Why use a model?

1. Models can give you data that cannot easily be collected.

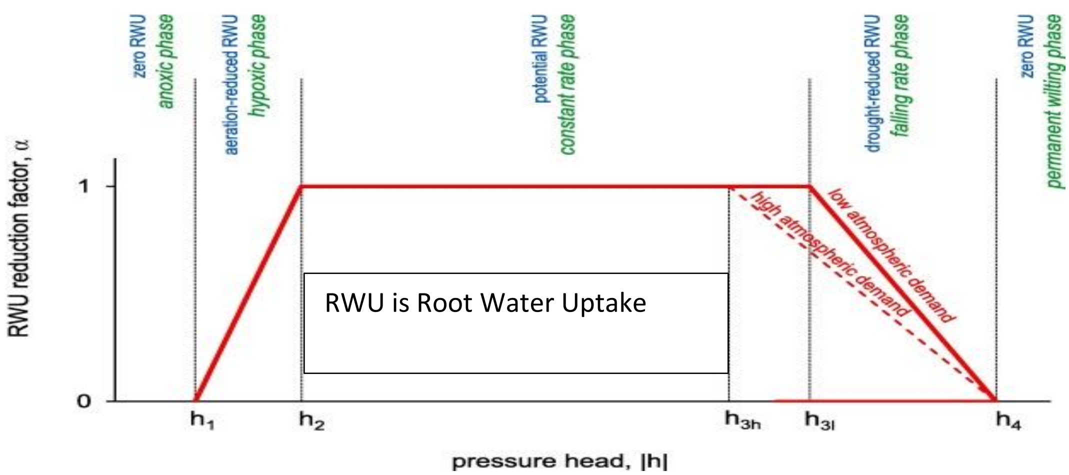
Water fluxes through the soil are difficult to measure and only with significant expense. One way to measure water fluxes out of a certain soil depth is to use weighing lysimeters such as those that were used by the USDA-ARS in Coshocton, or those that were used by the UK Forest Service at Plynlimon (Wales). These actually weight large soil columns to measure water content changes, percolation and infiltration. Some are still used and some new weighing lysimeter networks are being installed in Europe. However, the investment is too great to use them on a routine basis. Enter the soil hydrology model.

A model requires a computer, knowledge of the jargon (unfortunately), and some common sense. The model I am using is called HYDRUS. It allows you to calculate both the water movement through and out of the soil. In the configuration that I am using, the water is routed between about 100 digital layers of soil using some simple rules:

a. If the soil is saturated, infiltration into the top layer is restricted, generating runoff

b. If the soil moisture in a layer becomes greater than field capacity, the water in excess of field capacity is pushed down to the next layer.

c. Plants take up water most efficiently within a range of soil moistures characteristic for the crop. When the soil gets too wet the plants slow or even cease to pick up water. When the soil approaches the permanent wilting point, the plants also slow transpiration. Again that pattern depends on the crop. The graph below shows you what that pattern might look like.



Graph from: de Melo, M.L.A. and van Lier, Q.D.J., 2021. Revisiting the Feddes reduction function for modeling root water uptake and crop transpiration. *Journal of Hydrology*, *603*, p.126952.

2. Models can help you assess how a management change impact your field

Models are great at comparing management practices. So when you change some practice then it will tell you whether you are going to do better or worse. It won't necessarily tell you exactly how much worse or better, but it will probably indicate the direction of the change.

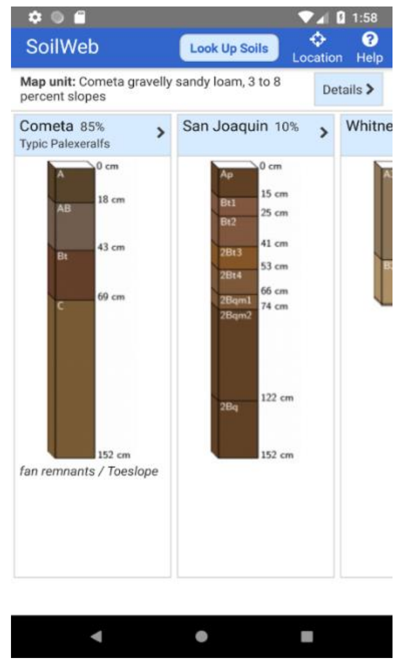
You already know one model that does just that: RUSLE 2 which evaluates how a change in practice can affect erosion and the soil building. NRCS may work with you evaluating different management scenarios that lead to improved soil retention.

3. Models at your fingertips

One reason why we are doing modeling is to lay the ground work for a model that will handily fit onto your computer or your smart phone. There are more and more apps coming online that empower the farmer to make informed decisions. Two of my favorite apps are the UC Davis SoilWeb app and Cornell's climate smart farming app.

UCDavis SoilWeb can be found here:

https://play.google.com/store/apps/details?id=com.casoilresourcelab.soilweb&hl=en_US&gl=US



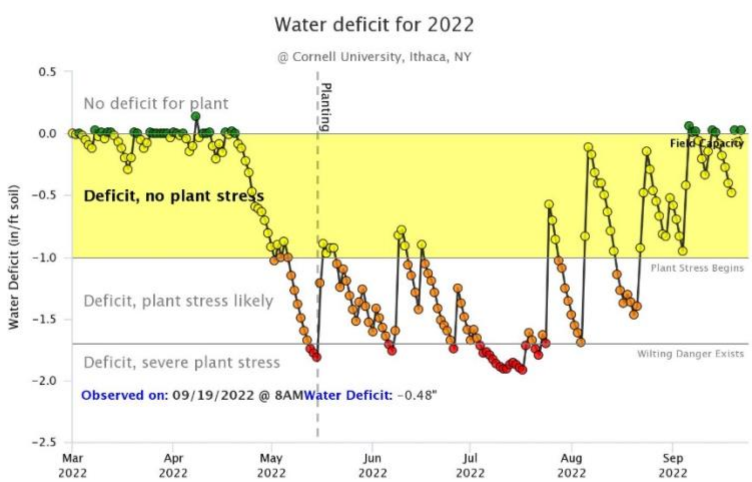
You can also find it in the apple store

This is a more elegant interface to the Soil Web Survey. And you can put it on your smart phone and get real time updates on which soil you are walking on. It also gives you a large amount of soils data for each soil map unit.

Cornell's climate smart farming app can be found here:

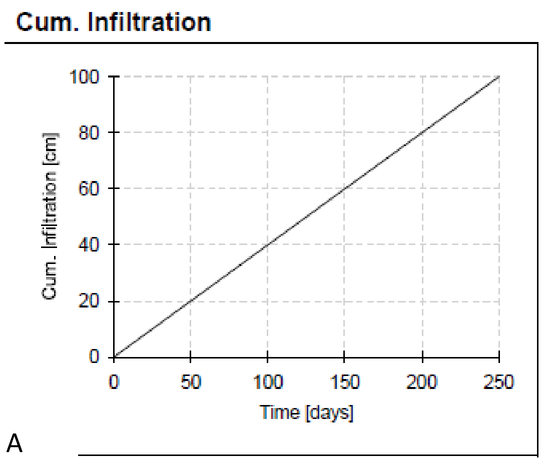
http://climatesmartfarming.org/tools/

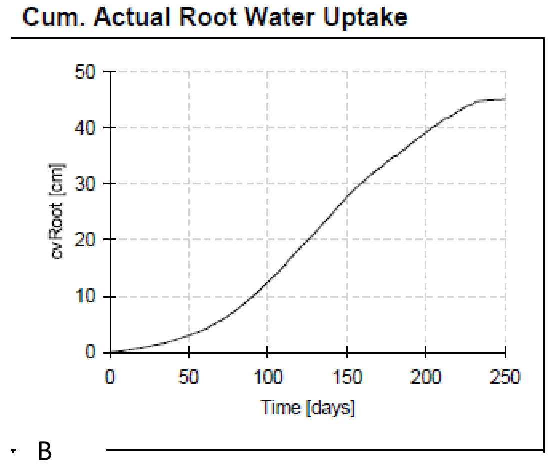
I love the CSF Water Deficit Calculator. It will tell you the current state of the soil in your region as the program interfaces with NWA weather stations.

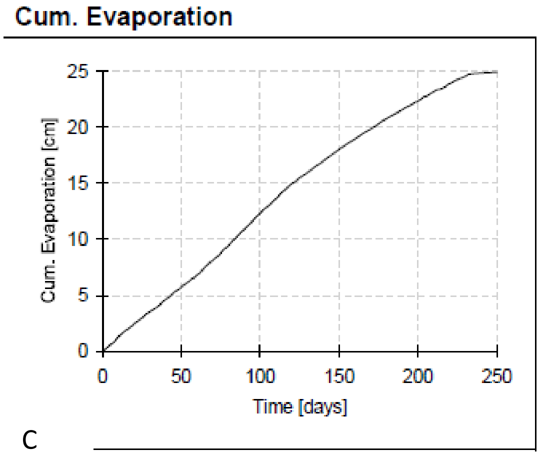


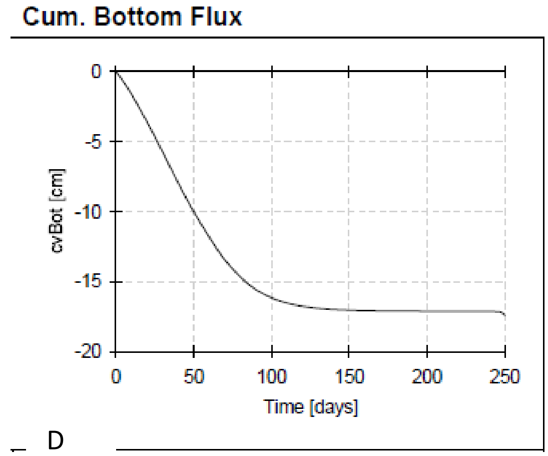
The idea of doing modeling as part of the project is to help develop an app for managing water and nutrients in high tunnels.

Stay tuned...



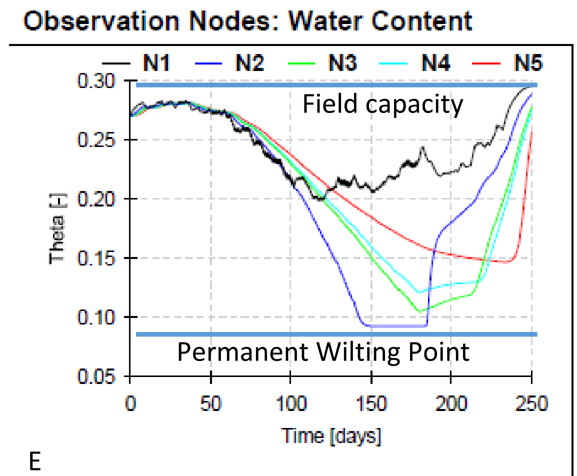




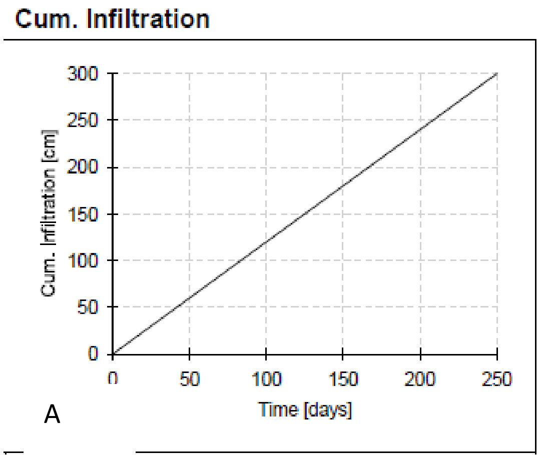


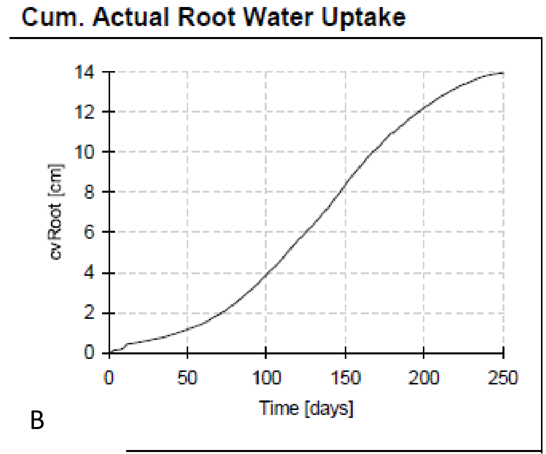
0.2 inches of irrigation water each day
Loam, field capacity about 30% volumetric mositure; 10% is moisture at permaent wilting point

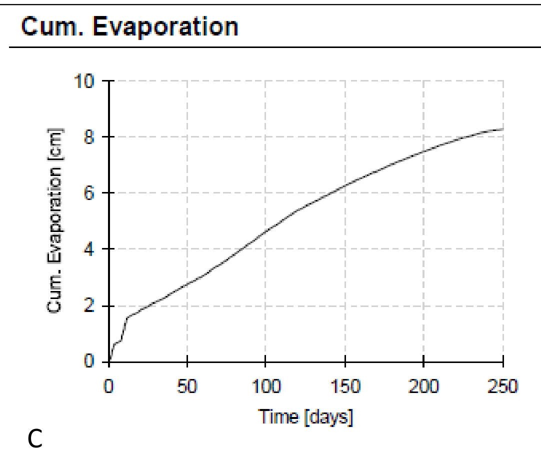
All water infiltrates (A);
45% of infitrated water is taken up by the plant (B)
25% is evaporated from the soil surface
17% is leached.
Only the second layer from the top reaches field capacity towards the end of the growing season (end of September). Steady decline in soil water

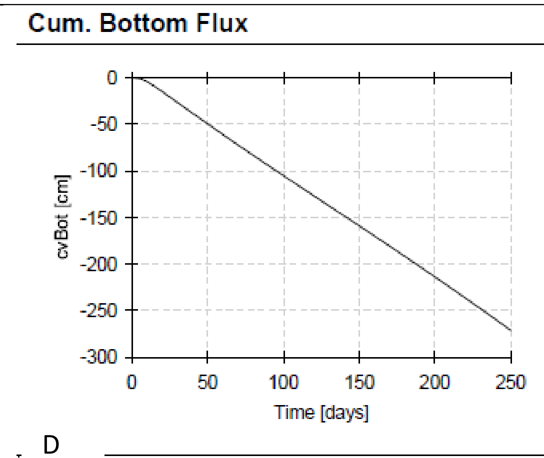


Fluxes and water content for a loam with 0.2 inches of irrigation per day, added each day.





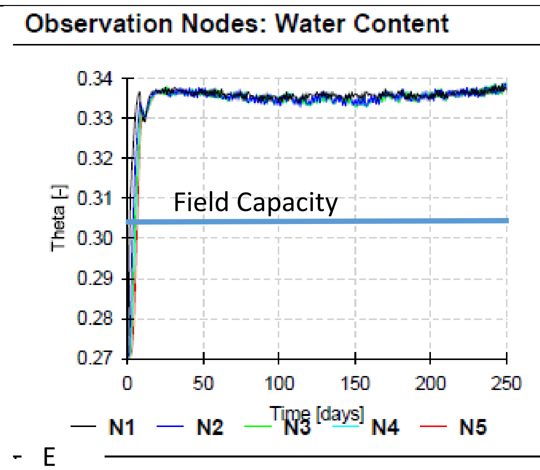




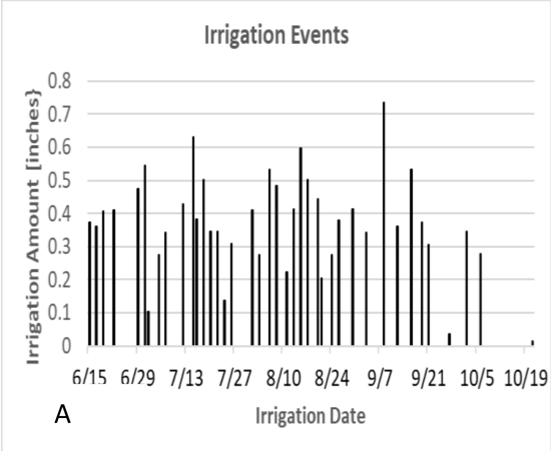
0.5 inches added in irrigation water each day. Loam, field capacity about 30% volumetric mositure; 9% is moisture at permanent wilting point

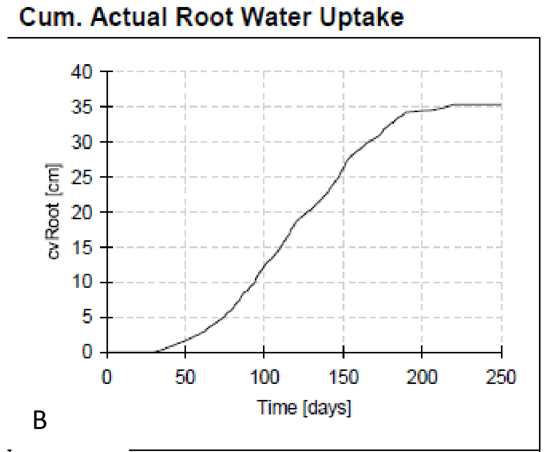
All water infiltrates (A);
Only 5% of infitrated water is taken up by the plant (B)
3% is evaporated from the soil surface (C)
93% is leached. (D)

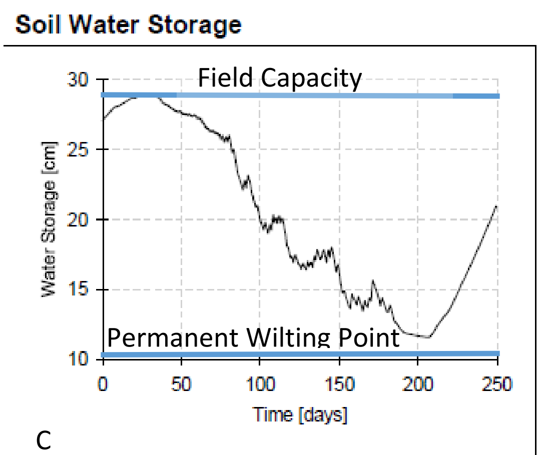
Soil is maintained too wet for plants to take up water (E)

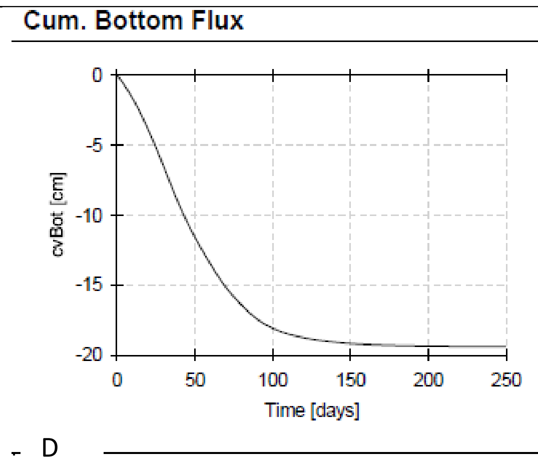


Fluxes and water content for a loam with 0.5 inches irrigation per day, each day



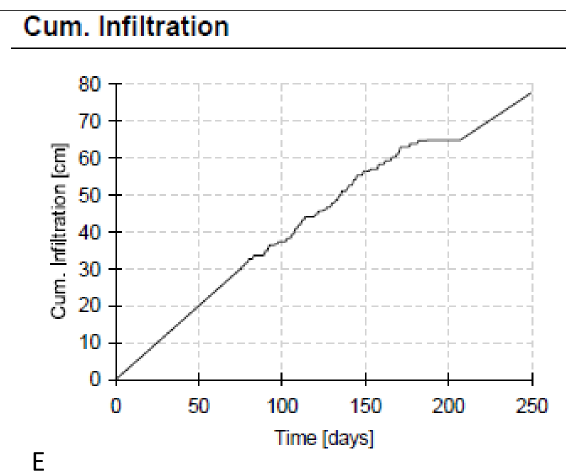




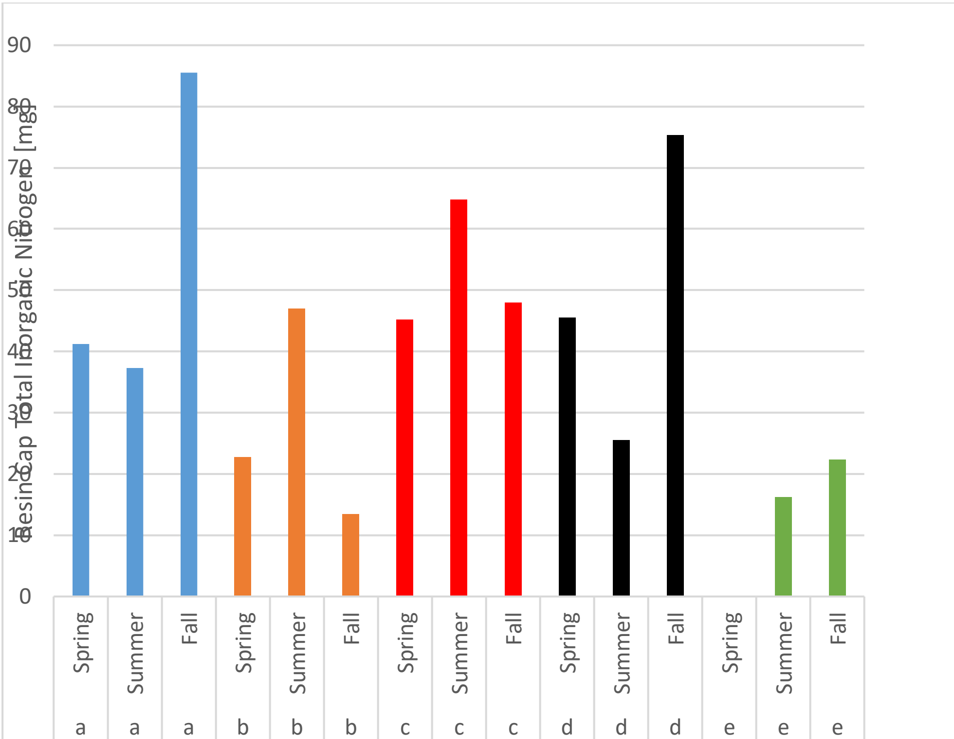


Intermittent irrigation between 0.1 and 0.7 inches per day
Loam, field capacity about 30% volumetric mositure; 9% is moisture at permanent wilting point

Irrigation record (A);
About 50% of infitrated water is taken up by the plant (B)
Irrigation not enough, soil moisture continuously decreases (C)
25% us lost to percolation (D)
25% is lost to evaporation(not shown
All irrigation water infiltrated (E)



Resin capsule data for 2021.



One would expect that the Fall N is greatest as plants die and nutrients are released into the soil. It should be lowest in the summer due to pant uptake.

For Farms a, d and e this is true. For Farms b and c it is not. Causes of this, different length of resin cap burial, the resin caps were collected at different times in the fall, or different levels and timing of fertilizer applications. Any of these could bend that curve.