time series variables are varying in some pattern due to the existence of artificial and natural forces. The model developed by Box and Jenkins during the seventies, popularly known as Autoregressive Integrated Moving Average (ARIMA) model, is often found to be superior among all above mentioned models in case of the univariate time series variables which are found correlated with their lag variables. The advantage of ARIMA modelling over the other univariate time series model is that besides displaying the intrinsic behaviour (generating process) in the time series variables itself, it produces the smallest mean squared forecast error variances. But as a mark of caution, it is noted that ARIMA models are useful only for forecasting the near future values destined to appear, usually, within the five years beyond the last datum observed on the time scale. Thus, in respect of given time series, the predicted values corresponding to the future time point considered in data set, cannot be relied upon. The strength of ARIMA models lies in their ability to reveal complex structures of temporal interdependence in time series. It has also been shown that ARIMA models are highly efficient in short term forecasting (Fatimah and Gaffar, 1986).

OBJECTIVE

To study the growth trend in cotton area for Junagadh district of Gujarat

METHODOLOGY

The time series data of area of cotton crop for Junagadh district for the period 1960-61 to 2014-15 were collected from Directorate of Agriculture, Gujarat state, Gandhinagar and WHO Cell, Department of Agricultural Economics, College of Agriculture, J.A.U. The data from 1960-61 to 2006-07 were used for model fitting. Data from 2007-2008 to 2014-15 were used for testing of forecast.

Fitting of Polynomial models

(1) Linear Regression Approach (Rangaswamy, 2006)

(2) Quadratic Regression Approach (Montgomery *et al.,* 2003)

(3) Cubic Regression Approach (Montgomery *et al*., 2003)

(4) Goodness of fit of the models (Montgomery *et al.,* 2003)

(5) Test for the randomness of the residuals: (Sidney and Castellan, 1988)

(6) Test for normality of the residual :(Shapiro – Wilk, 1965)

Autoregressive (AR) and Moving Average (MA) models : (Pankratz, 1983)

(1) Autoregressive (AR) process :

This model is in the same form as the well-known simple linear regression model in which Y_t (Z_t) is the dependent variable and Y_{t-1} is the explanatory variable.

$$Z_t = C + \varphi_1 Y_{t-1} + a_t$$

Z_t= time sequenced random variable

C = constant term related to mean (μ) such that C = $\mu(1-\varphi_1)$

Φ_1 = relationship of Y_t with Y_{t-1}

a_t = a random shock element at time t

(2) Moving average (MA) process :

$$Z_t = c - \grave{e}_1 a_{t-1} + a_t$$

Where C = constant term related to mean μ and

θ = relation of a_t with a_{t-1}

RESULTS AND DISCUSSION

Fitting of trend on cotton area in Junagdh district

(1) Fitting of polynomial models

The results of fitted polynomial model is given in Table- 1 and fitted ARIMA model is given in Table-2.

Table 1 : Fitted polynomial models for cotton area in Junagadh district

Model	Moving Average	Regression constant	Regression coefficients			Adj. R^2	RMSE	MAE	S-W Test	Run test (|Z|)
		a	b	c	d					
Linear	Original	419.015**	-4.065**	-	-	20.3**	103.822	82.090	0.995	2.062
	3 year	412.932**	-4.329**	-	-	37.9**	69.874	57.354	0.982	3.605**
	4 year	414.527**	-4.543**	-	-	42.9**	64.764	55.017	0.939	5.296**
	5 year	413.193**	-4.625**	-	-	44.7**	62.107	53.117	0.918**	5.123**
Quadratic	Original	520.979**	-16.551**	0.260**	-	32.3**	94.589	81.971	0.974	1.472
	3 year	480.514**	-12.956**	0.188**	-	46.8**	63.898	55.950	0.963	4.523**
	4 year	479.931**	-13.074**	0.190**	-	51.9**	58.719	51.346	0.946	5.031**
	5 year	477.618**	-13.216**	0.195**	-	54.0**	55.994	49.151	0.945	5.544**
Cubic	Original	407.231**	10.474	-1.133	0.019**	41.8**	86.703	71.770	0.976	0.882
	3 year	362.313**	16.284	-1.384**	0.023**	65.9**	50.543	42.628	0.981	421**
	4 year	365.280**	15.885	-1.401**	0.024**	71.2**	44.930	39.690	0.958	4.19**
	5 year	358.403**	17.544**	-1.533**	0.026**	75.9**	34.676	34.676	0.963	4.938**

Table 2 : Fitted ARIMA models for cotton area in Junagadh district

ARIMA	AIC	SBC	AR(ϕ)	MA(θ)	CONS	RMSE	SW-TEST	BLQ- TEST
(0,1,1)	277.110	182.216	-	0.643**	-2.420	103.980	0.983	7.424
(1,1,1)	277.704	184.992	0.144	0.217*	-2.599	104.358	0.982	7.344
(1,1,0)	279.627	185.210	-0.325*	-	-2.558	108.251	0.979	12.117

* Significant at 5% level, ** Significant at 1% level

The present investigation was similar to that by Shah *et al* (2005) on area of sunflower in Pakistan followed quadratic model and Balanagammal *et al.* (2000) and found ARIMA (0, 1, 1) model which fulfilled all diagnostic criteria for prediction of cotton area in Tamilnadu. Thus these results are in agreement with the authors.By using quadratic model of original data approach and ARIMA (0, 1, 1) predicted values and their error percentage are given in Table 3.

Table 3 : Testing of forecast values for remaining eight years by using selected models *i.e.* quadratic model in original data approach and ARIMA (0, 1, 1) of cotton area in Junagadh district

Years	Observed Values	Quadratic		ARIMA (0,1,1)	
		Predicted values	Error Per cent	Predicted values	Error Per cent
2007-08	587	466.838	20.471	420.916	28.293
2008-09	425	488.801	15.012	516.926	-21.638
2009-10	506	511.768	-1.139	469.805	7.153
2010-11	499	535.733	-7.361	493.769	1.048
2011-12	686	560.699	18.265	500.549	27.033
2012-13	698	586.663	15.950	607.343	12.988
2013-14	713	613.627	13.937	661.531	7.218
2014-15	756	641.590	15.133	693.971	8.204

All predicted values of quadratic model gave good prediction (except it was under estimated during 2009-10 and2010-11 and was over estimated during 2007-08. In ARIMA (0, 1, 1) model, year 2008-09 was under estimated while in years2007-08 and 2011-12 was over estimated with Good predictions in rest of years. From error percentage, it was observed that ARIMA (0, 1, 1) model gives better prediction than quadratic model of cotton area in Junagadh district. (Fig.1)

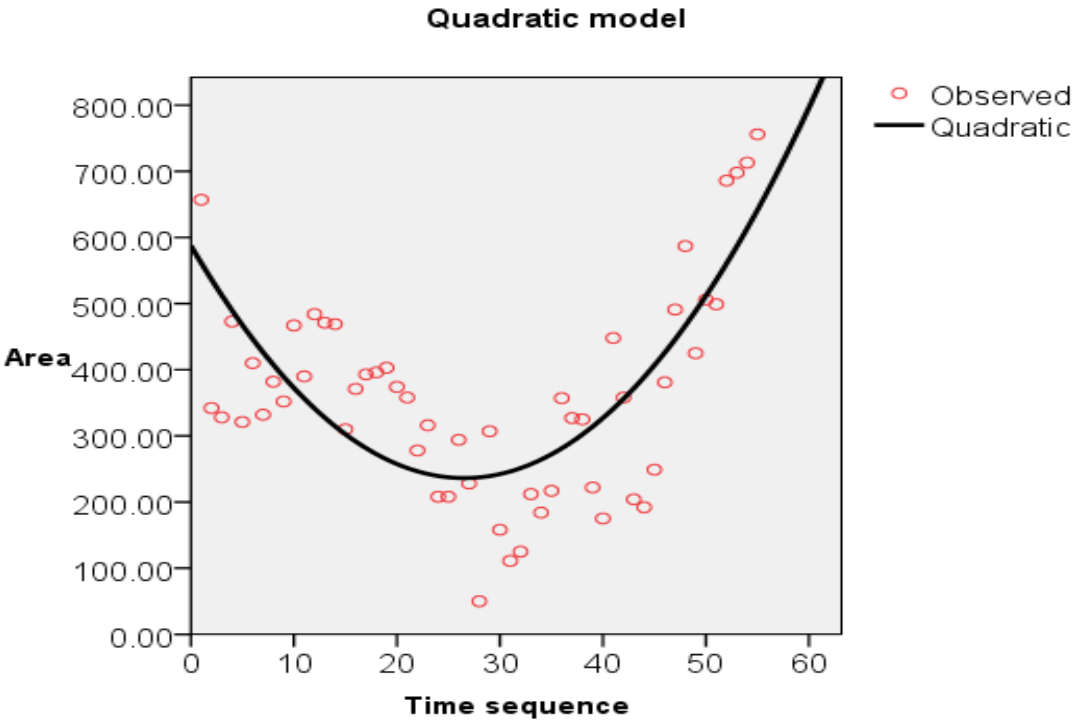

Fig. 1 : Trend in cotton area based on Quadratic model in original data approach and ARIMA (0,1,1) models in Junagadh district

CONCLUSION

The quadratic model on original data series from polynomial models was found suitable for fitting trend on area of Junagadh district. The area showed significant negative linear and positive quadratic trend. The fitted quadratic model for the production is

$\hat{Y}_t = 520.979^{**} - 16.551^{**}t + 0.260^{**} t^2$ (Adj. R^2 =32.30%)

The most suitable model on original data series for predicting the trend of cotton area in Junagadh district is ARIMA (0, 1, 1). The model is

$\hat{Y}_t = -2.420 + 0.643^{*}a_{t-1} + a_t$

For quadratic model , lowest error percentage was -1.139% during 2009-10 and highest was 20.471% during 2007-08, while in ARIMA (0,1,1) lowest error percentage was 1.048% during 2010-11 and highest (28.293%) during year 2007-08, hence ARIMA(0,1,1) gave good prediction than quadratic model.

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