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A STUDY ON PRE HARVEST FORECASTING OF CROP PRODUCTION USING DIFFERENT TECHNIQUES

Md. Atheeq Sultan Ghori[1] and M. Balakrishnan[2]

[1]Research Scholar, Research and Development Centre, Bharathiar University, Coimbatore .
[2]Sr. Scientist, National Academy of Agricultural Research Management (NAARM), ICAR, Rajendra Nagar, Hyderabad.

ABSTRACT

Reliable and timely forecasts of crop production are required for various policy decisions relating to storage, distribution, pricing, marketing, import-export, etc. The official forecasts (advance estimates) of major cereal and commercial crops are issued by Directorate of Economics and Statistics. However, these advance estimates are only gustimates and not the objective estimates. In working out these estimates there is lots of subjective assessment based on several qualitative factors. So there is an urgent need to develop an efficient forecasting model. The advances in computing and information storage hove provided vast amount of data. The challenge has been to extract knowledge from this raw data; this has lead to new methods and techniques such as data mining that can bridge the knowledge of the data to the crop yield estimation. This research aimed to assess these new data mining techniques and apply them to the various variables consisting in the database to establish if meaningful relationships can be found.

KEYWORDS:- *pre harvest forecasting , different techniques , Directorate of Economics and Statistics.*

INTRODUCTION:

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries accounted for 16.6% of the GDP 2009, about 50% of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. Indian agriculture is known for its diversity which is mainly result of variation in resource and climate, to topography and historical, institutional and socio economic factors. Policies followed in the country and nature of technology that became available over time has reinforced some of the variations resulting from natural factors. As a consequence, production performance of agriculture sector has followed on uneven path and large gaps have development in productivity between different

geographic locations across the country. Agriculture as a business is unique crop production is dependent on many climatic, geographical, biological political and economic factors that are mostly independent of one another. This multiple factor introduces risk. The efficient management of these risks is imperative for the successful agricultural and consistent output of food.

The Agricultural yield is primarily depends on weather conditions, diseases and pests, planning of harvest operation. Effective management of these factors is necessary to estimate the probability of such unfavourable situation & to minimize the consequences.

Accurate and reliable information about historical crop yield is thus vital for decisions relating to agricultural risk management. Historical crop yield information is also important for supply chain operation of companies engaged in industries that use agricultural produce as raw material. Livestock, food, animal feed, chemical, poultry, fertilizer pesticides, seed, paper and many other industries use agricultural products as intergradient in their production processes. An accurate estimate of crop size and risk helps these companies in planning supply chain decision like production scheduling. Business such as seed, fertilizer, agrochemical and agricultural machinery industries plan production and marketing activities based on crop production estimates[1].

APPLICATIONS

In past decades, IT has become more & more part of our day to day life. With IT improvements efficiency can be achieved in almost any part of industry and services, now a days this is especially true for agriculture. A farmer now harvests not only crops but also growing amounts of data. These data are precise & small in scale. However, collecting large amounts of data often is both a blessing and a curse. There is a lot of data available containing information about certain asset. The soil and yield properties, which can be used to the farmers advantage. This is a common problem for which the term data mining has been coined. Data mining techniques aim at finding those patterns or information in the data that are both valuable and interesting to the farmer. A common specific problem that occurs is yield prediction. As early into the growing season as possible, a farmer interested in knowing how much yield he is about to expect. In the past, this yield prediction has actually relied on farmer's long–term experience for specific yield, crops and climatic conditions. However, this knowledge might also be available, but hidden in the small–scale. Precise data which can be collected in seasons using a multitude of seasons[13].

Upgrading and stabilizing the agricultural production at a faster pace is one of the basic conditions for agricultural development. Productions of any crop lead either by attention of area or by improvement in productivity or both. In India, the possibility of extending the area under any crop, almost, does not exist except by restoring to increased cropping intensity or crop substitution. Moreover, area and productivity of different crops are the results, and as well as the reflection of the combined effect of many factors like agro-climatic conditions resource endowment technology level, techniques adopted infrastructure, social & economic conditions many schemes have been devised to maximize the productivity of various crops in different agro-climate region, state departments, credit institution, seed/fertilizer pesticide agencies & many other partners in public & private sections are actively engaged in enhancing the productivity of different crops in different regions and under different condition. However fluctuations in crop productivity continue to dog the sector and create severe distress.

Estimation of productivity of different crops is one of the important activities undertaken by the government departments in order to monitor the progress of the sector & provide insurance to the sector. Revenue, agriculture & Economics & statistics departments are jointly involved in the

estimation process.

Researcher & many other agencies use the data so generated by the Government departments. But these are usually available only in an aggregate form & maximum of taluka level satellite images of crop slate are being used increasingly to estimate the area but productivity data have to come from crop cutting experiment. Article 243-9 of constitution of India requires the panchayat Raj institutions to be the decision making bodies in various aspects of agricultural sector and especially the implementation of the schemes. Crop Insurance is one of the important schemes of the agricultural sector. The debate in implementation of this scheme indicated requirement of the yield estimates of lower than the taluka level and especially of panchayat level[40].

The critical review of the procedures followed in different countries for obtaining reliable and timely estimates of crop area and production.. In addition to critically reviews of different countries' systems, authors have also advocated the methodology of small area estimation for obtaining precise estimates for lower levels. Further they have also commented on accuracy and cost considerations in the conduct of survey for arriving at reliable crop area and production estimation. For making this review more exhaustive, it would be better if details of the Indian Agricultural Statistics System are also highlighted The gist of the system is for proper economic planning with respect to storage, distribution, pricing, marketing, import-export etc., reliable and timely estimation of Crop area and production is very important for any nation. The various countries of the world have realized its usefulness and have more or less finalized the procedures relevant to their needs for obtaining precise and reliable estimates of area and production of various food, vegetables and horticultural crops. Likewise India has also established a sound and internationally acknowledged Agricultural Statistical System. It is a decentralized system with the State Governments – State Agricultural Statistical Authorities (SASAs) to be more specific playing a major role in the collection and compilation of Agricultural Statistics at the state level while the Directorate of Economics and Statistics, Ministry of Agriculture (DESMOA) at the centre is the pivotal agency for such compilation at the All India level. The other data gathering agencies involved are the National Sample Survey Office (NSSO) and the State Directorates of Economics and Statistics (DESs). Indian Agricultural Statistics Research Institute (IASRI) is also contributing towards statistical methodological issues of crop area and production[38].

The Agricultural Statistics System in India has a long history and is very comprehensive and provides data on a wide range of topics such as crop area and production, land use, irrigation, land holdings, agricultural prices and market intelligence, livestock, fisheries, forestry etc. The detailed description can be seen from a Manual on Area and Crop Production Statistics prepared by Ministry of Statistics and Programme Implementation, Government of India.

The estimates of crop production based on area through field enumeration and yield rate through crop cutting experiments become available much after the crop is harvested. However, the government needs advance estimates of production for various decisions relating to pricing, distribution, export and import etc. The Directorate of Economics and Statistics, Ministry of Agriculture (DESMOA) releases advance estimates of crop area and production through periodical forecasts in respect of principal food and non-food crops (food grains, oil seeds, sugarcane, fibers etc.) which account for nearly 87% of agricultural output. Four forecasts are issued, the first in the middle of September, the second in January, the third towards the end of March and the fourth by the end of May. These are based on preliminary eye estimation analysis of priority enumeration of area and crop cutting experiments. Forecasts are successively revised with the receipt of complete information[37].

In addition to conduct of General Crop Estimation Surveys (GCES), for improving quality, reliability and timeliness of Agricultural Statistics, DESMOA has also initiated the following important

schemes
TRS (Timely Reporting Scheme)
ICS (Improvement of Crop Statistics)
EARAS (Establishment of an Agency for Reporting Agricultural Statistics)
FASAL (Forecasting of Agricultural Output Using Space, Agro meteorology and Land Based Observations)

These schemes have helped in improving the estimates of area and production considerably[12].

Further, in order to bring more efficiency in the Agricultural Statistical System, Ministry of Agriculture, Government of India has set up a National Crop Forecasting Centre (NCFC) with the object of examining the existing mechanism of building forecasts of principal crops and developing more objective techniques. The NCFC takes into account information on weather conditions, supply of agricultural inputs, pests, diseases and related aspects in the formulation of scientific and objective forecasting methods to replace the present system. Though the system has improved but still there are large number of inherent problems which need to be solved on priority basis so as to arrive at reliable and timely estimates of area and production. As per the above discussed methodology, the estimates of crop production in India are obtained at somewhat higher level. In view of the decentralized system of planning in India the estimates of crop production and other important parameters are being demanded at the lower level. The existing approach cannot be used for generation of estimates at the lower level as the desired sample size is expected to increase enormously for producing estimates of crop production/yield at the lower level[11].

An alternate approach, which does not require increasing the sample size over and above being currently used, is required for generating precise estimates at lower level. Following IASRI Reference Manual-1 on Techniques of Estimation and Forecasting of Crop Production In India (2012), Sud (2012) has suggested two alternative techniques of estimation of crop yield. Both the techniques make use of auxiliary information for improving the precision of estimator of crop yield.

The first technique is based on use of double sampling regression estimator for framing small area level estimates of yield of crops. The regression estimator utilizes information obtained from the farmer about his produce in the form of auxiliary information. Thus by exploiting correlation between the farmer appraisal data about crop produce and the available crop cutting experiment data from the ongoing surveys it is possible to obtain a precise estimator of crop produce. The suggested approach not only has the potential to provide reliable estimators of yield at smaller level but it has the additional advantage that the sampling design suggested for data collection can easily fit into the approach of data collection being followed in the official statistical system. Thus, by incurring a little extra expenditure involved in collecting data on the auxiliary variable it is possible to obtain reliable estimates of crop yield at the lower level without disturbing the existing structure of data collection being used in the official statistical system[1].

The second technique also utilizes farmer appraisal data for framing estimate of crop yield at lower level. The farmer appraisal data is used to apply correction factor to scale down the official estimates available at higher level. The resulting estimates are likely to be less influenced by the effect of stakeholder interest. Even though, the farmers' estimates are likely to be influenced by the interested parties, the proportions are expected to be free from such effects provided the underestimation or overestimation is behaving in a similar way in the entire area. This approach, in fact, emanates from the standard small area estimation technique known as Synthetic method of

estimation[3].

However, this approach is still to be implemented on a larger scale. It is suggested that this may firstly be tested on a pilot basis on selected areas. The cost incurred on data collection in this approach will be substantially less than the existing crop cutting approach.

The critical review of current crop yield forecasting methods and early warning systems. Broadly this paper examines scientifically in detail the influence of all the input factors and weather on the yield of the crop. The paper has shown that crop soil simulation models can serve a guiding factor for identifying suitable location (sum of soil characteristics and weather variables) to achieve sustainable crop production. This paper is based on excellent review coverage of many important relationships between yield and various attributes affecting yield like soil and plant characteristics (both spatial and temporal) through Crop Simulation Models, Mechanistic Models and Functional Models approach. The relationship between yield and various vegetative indices has also been highlighted.

The Crop Yield Forecast has been reviewed through various angles like Crop Yield Forecast Using Statistical Models, Process Based Models and Remote Sensing.The application of remote sensing has also been illustrated to study the Yield Gap. The studies on Precision Agriculture, Nutrient Management, and Pest Management have also been highlighted by exploiting the basic concepts of remote sensing. The linkages and integration of Crop Simulation Models and Remote Sensing have been exhibited for Crop Yield Forecasting. Finally an excellent review of methodologies for Early Warning Systems is outlined by establishing relationship with droughts and climate change. In the end very useful conclusions have been drawn.

From all these methodologies, it is inferred that construction of statistical models using many variables relating to inputs, soil, plant characteristics, weather, remote sensing is a very challenging job. The worst part of statistical models is its repeatability i.e. the performance of a specific yield forecast model for a particular crop may not perform equally good in all locations or different environments. It has been felt that in real practical situations, a fresh exercise of model fitting need to be undertaken because interrelations among the variables themselves and relation with the yield may not be same in all situations. Because of this very reason, the generalization of the statistical methodology/theory is not standardized and as such the yield forecasts are mostly based on empirical statistical models only[6].

Yield Forecast Using Weather Parameters On the similar lines, some work has also been carried out in India in general and at IASRI in particular. Following IASRI Reference Manual-2 on Techniques of Estimation and Forecasting of Crop Production In India (2012), Agarwal (2012) advocated that weather affects crop differently during different stages of crop growth. Thus extent of weather influence on crop yield depends not only on the magnitude of weather variables but also on the distribution pattern of weather over the crop season which, as such, calls for the necessity of dividing the whole crop season into fine intervals. This will increase number of variables in the model and in turn a large number of parameters will have to be evaluated from the data. This is a problem of small n and large p. This will require a long series of data for precise estimation of the parameters which may not be available in practice. Thus, a technique based on relatively smaller number of manageable parameters and at a same time taking care of entire weather distribution may solve the problem. This can be achieved by following Fisher (1924) technique which requires small number of parameters to be estimated while taking care of distribution pattern of weather over the crop season by using the concept of orthogonal functions. Further Hendricks and Scholl (194) have modified Fisher's technique by dividing the crop season into n weekly intervals and have assumed that a second degree polynomial in week number

would be sufficiently flexible to express the relationship[7].

According to Baier (1977) crop weather can be classified broadly into three categories. Crop Growth Simulation Models Crop Weather Analysis Models Empirical Statistical Models The most commonly used models in crop forecasting are Empirical Statistical Models.

In this approach, one or several variables (representing weather or climate, soil characteristics or a time trend) are related to crop responses such as yield. The weighting coefficients in these equations are by necessity obtained in an empirical manner using standard statistical procedures, such as multiple regression analysis. Several empirical statistical models were developed all over the world. The independent variables included weather variables, agro meteorological variables, soil characteristics or some suitably derived indices of these variables. Water Requirement Satisfaction Index (WRSI), Thermal Interception Rate Index (TIRI), Growing Degree Days are some agro climatic indices used in models. Southern Oscillation Index (SOI) has also been used with some weather variables to forecast crop yield (Ramakrishana et al 2003). To account for the technological changes year variable or some suitable function of time trend was used in the models. Some workers have also used two time trends. Moving averages of yield were also used to depict the technological changes[8].

At IASRI, the model suggested by Hendricks and Scholl has been modified by expressing effects of changes in weather variables on yield in the wth week as function of respective correlation coefficients between yield and weather variables. This will explain the relationship in a better way as it gives appropriate weightage to different periods. Under this assumption, the models were developed for studying the effects of weather variables on yield using crop season data whereas forecast model utilized partial crop season data. Models were successfully used for different crops and at different climatic regions for forecasting (Agarwal et al 1980, 1983, 1986, 2001; and many more).

YIELD FORECAST BASED ON PLANT CHARACTERS

Effects of weather and inputs are manifested through crop stand, number of tillers, leaf area and number of ear heads etc. which ultimately determine crop yield. Usually crop features depend on different variables and inputs to crop .This procedure is used to obtain forecasting method and work regarding this is going on at IASRI.Further work in this area has been carried out by many researchers by exploiting the relationship of yield with various plant characteristics at different stages of plant growth e.g. Deosthali and Akmanchi (2006) carried out one study for yield estimation of summer crops grown in a mixed cropping area by using a spectral growth curve profile approach, Probability Model Multiple regression technique has been extensively used in developing models for crop yield forecasting. Least squares technique is used for estimating the parameters of the regression model. The optimality properties of these estimates are described in an ideal setting which is not often realized in practice. It has been observed that regression based on different subsets of data produce very different results, raising questions of model stability. To overcome some of the drawbacks of regression model, probability model for forecasting crop yield using Markov Chain theory has been developed. This method, being completely model free, does not require any assumption about independent and dependent variables. Markov Chain method has the advantage of providing non-parametric interval estimates and is robust against outliers/extreme values.

This method was applied to forecast yield of corn and cotton by USDA (Matis et al. 1985, 1989) and for sugarcane (Jain and Agarwal 1992, Agarwal and Jain 1996). Models using higher order Markov Chain and using Principal Components and growth indices of plant characters in Markov Chain approach were also developed. (Jain and Ramasubramanian, 1998; Ramasubramanian and Jain 1999; Ramasubramanium et al. 2004)

MODELS USING FARMERS' APPRAISAL

Farmer is the best udge of the likely production in the field. Farmers' appraisal therefore could serve as a good input for forecasting the yield and replace some of the characters requiring expertise or use of sophisticated instruments for the measurements and thus reducing the cost of data collection. A study was carried out to study the feasibility of using farmers' appraisal in the forecast model for sugarcane. (Agarwal and Jain 1996) The results revealed that reliable forecast could be obtained using plant population and farmers' appraisal.

Another methodology based on farmers' appraisal data has been developed using Bayesian approach. Actual harvest yield and farmers' appraisal data on yield for previous year(s) were taken into account to obtain posterior probabilities which were then used for obtaining Bayesian forecast of crop yield to current year. (Chandrahas et al. 2001)

INTEGRATED APPROACH

Further models using data on plant characters along with agricultural inputs were found to be better than models based on plant characters alone in Jowar and Apple (Jain et al. 1985, Chandrahas and Narain, 1992).

In one model it is normally impossible to include all the variables. Different models of forecasting can be combined to get a cumulative forecasting result. Different methods of combining forecasts are suggested in different situations (Mehta, 2000).

Different methods of forecasting like agro-met method and econometric method can be used at the planting time of the crop by using historical data of yield , cost, weather, humidity and other variables which will have direct impact on yield forecasting. At this stage, farmer's response may be unpredictable. Remote Sensing technique becomes effective by crop assessment once it attains sufficient ground coverage, say around 45 days after sowing. Remote sensing data provides information regarding area covered by crop, its condition and the likely yield. This coupled with agro-meteorological observations and limited field observation can provide fairly accurate information on likely yield of the crop. Remote Sensing, weather and field observations provide complementary and supplementary information for making crop forecasts. Thus an approach which integrates inputs from the three types of observations is needed to make forecasts of desired coverage, accuracy and timeliness.

This concept has been put into practice in India in the form of project named as Forecasting Agriculture output using Space, Agro-Meteorology and Land based observations or FASAL[34].

RECENT AREAS OF RESEARCH

Recently, researchers have also used Geo-informatics, Data Mining techniques, Machine Learning, Fuzzy Regression, Principal Component Regression, Discriminant Function, Neural Networks and Remote Sensing procedures for forecasting of crop yield. Lack of Proper Statistical Methodology The other concern is the lack of proper statistical methodology for real practical problems of interest, like the standard methodology for mixed crops, continuous cropping, roots crops, crops of perennial nature and fruit and vegetable crops.

In mixed cropping, at times the signatures by remote sensing are not very distinct and as such create problems in integration of information from different sources and thus needs more emphasis on research. Further the procedure of apportionment of area of different crops in mixed cropping is also not very objective and needs immediate attention of researchers. Small Farm Sizes and Crop Diversity The other problem of concern is small sizes of farms and diversity in cultivation of the crops in different

fields. This problem is of great concern for India which hinders the use of Remote Sensing technology in a bigger way. Climate Change Finally due to rapid changes in climate and natural disasters, this has put forth many challenges. Crop loss and assessment of the damages due to natural disasters is of great interest to policy planners and as such require immediate concern for the researchers[27].

CONCLUSION

Presently and huge amount of data is available with the government which can be utilized for the forecasting of the yield of the crop using the advance techniques of the data mining and neural networks which will consider all the parameters which will effect the crop yield the data sets related to that crop will be collected and after cleaning the data, The original data set was subjected to pre-processing techniques and converted in to the required format. The missing values are replaced by mean values. Then apply the data mining technique namely k-means clustering algorithm on the data set and then we get the new data set namely clustered data set. The classification technique will be applied on that clustered data set which results in hybrid model with Decision Tree which will be help full for the forecasting of the crop yield.

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Research Scholar, Research and Development Centre, Bharathiar University, Coimbatore .

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