Case Study:
Corn Harvest on Walnut Farm

An incomplete moisture picture turned out to be costly

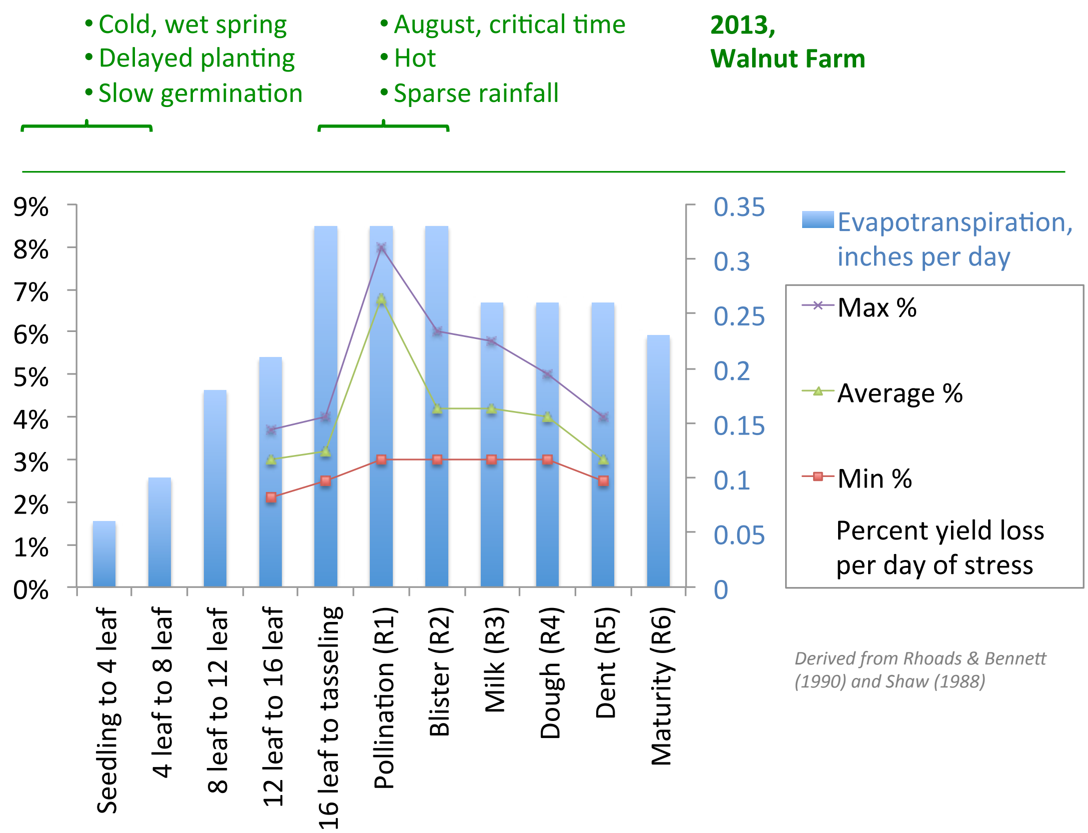
Walnut Farm is on the sandy bottom ground of the West Fork of the Des Moines River in North West Iowa. The soil isn't very thick and after about the depth of one foot it turns from soil to gravel. It doesn't hold water well and requires a center pivot irrigator (shown in the photo) to maintain adequate moisture for row crops.

The weather during the growing season in 2013 in this part of Iowa was difficult, making it hard to judge when to irrigate and by how much. One week's delay in irrigation cost more than $100,000.

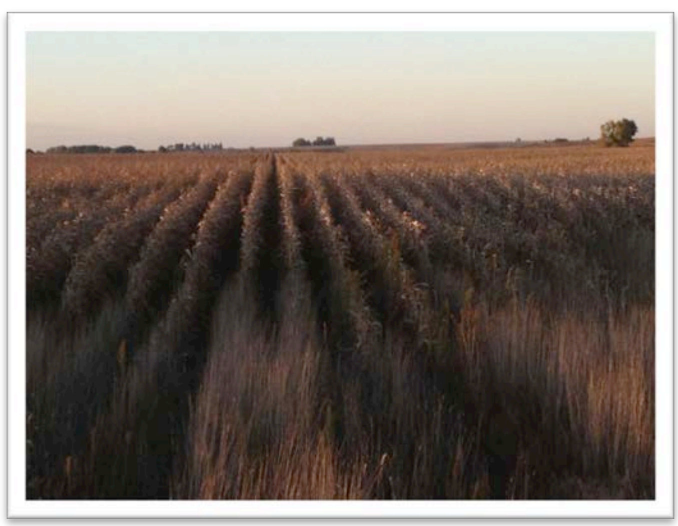
Its All About Timing

The year had a difficult start, with a very wet and cold spring. This caused the corn planting to get a late start, and the corn germination was slower than desired. As the summer progressed into August, rainfall was sparse requiring careful irrigation. This is mapped out in a rough timeline in the picture on the next page. Below it is a set of graphs; the first is a bar graph (blue bars) showing the amount of moisture corn generally loses during its growing cycle through evapotranspiration (soil and plant evaporation). The other lines show a range of % yield loss per day of stress that the corn undergoes. August coincided with the stages in corn development where the plant is most sensitive to moisture.

The corn plant is easily water stressed in this August period when it is flowering and pollinating, after which moisture is needed to grow a large ear, fill out kernels, and maximize the number of rows on the ear. Drought stress may also delay silk emergence until pollen shed is nearly or completely finished. During periods of high temperatures, low relative humidity, and inadequate soil moisture levels, exposed silks may desiccate and become non-receptive to pollen germination.



Once the irrigation program gets behind the crop demands it is hard to catch up. Knowing when and how much to irrigate is a challenge. As can be seen in the graph, the potential yield hit if the plants are starved of water at the most critical time can be 7 or 8% *per day* of stress. And that is exactly what happened. The combination of a cold wet spring, and a dry August with a sub-optimal irrigation strategy caused a 40% yield hit. With each rotation of the pivot costing $2,000 in fuel, it is a complex task to get the cost balance right, and the farm manager has deduced that there was a gap of about a week where they should have irrigated and didn't. And yet, from the photo of the field and in person at the time, it was impossible to tell visually that anything was amiss. The plants on the edge of the field looked good.



Looking at Dollars and Cents

At harvest time it became very obvious that there was an issue, as can be seen in the photo of a few of the ears. The field should have yielded 170 bu./acre and only managed 100. A summary of costs is given in the table below[1]. The crop was Organic Waxy Corn used in organic food processing. The average contracted price for this crop was $14/bu. The loss for the 110 acres was $107,800.

Ouch.

Crop insurance coverage of 75% made up for some of the loss. But crop insurance is no substitute to better farming practices. In addition, the energy cost of irrigation and also water source depletion are critical factors to take into account. Watering too much is costly to both farm income and environmental stability.

Water Input Costs

Fuel	Gallons needed for one pivot rotation	500
	Cost/gallon	$4
	Cost/acre inch	$2,000
Cost of water		$0
Water input costs/inch		$2,000

Average amount of water needed, inches	30
Water input cost if all from irrigation	$60,000

Corn Output	**Typical**	**Actual**
Yield for this ground, bu./acre	170	100
Conracted price/bu.	$14	$14
Income/acre	$2,380	$1,400
Loss/acre		-$980
Planted acerage	110	110
Income for the farm	$261,800	$154,000
Loss for the farm		**-$107,800**

[1] Costs are gross. Only partial expenses shown here, figures do not include labor, fertilizer, planting and harvesting fuel, etc.

The Value of Greater Visibility

Placing a gThrive system in the field would have transformed last year's harvest. gThrive stake sensor technology monitors soil moisture multiple times per hour. The stakes talk to each other and to a base station; from the base station the data is sent to the cloud and this feeds it to your computer and smartphone for instant updates. The system doesn't require professional installation, and the stakes can be relocated whenever desired. Each stake measures:

- Moisture level, at up to 12" deep
- EC – level of fertilization so you can see whether amendments are being washed away, for example
- Soil temperature, so you can decide when to plant
- Air temperature, to detect frost
- Incident light level, great for correlating sunlight with other measurements

A starter system of a base station and 4 stakes costs around $2,000, and the stakes are guaranteed to last at least 3 years. At the beginning of the year, placing a stake in the wettest part of the cornfield, the driest, and two other places in between would have given Walnut Farm the missing visibility on field conditions. In August, they would have guided irrigation decisions long before any distress was evident on the plants. In the spring, they could have helped the decision making to start planting based on the soil temperature and moisture levels.

A $2,000 investment, about the same as one acre-inch of irrigation at that farm, would have added a lot of knowledge to guide decisions, and more than paid for itself in corn yields in 2013.