HOW MUCH WATER EVAPORATES EACH DAY FROM A CRANBERRY MARSH?

William L. Bland
Department of Soil Science
University of Wisconsin-Madison

Cranberry plants love water. Perhaps the significant amount of time you spend maintaining equipment and structures that manage water on the marsh serves to remind you daily of the importance of water to cranberry production. Water enters and exits a cranberry bed by several pathways, most of which you can readily see. For example, rain and irrigation are inputs that you can see, feel, and easily measure. Water flowing in a ditch away from a bed is also easy to observe. There are two other pathways for water movement into and out of a bed that cannot be seen, and are hard to measure: movement up and down in the soil, and evaporation.

Why do we care what happens to water in a marsh? There is almost always plenty of it around, and pumping is inexpensive relative to the value of the crop. The reason we need to better understand the flows of water in cranberry production is because application of water in excess of what the crop needs drains through the soil, possibly collecting fertilizers and agricultural chemicals and carrying them away. Water that drains through the soil leaves the bed in the ditches or straight downward toward the groundwater. You went to the trouble and expense of applying these chemicals, so you want them to remain and work as planned., and users of the water downstream may object to their presence. By understanding the behavior of water in the cranberry system, you can better control how much is available to possibly carry chemicals away from your marsh.

The Water Budget

The amount of water that flows into a cranberry bed must, over a period of a week or so, equal what flows out. This is because water is neither created nor destroyed within a marsh (or most anywhere else). As a result, we can write what we call a water budget. To clarify how a water budget works, think of a personal financial budget. I once asked the field manager at the Potter and Son Marsh in Cranmoor (who shall remain nameless) how much he would pay me to work there during my vacation. He had watched me doing research on his marsh and said he figured I was worth about $2.50/hr. For a forty-hour week. (which is the most anyone there has to work), I would be paid $100. My budget for the week would then be:

Income	$100
Tax	-$13
Food	-$65
Savings	-$5
Gas for car	-$15
Lottery or Throw-out	-$2
Balance	$0

So inflow and outflow of money is in balance. A water budget works the same way; for example, using numbers that could be gallons, liters, inches of water depth or an other unit of measure:

Rain+Irrigation	+100
Outflow in ditches	-15?
Flow up/down in soil	-15?
Evaporation	-75?
Change in water stored in the soil	+5?
Balance at end of week	0

The only thing I did not put a question mark after is rain+irrigation, because it is fairly straight forward to measure (use Hawaiian Punch cans; other beverage containers that you might have around do not have flat bottoms). We could measure flow in ditches with special flumes and height measuring devices, and changes in the amount of water stored in the soil could be determined in a number of different ways. The remaining two pathways, flow in the soil and evaporation, are tricky to measure. Although the water in soil is liquid and so visible, the soil is hard to see through. There is no way to measure this with confidence in a particular field. For research one can construct what is called a lysimeter, which is a large (say 10' square by 3'deep) box on a scale filled with soil and planted to cranberry. Then the total water flow into or out of the bottom of the soil can be measured. Note that this flow can go in either direction: it could be a source of water for the crop, or a pathway for loss.

At last we come to the topic of this paper, evaporation (also called evapotranspiration, ET). This loss occurs as water vapor, so we cannot see it with the naked eye. Radar-like devices now being developed can create images of the vapor above a field, but the amount of water escaping is hard to estimate by this technique. Fortunately, there are several research instruments that allow us to measure the rate at which water is evaporating from a field.

What We Did

Last summer we measured evaporation from a bed at the Potter and Son marsh, Cranmoor, using the Bowen ration technique. This involved very carefully measuring air and dewpoint temperatures at two heights, and some other things such as solar radiation and soil temperature. The equipment was fairly reliable compared to most research instruments, and we considered getting 28 days of good data during the whole summer a triumph.

What We Found

Evaporation rate during the course of a single day is shown in Fig. 1; the rate is expressed in inches/hr, just as you think of the depth of water from a rainstorm or irrigation. Also shown is the net radiation, which consists of radiation directly from the sun, plus that from the rest of the sky, minus the amount reflected (and re-radiated, technically) from the ground. Net radiation is by far the major energy source for evaporation in Wisconsin and similar humid areas. Net radiation, and evaporation, closely follow the daily cycle of sunshine.

When attempting to fill out a water budget, however, We are more interested in daily total evaporation so all of the (40-min) rates, like those shown in Fig. 1, were summed for each day. Values of total ET for individual days ranged from 0.04" to 0.22", depending mostly on the sunshine that day.

This is fine, but is it possible to estimate evaporation, rather than measure it with delicate and complicated instruments not designed for routine use? One of the main purposes of our research was to determine if the procedure we use to estimate evaporation from irrigated potatoes applies to cranberry. We make these estimates every day of the growing season from data collected by the weather station on the Potter and Son marsh, and at 19 other stations around the state. The advantage of using a prediction is that the weather station is designed to operate continuously and require little maintenance, while the measurement system is for research use only. The preliminary results of the comparison are shown in Fig. 2. In general, agreement is good between the measured and predicted daily evaporation amounts. A few days had discrepancies that are unacceptably large (Over 0.05"). The source of these errors could be either the measurements or the model. We may have overlooked some problem with the Bowen ratio device on that day, or weather conditions may have been peculiar in some way that causes the prediction to fail.

In conclusion, the evaporation estimates currently produced by the University of Wisconsin Agricultural Weather Observation Network are reasonable for use with cranberry. These estimates are made early each morning for the previous day. They are available on the University of Wisconsin Extension computer bulletin board WISPLAN (along with other weather information) for a nominal fee. Contact WISPLAN at 608-262-4552. Telephone access to the data is available anytime from a computer synthesized voice by calling 800-263-4264. As a first step toward better understanding the behavior of water on your marsh, keep a record of predicted ET losses and compare it to rain and irrigation inputs over several weeks. Hopefully, your water applications are not too much in excess of the crop's ET, so drainage through the soil is controlled.

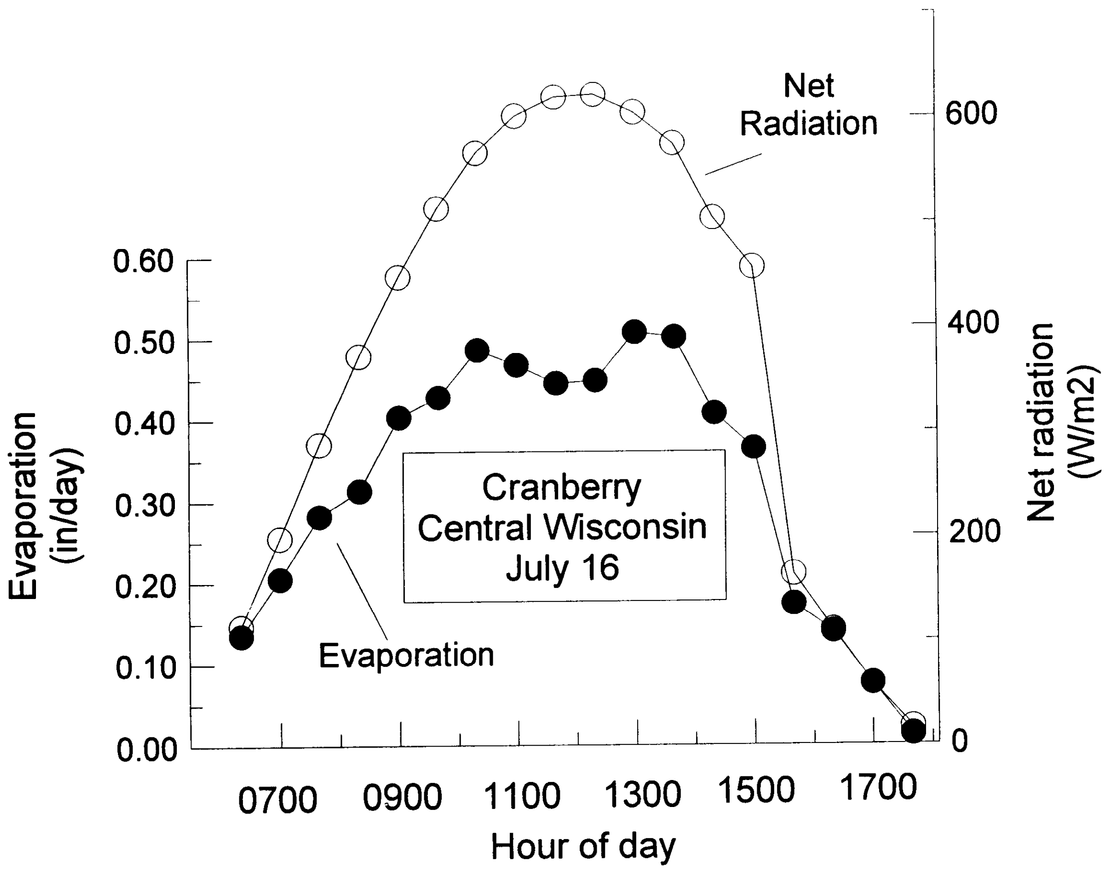

Figure 1. The net radiation and measured evaporation rate from a cranberry bed in Central Wisconsin on July 16, 1993. The evaporation closely followed the net radiation, which in turn closely followed sunshine. The total amount of evaporation on this day was 0.2 inches.

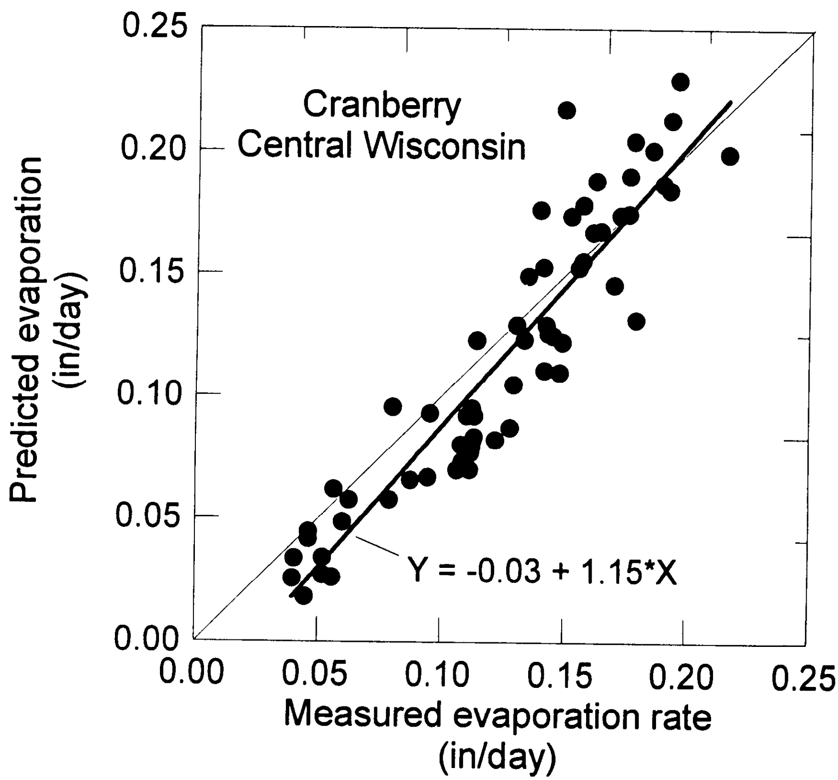

Figure 2. Comparison of measured daily total evaporation with that predicted from data collected by an automated weather station. If our measurements agreed perfectly with the predictions each day, all points would be on the diagonal 1: 1 line. Agreement is generally good, although there are unacceptable discrepancies (over 0.05"0 on several days. We do not know if these were due to an undetected error in our measurement, or in the prediction method.