ISSN 1819-1894

Asian Journal of Agricultural Research

http://knowledgiascientific.com

Knowledgia SCIENTIFIC
A Place to Publish Outstanding Research

OPEN ACCESS Asian Journal of Agricultural Research

ISSN 1819-1894
DOI: 10.3923/ajar.2019.1.5

Review Article
Note on the Crop Yield Forecasting Methods

[1]R.K. Singh, [2]T.R. Singh and [2]U. Kaushal

[1]Department of ASH, GIDC Engineering College, Navsari, India
[2]AMHD, SVNIT, Surat-Gujarat, India

Abstract
Increasing the accuracy of agricultural forecasting is an important application of earth observation. The study on review to aware about the ability to reliably forecast crop production, yield and quality is valuable for economic planning and commodities forecasting as well ensuring global food security. Study, regarding the overview of the current crop yield forecasting methods, which includes ways to use crop yield forecasting method to improve agriculture and rural statistics across the globe. Remote sensing, yield gap analysis and methods to yield forecasting have been discussed in this article.

Key words: Copy yield forecasting, crop yield prediction, remote sensing

Citation: R.K. Singh, T.R. Singh and U. Kaushal, 2019. Note on the crop yield forecasting methods. Asian J. Agric. Res., 13: 1-5.

Corresponding Author: T.R. Singh, AMHD, SVNIT, Surat-Gujarat, India Tel: 7096973435; 9898374543

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Agriculture occupies a significant role in the development of any country. Not just for its economy but also for the number of people who are directly or indirectly associated with it. In India as well as world over sustainable crop production has been a consistent challenge that has intrigued the agricultural researchers. Over 60% of India's land areas are cultivable making it the second leading nation in terms of total cultivable land. Agriculture products of important economic value include rice, wheat, potato, tomato, onion, mangoes, sugarcane, beans, cotton, etc. India ranks among the top five producers of many agricultural items like coffee, cotton, etc. It ranks the second biggest manufacturer of wheat and rice in the world. While India is the largest manufacturer of items like milk, many fresh fruits, spices, jute, wheat, rice, etc, it is one of the biggest producers of sugarcane in the world. In India, the majority of the farmers are not receiving the estimated crop yield due to several reasons. Every cultivator eagerly waits for the harvest which is dependent on a number of factors. In the ancient times, crop yield forecast was gathered by farmer's earlier experience with the crop. The volume of data is massive in Indian agriculture. In India the agricultural yield mainly depends on the weather conditions. The dependence on weather condition, land type, resources available leads to unpredictable crop yield. Therefore scientists and researchers are exploring methods of crop yield forecasting, which will warn farmers on the basis of the data collected and methods formulated by scientists. However maintaining land for agriculture involves a number of factors like social, political, economic and ecological factors. It also includes the number of people managing the farm, type of farm, policies of that area, resources and most importantly the weather condition. While studying these, the challenges that confront the researcher are weather that leads to variation in crop yield, soil simulation and variation in soil properties.

Only by systematic study of methods like planting, fertilisation, irrigation, cultivation, weather conditions crop forecasting can be made possible. Researchers have toiled to come up with solutions for yield forecasting and soil and crop maintenance that can optimise sustainable management of crop production. Besides this in experiments with crop and soil properties, socio-economic aspect and ecological changes have to be taken into consideration. It is difficult to find best land management practices, suitable for sustainable crop production using long term field experiment with suitable detail in space and time. Crop and soil simulation methods are affected by a number of factors therefore in different place, time and weather conditions they require different management strategies. It can be developed by testing the simulation models in diverse conditions and a combination of management strategies, that would benefit the majority of agricultural community in its endeavour to formulate sustainable crop production. In addition to providing food and unprocessed material, agriculture also gives employment to the very big percentage of the people. In crop production attack of pests and diseases are the two major aspects which need consideration. Forecasts of crop productivity, previous to harvest are needed for assorted policy agreements relating to distribution, storage, rating, marketing, import-export, etc., pests and diseases are one of the key elements of the reduction in crop yield. Suitable application of curative measures may decrease the yield loss.

HISTORY OF THE FIELD

Crop forecast greatly depends upon known facts of a certain period and it is based on assumption that the weather will approximately be the same in that period. Inputs are given by farmers, using these inputs, easily predict crop yields. Agarawal[1] has studied and explained the crop yield prediction models with reference to weather details and prediction methods.

Another significant research in the field is by Jame and Cutforth[2], who present interesting insight as their study shows conventional experience based agronomic research depending upon statistical analysis which has many limitations. On the basis of their study they remarked that traditional approach to agricultural decision making involved in which crop yields were related to some defined variables based on correlation and regression analysis. The application of correlation and regression analysis has provided some qualitative understanding variables. But the quantitative applicability of regression-based crop yield models for decision making has many limitations. Therefore Jame and Cutforth[2] recommend DSSAT or decision support system for agro-technology transfer which according to them will improve the understanding of the process and support strategic agricultural research. DSSAT is a tool that will help farmers to match the biological requirement of a crop to the physical characteristics of the land, in order to obtain specific objectives. Understanding the complexity of the agricultural system they conclude that knowledge-based systems-approach research is the key to the future of crop forecasting and it will gradually gain importance over experience-based traditional approach. Fischer *et al*.[3] have explored about plant genetic effects on soil function in the context of climate change and selection by soils, soil biota and plant-soil feedbacks.

A comprehensive study of these factors and mathematical models can be designed for sustainable productive systems.

CROP YIELD PREDICTION

The measurement of crop yield is used for food grains, legume and is usually calculated in metric tons per hectare. Crop harvest is able to refer the real seed invention from the plant. For model, production of corn yielding four innovative productions of corn would have a crop harvest of 1:4. It is also called as agricultural output. Architecture of the crop yield prediction model which includes an input module, is responsible for taking input from the farmer. The input module contains crop name, land area, soil type, soil pH, pest details, weather, water level and seed type. The feature selection module is responsible for subset selection of an attribute from crop details. The crop yield prediction model is used to predict plant growth and plant diseases. After feature selection, the data go to classification rule for grouping similar contents.

CROP SIMULATION MODEL

A Crop Simulation Model (CSM) is a simulation model that describes processes of crop growth and development as an outcome of climate, soil conditions, land surface and crop management, etc. The CSM's strength is in their ability to extrapolate the temporal patterns of crop growth and yield beyond a single experimental site. Hoogenboom *et al.*[4,5] have studied the effect of genome on cultivation as well as crop and they developed gene-base model.

To overcome some of the problems with spatial soil variability, soil properties are sub-divided into small homogenous units and results using deterministic models are aggregated to provide the entire field yield. The crop growth system in general is more stochastic than deterministic because many parts of the agro-ecosystem are heterogeneous. However, to date, crop models using a stochastic approach have not been developed to a level of usefulness in decision making except in cases where year-to-year variations in weather are accounted for using deterministic models. It is noted that deterministic crop models can be classified into three basic types: statistical, mechanistic and functional. The number of data inputs and the number and degree of sophistication of functions help to contrast model types[6].

Since the radiation (Heat) balance of the Earth is continuously perturbed cause of human activities, then as consequence the earth surface and climate changing take palace continuously. Climate as variable has major impact on regional and global crop production[7]. Mathematical models of global climate as well as regional climate model are function of atmosphere, land surface, oceans and sea ice[8]. Crop simulation models, CERES-Maize (Crop Environment Resource Synthesis), CERES-Wheat, SWAP (soil-water-atmosphere-plant) and in FoCrop[9] have been widely used to evaluate impact of climate change on crop yield. Further, Kang *et al.*[10] discussed climate change impact on crop yield, crop water productivity and food security.

REMOTE SENSING

Remote Sensing is defined as the science of acquiring information form of reflecting light/radiation, about an objects, crop canopies and forest, through the analysis of data obtained by a device, satellite or aircraft, that is not in contact with the object[11].

Continuously gathered information of land surface, crop covering area, forest vegetation, primary soil properties, climate and water monitoring are some of major applications of remote sensing. Thus remote sensing is a kind of revolution for sustainable agriculture and forest management in adverse conditions[12,13]. In future, remote sensing will play major role to estimate agricultural production, crop management and model development.

ABOUT METHODS OF CROP FORECASTING

According to Spinks[14] "Research into the methods of collecting and analyzing agricultural data has been conducted only during a comparatively short period. Much of the work carried out in developing techniques which are satisfactory from both the theoretical and practical viewpoints is widely scattered throughout individual journals. Spinks[14] survey found Sanderson[15] to be the only comprehensive work but it only discusses the methods used in United States. These methods were adopted in all countries and showed considerable scope for improvement.

When reviewing about CFM, it is noted, that the process involves extensive survey and field observations by crop correspondents who have to be stationed in the area throughout the productive period. Finally, their reports help to find crop estimation. Researchers have also identified two important components that determine crop forecasting-namely the area used for crop production and the yield per unit. The result for forecast is sought by multiplication of these two components. In this regard forecaster may use either subjective or objective method. Where subjective methods are based on the judgment of individuals and objective methods depend upon statistical data and techniques. In forecasting of both the things the area and crop yield, subjective as well as objective methods have been used.

EARLY WARNING SYSTEMS AND APPLICATIONS (EWS)

Early warning system (EWS) more advance than forecasting and it consists of risk information and communication system that actively engages communities involved in alertness. The weather and climate conditions in most of the countries are highly precarious and beside of this, some terrain experiencing frequent droughts and crop failures whose results are the ever recurring famines. Therefore, there is requires a reliable and effective early warning system (EWS) for climate monitoring and food security. The World Bank Workshop and World Meteorological Organization put emphasis on establishing reliable national and regional early warning systems for food security.

Most of the EWS worked on data, collected by remote sensing, for crop monitoring and early screening of drought, for flood as well as for climate change impacts.

Every EWS use different satellite (due to different sensor) like the advanced very-high-resolution radiometer (AVHRR) sensor used for monitor clouds and measure the thermal emission of the Earth, SPOT used for exploring the Earth's resources, climatology and oceanography and monitoring human activities, whereas Moderate Resolution Imaging Spectroradiometer (MODIS) used for time-series analyses with vegetation indices. The VIs images of several years during the growing season can help to identify crop and climate had better or worst from an old trend. Also, in east Africa, the seasonal patterns of normalized difference vegetation index (NDVI) have been associated with El Nino/Southern Oscillation (ENSO) index. Such index is derived from the atmospheric pressure patterns in the Pacific sea, the temperature anomalies of the sea surface and the anomalies in the outgoing long-wave radiation. If the ENSO information can be translated into practical advices and spread in a timely manner, farmers can adjust their management factors (such as planting, fertilization, irrigation) in order to gain positive impacts on food security and crop production. For example, in Mexico the economic gains of a EWS based on the ENSO has been estimated of about US$ 10 million annually[16]. The El Nino events are known to cause issues to farmers in South East Asia as well. For example, an El Nino event in Indonesia means delayed rainfall and less planted rice areas reducing the amount of rice produced for that growing season, thus increasing the risk of annual rice deficits[17]. Predictions of what could happen in the next 50 years suggested that farmers need to adopt new management strategies to cope with reduced rainfall during the important crop stages. The 1997-98 El Nino events, which was considered one of the strongest of the previous 50 years was related to vegetation patterns monitored by NDVI in Africa by Kogan[18]. Naylor *et al.*[17] concluded that increased investments in water storage, drought-tolerant crops, crop diversification and EWS can be adaptation strategies Indonesians' farmers could adopt to offset the negative effects of El Nino events in the future. Another part of the world where the southern oscillation is known to affect crop yield is Australia. Rimmington and Nicholls[19] discussed how the wheat yields in Australia are correlated with values of the southern oscillation index, which affects growing season rainfall. Information of the southern oscillation Index is generally available around the sowing date and therefore can provide interesting yield forecasts.

CONCLUSION

It has been concluded over the overviews of crop yield forecasting is that crop simulations models vary greatly between them. To minimize error in estimating crop production as output, through simulation models, require high quality data of soil, weather, crop management as well as highly efficient computing equipment with skilled human resources for analysis of input-data.

Further, for calibration need extensive and highly accurate quite extensive data, therefore it is not applicable to some developing countries. The integration of RS, yield gap and CSM represents an interesting alternative in crop yield forecasting. Remote sensing can quantify crop status at any given time during the growing season in a spatial context, while CSM can describe crop growth every day though the season.

REFERENCES

1. Agarawal, R., 2004. Forecasting Techniques in Crops. Indian Agricultural Statistics Research Institute, New Delhi, pp: 15.
2. Jame, Y.W. and H.W. Cutforth, 1996. Crop growth models for decision support systems. Can. J. Plant Sci., 76: 9-19.
3. Fischer, D.G., S.K. Chapman, A.T. Classen, C.A. Gehring, K.C. Grady, J.A. Schweitzer and T.G. Whitham, 2014. Plant genetic effects on soils under climate change. Plant Soil, 379: 1-19.

4. Hoogenboom, G., J.W. White, J. Acosta-Gallegos, R. Gaudiel, J.R. Myers and M.J. Silbernagel, 1997. Evaluation of a crop simulation model that incorporates gene action. Agron. J., 89: 613-620.
5. Hoogenboom, G., J.W. White and C.D. Messina, 2004. From genome to crop: Integration through simulation modeling. Field Crops Res., 90: 145-163.
6. Addiscott, T.M. and R.J. Wagenet, 1985. Concepts of solute leaching in soils: A review of modelling approaches. Eur. J. Soil Sci., 36: 411-424.
7. Abraha, M.G. and M.J. Savage, 2006. Potential impacts of climate change on the grain yield of maize for the midlands of KwaZulu-Natal, South Africa. Agric. Ecosyst. Environ., 115: 150-160.
8. Mearns, L.O., 2000. Climate Change and Variability. In: Climate Change and Global Crop Productivity, Reddy, K.R. and H.F. Hodges (Eds.). CABI Publishing, New York, ISBN: 9780851997094, pp: 7-35.
9. Aggarwal, P.K., N. Kalra, S. Chander and H. Pathak, 2006. InfoCrop: A dynamic simulation model for the assessment of crop yields, losses due to pests and environmental impact of agro-ecosystems in tropical environments. I. Model description. Agric. Syst., 89: 1-25.
10. Kang, Y., S. Khan and X. Ma, 2009. Climate change impacts on crop yield, crop water productivity and food security-A review. Progr. Nat. Sci., 19: 1665-1674.
11. Lillesand, T.M. and R.W. Keifer, 1994. Remote Sensing and Image Interpretation. 3rd Edn., John Wiley and Sons Inc., USA., ISBN: 0471026093.
12. Jaafar, H.H. and E. Woertz, 2016. Agriculture as a funding source of ISIS: A GIS and remote sensing analysis. Food Policy, 64: 14-25.
13. Meena, R.S., T. Mitran, S. Kumar, G.S. Yadav, J.S. Bohra and R. Datta, 2018. Application of remote sensing for sustainable agriculture and forest management. Inform. Process. Agric., 5: 295-297.
14. Spinks, G.R., 1956. Uses and methods of crop forecasting. Rev. Market. Agric. Econ., 24: 1-15.
15. Sanderson, F.H., 1954. Methods of Crop Forecasting. Harvard University Press, Cambridge, UK.
16. Adams, R.M., L.L. Houston, B.A. McCarl, M. Tiscareno, J. Matus and R.F. Weiher, 2003. The benefits to Mexican agriculture of an El Nino-Southern Oscillation (ENSO) early warning system. Agric. For. Meteorol., 115: 183-194.
17. Naylor, R.L., D.S. Battisti, D.J. Vimont, W.P. Falcon and M.B. Burke, 2007. Assessing risks of climate variability and climate change for Indonesian rice agriculture. Proc. Natl. Acad. Sci. USA., 104: 7752-7757.
18. Kogan, F.N., 1998. A typical pattern of vegetation conditions in southern Africa during El Nino years detected from AVHRR data using three-channel numerical index. Int. J. Remote Sens., 19: 3688-3694.
19. Rimmington, G.M. and N. Nicholls, 1993. Forecasting wheat yields in Australia with the Southern Oscillation index. Aust. J Agric. Res., 44: 625-632.