Introduction

The Decision Support System for Agrotechnology Transfer (DSSAT) Version 4.8 is a software application program that comprises crop simulation models for over 45 crops. DSSAT v4.8 is supported by data base management programs for soil, weather, and crop management and experimental data, and by utilities and application programs to make it functional for users. The crop simulation models simulate growth, development, and yield as a function of the soil-plant-atmosphere dynamics. DSSAT and its crop simulation models are being used for many applications ranging from gene-based modeling, on-farm, and precision management to regional assessments of the impact of climate variability and climate change. It has been in use for more than 30 years by researchers, educators, consultants, extension agents, growers, and policy and decision makers in over 190 countries worldwide.

The crop models require daily weather data, soil surface and profile information, and detailed crop management as input. Crop genetic information is defined in a crop species file that is provided by DSSAT and cultivar or variety information that should be provided by the user. Simulations are initiated either at planting or prior to planting through the simulation of a bare fallow period. These simulations are conducted at a daily step and, in some cases, at an hourly time step depending on the process and the crop model. At the end of the day the plant and soil water, nitrogen and carbon balances are updated, as well as the crop's vegetative and reproductive development stage.

For applications, DSSAT combines crop, soil, and weather databases with crop models and application programs to simulate multi-year outcomes of crop management strategies. DSSAT integrates the effects of soil, crop phenotype, weather, and management options, and allows users to ask "what if" questions by conducting virtual simulation experiments on a desktop computer in minutes that would consume a significant part of an agronomist's career if conducted as real experiments.

DSSAT also provides for evaluation of crop model outputs with experimental data, thus allowing users to compare simulated outcomes with observed results. This is critical prior to any application of a crop model, especially if real-world decisions or recommendations are based on

modeled results. Crop model evaluation is accomplished by inputting the user's minimum data, running the model, and comparing outputs with observed data. By simulating probable outcomes of crop management strategies, DSSAT offers users information to rapidly appraise new crops, products, and practices for adoption.

The release of DSSAT v4.8 incorporates changes to both the structure of the crop models and the interface to the models and associated analysis and utility programs. The DSSAT package incorporates models of more than 45 different crops, data management tools and application programs. The new crops that were recently added are amaranth, sunflower, safflower, alfalfa, quinoa, chia, teff, Guinea grass, strawberry, guar, lentil, and carinata. New crop modules include the CROPGRO-Forage module for forage simulations, the NWheat module for simulation of wheat and teff, the MANIHOT module for the simulation of cassava, the SAMUCA module for the simulation of sugarcane, and the CERES-Teff model for the simulation of teff.

Minimum Data

The minimum data set (MDS) refers to a minimum set of data required to run the crop models and evaluate crop model simulation and outputs. Evaluation requires:

1. Site weather data for the duration of the growing season
2. Site soil profile and soil surface data
3. Crop management data from the experiment
4. Observed experimental data from the experiment

Weather Data

The minimum required weather data includes:

- Latitude and longitude of the weather station,
- Daily values for total incoming solar radiation (MJ/m²-day),
- Maximum and minimum daily air temperature (ºC), and
- Daily total rainfall (mm).

You may also include dry and wet bulb temperatures and wind speed as optional data. The length of weather records for evaluation must, at minimum, cover the duration of the experiment and preferably should begin a few weeks before planting and continue a few weeks after harvest so that "what-if" type analyses may be performed.

Soil Data

Desired soil data includes soil classification using the traditional US system from the Soil Conservation Service (SCS), surface slope, color, permeability, and drainage class. Soil profile data by soil horizons include:

- upper and lower horizon depths (cm),
- percentage sand, silt, and clay content,
- 1/3 bar bulk density,
- organic carbon,
- pH in water,

- aluminum saturation, and
- root abundance information.

Management and Experiment Data
Management data includes information on planting date, dates when soil conditions were measured prior to planting, planting density, row spacing, planting depth, crop variety, irrigation, and fertilizer practices. These data are needed for both model evaluation and strategy analysis. In addition to site, soil, and weather data, experimental data include crop growth data, soil water and fertility measurements. These observed data are needed for model evaluation.

Product Information

Components
The Cropping System Model (CSM) released with DSSAT v4.8 represents a major departure from DSSAT v3.5 and earlier released versions of DSSAT. This does not refer to the function but more to design. The computer source code for the model has been restructured into a modular format in which components separate along scientific discipline lines and are structured to allow easy replacement or addition of modules. CSM now incorporates all crops as modules using a single soil model and a single weather module. The new cropping system model now contains models of more than 45 crops derived from the old DSSAT CROPGRO, CERES, and SUBSTOR crop growth models, as well as other new model templates such as NWheat, MANIHOT, and SAMUCA.

The major modules are:

- **Land Module**

- **Management Module**

- **Soil module**
  - A soil water balance sub-module
  - An inorganic nitrogen sub-module
  - Two nitrogen and carbon organic matter sub-modules
  - A phosphorus sub-module

- **Weather module** - Reads or generates daily weather data

- **Soil-Plant-Atmosphere module** - Deals with competition for light and water among the soil, plants, and atmosphere

- **Pest module**
  - A pest coupling point sub-module

- **CROPGRO Plant Growth Module**
  - Grain Legumes - Soybean, peanut, dry bean, chickpea, cowpea, velvet bean, pigeon pea, faba bean, guar, lentil, Bambara groundnut
  - Vegetables – Tomato, bell pepper, cabbage, and green bean
  - Fiber crops – Cotton
  - Fruit crops – strawberry, pineapple
  - Oil crops – Canola, carinata, safflower, sunflower
  - Pseudo cereals – Chia, quinoa, amaranth

- **CROPGRO Forage Plant Growth Module**
  - Alfalfa
  - Bahia Grass
  - Brachiaria
  - Bermuda Grass
  - Guinea Grass

- **CERES-Maize Plant Growth Module**
  - Grain Cereals – Maize

- **CERES-Sweetcorn**
  - Vegetables – Sweet Corn

- **CERES-Rice Plant Growth Module**
  - Grain Cereals - Rice

- **CERES-Sorghum Plant Growth Module**
  - Grain Cereals - Sorghum

- **CERES-Millet Plant Growth Module**
  - Grain Cereals – Pearl Millet
-
- **CERES-Wheat Plant Growth Module**
  - Grain Cereals – Wheat, barley

- **IXIM Plant Growth Module**
  - Grain Cereals - Maize

- **SUBSTOR Plant Growth Module**
  - Root Crops - Potato

- **AROID Plant Growth Module**
  - Root Crops - Taro
  - Root Crops – Tanier

- **CROPSIM Plant Growth Module**
  - Root Crops – Cassava
  - Grain Cereals – Wheat, barley

- **CANEGRO Plant Growth Module**
  - Sugar/Energy Crops – Sugarcane

- **CASUPRO Plant Growth Module**
  - Sugar/Energy Crops – Sugarcane

- **NWHEAT Plant Growth Module**
  - Grain Cereals – Wheat
  - Grain Cereals – Teff

- **MANIHOT Plant Growth Module**
  - Root Crops – Cassava

- **SAMUCA Plant Growth Module**
  - Sugar/Energy Crops – Sugarcane

- **CERES-Sugarbeet Plant Growth Module**
  - Sugar/Energy Crops – Sugar beet

- **ALOHA-Pineapple Plant Growth Module**
  - Fruit Crops – Pineapple

Source code

The source code for the underlying Cropping System Model (CSM) and associated data of DSSAT can be obtained from the DSSAT Foundation repository on GitHub (https://github.com/DSSAT). CSM is distributed under the 3-Clause BSD Open Source License (https://opensource.org/licenses/BSD-3-Clause).

For further updates on DSSAT, the individual components, development, training, and related activities, please check the DSSAT web portal at www.DSSAT.net. You might also want to subscribe to the DSSAT Listerv, with over 29,500 unique e-mail addresses of DSSAT users and others interested in crop modeling and decision support systems.

References

Hoogenboom, G., C.H. Porter, K.J. Boote, V. Shelia, P.W. Wilkens, U. Singh, J.W. White, S. Asseng, J.I. Lizaso, L.P. Moreno, W. Pavan, R. Ogoshi, L.A. Hunt, G.Y. Tsuji, and J.W. Jones. 2019. The DSSAT crop modeling ecosystem. In: p.173-216 [K.J. Boote, editor]

Advances in Crop Modeling for a Sustainable Agriculture. Burleigh Dodds Science Publishing, Cambridge, United Kingdom (http://dx.doi.org/10.19103/AS.2019.0061.10)

Hoogenboom, G., C.H. Porter, V. Shelia, K.J. Boote, U. Singh, W. Pavan, F.A.A. Oliveira, L.P. Moreno-Cadena, T.B. Ferreira, J.W. White, J.I. Lizaso, D.N.L. Pequeno, B.A. Kimball, P.D. Alderman, K.R. Thorp, S.V. Cuadra, M.S. Vianna, F.J. Villalobos, W.D. Batchelor, S. Asseng, M.R. Jones, A. Hopf, H.B. Dias, A. Jintrawet, R. Jaikla, E. Memic, L.A. Hunt, and J.W. Jones. 2024. Decision Support System for Agrotechnology Transfer (DSSAT) Version 4.8.5 (www.DSSAT.net). DSSAT Foundation, Gainesville, Florida, USA.

Jones, J.W., G. Hoogenboom, C.H. Porter, K.J. Boote, W.D. Batchelor, L.A. Hunt, P.W. Wilkens, U. Singh, A.J. Gijsman, and J.T. Ritchie. 2003. DSSAT Cropping System Model. European Journal of Agronomy 18:235-265.

DSSAT History

DSSAT has been developed through a collaboration among scientists at the University of Florida, University of Hawaii, University of Guelph, the International Fertilizer Development Center, USDA-Agricultural Research Service, Universidad Politecnica de Madrid, and other scientists associated with the DSSAT Foundation and the former International Benchmark Sites Network for Agrotechnology Transfer Project.

Contact Information

For further information about DSSAT or if you experience any problems, please do not hesitate the core DSSAT development team listed below.

- Gerrit Hoogenboom, University of Florida; gerrit@ufl.edu
- Vakhtang Shelia, University of Florida; vakhtang.shelia@ufl.edu
- Fabio Oliveira, University of Florida; fabioaug.antunes@ufl.edu
- Willingthon Pavan, University of Florida; wpavan@ufl.edu
- Upendra Singh, International Fertilizer Development Center; usingh@ifdc.org