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Application of Growth Models for Trend in Area of Wheat Crop in India

Keywords: *Linear and non-linear models and wheat and R^2 value*

Wheat crop is India's prime most staple harvest, placed second only to rice.The total area under the crop is about 29.8 million hectares in the country. In 2020, wheat production for India was 107,860 thousand tonnes.(Agricultural statistics at glance, 2020). Wheat production of India increased from 23,832 thousand tonnes in 1971 to 107,860 thousand tonnes in 2020 growing at an average annual rate of 3.42% and having a significant share in consumption of food basket with a 36% share in the total food grains produced from India and ensuring not only food security but also nutrition security (Sendhil *et al* 2019).

Growth models are widely employed in the field of agriculture as these have important policy implications (Rankja *et al,* 2019). It is a rate of variation (rate of change) in particular variable during particular time. Several linear and non - linear growth models were applied to study the trend in area of wheat in India and identifying best statistical model for analysing the area of the wheat crop and using that model in forecasting of wheat area.

The present investigation was based on secondary data which were collected from Food and Agricultural Organization (FAOSTAT) for the period of 44 years 1974-75 to 2018-19. Trend was examined by fitting seven Growth models as given in the table 1.

Table 1. Mathematical Equations for seven Growth Models

S. No.	Growth Models	Mathematical Equation
1	Linear	Y = a + bt
2	Logarthmic	Y= a + blnt
3	Quadratic	Y= $a+bt+ct^2$
4	Logistic	Y= c/(1+b*exp(-a*t))
5	Monomolecular	Y= a*(1-b*exp(-k*t))
6	Gompretz	Y= a*exp(-b)*exp(-k*t)
7	Richard	Y= a/(1+bexp(-kt))^1/m

Where, Y is the dependent variable i.e., area.
t is the independent variable, time in years,
a, b, c, k, and m are the constants. The constants 'a', 'b', 'c', 'k,' and 'm' are estimated by applying the Ordinary Least Square approach. Analysis has done by using Microsoft excel (solver).

Table 2. Growth Models for the Area of wheat in India.

Model	a	b	c/k	m	R^2	MSE	MAE	MAPE	RMSE
Linear	20.389	20.389	_	_	0.912	0.808	228310	0.001	0.899
Logarithmic	0.228	0.228	_	_	0.913	1.719	0.000	0.002	0.879
Quadratic	20.31	0.238	0.000	_	0.915	0.806	0.000	0.000	0.868
Logistic	0.022	1.131	43.15	_	0.913	0.815	0.002	0.001	0.903
Monomolecular	20.36	0.298	48.216	_	0.912	0.817	0.03	0.004	0.875
Gompertz	0.022	1.131	43.15	_	0.911	0.815	0.002	0.001	0.903
Richard	41.751	0.527	0.014	0.009	0.912	0.846	0.04	0.000	0.92

Note: The constants 'a', 'b', 'c', 'k,' and 'm' are estimated by applying the Ordinary Least Square approach.

The model with relatively high significant R^2 with least Mean Squared Error(MSE), Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE) was chosen to fit a trend equation. The best fitted growth model, which was used to fit the trend equations, can be used to estimate future estimates of wheat area.

Fitting of Growth Models for Area of wheat crop in India

Different linear and nonlinear growth models were employed to study the trends in the area of wheat It has been observed from table 2 that all the models were well fitted with the data set. However, when we compared the models using various goodness of fit criteria, it was found that quadratic model performed better than the other models. As it showed highest R^2 (0.915) value and MSE (0.806), low MAE (0.000), RMSE (0.868) and MAPE (0.000) values.

The regression coefficient (b) was positive for all the models. From this, we conclude that the wheat area was in increasing rate with respect to time in India. The quadratic model was found to be best model for prediction of wheat area in India. The result is on par with the result of Greehma *et al*. (2017) where they found that the quadratic model was the best fitted model for the prediction of area and production of Sugarcane crop for coastal region of Andhra Pradesh.

CONCLUSION

The trend in wheat area for the period 1974-75 to 2018-19 were analysed for India by using seven growth models via comparing and analysing the R^2, RMS, MAE, RMSE and MAPE values. Quadratic model was found to be best to study the trend in wheat area in India.

LITERATURE CITED

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