User's Manual for the Irrigation Recommendation System

The most important part of using the Irrigation Recommendation System (IRS) is formatting the Comma Separated Values (CSV) file that will be uploaded using the Graphical user Interface (GUI) for the system.

1. Format the csv file that you will be uploading to the IRS. Figures 1-3 display the correct format for the csv file, depending on the number of soil moisture sensors that the user has for a specific soil and crop type.

time/date	Port 3 (VWC	Port 3 (EC)	Port 3 (temp	2m Rain (in)	2m Rel Hum	ET (in)	observed
5/26/17 13:20	0.144	0.067	73.6	0	37	0.18	0.2614644
5/26/17 13:25	0.144	0.067	73.6	0	37	0.19	0.4988824
5/26/17 13:30	0.144	0.067	73.6	0	35	0.2	0.00427688
5/26/17 13:35	0.144	0.067	73.6	0	34	0.21	0.17976658
5/26/17 13:40	0.143	0.067	73.6	0	34	0.17	0.35563846
5/26/17 13:45	0.144	0.067	73.6	0	33	0.17	0.82282845
5/26/17 13:50	0.143	0.067	73.6	0	33	0.14	0.31986113
5/26/17 13:55	0.143	0.067	73.6	0	33	0.14	0.7567945
5/26/17 14:00	0.143	0.067	73.6	0	32	0.17	0.13231277
5/26/17 14:05	0.143	0.067	73.6	0	33	0.16	0.97018095
5/26/17 14:10	0.143	0.067	73.6	0	33	0.13	0.11424363
5/26/17 14:15	0.142	0.067	73.6	0	33	0.07	0.80130519
5/26/17 14:20	0.142	0.067	73.6	0	32	0.12	0.53551038
5/26/17 14:25	0.141	0.067	73.6	0	33	0.09	0.50149782
5/26/17 14:30	0.141	0.067	73.6	0	33	0.19	0.36444464

Figure 1. CSV file formatted for 1 SMS.

time/date	Port 3 (VWC	Port 3 (EC)	Port 3 (temp	Port 4 (VWC	Port 4 (EC)	Port 4 (temp	2m Rain (in)	2m Rel Hum	ET (in)	observed
5/26/17 13:20	0.144	0.067	73.6	0.114	0.164	72.9	0	37	0.18	0.2614644
5/26/17 13:25	0.144	0.067	73.6	0.114	0.164	72.9	0	37	0.19	0.4988824
5/26/17 13:30	0.144	0.067	73.6	0.114	0.164	72.9	0	35	0.2	0.00427688
5/26/17 13:35	0.144	0.067	73.6	0.114	0.164	72.9	0	34	0.21	0.17976658
5/26/17 13:40	0.143	0.067	73.6	0.114	0.164	72.9	0	34	0.17	0.35563846
5/26/17 13:45	0.144	0.067	73.6	0.114	0.164	72.9	0	33	0.17	0.82282845
5/26/17 13:50	0.143	0.067	73.6	0.114	0.164	72.9	0	33	0.14	0.31986113
5/26/17 13:55	0.143	0.067	73.6	0.114	0.162	72.9	0	33	0.14	0.7567945
5/26/17 14:00	0.143	0.067	73.6	0.114	0.164	73	0	32	0.17	0.13231277
5/26/17 14:05	0.143	0.067	73.6	0.114	0.162	72.9	0	33	0.16	0.97018095
5/26/17 14:10	0.143	0.067	73.6	0.114	0.162	73	0	33	0.13	0.11424363
5/26/17 14:15	0.142	0.067	73.6	0.114	0.162	73	0	33	0.07	0.80130519
5/26/17 14:20	0.142	0.067	73.6	0.114	0.162	73	0	32	0.12	0.53551038
5/26/17 14:25	0.141	0.067	73.6	0.114	0.162	73	0	33	0.09	0.50149782
5/26/17 14:30	0.141	0.067	73.6	0.114	0.162	73	0	33	0.19	0.36444464

Figure 2. CSV file formatted for 2 SMSs.

time/date	Port 3 (VWC	Port 3 (EC)	Port 3 (temp	Port 4 (VWC	Port 4 (EC)	Port 4 (temp	Port 5 (VWC	Port 5 (EC)	Port 5 (temp	2m Rain (in)	2m Rel Hum	ET (in)	observed
5/26/17 13:20	0.144	0.067	73.6	0.114	0.164	72.9	0.176	0.039	71.6	0	37	0.18	0.2614644
5/26/17 13:25	0.144	0.067	73.6	0.114	0.164	72.9	0.176	0.038	71.8	0	37	0.19	0.4988824
5/26/17 13:30	0.144	0.067	73.6	0.114	0.164	72.9	0.176	0.038	72	0	35	0.2	0.00427688
5/26/17 13:35	0.144	0.067	73.6	0.114	0.164	72.9	0.176	0.039	72.1	0	34	0.21	0.17976658
5/26/17 13:40	0.143	0.067	73.6	0.114	0.164	72.9	0.176	0.038	72.3	0	34	0.17	0.35563846
5/26/17 13:45	0.144	0.067	73.6	0.114	0.164	72.9	0.176	0.039	72.5	0	33	0.17	0.82282845
5/26/17 13:50	0.143	0.067	73.6	0.114	0.164	72.9	0.175	0.039	72.7	0	33	0.14	0.31986113
5/26/17 13:55	0.143	0.067	73.6	0.114	0.162	72.9	0.175	0.039	72.9	0	33	0.14	0.7567945
5/26/17 14:00	0.143	0.067	73.6	0.114	0.164	73	0.175	0.038	73	0	32	0.17	0.13231277
5/26/17 14:05	0.143	0.067	73.6	0.114	0.162	72.9	0.175	0.038	73.2	0	33	0.16	0.97018095
5/26/17 14:10	0.143	0.067	73.6	0.114	0.162	73	0.175	0.038	73.4	0	33	0.13	0.11424363
5/26/17 14:15	0.142	0.067	73.6	0.114	0.162	73	0.175	0.039	73.6	0	33	0.07	0.80130519
5/26/17 14:20	0.142	0.067	73.6	0.114	0.162	73	0.174	0.038	73.8	0	32	0.12	0.53551038
5/26/17 14:25	0.141	0.067	73.6	0.114	0.162	73	0.174	0.038	73.9	0	33	0.09	0.50149782
5/26/17 14:30	0.141	0.067	73.6	0.114	0.162	73	0.174	0.038	74.1	0	33	0.19	0.36444464

Figure 3. CSV file formatted for 3 SMSs.

Below is the required data format for any data uploaded using the GUI when only 1 sensor depth is entered:

Date	VWC (m3/m3)	EC (dS/m)	Temp (F)	Rainfall (in)	Relative Humidity (%)	ET (in)

Below is the required data format for any data uploaded using the GUI when 2 sensor depths are entered (columns 2-4 are the volumetric water content (VWC), electrical conductivity (EC), and temperature for SMS #1, columns 5-7 are the VWC, EC, and temperature for SMS #2):

Date	VWC (m3/m3)	EC (dS/m)	Temp (F)	VWC (m3/m3)	EC (dS/m)	Temp (F)	Rainfall (in)	Relative Humidity (%)	ET (in)

Below is the required data format for any data uploaded using the GUI when 3 sensor depths are entered (columns 2-4 are the volumetric water content (VWC), electrical conductivity (EC), and temperature for SMS #1, columns 5-7 are the VWC, EC, and temperature for SMS #2, columns 8-10 are the VWC, EC, and temperature for SMS #3):

Date	VWC (m3/m3)	EC (dS/m)	Temp (F)	VWC (m3/m3)	EC (dS/m)	Temp (F)	VWC (m3/m3)	EC (dS/m)	Temp (F)	Rainfall (in)	Relative Humidity (%)	ET (in)

Please note, again, that your data must be in one of these 3 formats, depending on the number of SMS depths you enter in the GUI. If the format is incorrect or the number of depths entered in the GUI don't conform to the format of the CSV file that is uploaded, you will receive an error.

2. Enter the crop type in the "Enter Crop Type" field. **This field is required prior to being able to Train the System Using Your Crop and Soil Data, Load Parameters from a**

Previous Model Run, or Generate Irrigation Recommendation Report. Figure 4 shows highlights the "Enter Crop Type" field.

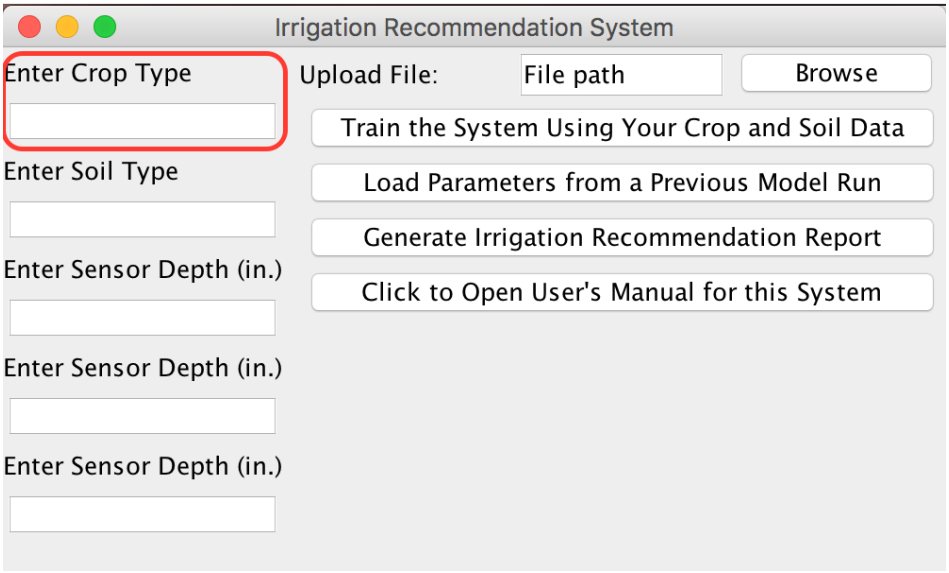

Figure 4. "Enter Crop Type" field.

If the crop type isn't entered, you will receive the error in Figure 5.

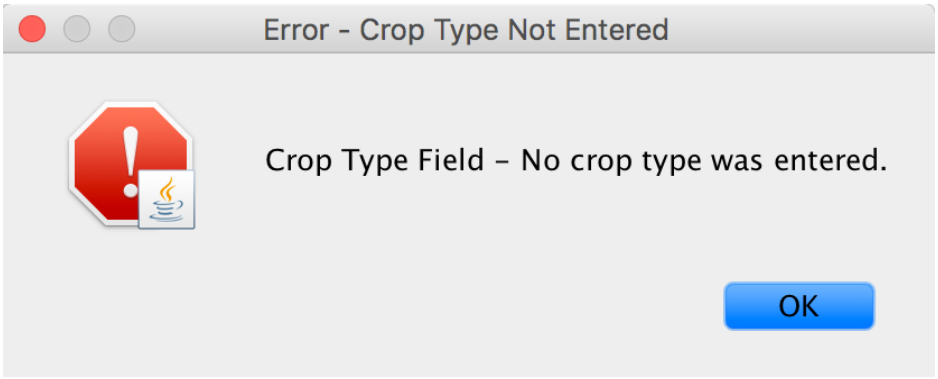

Figure 5. Crop Type field error.

3. Enter the crop type in the "Enter Soil Type" field. **This field is required prior to being able to Train the System Using Your Crop and Soil Data, Load Parameters from a Previous Model Run, or Generate Irrigation Recommendation Report.** Figure 6 shows highlights the "Enter Soil Type" field.

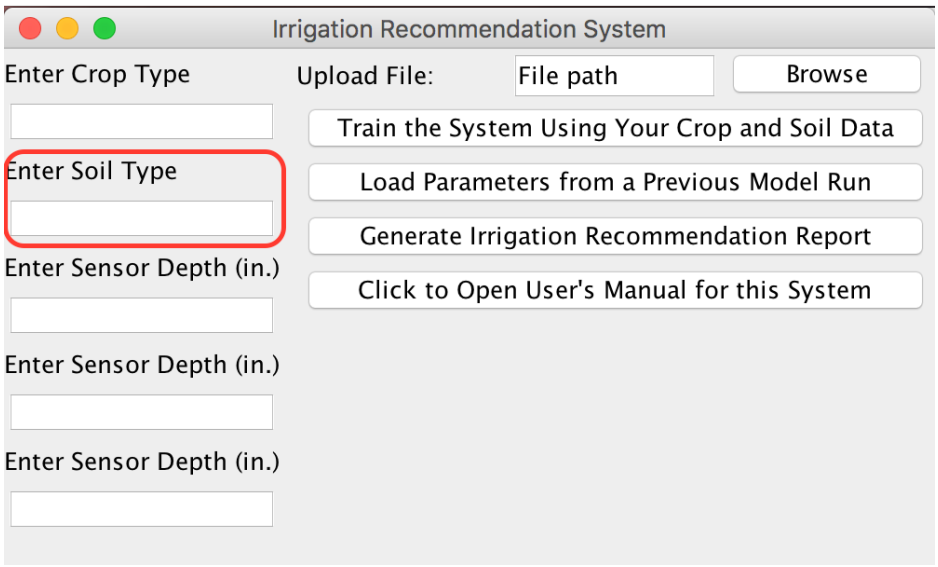

Figure 6. "Enter Soil Type" field.

If the soil type isn't entered, you will receive the error in Figure 7.

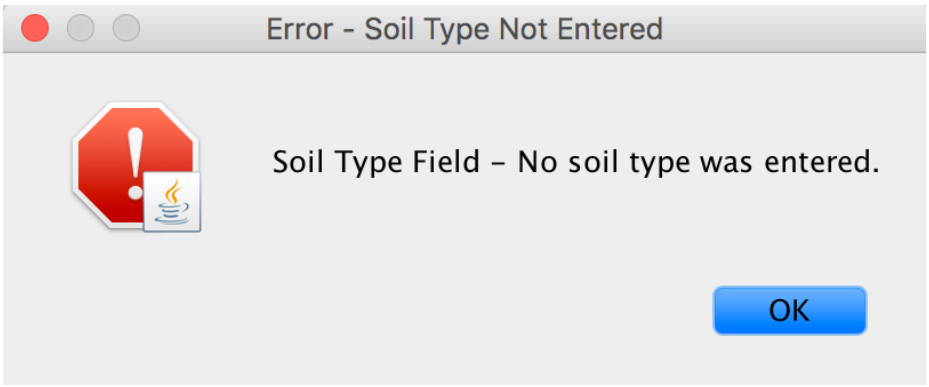

Figure 7. Soil Type field error.

4. Enter the sensor depths, in inches, in the "Enter Sensor Depth (in.)" fields. **A minimum of 1 sensor depth field is required prior to being able to Train the System Using Your Crop and Soil Data, Load Parameters from a Previous Model Run, or Generate Irrigation Recommendation Report.** Note, the sensor depths can be provided in any of the fields shown.

   Please note that the number of sensor depths entered **must** match the number of sensor data provided with the "Upload File" field and the "Generate Irrigation Report" button. For example, if 2 sensor depths are entered in the "Enter Sensor Depth (in.)" fields, then the system expects to see data formatted as shown in Figure 2.

   Figure 8 shows highlights the "Enter Sensor Depth (in.)" fields.

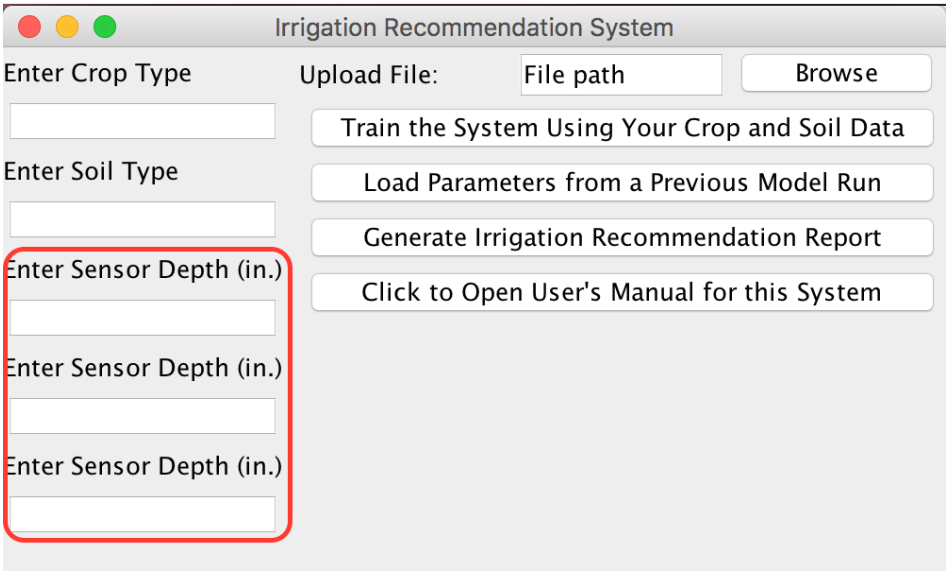

Figure 8. "Enter Sensor Depth (in.)" fields.

If a minimum of 1 sensor depth isn't entered, you will receive the error in Figure 9.

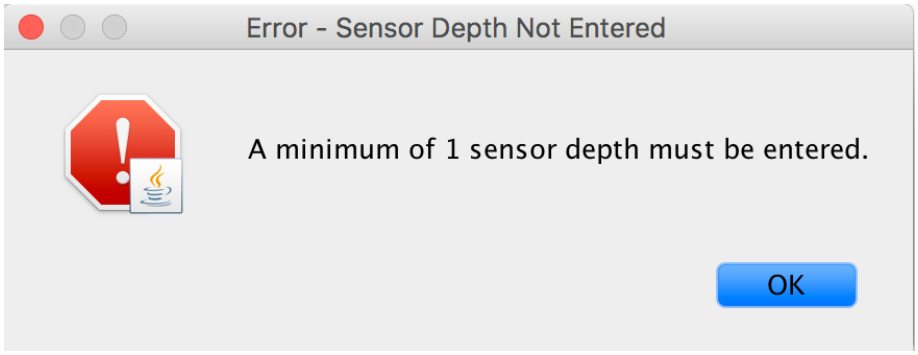

Figure 9. Minimum of 1 sensor depth error.

5. Once steps 1-4 are completed and there are no errors, the GUI will look like Figure 10 (depending on the number of sensor depths you entered).

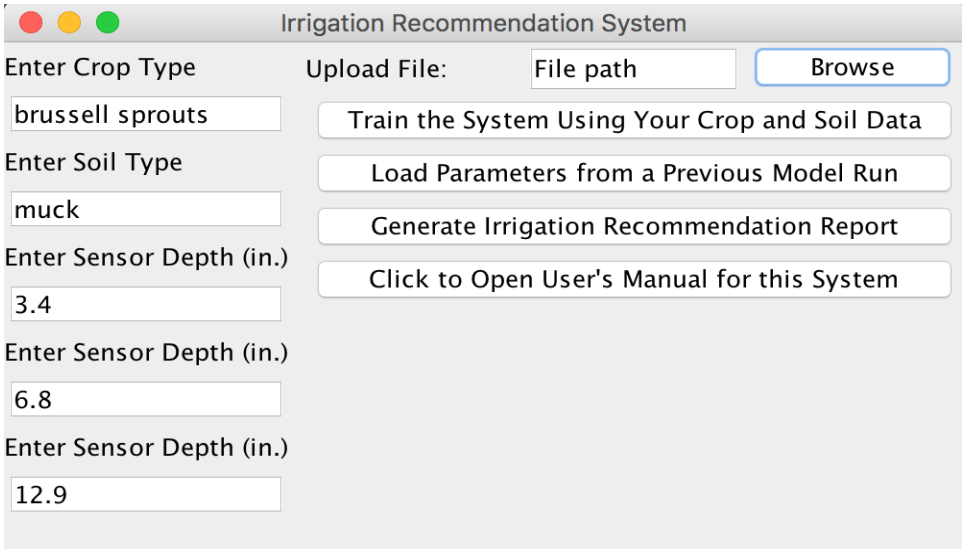

Figure 10. GUI displayed with required info entered.

6. Now you can select a file to upload to the IRS. Select the Browse button as shown in Figure 11.

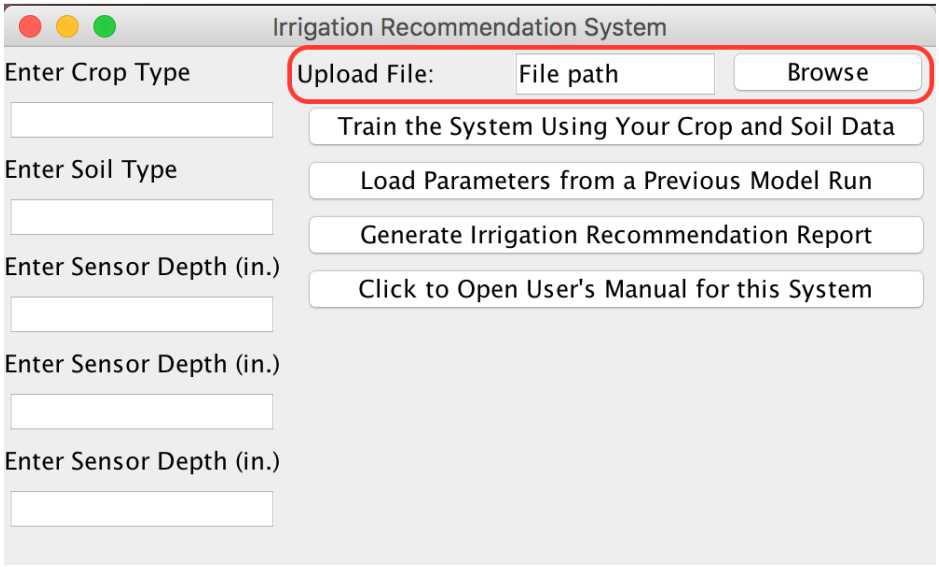

Figure 11. Upload file field and button.

This will open the dialog screen shown in Figure 12.

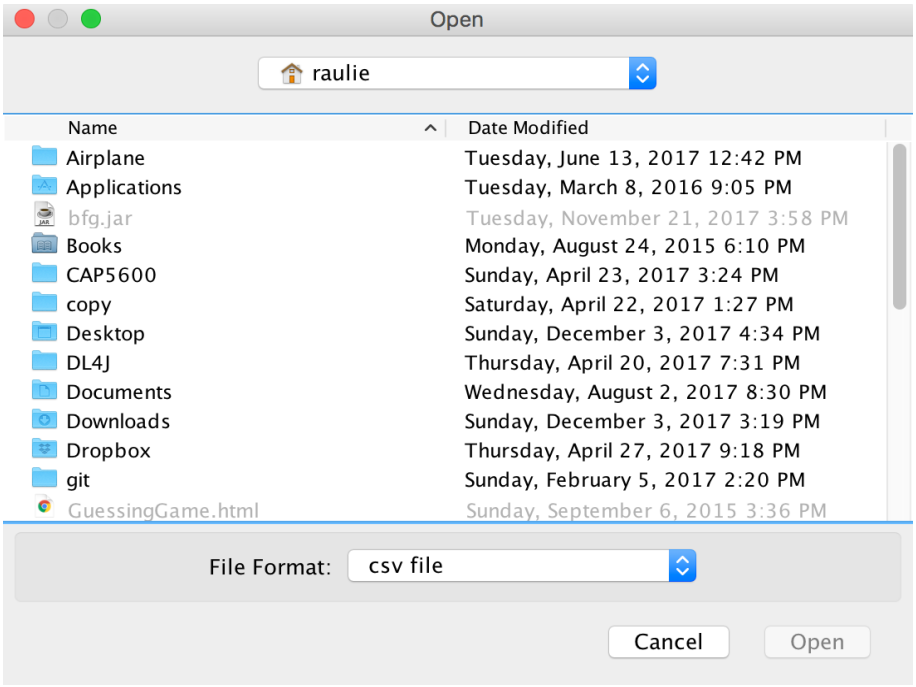

Figure 12. Open file dialog box.

If you are going to Train the System Using Your Crop and Soil Data, then you should upload a csv file. However, if you are going to Load Parameters from a Previous Model Run, you need to upload a zip file. You can select the file extension you are looking as shown in Figure 13 below.

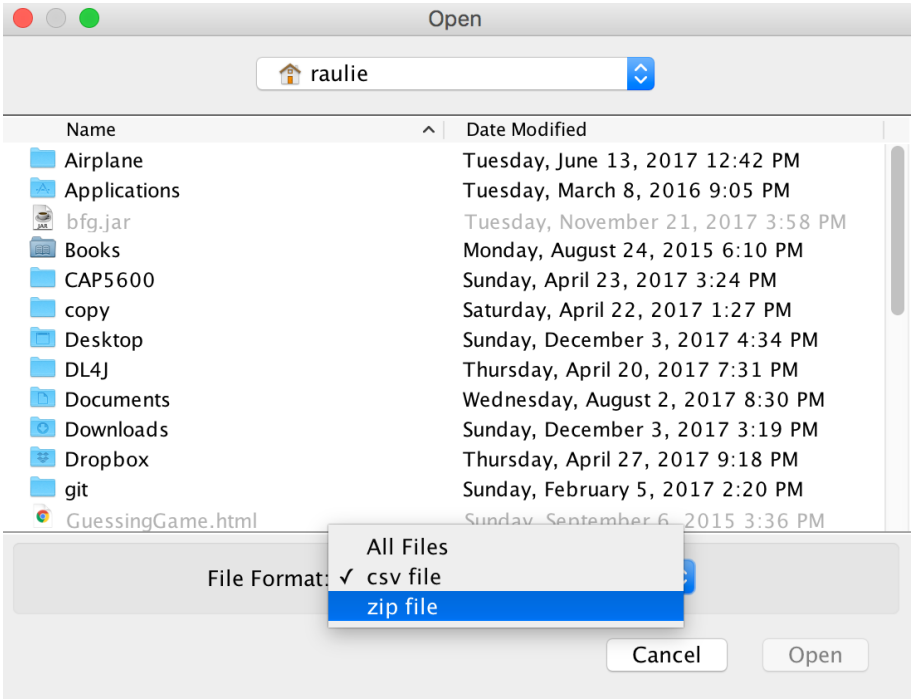

Figure 13. Open file dialog box with file extensions choice.

7. Once you've selected a file, the GUI should look like Figure 14 or 15, depending on whether you plan to train the recurrent neural network (RNN) or load parameters from a previous model run.

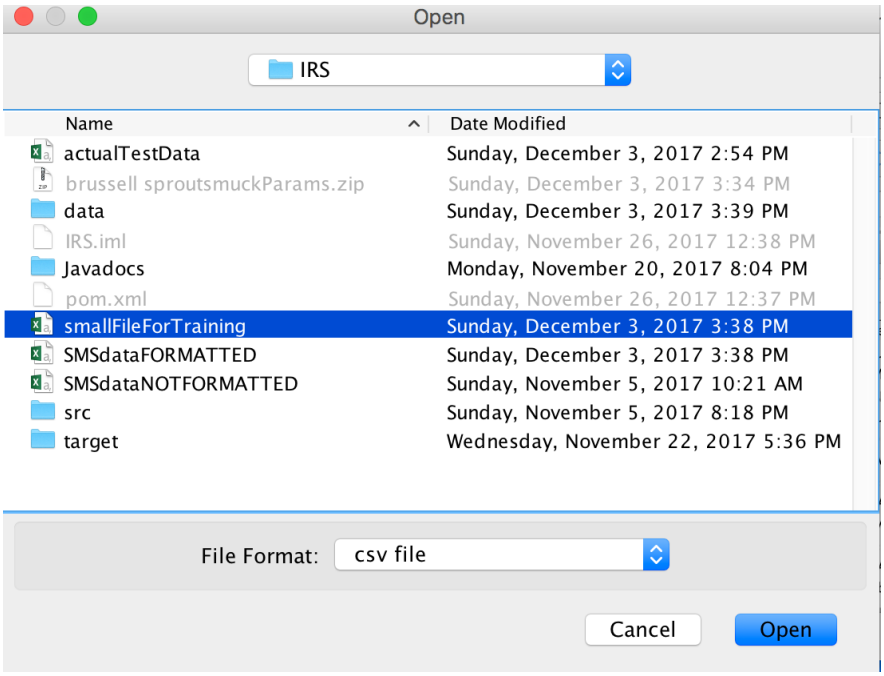

Figure 14. Open file dialog box with csv file selected to open.

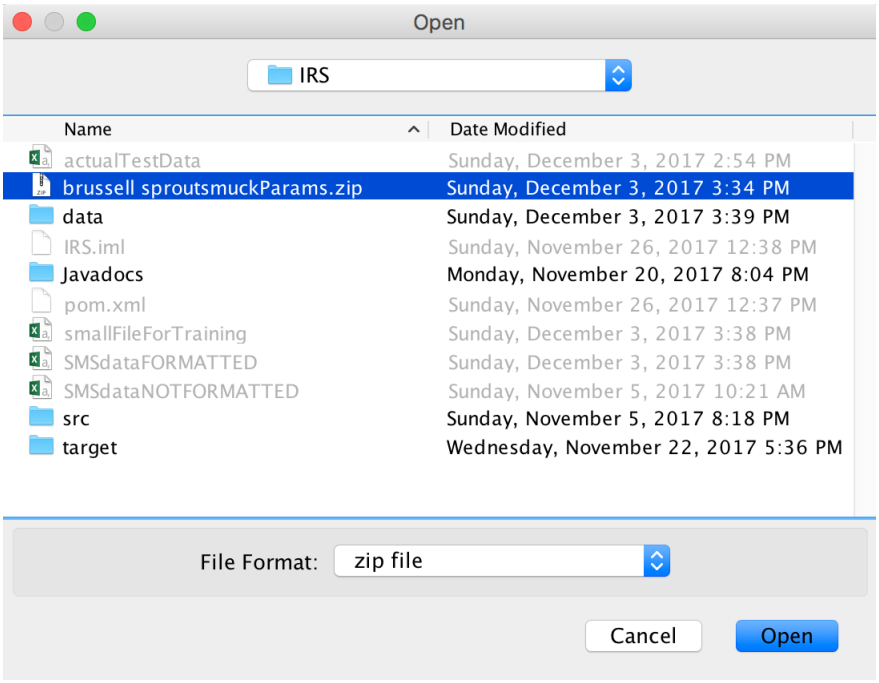

Figure 15. Open file dialog box with zip file selected to open.

8. Once you've selected your file, select the Open button. This will prompt the File Selected message dialog box displayed in Figures 16 or 17, depending on the file you selected.

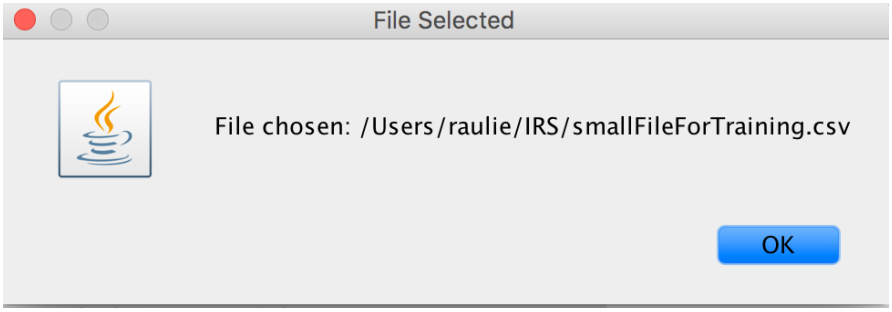

Figure 16. File Selected is a csv file.

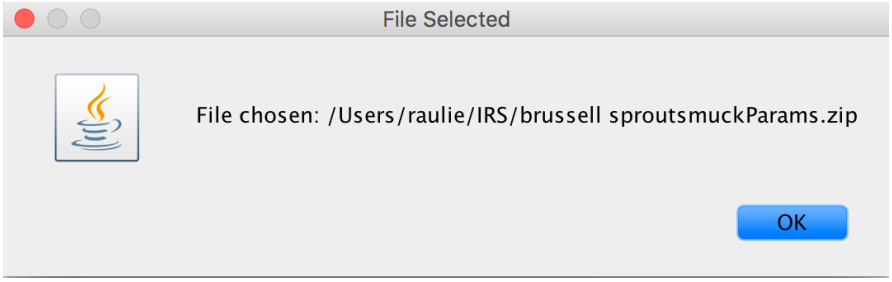

Figure 17. File Selected is a zip file.

The GUI should now look like Figure 18 or 19, depending on the file you selected.

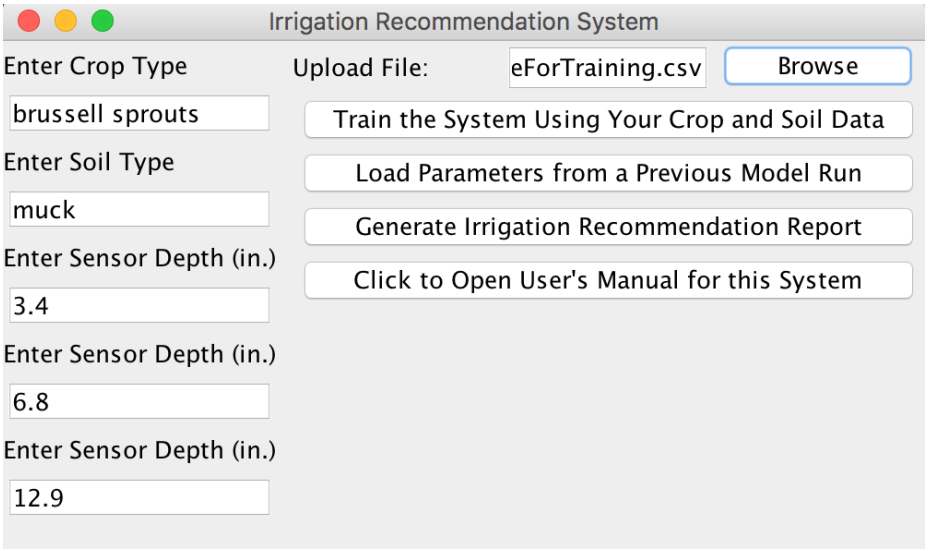

Figure 18. GUI displayed with csv file uploaded.

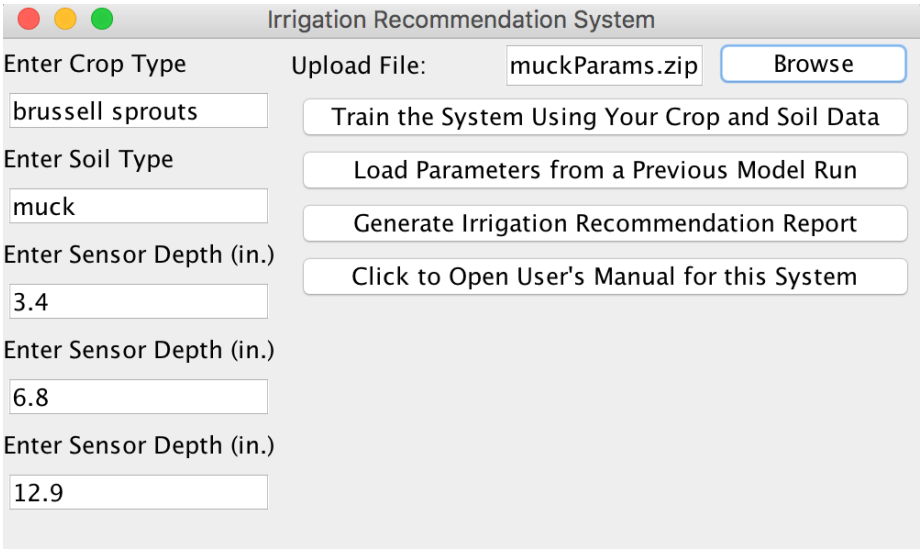

Figure 19. GUI displayed with zip file uploaded.

9. Now that you have successfully uploaded a file to the IRS, you can Train the System Using Your Crop and Soil Data or Load Parameters from a Previous Model Run. This step focuses on how to Train the System Using Your Crop and Soil Data, thus you should have uploaded a csv file.

Once you have successfully uploaded a csv file, formatted appropriately (see step 1), select the Train the System Using Your Crop and Soil Data button that is shown in Figure 20.

Note: If you are going to Load Parameters from a Previous Model Run, please skip ahead to step 10.

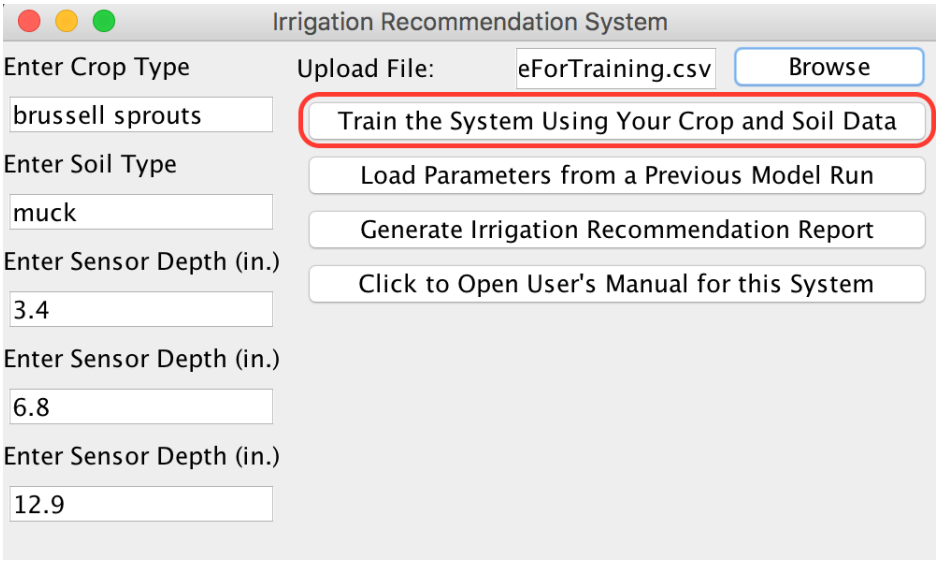

Figure 20. GUI displayed with csv file uploaded.

Selecting the train button will prompt you with the message shown in Figure 21. If you select No, you won't be prompted again until the model is trained successfully (see Figure 23).

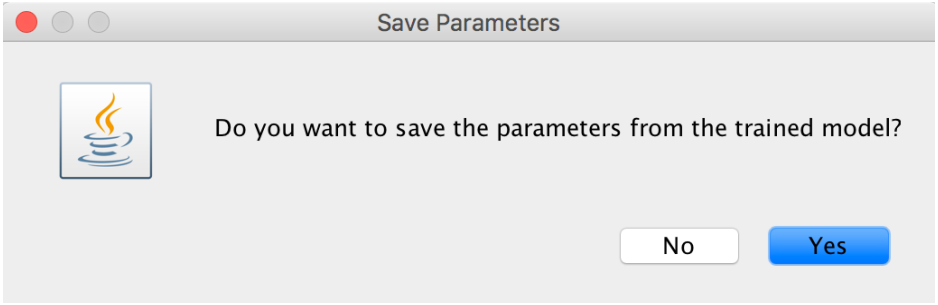

Figure 21. Save Parameters dialog window.

If you want to save the parameters from the trained model, select Yes and you will be prompted with a Save message shown in Figure 22. This message indicates that the model was trained and that the parameters can be found at the file path noted in the message.

Figure 22. Model parameters saved message.

Once the parameters are saved, or not saved, the GUI will output a message indicating that the RNN was successfully trained (if the file uploaded was formatted correctly). The GUI also includes stats about the RNN's performance in this message. See Figure 23 for a screenshot of the message.

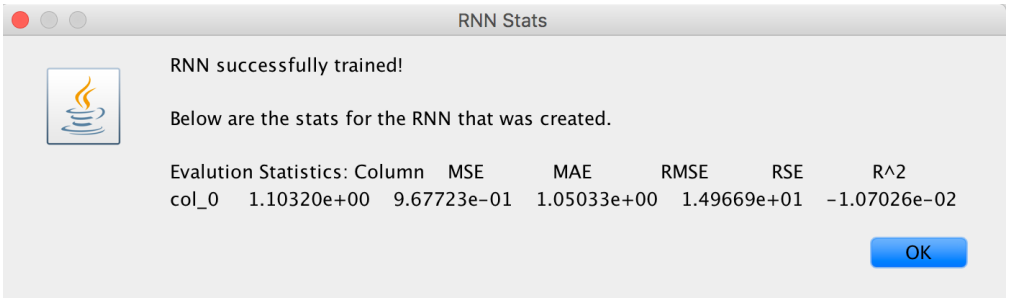

Figure 23. RNN trained successfully message.

10. Now that you have successfully uploaded a file to the IRS, you can Load Parameters from a Previous Model Run. For this step to work correctly, you should have uploaded a zip file.

    Once you have successfully uploaded a zip file, which was saved from a previous model run, select the Load Parameters from a Previous Model Run button that is shown in Figure 24.

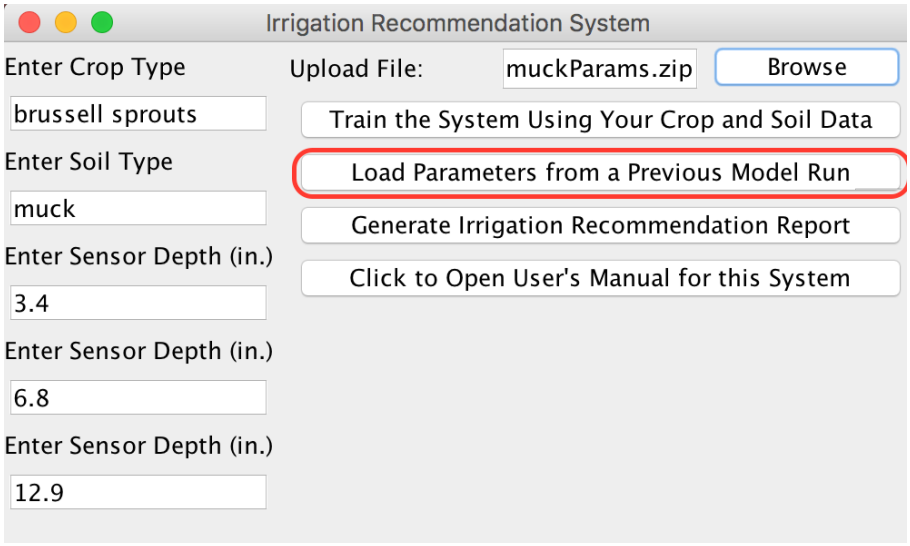

Figure 24. GUI displayed with zip file uploaded.

Once you select the Load Parameters from a Previous Model Run button, you will see the message as shown in Figure 25.

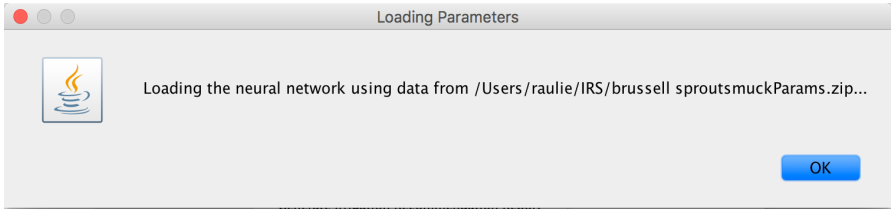

Figure 25. Loading parameters message.

Once the parameters from a previous model run are loaded, the GUI will output a message indicating that the RNN was successfully loaded (if the file uploaded is appropriate). See Figure 26 for a screenshot of the message.

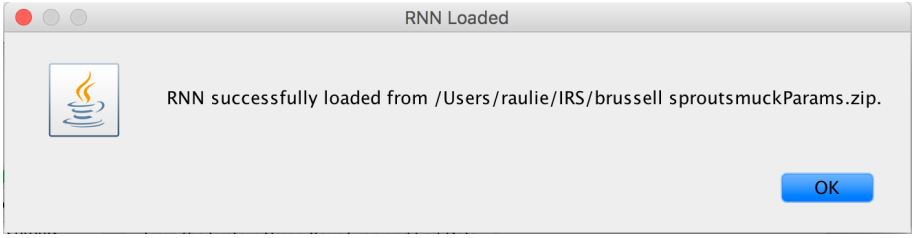

Figure 26. RNN loaded message.

11. Once the model is either trained or loaded from a previous run, you can select the Generate Irrigation Recommendation Report button as shown in Figure 27.

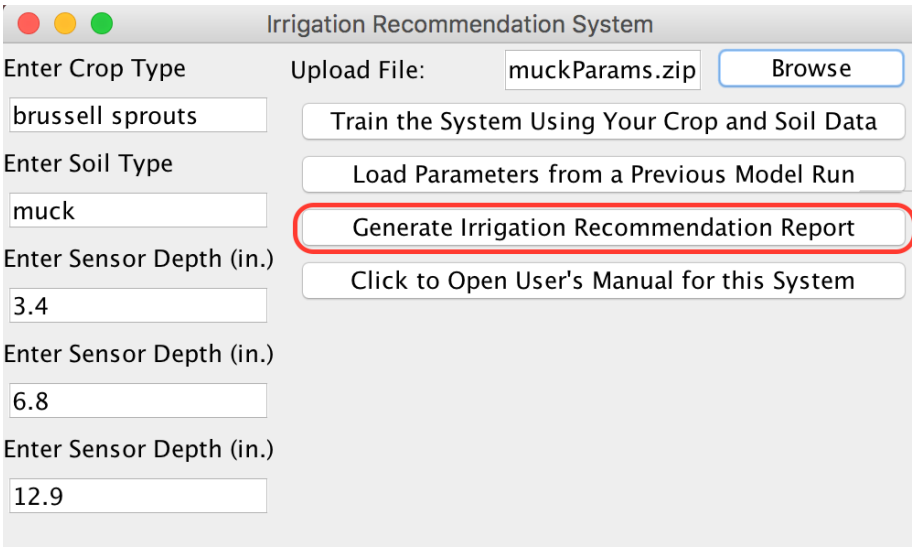

Figure 27. GUI displayed with file uploaded.

This will open the dialog screen shown in Figure 12.

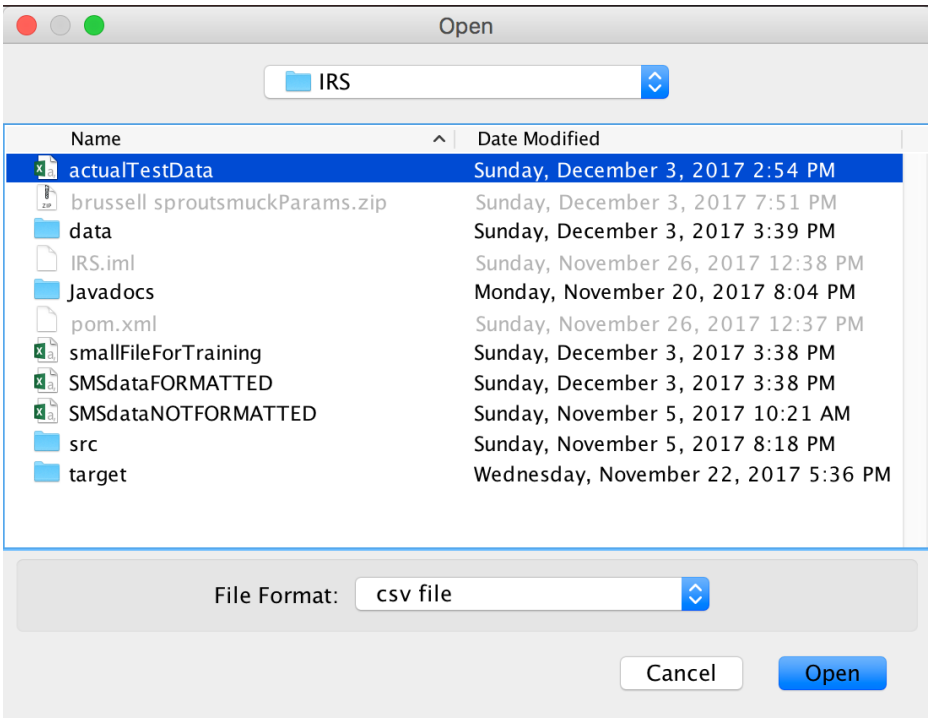

Figure 28. Open file dialog box.

It is very important that you select a csv file that is formatted in the same manner as the csv file that was originally used to train the RNN. For example, if you trained the RNN using 2 SMSs, then you should upload a csv file when generating a recommendation

report that conforms to the format in Figure 2 (format is for a csv with 2 SMSs). This is the case even if you load the RNN from a previous model run.

12. Once you select the csv to use to generate a recommendation report, you will receive the message prompt shown in Figure 29. Please note that this file should typically contain less data than the file used to train the RNN.

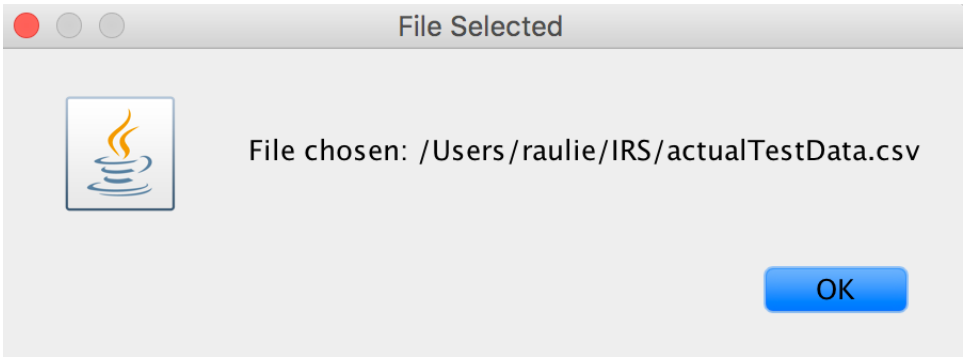

Figure 29. File Selected is a csv file.

After the csv file is uploaded, the system will generate a Recommendation report in the user's current working directory. The file will be a text file that is a concatenation of "Report" + crop (in uppercase) + soil (lowercase) + month + day + year. The month, day, and year will be created by the system clock on the date the report is generated. See Figure 30 for an example of this message.

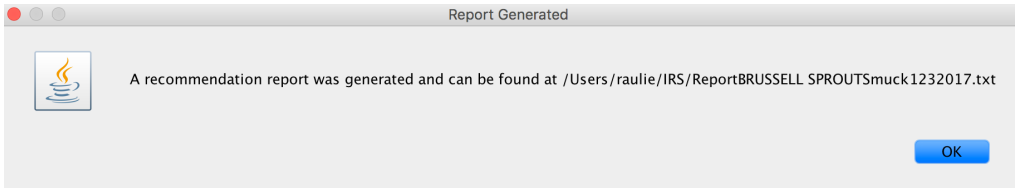

Figure 30. Report Generated message.

Once OK is selected in the Report Generated message, the report will be displayed on screen (Figure 31). The report will reflect the data entered into the GUI and will generate an irrigation recommendation based on the csv file uploaded during the Generate Irrigation Recommendation Report step.

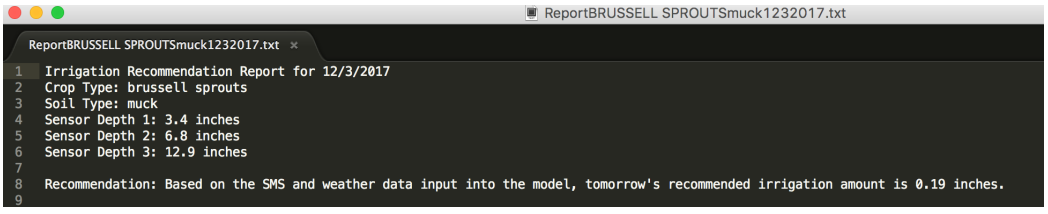

Figure 31. Example Recommendation Report.