Jan - March 2026

Forecasting production of sugarcane crop of India

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Abstract

Agriculture is the most important sector in the Indian economy and contributes 18% of Gross Domestic Product (GDP). India is the second largest producer of sugarcane crop and produces about 20% of the world's sugarcane. This paper studies to forecast production of major commercial crop namely sugarcane of India by using Auto Regressive Integrated Moving Average (ARIMA) models, Multilayer Perceptron (MLP) and Recurrent Neural Networks (RNN) of forecasting through Python code. Data is collected from Reserve Bank of India (RBI) and used from 1960-61 to 2016-17. Productions of crop were forecasted for 7 years starting from 2017-18 to 2027-28. The performances of models are validated by comparing Root Mean Square Error (RMSE) and mean absolute percentage error (MAPE). The study of the results shows that RNN is performing better than the other models ARIMA and MLP.

Keywords: Sugarcane, Forecast, ARIMA model, RNN and MLP.

Introduction:

In India, Sugarcane is grown as a Kharif Crop. It needs hot and humid climate with an average temperature of 21°C to 27°C. 75-150 cm rainfall is favorable for sugar cane cultivation. Irrigation needed for areas with lesser rainfall. Sugarcane can grow in any soil which can retain moisture. Ideal soil for sugarcane is deep rich loamy soil. The soil needs to be rich in nitrogen, calcium and phosphorus but neither it should be neither too acidic nor too alkaline.

Sugarcane is the most important Karif crop which is cultivated in India. India is also the second largest producer of sugarcane in the world. Apart from being a second largest India is also a leading sugarcane exporter in the last financial year, India exported more than 28 lakh tons of sugarcane production. Sugarcane is used for making many things such as sugar, gur and khandsari. All these sugarcane products are widely used across India. Among all states in the country, Uttar Pradesh is the leading sugarcane producer with a production of more than 13 Crore tons. These have made the country to achieve self-sufficiency in Sugar cane, thus stabilizing the country's economy.

Sustainable Sugarcane Initiative is all about cultivating sugarcane mainly by changing the way the inputs and methods are used. It involves less use of seeds; less user of water and optimum utilization of fertilizers and land; so that more yields is obtained with minimum use of inputs. Its basic premise is to obtain "more with less" in agriculture. By changing the way of raising nursery, it brings down the cost up to 75%. It reduces plant mortality rate; helps in increasing the length and weight of cane. However, SSI is farmer driven method; and its advantages are dependent on the efforts of cultivator himself rather.

Review of Literature

Atilla Aslanargun, Berna Yazici[(1)]: Have researched on ARIMA, linear ANN, multilayer perceptron (MLP), and radial basis function network (RBFN) models are considered along with various combinations of these models for forecasting tourist arrivals to Turkey. Comparison of forecasting performances shows that models with nonlinear components give a better performance.

Vishwajith K P, Bhagyashree Dhekale[(2)]: forecasted the sugarcane area, production and productivity and sugar production of India and as well as major sugarcane growing states of India through fitting of univariate Auto Regressive Integrated Moving Average (ARIMA) models. The performances of models are validated by comparing with actual values. Using the models developed, forecasted values for sugarcane area, production, productivity and sugar production are worked out for subsequent years. These projections will help in making good policies with respect to the production scenario of the country.

Sunil Kumar Dubey, S. K. Yadav's[(3)]: This current study explored a remote sensing-based approach of predicting sugarcane yield, at district level, using Vegetation Condition Index (VCI), under the FASAL programme of the Ministry of Agriculture & Farmers' Welfare. 13-years' historical database (2003–2015) of NDVI was used to derive the VCI. NDVI products (MOD-13A2) of MODIS instrument on board Terra satellite at 16-day interval from first fortnight of June to second fortnight of October (peak growing period) were used to calculate the VCI. Stepwise regression technique was used to develop empirical models between VCI and historical yield of sugarcane over 52 major sugarcane-growing districts in five states of India. For all the districts, the empirical models were found to be statistically significant. A large number of statistical parameters were computed to evaluate the performance of VCI-based models in predicting district-level sugarcane yield. Though there was variation in model performance in different states, overall, the study showed the usefulness of VCI, which can be used as an input for operational sugarcane yield forecasting.

Vijay S. Rajpurohit and Anand M. Ambekar[(4)] : In this paper, a novel approach to sugarcane yield forecasting in Karnataka(India) region using Long Term-Time-Series (LTTS), Weather-and-soil attributes, Normalized Vegetation Index(NDVI) and Supervised machine learning(SML) algorithms have been proposed. Sugarcane Cultivation Life Cycle (SCLC) in Karnataka (India) region is about 12 months, with plantation beginning at three different seasons.

Supawadee Srikamdee, Sunisa Rimcharoen, Nutthanon Leelathakul[5]: Have researched three forecastin on a backpropagation neural network (BPNN), (μ+λ) adaptive evolution strategies (A-ES) [2], and a deep (DNN)) for predicting sugarcane quality levels (called commercial cane sugar, CCS) and yield. The perform the three models is also discussed.

Jeferson Lobato Fernandes[I]; Jansle Vieira Rocha[II,*]; Rubens Augusto Camargo Lamparelli[III(6)]:This stuc feasibility to estimate the yield at municipality level in São Paulo State, Brazil, using 10-day periods of SI NDVI images and ECMWF meteorological data. Twenty municipalities and seven cropping seasons were s 1999 and 2006. The plant development cycle was divided into four phases, according to the sugarcane physi spectral and meteorological attributes for each phase. The most important attributes were selected and the av classified according to a decision tree.

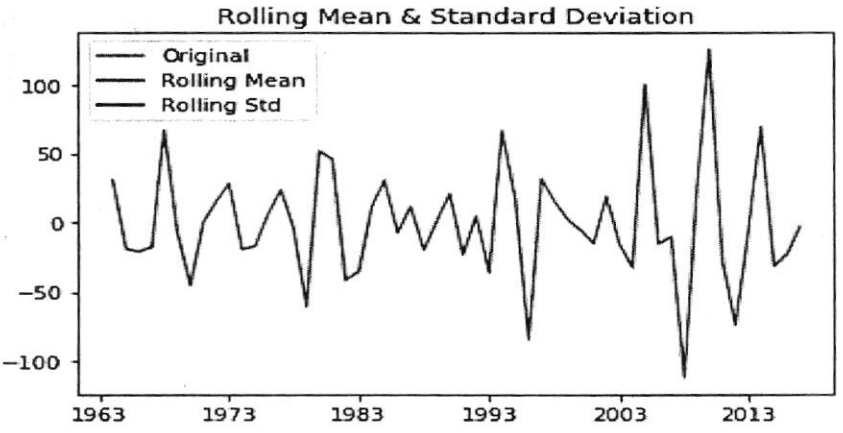
Objectives of the Study

1. Fitting ARIMA model, RNN and MLP for the sugarcane production using python code
2. To Compute the MSE, RMSE and MAPE values in all the three methods using python code
3. Forecasting sugarcane production for the next 7 years from 2017-18 to 2023-24 by using best method

Research Methodology

To fit an ARIMA model, Recurrent Neural networks and Multilayer perceptron requires a sufficiently large c study, we collected data from RBI website and used the data for commercial crop sugarcane production for th to 2016-17. As we have earlier stated that development of ARIMA model for any variable involves three steps: estimation and verification. Each of these three steps is now explained for sugarcane production.

Rolling mean and Standard Deviation for production of sugarcane




```
Results of Dickey-Fuller Test:
Test Statistic                  -6.054202e+00
p-value                          1.256511e-07
#Lags Used                       7.000000e+00
Number of Observations Used      4.600000e+01
Critical Value (1%)             -3.581258e+00
Critical Value (5%)             -2.926785e+00
Critical Value (10%)            -2.601541e+00
dtype: float64
```

First we tested whether the data is stationary by using Dickey-Fuller test
p-value less than 0.05: Reject the null hypothesis (H0), the data does not have a unit root and is stationary.
Once the data is stationary we trained years from 1961 to 2010 overall 50 years data based on this we tested th of sugarcane for 7 years from 2011 to 2017