Conclusions
CONCLUSIONS

The effective mechanism of crop forecast has enormous utility in stabilizing economy, reducing risk in production and marketing. Though forecast estimates are valid for a short life span until the availability of actual estimates, their utility in decision making is immensely recognized by the government. Imprecise forecasts in recent past have been the subject of great concern. This initiated the necessity of developing statistical models for forecasting yield of sugarcane, an important commercial crop. Yield forecast models developed with a specific data like weather may not fit other conditions. So, specific models are developed in order to suit the climatic conditions of Coimbatore region. Data pertaining to this region are collected from various resources extensively for developing models. Raw data available at source has been converted to an applicable form which could be a ready reference for future researchers to develop new models for this region. The same is presented in Appendix-I to IV. Moreover without much statistical knowledge, by simply applying values of independent variables in the model developed, pre-harvest forecast values for sugarcane crop could be obtained.

In this study, three popular nonlinear sigmoidal models namely Monomolecular, Logistic and Gompertz are used. These models are estimated using Levenberg-Marquardt algorithm, a nonlinear estimation procedure. As very limited research work has been carried out using this procedure, the present study focuses on using this procedure for sugarcane yield forecasting. Parameter estimates and percentage of deviation values of this study shows that among the three models, monomolecular model is found to be more suitable for sugarcane data on area, production and productivity. Though the parameter estimates and goodness of fit values are almost same for monomolecular and logistic models based on percentage of deviation values, it is concluded that monomolecular model best suits the data. The forecast values for sugarcane area, production and productivity are calculated using monomolecular model. Growth rates for sugarcane crop are also forecasted using monomolecular model.
ARIMA models are developed for forecasting sugarcane area, production and productivity. ARIMA (1, 1, 1) model is found to be appropriate for sugarcane area and productivity. And (2, 1, 2) model is found suitable for sugarcane production data. Results of nonlinear models are compared with ARIMA models. Comparison of results shows that the goodness of fit measures namely MSE, MAE and RMSE are very low for ARIMA model. Moreover the percentage of deviation values for ARIMA is low compared to monomolecular model. Based on above results, among two univariate models, ARIMA model best suits the Tamilnadu data on sugarcane area, production and productivity.

ARIMA and exponential smoothing models are developed for forecasting sugarcane productivity of Coimbatore. ARIMA (1, 1, 1) model is appropriate for the productivity data. The error values for ARIMA model are much less compared to exponential model. Further the percentage of deviation values for ARIMA model are less compared to exponential model. Based on this it is concluded that ARIMA model is more suitable to the Coimbatore data compared to exponential smoothing model. Further the results of ARIMA model are compared with the other multivariate models.

A new methodology is attempted in this study to use discriminant function for yield forecasting, as this methodology has not been adopted for crop yield forecasting in literature of past two decades. A quadratic model is developed for yield forecast using discriminant scores as independent variable and yield as a dependant variable.

Yield forecast model is developed using principal components as regressors. In sugarcane crop, studies have not been carried out using principal component technique. First few principal components are developed account for most of the variability in the original data. The model is developed based on principal component scores as independent variables in the place of weather variables and yield as a dependant variable. This method is considered to be advantageous as it removes multicollinearity in the data. Both discriminant function and principal component technique are data reduction methods. The number of variables used in the yield forecast model is reduced thus
avoiding the complexity of the forecast model. On comparing the results, $R^2$ values are almost same for both the models. Among other goodness of fit values, MSE value of principal component model is slightly higher compared to model using discriminant function. Percentage of deviation values for model using discriminant function is high for the year 2002, whereas for model using principal component regression, deviation values are high for the year 2003. Based on these factors it is concluded that both models perform equally better.

District level models are developed for Coimbatore district using weather variables as independent variables. Until now no attempts have been made to develop sugarcane yield forecast model for Coimbatore district using weather indices. In this study an attempt has been made to develop various different models. Among the different models developed, model using yield adjusted for trend performs better. Forecast values are calculated for the selected model. Results of the model show that $R^2$ value is slightly better and error values are lower in comparison with models using data reduction technique. Though goodness of fit measures are better, percentage of deviation values for model using weather indices is higher in comparison with the models using data reduction technique. Since the deviation values are lower for models using data reduction technique when compared to model using weather indices, it is inferred that models using data reduction technique are more accurate for forecasting. Moreover models using weather indices are computationally tedious and time consuming. And the model using weather indices requires fortnightly data. With all these shortfalls it is concluded that models using data reduction technique are more advantageous.

On comparing the three multivariate models with ARIMA model for Coimbatore district, error values are high in ARIMA model when compared with multivariate models. But percentage deviation values are better in ARIMA than the model using weather indices. It is concluded that next to models using data reduction technique, ARIMA model performs better.
Results of multivariate and ARIMA models are compared with the multiple regression method. For multiple regression model, goodness of fit measures are better when compared to other two models. But similar to the model using weather indices, though the goodness of fit measure are better, percentage of deviation values are high compared to all other models.

Based on goodness of fit measures and percentage of deviation values, it is concluded that both discriminant function model and principal component regression model perform equally better in comparison with model using weather indices, multiple regression model and univariate ARIMA model. Based on type of data available either of the models using data reduction technique could be adopted for yield forecasting. In both the models, percentage of deviation from actual value is low. Next to the above models, ARIMA model performs better. In case only univariate data is available, then ARIMA model would be an ideal choice.

Scope of Future Research

More sophisticated techniques like artificial neural networks could be applied for forecasting in future research. Since the technique requires long duration of data than available at present for model building as well as for validation, this technique is not attempted in the present study.