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Statistical Modeling for Rice Production in Pakistan

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Abstract

The aim of this study was to forecast the production of rice in Pakistan by using best fitted model on time-series data for the period 1981-82 to 2015-16 on production of rice in Pakistan. For forecasting purpose, different linear and non-linear growth models such as Linear trend model, Quadratic trend model, Cubic model, Logarithmic and Inverse models were used to find the best fitted model for production of rice in Pakistan. The best-fitted model for future forecast was chosen based upon highest Theil's U-Statistic, coefficient of determination (R^2) and significant Adjusted R^2 with least Mean Absolute Percentage Error (MAPE) values. The results showed that cubic model was best fitted model for predicting future estimates of rice production in Pakistan due to highest Theil's U-Statistic (model accuracy), highest R^2 and Adjusted R^2 having least MAPE values. By cubic model forecasted values of rice production for the year 2016-17 to 2020-21 6829.8, 6904, 6964.2, 7009.6 and 7039.1 thousand tones respectively. Price fluctuations, demand can also be estimated with these forecasts. This could be used as a guideline for policy makers in order to bring about the development of the country.

Keywords: Forecasting, linear and no-linear models, best fitted, cubic model

INTRODUCTION

Agriculture is the lifeline of Pakistan's economy accounting for 19.5 percent of the gross domestic product, employing 42.3 percent of the labour force and providing raw material for several value-added sectors. It thus plays a central role in national development, food security and poverty reduction (Government of Pakistan, 2018). In Pakistan, rice is an important food as well as cash crop, it is the second main staple food crop after wheat and second major exportable commodity after cotton. During 2017-18, area cultivated under rice crop has increased by 6.4percent to 2,899 thousand hectares compared to 2,724 thousand hectares of the corresponding period of last year. The production of rice reached historically high level of 7,442 thousand tonnes and recorded an increase of 8.7 percent over production of last year. Rice accounts for 3.1 percent in the value added in agriculture and 0.6 percent of GDP. Rice area increased due to higher domestic prices and availability of inputs on subsided rates, good advisory along with increase in export, which made rice cultivation attractive for growers, (Government of Pakistan, 2018).

Forecasting is one of the main objectives of time series analyses having the art of saying "what will happen in the future" rather than "why". There are various forecasting models in use nowadays. Forecaster can choose his own method based on his knowledge and available external information. As the process goes on, this procedure can be modified to meet the conditions and to satisfy the current situation. Different forecasting models may be fitted more or less equally well to a set of data, but they forecasts different future. Forecasting provides an important and useful input for proper, foresighted and informed planning, more so, in agriculture which is full of uncertainties. Now a day's agriculture has become highly input and cost intensive. Under the changed scenario today, forecasting of various aspects relating to agriculture is become essential. Crop yield forecasts are extremely useful in formulation of policies regarding stock distribution and supply of agricultural produce to different areas in the country. It is also used for forewarning of incidence of crop pests and diseases, weather forecasts, price forecast etc. Forecasting is central in making food policy decisions in developing countries. Keeping in view of the importance of forecasting a number of studies had been conducted by different researchers such as Abid,

S.et al. (2014a), Sudhaet al. (2013), Khan et al. (2013), Prasad et al. (2012), Sabir and Tahir (2012), Abid et al, (2014b), Bibiet al, (2014) and so on. The present study has been undertaken to evaluate the growth in production of rice in Pakistan by using different linear and non-linear growth models and also to project the same. This study has been undertaken to throw light on the policy decision to invest accordingly for the short and long-term plans and also to provide a direction of research which would bring sustainable development in agriculture. The reason that forecasting is so important is that prediction of future events is a critical input in many types of planning and decision making process with application to areas such as operation management, marketing, finance and risk management, economics, industrial process control and demography. In the computer era, forecasting can be done with the help of sophisticated statistical software more efficiently like SPSS and Minitab Software etc. The main objective of the study was to forecast the production of rice crop in Pakistan by using best fitted model.

MATERIAL AND METHODS

The trend equations were fitted by using different linear, non-linear models, exponential smoothing models and time series models for identifying the trend. Growth models are nothing but the models that describe the behaviour of a variable varying with respect to time. They are very quick to estimate and less expensive, although less efficient. They are very good in many situations for describing the growth pattern and the future movement of a time series models are widely used to estimate the growth rate of time series data.

The time-series data on production for the period 1981-82 to 2015-16 was collected from various issues of Agricultural Statistics of Pakistan, Ministry of National Food Security and Research, Government of Pakistan. For forecasting purpose, different linear and non-linear growth models such as Linear trend model, Quadratic trend model, Cubic model, Logarithmic and Inverse models were used to find the best fitted model for production of rice in Pakistan. Mathematical equations of the models were: (i) Linear trend model=$Y_t = a + bt$ (ii) Quadratic trend model= $Y_t = a + bt + ct^2$ (iii) Cubic model =$Y_t = a + bt + ct^2 + dt^3$ (iv) Logarithmic model =$Y_t = a + b \ln (t)$ (v) Inverse model = $Y_t = a + b/t$

The best-fitted model for future forecast was chosen based upon highest Theil's U-Statistic, coefficient of determination (R^2) and significant Adjusted R^2 with least Mean Absolute Percentage Error (MAPE) values.

RESULTS AND DISCUSSION

Trend in area and production of rice crop in Pakistan during the period 1981-82 to 2015-16 were presented in Figure-1. The results indicated that for the period of 1981-85 the area under the rice crop in Pakistan was 1963 thousand hectares as compared to 2660 thousand hectares planted during 2011-15, which demonstrate that area of rice crop increased over the time. The production of rice during 1981-85 to 2011-15 was increased from 3289 thousand tonnes to 6460 thousand tonnes due to the corresponding increase in rice area and increase in per hectare yield in Pakistan.

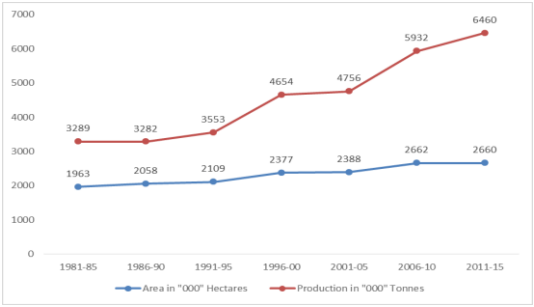

Fig.-1: Trend in area and production of Rice crop in Pakistan, 1981-82 to 2015-16

LINEAR AND NON-LINEAR MODELS FOR RICE PRODUCTION IN PAKISTAN

The performance of the model is related with how close are the prediction values for test data and the observed values. Five forecasting models such as Linear, Quadratic, Cubic, Logarithmic and Inverse models were used to find the best fitted model for production of rice in Pakistan. The results obtained for production of rice in Pakistan by fitting all the linear and non-linear models were presented in Table-1.

Table-1: Linear and non-linear models of rice production in Pakistan

Model	Parameter				Criteria			
	a	b	c	d	Theil's U-Statistic (%)	R^2	Adj R^2	MAPE
Linear	2498.3	114.6			7.88	0.82	0.81	0.9963
Quadratic	3103.4	16.5	2.72		7.28	0.86	0.85	0.9203
Cubic	**3535.1**	**-118.0**	**11.94**	**-0.17**	**17.5**	**0.87**	**0.86**	**0.634**
Logarithmic	1620.9	1116.8			7.91	0.55	0.54	0.9994
Inverse	4915.7	-2995.1			7.92	0.17	0.15	0.9994

Author's own calculation

From the above table-1, it was found that all the models fitted well showing significant adjusted R^2 values. In comparison with all other models, cubic model was with high Theil's U-Statistic (17.5 percent), high R^2 (0.87) with significant adjusted R^2 (0.86) and the low MAPE (0.634) values. Hence, the among the linear and non-linear growth models cubic model identified as the best fitted model for rice production based on model selection criteria.

FORECASTING OF RICE PRODUCTION IN PAKISTAN BY USING BEST FITTED MODEL

The future forecasts of rice production in Pakistan were calculated based on the best fitted model in Linear and Non-Linear models. Among all the models cubic was found to be best fitted model for rice production in Pakistan as it has exhibited highest Theil's U-Statistic (model accuracy), highest R^2 and Adjusted R^2 having least MAPE values.

Forecasted Cubic model is $Y_{production} = 3535.1 - 118.0\, x + 11.94\, x^2 - 0.17\, x^3$

Based on the best identified fitted cubic model the rice production was forecasted and tabulated in the Table-2. The forecast values of rice production were 6829.8, 6904, 6964.2, 7009.6 and 7039.1thousand tonnes for the year 2016-17 to 2020-21 respectively. The results of the study showed that cubic model was best fitted to production of rice crop of Pakistan.

Table-2: Forecasted production of rice crop in Pakistan by Cubic model

Year	Forecasted Rice Production ('000' tonnes)
2016-17	6829.8
2017-18	6904.0
2018-19	6964.2
2019-20	7009.6
2020-21	7039.1

Author's own calculation

CONCLUSION

The study reveals that cubic model was identified as the best model in rice production in Pakistan due to highest Theil's U-Statistic (model accuracy), highest R^2 and Adjusted R^2 having least MAPE values. It was observed that rice crop showed increasing trend by 2020-21 in production. Price fluctuations, demand can also be estimated with these forecasts. This could be used as a guideline for policy makers in order to bring about the development of the country.

REFERENCES:

1. Abid, S., I. Raza, A. Khalil, N. Khan, A. Saqib and M. A. Masood. 2014a. Trend Analysis and Forecasting of Maize Area and Production in Khyber Pakhtunkhwa, Pakistan. European Academic Res. 2(4): 4653-4664.
2. Abid, S., N.A.Shah, Hassan, A and Farooq, A. 2014b. Growth and trend in area, production and yield of major crops of Khyber Pakhtunkhwa, Pakistan. Asian Journal of Agriculture and Rural Development. 4 (2): 149-155.
3. Bibi, A., Naheed, S., Raza, I., and Khan, N. 2014. Past trends and future prospects of rice area and production in Khyber Pakhtunkhwa. International Journal of Agronomy and Agricultural Research, 4(1), 40-46.
4. Government of Pakistan. 2018. Economic Survey 2017-18 Finance Division. Economic Advisor's Wing, Islamabad.
5. Khan, S., Bhardwaj, R.K., Saxena, R.R., Bhagat, R.K and Jatav, G.K. 2013. Non-linear statistical modelling for area, production and productivity of rice crop in chattisgarh. An Asian Journal of Soil Science. 8 (1): 98-102.

6. Prasad, P.R., Supriya, K., Bhave, M.H.V and Vijayakumari, R. 2012. Growth trends of maize crop in Telangana region of Andhra Pradesh. Journal of Research, ANGRAU. 40 (4): 104-107.
7. Sabir, H.M. and S.H. Tahir. 2012. Supply and demand projection of wheat in Punjab for the year 2011-2012. Interdis.L. Contemp. Res. Bus. 3:800-808.
8. Sudha, C.K., Rao, V.S and Suresh, C. 2013. Growth trends of maize crop in Guntur district of Andhra Pradesh. International Journal of Agricultural Statistical Sciences. 9 (1): 215-220.