

Crop-Weather Modelling

Sugandha Chauhan^{1*} and N K Sankhyan²

¹Ph.D. Scholar, Department of Soil Science, CSK HPKV, Palampur, (H.P.) India-176062

²Registrar, Central University of Himachal Pradesh, Dharamshala, Kangra, (H.P.) -176215

Corresponding Author

Sugandha Chauhan

Email: sonnychauhan78@gmail.com



OPEN ACCESS

Keywords

Climate, Crop-weather, Crop yield, Dataset, Forecasting, Modelling

How to cite this article:

Chauhan, S. and Sankhyan, N. K. 2025. Crop-Weather Modelling. *Vigyan Varta* 6 (10): 122-125.

ABSTRACT

The change in temperature, rainfall and CO₂ concentrations do not act independently but interact with each other. The global climate is changing and agriculture have to adapt to ensure sustainability and survival. Climate disruptions to agricultural production have increased since past 40 years and are projected to increase over the next 25 years. Therefore, ensuring food security has become a paramount concern globally. Crop models are used to understand the impact of climate change on agriculture and to assist in the development of adaptation strategies. A well-tested, locally calibrated, and validated simulation models are useful tools for examining opportunities for increasing system productivity, assessing environmental trade-offs, assessing the effects of climate change and changes in soil fertility. The evaluation of a crop simulation model entails establishing trust in its ability to predict real-world outcomes. Agricultural system models are tools that provide a synthesis and quantification to evaluate the effects of water, soil, crops, management practices, and climate on the sustainability of agricultural production and to ensure food security. These models are a simplification of the reality, allow a first assessment of the complexity of climate change impact in agriculture. Crop-weather modelling involves the integration of weather data into models to simulate and predict the impact of weather conditions on crop growth, development, and yield. The integration of meteorological data, soil information, and crop-specific parameters, offer a comprehensive understanding of how different crops respond to various climatic scenarios.

INTRODUCTION

Climate change is generally a long-term change in weather over a long period of time. Due to the complexity of both agricultural systems and climate change, it is important to understand the interactions between different aspects of climate change. As per the UN report 2020, the Earth's temperature is expected to increase by 1.5 degree Celsius by 2030 due to the changing climatic dynamics. The increase in CO₂ concentration have also broken the records after the start of industrial revolution since 1950. Climate disruptions to agricultural production have increased since past 40 years and are projected to increase over the next 25 years. Therefore, ensuring food security has become a paramount concern globally.

In agriculture, researchers study the behaviour of complex agricultural systems and generate knowledge that helps researchers address complex agricultural issues or make informed decisions regarding agricultural production (Jones *et al.* 2017a, b). Agricultural system models with predictive and estimation competency have become essential tools to a growing array of farmers and decision-makers. The utilization of advanced technological tools emerges as a crucial endeavour to mitigate or predict the impact of climate change on agricultural productivity.

A model is a programme that simulates (predicts) a plant's behaviour (output) based on environmental conditions (inputs, including management) and factors describing the plant's ecophysiology (parameters). Agricultural system models are tools that provide a synthesis and quantification to evaluate the effects of water, soil, crops, management practices, and climate on the sustainability of agricultural production and to ensure food security. These models are a simplification of the reality, allow a first assessment of the

complexity of climate change impact in agriculture.

Crop-weather models by using mathematical or statistical techniques provide a simplified representation of the complex relationships between weather/climate and crop performance (growth, yield and yield components) (Baier, 1979). Crop-weather models utilize both historic and futuristic data for predicting yield parameters, planting and harvesting times for long-term planning, enhance productivity, optimize resource use, and improve resilience in the face of changing weather patterns. Ramaraj *et al.* (2013) studied the impact of climate change in agriculture over Tamil Nadu using DSSAT model on rice and groundnut and observed no trend of impact of predicted temperature on both rice and groundnut yield but CO₂ enrichment had increased the yield of both crops.

Crop models are divided into 3 types:

1. **Mathematical Models:** Physical relationship of natural phenomenon is determined by means of mathematical equation.
2. **Growth Models:** Phenomenon is expressed in the growth.
3. **Crop-Weather Models:** Govern the development of crop and its growing period based on temperature and day length.

Minimum Dataset Required by Crop-Weather Models: Good-quality data are required for the successful usage of simulation models, and such models require considerable information regarding weather, soil, cultivar, and management variables. However, the following datasets are generally necessary to run the crop models.

- a) **Weather Information:** This database provides daily temperature (maximum and minimum), sunlight hours / solar radiation, and rainfall statistics. Furthermore, data on wind speed, relative humidity and soil moisture at various depths is useful if available.
- b) **Soil Information:** This database is mostly made up of the experimental site's soil physical, chemical, and biological features.
- c) **Data on crop management:** This information contains planting date, dates when initial soil conditions were measured prior to planting/sowing, plating density, row spacing, variety, irrigation, and fertilizer practices.
- d) **Crop data that has been observed or measured:** This data includes, time series (phenology-wise or at predetermined intervals) statistics on the amount of dry matter output, height of the plant, quantity of seeds/pods per plant, leaf area index, by product yield, and grain yield.

Examples of Crop Weather Models/Simulation Models

1. Decision Support System for Agrotechnology Transfer (DSSAT)

Model: It is a software application which has crop simulation model for 42 different crops. The software utilizes input data such as daily weather data, soil surface and profile information, and detailed crop management with output as experimental data so that farmers can compare the predicted and actual output. It simulates growth, development and yield as well as precision management & regional assessments of the impact due to climate change.

2. Agriculture Production System Simulator (APSIM) Model:

A software system that provides a versatile framework

for simulating climate and soil management effects on crop growth in agricultural systems and soil resource changes. APSIM allows modular configuration of crop models, soil water, nutrients and erosion to simulate the different production systems.

3. **Info Crop Model:** It is a generic crop model that simulates the effects of weather, soils, agronomic management (planting, nitrogen, residues and irrigation) and major pests on crop growth, yield, soil carbon, nitrogen and water, and greenhouse gas emissions.

CONCLUSION

The use of advanced crop-weather models has become indispensable tool for assessing and mitigating the impact of shifting climatic patterns on crop yield. The models simulate and analyze diverse climatic scenarios, enhance crop yield, support food security, and contribute to the overall resilience of agricultural systems. The crop-weather models serve as indispensable assets in the realm of modern agriculture, offering a means to navigate the complexities posed by climate change.

REFERENCES

- Baier, W. (1979). Note on the terminology of crop-weather models. *Agricultural Meteorology*, 20,137-145.
- Jones, J.W., Antle, J.M., Basso, B., Boote, K.J., Conant, R.T., Foster, I., Godfray, H.C.J., Herrero, M., Howitt, R.E., Janssen, S., Keating, B.A., Munoz-Carpena, R., Porter, C.H., Rosenzweig, C. & Wheeler, T.R. (2017b). Toward a new generation of agricultural system data, models, and knowledge products: state of agricultural systems science. *Agric Syst*, 155,269–288.

Jones, J.W., Antle, J.M., Basso, B., Boote, K.J., Conant, R.T., Foster, I., Godfray, H.C.J., Herrero, M., Howitt, R.E., Janssen, S., Keating, B.A., Munoz-Carpena, R., Porter, C.H., Rosenzweig, C. & Wheeler, T.R. (2017a). Brief history of agricultural systems modelling. *Agric Syst*, 155,240–254.

Ramaraj, A.P., Jagannathan, R. & Dheebakaran, G. (2013). Impact of climate change on rice and groundnut yield using précis regional climate model and DSSAT crop simulation model. ISPRS Archives XXXVIII-8/W3 Workshop Proceedings. Impact of Climate Change on Agriculture,143-146.