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Analysis of Trend in Cotton Arrivals in Vijayapura, Haveri, Raichur and Ranibennur Markets of Karnataka, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cotton is the most important commercial crop grown in India. It is also known as 'White Gold'. India is the highest producer of cotton in the world followed by USA and China. Karnataka has the fourth position in area and production of cotton in the country. To analyse cotton arrival trend, the monthly data on arrivals of cotton was collected from Vijayapura, Haveri, Raichur and Ranibennur APMCs for the period of 16 years (2003-2018). To analyze the trend in arrivals of cotton, linear and

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nonlinear models were fitted. RMSE and R^2 values were considered to check the adequacy of the fitted models. For arrivals of cotton, in few markets linear and in other markets nonlinear models were best fitted.

Keywords: Linear model; quadratic model; cubic model; exponential model; sigmoid model; RMSE and R^2.

1. INTRODUCTION

Commercial crops play an important role in the development Indian economy. Cotton is considered as the most important commercial crop grown in India. Cotton is a natural plant fiber which grows around the seed of the cotton plant. It is also known as 'White Gold'. Among the cash crops, cotton provides the raw material to the textile industry. A significant position in the Indian economy is occupied by Cotton. Cotton does provide direct employment for about 35 million people in textile manufacturing industry which contributes about 14 per cent of export earning in our country and about fourper cent is contributed for the gross domestic product in India. India has emerged as the largest producer of Cotton in the world and occupies the first position in terms of total area and production. Among the major Cotton exporting countries in the world, India occupied third position with 5.5 million bales (USA–16.25 million bales and Brazil –10.70 million bales) (USDA, 2020-21). In India during 2020-21, production of Cotton was 371.00 lakh bales cultivated under an area of 129.57lakh hectares with a productivity of 487 kg per hectare (Cotton Corporation of India). Agricultural marketing playsan important role in the movement of farm produce from producers to the consumers and it also helps in stabilizing the prices of a commodity [1-3]. The trend in arrivals of any commodity was the long term changes observed over the years. The arrival trends are related to the growth of manufacturing technology, input supply and infrastructure. The proper research on trends allows us to show the overall direction of change in arrivals and prices in different markets.

2. METHODOLOGY

For this study, major cotton markets were selected. As per the Karnataka State Agricultural Marketing Board (KSAMB), the major cotton markets in Karnataka were Vijayapura, Haveri, Raichur, Ranibennur, Manvi and Sindhanur. Out of these six markets, Vijayapura, Haveri, Raichur and Ranibennur markets were selected for the present study based on the maximum volume of arrivals of cotton.

2.1 Data Source

The monthly data on arrivals of cotton were collected from the respective Agricultural Produce Marketing Committee (APMC) of the Vijayapura, Raichur, Haveri and Ranibennur markets. The monthly data on arrivals of cotton refers to the total arrivals of cotton in quintals during the particular month in that market. To find the trend in cotton arrival, monthly secondary data on arrivals of cotton were collected for the period of 16 years from January 2003 to December 2018. Time series analysis was adopted to study the fluctuations in monthly arrivals and prices of cotton. Time series data contains four different components namely, Secular trend (T_t), Seasonal variations (S_t), Cyclical variations (C_t) and Irregular variations (I_t). These four components are assumed to be combined different models viz., additive model, multiplicative model and pseudo additive model. For the present analysis, the multiplicative model was considered because as time progresses the fluctuations also increases in the data.

$$Y_t = T_t \times S_t \times C_t \times I_t$$

Where,

Y_t = Observation at time "t"
T_t = Trend component at time period t
S_t = Seasonal variations at time period t
C_t = Cyclical component at time period t
I_t = Irregular variations at time period t

2.2 Analysis of Long-term Movements or Trend

The trend represents the long term movement without considering the short term fluctuations in the data. The series obtain (T = Y/SC) after eliminating the seasonal component and cyclical component (if any) from the original series of data (Y_t) are used to calculate the trend. If the cyclical component is absent then trend-cycle component is treated as a trend component. To analyze the trend in arrivals of cotton, different linear and nonlinear models were fitted. The fitted models are listed as below,

Linear model, $Y_t = \beta_0 + \beta_1 T + \varepsilon$
Quadratic model, $Y_t = \beta_0 + \beta_1 T + \beta_2 T^2 + \varepsilon$
Cubic model, $Y_t = \beta_0 + \beta_1 T + \beta_2 T^2 + \beta_3 T^3 + \varepsilon$
Exponential model, $Y_t = \beta_0 \times e^{\beta_1 T} \times \varepsilon$
Sigmoid model, $Y_t = e^{\left(\beta_0 + \frac{\beta_1}{T}\right)} \times \varepsilon$

Where,

Y_t = Trend values at time t
T = Time variable
ε = Error term,

β_0 , β_1, β_2 and β_3 = the coefficients to be estimated

Analysis of data was carried out by using MINITAB and SPSS software. The best fitted model was chosen based on the $R^2$and RMSE values. The model which has the lowest RMSE value and highest R^2 value will be considered as the best fitted model.

3. RESULTS AND DISCUSSION

3.1 Cotton Arrival Trend in Vijayapura Market

To analyze the trend in arrivals of cotton in Vijayapura market, five models were fitted and estimates of the parameter for the fitted models were tabulated in Table 1. The estimates of parameters for the exponential model were found to be significant at 1 per cent level of significance. The fitted trend equation was given as follows.

$$\hat{Y}_t = 106488.94 \times e^{0.093T}$$

Where,

$\hat{Y}_t$= predicted values of arrivals at time point t
T = time variable

Model adequacy for the fitted model was done based on the value of RMSE and R^2. The exponential model was significant at 1 per cent level of significance with lowest RMSE value (101496.25) and highest R^2 value (60.4 %) among the significa nt models [4]. Actual and predicted values of arrivals by the exponential model are shown in Fig. 1.

3.2 Cotton Arrival Trend in Haveri Market

In order to analyze the trend of cotton arrival in Haverimarket, five models were fitted. The estimates of the parameters of all the fitted models are given in Table 2. The intercept of the quadratic model was found to be not significant but estimates of the coefficient of the linear and quadratic terms were significant at 1 per cent level of significance. The fitted trend equation for this model was given below.

$$\hat{Y}_t = 71862.84 + 57742.88\,T - 3064.86\,T^2$$

Where,

$\hat{Y}_t$= predicted values of arrivals at time point t
T = time variable

The quadratic model was significant at 1 per cent level of significance with lowest RMSE value (62914.86) and highest R^2 value (50.4%) among the significant models. Hence, this model was adequately fitted compared to other models. The quadratic model showed an upward trend up to 2011 after that a declining trend was observed because of change in the cropping pattern [5] Fig. 2 shows the actual and predicted values of cotton arrival by the quadratic model.

3.3 Cotton Arrival Trend in Raichur Market

Five models were fitted to analyze the trend in arrivals of cotton in Raichur market,. The estimates of the parameters of the fitted models are given in Table 3. The intercept of the quadratic model was not significant but estimates of the coefficient of the quadratic model were significant at 1 per cent level of significance. The fitted trend equation is given below.

$$\hat{Y}_t = 3939.37 + 144219.50\,T - 8600.78\,T^2$$

Where,

$\hat{Y}_t$ = predicted values of arrivals at time point t
T = time variable

RMSE and R^2 value were considered to check the adequacy of the fitted models. The quadratic model was significant at five per cent level of significance with lowest RMSE value (187939.88) and highest R^2 value (42.9 %) among the significant models [6]. Hence, this model was adequately fitted compared to other models. The quadratic model showed an upward trend up to 2011 after that a declining trend was observed. Actual and predicted values of arrivals by the quadratic model are shown in Fig. 3.

3.4 Cotton Arrival Trend in Ranibennur Market

In order to analyze the trend in arrivals of cotton in Ranibennur market, five models were fitted. The estimates of the parameters for the fitted models are given in Table 4. The estimates of the sigmoid model were significant at 1 per cent level of significance. The fitted trend equation is given below.

$$\hat{Y}_t = e^{[13.28-1.39/T]}$$

Where,

$\hat{Y}_t$= predicted values of arrivals at time point t

T = time variable

RMSE and R^2 value were considered to check the adequacy of the fitted models. The sigmoid model was significant at 1 per cent level of significance with lowest RMSE value (189677.57) and highest R^2 value (51.8%) among the significant models [7]. Hence, this model adequately fitted compared to other models. In this market, less fluctuation in arrivals was observed in the initial period and in the later period, the high fluctuation was observed. Actual and predicted values of arrivals by the sigmoid model are shown in Fig. 4.

Table 1. Estimates of parameters of fitted models for arrivals of cotton in Vijayapura market

Estimates of Coefficients of the fitted model	Fitted models for cotton arrival in Vijayapura Market				
	Linear	**Quadratic**	**Cubic**	**S curve**	**Exponential**
$\hat{\beta}_0$	48033.48^{NS}	179738.76^{NS}	122652.95^{NS}	12.578**	106488.94**
$\hat{\beta}_1$	26486.27**	-17415.49^{NS}	17676.47^{NS}	-1.01^{NS}	0.093**
$\hat{\beta}_2$		2582.46^{NS}	-2425.07^{NS}		
$\hat{\beta}_3$			196.37^{NS}		
R^2	56.8	65.8	66.7	18.5	60.4
RMSE	106544.72	94713.81	935528.64	150596.36	101496.25
p-Value	0.001	0.001	0.003	0.096	<0.001

***: Significant at 1 % level, *: Significant at 5 % level, NS: Non-significant*

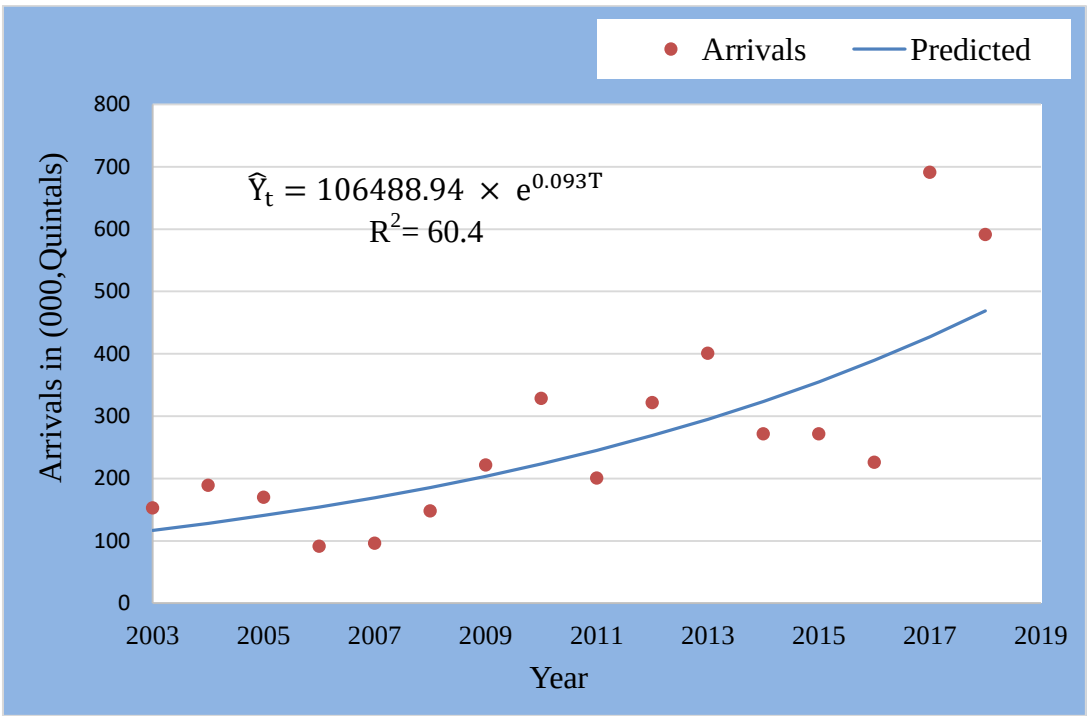

Fig. 1. Best fitted exponential model for arrivals of cotton in Vijayapura market

Table 2. Estimates of parameters of fitted models for arrivals of cotton in Haveri market

Estimates of Coefficients of the fitted model	Fitted models for cotton arrival in Haveri Market				
	Linear	Quadratic	Cubic	S curve	Exponential
$\hat{\beta}_0$	228170.65**	**71862.84**^{NS}	111557.94^{NS}	12.65**	216381.24**
$\hat{\beta}_1$	5640.269^{NS}	**57742.88****	33341.38^{NS}	-0.87*	0.021^{NS}
$\hat{\beta}_2$		**-3064.86****	417.17^{NS}		
$\hat{\beta}_3$			-136.55^{NS}		
R^2	08.5	**50.4**	51.8	27.3	06.1
RMSE	85508.54	**62914.86**	62069.18	77496.75	87820.47
p-value	0.274	**0.010**	0.028	0.038	0.357

**: Significant at 1 % level, *: Significant at 5 % level, NS: Non-significant*

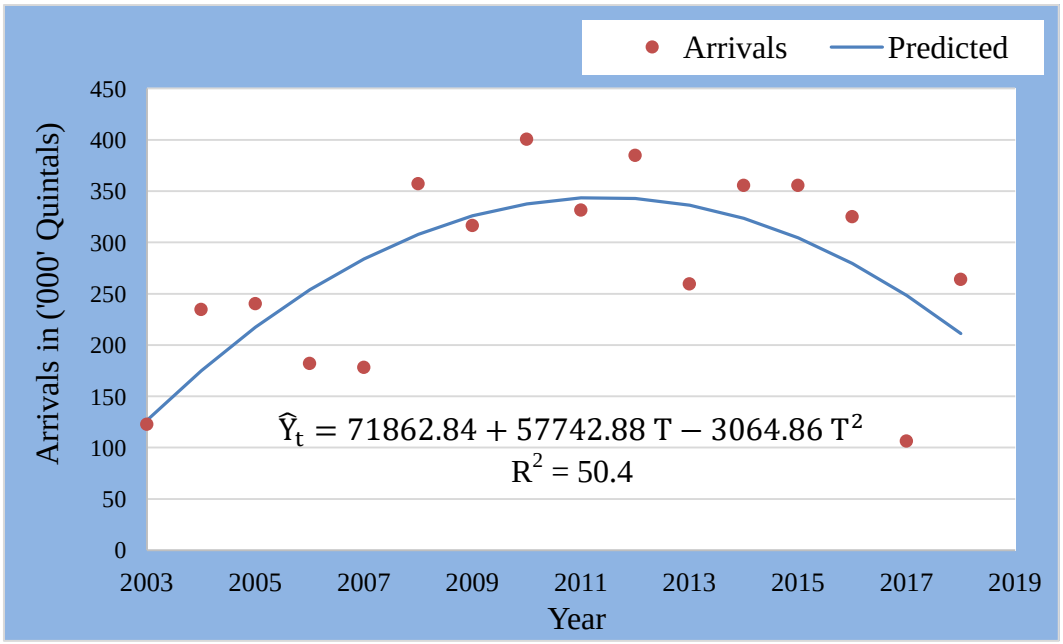

Fig. 2. Best fitted quadratic model for arrivals of cotton in Haveri market

Table 3. Estimates of parameters of fitted models for arrivals of cotton in Raichur market

Estimates of Coefficients of the fitted model	Fitted models for cotton arrival in Raichur Market				
	Linear	Quadratic	Cubic	S curve	Exponential
$\hat{\beta}_0$	442579.0**	3939.37^{NS}	144447.923^{NS}	12.967**	408276.71**
$\hat{\beta}_1$	-1993.71^{NS}	144219.50**	57845.655^{NS}	-0.774^{NS}	-0.014^{NS}
$\hat{\beta}_2$		-8600.78**	3724.53^{NS}		
$\hat{\beta}_3$			-483.35^{NS}		
R^2	00.1	42.9	45.0	10.4	01.3
RMSE	248455.0	187939.88	184382.95	247030.60	256751.36
p-value	0.892	0.026	0.059	0.222	0.676

**: Significant at 1 % level, *: Significant at 5 % level, NS: Non-significant*

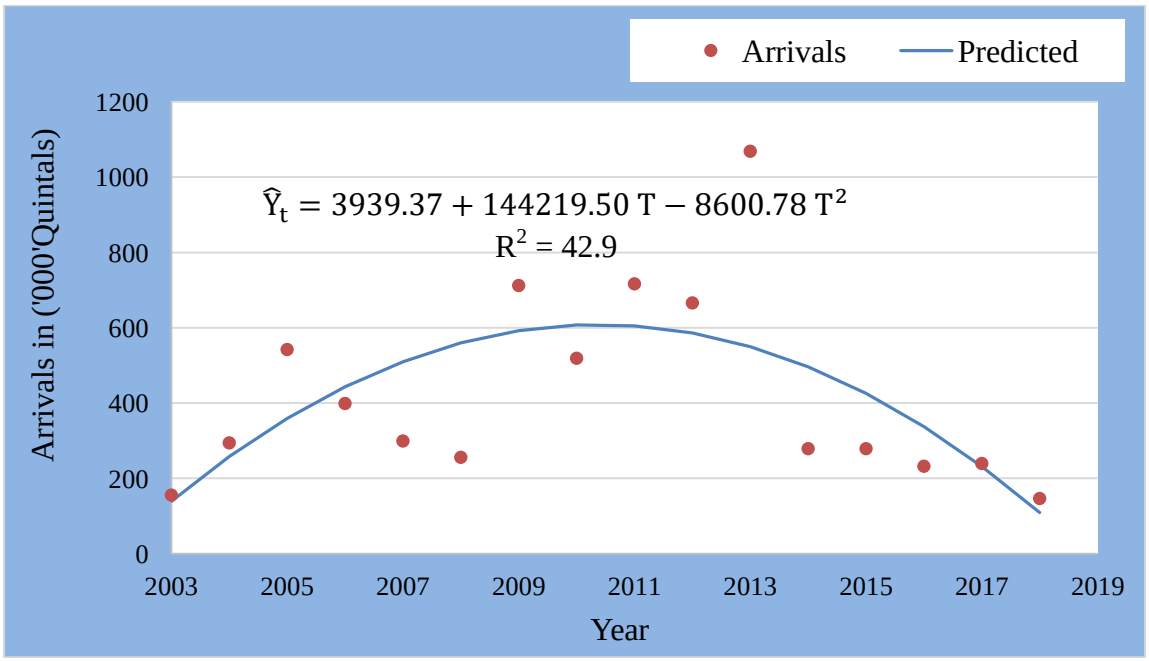

Fig. 3. Best fitted quadratic model for arrivals of cotton in Raichur market

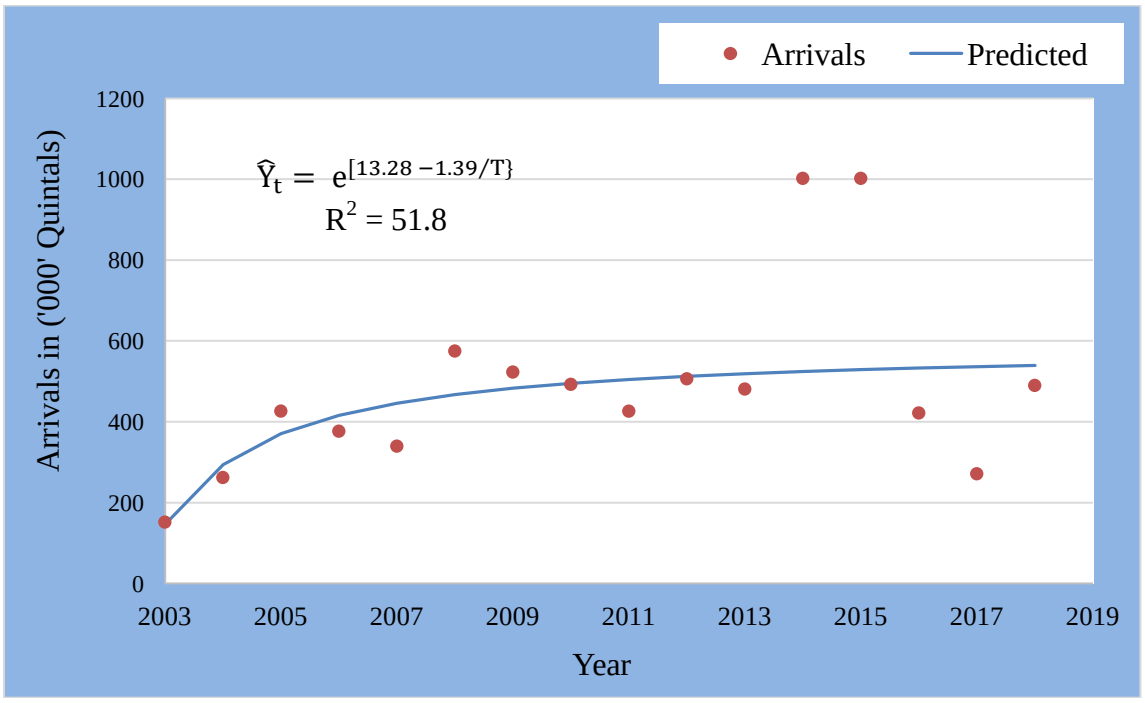

Fig. 4. Best fitted sigmoid model for arrivals of cotton in Ranibennur market

Table 4. Estimates of parameters of fitted models for arrivals of cotton in Ranibennur market

Estimates of Coefficients of the fitted model	Fitted models for cotton arrival in Ranibennur Market				
	Linear	Quadratic	Cubic	S curve	Exponential
$\hat{\beta}_0$	299308.10*	59542.82^{NS}	231632.72^{NS}	13.285**	290175.13**
$\hat{\beta}_1$	21793.907^{NS}	101715.666*	-4071.970^{NS}	-1.388**	0.049*
$\hat{\beta}_2$		-4701.28^{NS}	10394.33^{NS}		
$\hat{\beta}_3$			-591.98^{NS}		
R^2	20.3	36.2	40.2	51.8	24.9
RMSE	199006.73	178082.16	172414.33	189677.57	206675.36
p-value	0.080	0.054	0.094	0.002	0.049

***: Significant at 1 % level, *: Significant at 5 % level, NS: Non-significant*

4. CONCLUSION

To analyze the trend in arrivals of cotton in selected markets of Karnataka *viz.,*Vijayapura, Haveri, Raichur and Ranibennur market, different linear and non-linear models were fitted, among these different models Exponential model was best fitted for Vijayapura market, Quadratic model was best fitted for both Haveri and Raichur markets and S-curve model for Ranibennur market. These models were found to be best fitted models based on the value of RMSE and R^2.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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