

## How to Introduce a New Crop into DSSAT [DRAFT of actual material for documentation]

### Introduction

As eco-physiological models increase in agricultural research and decision support, demand for the ability to simulate the performance of crops not currently presented in DSSAT is also increasing. Similarly, model inter-comparisons consistently show that ensemble predictions from different models of a given crop are generally more accurate than any single model. Together, these remarks indicate a need to allow DSSAT to readily incorporate new crops as well as alternate models of crops already represented in DSSAT. Previously, introducing new crops or alternate models required updating the DSSAT shell source code, re-compiling the code, providing the updated executable, manually editing several the Cropping System Model (CSM) supporting files and changing root folder structure by adding new folders for newly introduced crops by the DSSAT development team and not by a user. For crops modeled within CSM, the CSM source code also required changes to accommodate new crops even if its physiology was similar to existing crops. Through a collaborative project of the University of Florida and USDA-ARS, the DSSAT and CSM code were modified to allow users to introduce new crops and alternate models without having to modify the source code of the DSSAT Shell or CSM and consequently, to re-compile them. The use of this feature is outlined below.

We emphasize that introducing new crops or models requires a solid understanding of the basic operation of DSSAT and of the meaning of parameters found in the cultivar, species, and ecotype files. For people wishing to learn more about DSSAT, an excellent starting point is a [DSSAT training workshop](#). A further requirement is to have reliable time-series and/or end-season data from field experiments that quantify crop growth and development in order to support model calibration and evaluation. See [Data Resources](#) for information on acquiring data for model development and evaluation.

The key to our approach for adding new crops is to insert mandatory information for a new crop and its associated model(s) to three parameter files used by DSSAT:

```
SIMULATION.CDE
DETAIL.CDE
DSSATPRO.v??
```

Where ?? replaces version number related information (for example, 48 for DSSAT version 4.8). Also it is mandatory to create a new folder under crop name (without spaces) in the DSSAT root folder. The three files contain a subset of the information generated from the DSSAT crop master list (viewable and downloadable [here](#)). The files are located in the root DSSAT folder and normally, should not be edited by users. Table 1 shows selected content of the DSSAT crop master list needed for this purpose. The five parameters required are as follows:

Crop name: The common, unique name of the crop being added or for which a model is being added. Given in the crop master list in the column with header "Common\_name".

Crop code: A unique two-letter code assigned to the crop. Given in the crop master list in the column with header “DSSAT\_code”.

Model: The five-letter name of the model that is used to simulate the crop. Given in the crop master list in the column with header “Default\_module”.

Description: A brief description that indicates the crop and the models (e.g., “CRGRO-Lima bean”. This name appears when the mouse pointer hovers over the corresponding node for the crop. Given in the crop master list in the column with header “Default\_description”.

Tree node: The group name within the tree view in the DSSAT Shell where the crop will appear such as “Cereals”, “Legumes”, etc. Given in the crop master list in the column with header “DSSAT tree node”.

**Table 1.** Examples of parameter values that are required by the DSSAT shell to identify a new crop or model.

Common name	Crop code	Module	Description	Tree node
Lima bean	LB	CRGRO	CRGRO-Lima bean	Legumes
Tepary bean	TB	CRGRO	CRGRO-Tepary bean	Legumes

## **Adding New Crops or Models to DSSAT**

There are two modes for adding crops or models to DSSAT. The primary mode allows for any DSSAT user to add a crop or model locally (i.e., only on their computer system) and accessible only by him/her. The second allows the core DSSAT development team to add crops or models in such a way that the changes are accessible to the entire DSSAT user community.

### **Adding new crops/model: local addition**

From the DSSAT shell interface and main menu “Crops”, users can introduce a new crop by selecting “Add new crop” (Fig. 1) and filling in the fields on the displayed form (Fig. 2). Upon saving the changes, the various files are automatically modified, and the new crop folder is created. Additionally, from the same menu option, a user can edit or delete any new, only-locally introduced crop related information.

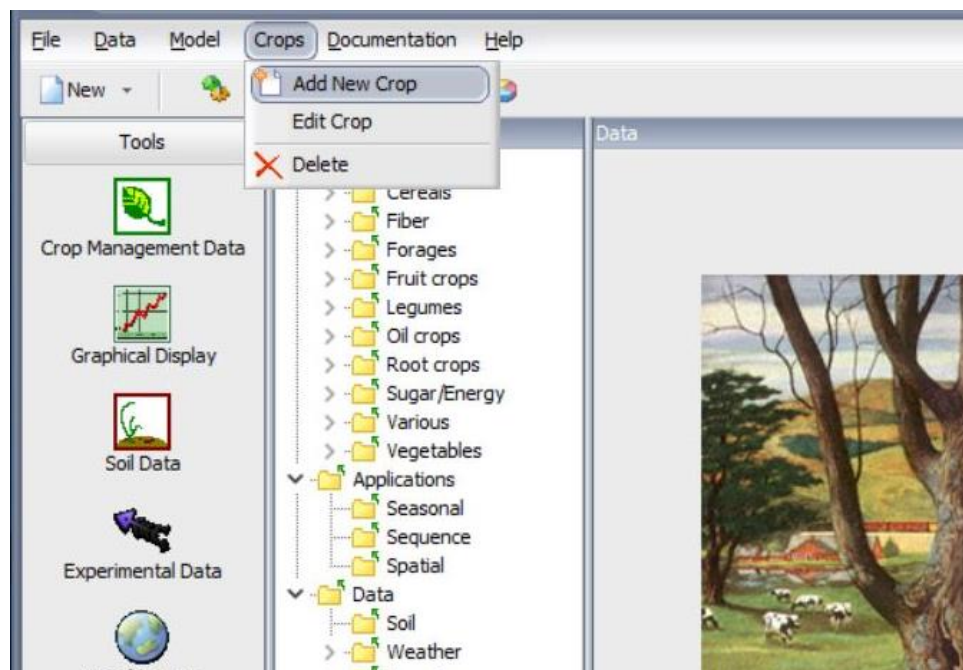


Fig. 1. The DSSAT shell menu option “Crops” for working with a new crop.

 The image shows the 'Add New Crop' dialog box. It contains several input fields: 'Crop:' with the text 'Lima bean', 'Crop Code:' with 'LB', 'Module Name:' with 'CRGRO', and 'Description:' with 'CRGRO-Lima bean'. The 'DSSAT Tree Node:' field is a dropdown menu currently showing 'Legumes'. At the bottom right, there are 'Save' and 'Cancel' buttons.

Fig. 2. The form for entering a new crop related information.

Alternatively, a user has an option to add/edit/delete a new crop by right clicking on the crop tree view and on the selected crop group node or under it in the DSSAT Shell interface and using context-sensitive menu options (Fig. 3). This menu has the same effect as from the main

menu “Crops” option, but additionally allows automatically taking selected the tree node for adding or crop for editing/deleting by filling fields in the popup window.

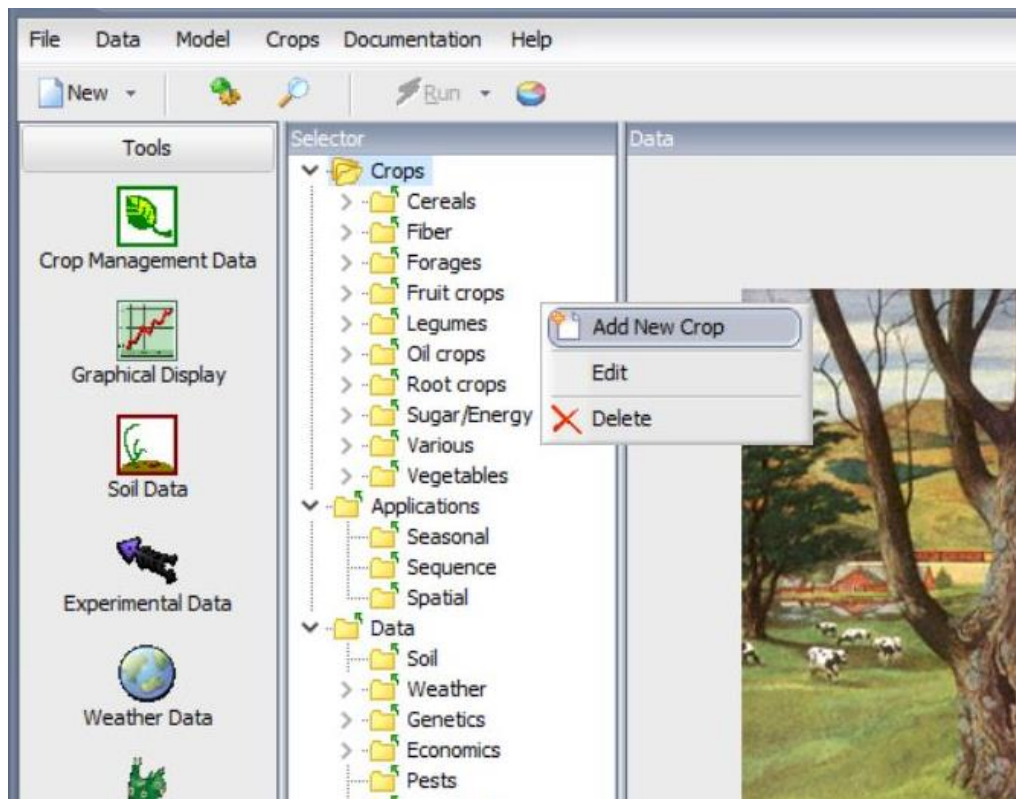


Fig. 3. A context-sensitive menu for working with a new crop.

Users are not allowed to duplicate crop names or crop codes when adding a new crop. The software checks for inconsistencies and upon finding a conflict, returns to the corresponding field. If introducing a new crop would result in a folder name that conflicts with an existing folder (e.g., because the crop is already in DSSAT), the user is forced to provide an alternate name to avoid overwriting existing data. Users cannot create crop groups nodes under the main root node (named “Crops” in the tree view), only under crop groups (such as Cereals, Fiber, etc.). (In the case that a user decides to cancel the process due to a conflict with a previously used crop name or code, the Cancel option only works if the form contains partially but correctly filled data field(s).)

NOTE:

- a. In the DSSAT shell interface and the main menu Model -> Experiment -> Cereals (Fiber, etc.) will update dynamically after clicking on the node.
- b. When adding/editing a new crop, if a folder with the same name already exists in the DSSAT root folder, the existing folder will remain. One can keep files there.

- c. Users are not allowed to manually create a crop folder in the DSSAT root directory. Crop folder will be automatically created when adding a new crop from the DSSAT shell menu option. User only need copy his/her experiment related files to that folder.

We emphasize that any crop additions made with this mode remain local. If the user wishes to share a new crop with the DSSAT community, he/she should contact the core DSSAT development team. The expectation is that any data or crop model provided will be freely available under the [BSD-3-Clause](#) license.

### **Adding a new crop or model to DSSAT by the core DSSAT development team:**

This procedure describes how a developer can update the crop master list available for all DSSAT users. Since it requires editing the central repository of crop identifiers used by DSSAT, only members of the core development team are permitted to use this mode. If a user has parameters and/or code for a new crop or module and would like to make these available to all DSSAT users, they should contact the core development team, which will assess the material and update the crop or model information (as described here) as well as arrange for the files themselves to be made available.

The specific steps for updating are as follows:

1. Review of the DSSAT crop master list to determine whether the crop is already listed. We list many crops that are not implemented in DSSAT, so search carefully by common names and a scientific name.
2. Decide on a new, unique crop name and two-letter code for the crop.
3. Review the DSSAT crop list again to ensure that neither the name nor the code have been used previously.
4. For crops already listed but not fully specified, locate the row in the crop master list and edit or complete the following mandatory fields:
  - a. Common\_name (column B)
  - b. DSSAT\_code (G) – 2 letters
  - c. DSSAT tree node (S)
  - d. Default\_module (U) – 5 letters
  - e. Default\_description (V)
  - f.

We emphasize that these fields are mandatory not being empty and additionally Common\_name and DSSAT\_code require unique values.

5. After finishing modifications rename the sheet name (e.g., v4.8) in the crop master list by increasing the version number, conserving the format v\*.\* or v\*.\*.\* (e.g., v4.8). Crop master spreadsheet file name on Google drive should end with a format similar to the following: v4.8 containing one period or v4.8.0 containing two periods. Either of them is allowed. When comparing version on the internet server and local one in the DSSAT root folder then extracted values (4.8 or 4.8.0) are used. This number provides the flag for the DSSAT shell indicating that new mandatory information on new crop(s) was added to the crop master list (Table 1).
6. Finally, from the DSSAT main menu bar, select Help > Update crop master list... allows all DSSAT users to access the newly introduced crop(s)/model(s) (Fig. 4).

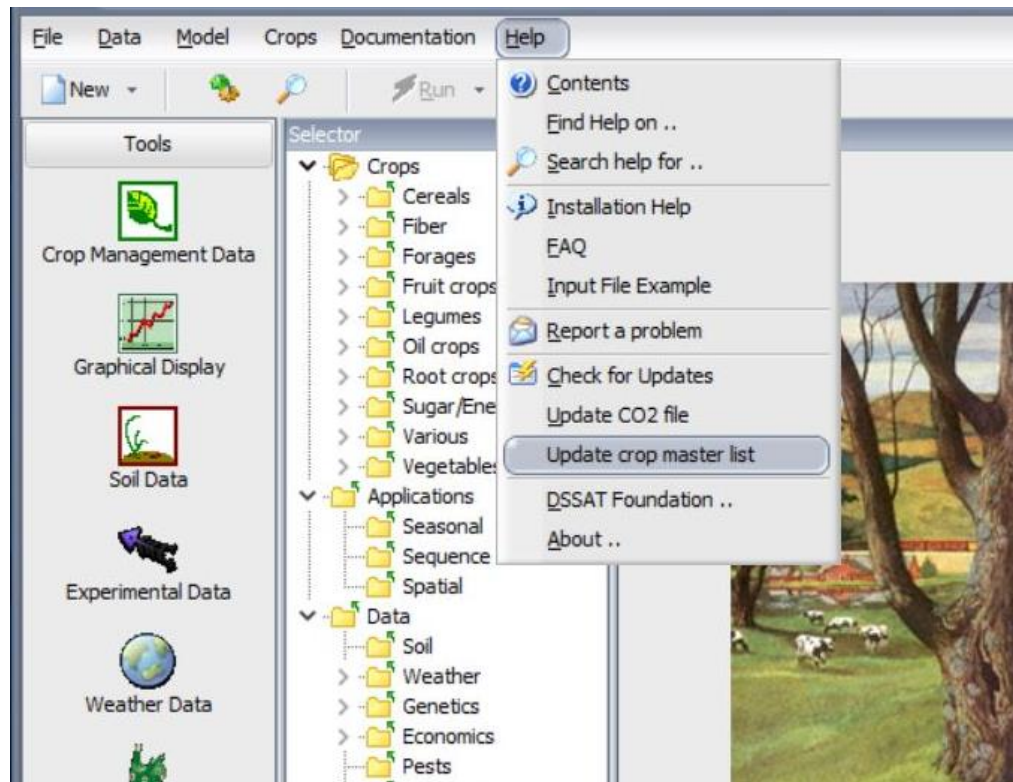


Fig. 4. Menu option for updating crops from the crop master list.

7. When selecting “Update crop master list”, a message should appear indicating that the software has detected the update. If the message reports no updates found, then the crop master list tab still has the previous name (e.g. “v4.8”) meaning that no newly introduced crops are available.
8. Afterwards, two additional messages confirming that the crop master list was downloaded and requires that the application restart. This allows for the crop list in the DSSAT shell to be updated, along with all necessary changes in the DSSAT shell interface, folder structure and files content.

The specific changes made by the DSSAT shell are as follows:

- a. DETAIL.CDE file is modified in the section:

```
*Crop and Weed Species
@CDE  DESCRIPTION          SO
AL    Alfalfa              IB
```

At the end of the list, any new crops with the similar information should appear.

- b. SIMULATION.CDE file will be modified in the section:

```
*Simulation/Crop Models
@MODEL CROP  Description
```

CRGRO    BM    CROPGRO-Bermuda

A new line should appear at the end of the section.

c. For each new crop, DSSATPRO.v\* file will be appended with two lines similar these (where, for example, 48 is from version number 4.8):

```
MBS C: \DSSAT48 DSCSM048.EXE BSCER048
BSD C: \DSSAT48\BERMUDAGRASS
```

d. Under the root DSSAT48 folder, a new folder bearing the name of the new crop (without spaces) will be created.

e. The Windows registry settings will be updated accordingly under the key related to the DSSAT version. For example, under key DSSAT48 for DSSAT version 4.8.

Again, unlike changes introduced by a single user via the “Crops” menu or context-sensitive popup menu, these changes are irreversible. Users cannot edit or delete them from the DSSAT interface using same options (functionality).

**NOTE:**

When updating crops from the Google spreadsheet (crop master list), already existing in DSSAT user-introduced crops remain unchanged.

**Preparing files for a crop that uses CSM-CROPGRO**

Many annual or short-cycle perennial crops can be modeled using the CROPGRO module (CRGRO) or the perennial forage module (PRFRM) of CSM by modifying the species (\*.SPE), ecotype (\*.ECO) and cultivar (\*.CUL) files to match expected traits of the new crop. The first step would normally be to identify a crop with physiological characteristics similar to the new crop and use files for the existing crop as templates for the new crop. Thus, the three files should be copied within the Genotype folder under the DSSAT root folder and renamed using the corresponding two-letter crop code found in the DSSAT crop master list or if the crop is not present there, a new code (selected with care to ensure it is not already used for another crop). Additionally, if pest or disease effects are of interest, a pest coefficient file (\*.PST) should be created in the Pest folder.

Any data from field experiments should be prepared as conventional experiment files (“file-Xs”) with associated weather, soil, summary measurement data, and time series data, using the selected two-letter code as appropriate. Then calibrate and evaluate parameters' values given in those three files based on field experiment measurements. Again, this process requires that the user have substantial experience in crop modeling and in measuring of crop responses under field conditions.

[Could link to other material.]