A Critical Evaluation of Computational Methods of Forecasting Based on Fuzzy Time Series

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ABSTRACT

The agricultural production is a process, which being nonlinear in nature, due to various influential parameters like weather, rainfall, diseases, disaster, area of cultivation etc., is not governed by any deterministic process. Fuzzy time series forecasting is one of the approaches for predicting the future values where neither a trend is viewed nor a pattern is followed, for example, in case of sugar, Lahi and rice production. Various forecasting methods have been developed on the basis of fuzzy time series data, but accuracy has been a mercurial factor in these forecasts. In this paper, performance analysis of different fuzzy time series (FTS) models has been carried out. The analysis is applicable to any available time series data of product. In this paper performance analysis is done on the data of Indian agro products that include sugarcane, Lahi and rice. The suitability of different FTS models have been critically examined over the production data of the three agro products. The paper establishes the applicability of FTS methods also in the agriculture industry.

Keywords: Forecasting, Fuzzy Set, Fuzzy Time Series, High Order Model, Linguistic Value, Production

1. INTRODUCTION

Time series forecasting gives future values on the basis of past data measured over time. Forecasting on the basis of past data are carried out by various methods like regression analysis, moving averages, integrated moving average and autoregressive integrated moving average, but these methods does not support if the historical data are in linguistic terms (Singh, 2008). The sugar production and productivity are one of the such processes, which is not governed by any deterministic process due to large non-linearity caused by various influential production parameters like weather, rainfall, sunshine, diseases, disaster, area of cultivation etc. Not

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only Indian sugar industry is the second largest sector after the textile industry in its volume, but also India is the largest consumer of sugar in the world. In India, Sugar cane is the source of Sugar, which is cultivated in almost all parts of India as the country’s climatic conditions are suitable for the cane cultivation. Apart from sweetening product other by-products that are generated during processing are molasses, bagasse and ethanol. The present work aims at applying fuzzy time series models for forecasting of sugar, Lahi and rice production. It also compares the results of various forecasting models. The objective of the present work is to provide practical computational techniques using fuzzy time series with output having a higher degree of accuracy and to show the application of fuzzy time series in the field of agriculture management.

Fuzzy set theory and fuzzy logic introduced by Zadeh (1965) provides a general method for handling uncertainty and vagueness in data in linguistic terms. Various authors have given different methods for forecasting using fuzzy time series. The first model was given by Song & Chissom (1993) that used fuzzy set theory to develop models for fuzzy time series forecasting and considered the problem of forecasting enrollments in the time series data of University of Alabama. Chen (1996) proposed a method of fuzzy time series using simple arithmetic operations. (Chen, 2002) considered the forecasting of enrollments with high-order fuzzy time series models. Song and Chissom (1993) considered an average autocorrelation function as a measure of the dependency between fuzzy data for the selection of suitable order for the fuzzy time series model of forecasting. Huarng (2001a) uses the heuristic knowledge in improving Chen (1996) first order model. A major concern in using FTS as a forecasting technique lies in its applicability over different domains of data, as many researchers only worked on enrollment forecasting of University of Alabama. Singh (2007a, 2008) used the concept of difference operators in fuzzy time series forecasting. Our work analyzes these models and reaffirms the applicability of FTS methods in the field of agriculture and sugar production.

The motivation of applying the fuzzy time series forecasting models is to find ways of modeling the prediction of crop yield which is dependent on various factors. The forecasting for a lead year may be applied to help the crop planning and agro based business planning of the area and can be used in economics and business analysis. The historical time series data for sugar production used to present study have been collected from various online sources (DOFPD, 2011; ISEC, 2012; ISMA, 2012) for the period 1988 to 2010.

Figure 1 depicts the various ups and downs in the data which highlights the uncertainty and vagueness in information. These up and down depend on various factors like drought, weather, rainfall, sunshine, diseases, disaster and area of cultivation. For example, in 2003-04 due to severe drought and pest attack sugar cane area has declined. The year 2005-06 proved good for sugarcane cultivation as it received good rains during monsoon period (Nabard, 2011). From 2001-02, the area under sugarcane cultivation has declined following the continuous drought condition in the country but during 2005-06 the coverage has recovered from these short falls following the good rains and also all the state governments’ decision to hike in Statutory Minimum Price to be paid to the farmers. The recovery in acreage resulted in recovery in production as it could be evident from the graph. From 1995-96, the production displayed an increasing trend up to 2002-2003. The time series data show an uncertainty which can be resolved by fuzzy time series giving a good decision in forecasting sugar production.

2. REVIEW OF FUZZY SET THEORY AND FUZZY TIME SERIES

2.1. Fuzzy Set Theory

In the fuzzy set concept, the membership of an individual in a fuzzy set is a matter of degree (Zadeh, 1965). A function, called a membership function, assigns to each element a number in the closed unit interval (0, 1) that characterizes
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