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IRRIGATION MANAGEMENT SERIES

WHAT IS ET?

(EVAPOTRANSPIRATION)

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The term **evapotranspiration** combines *evaporation* from soil with *transpiration* from plants to describe the total water loss from a crop to the air.

Water evaporates from any moist surface to the air as long as the air is not saturated. This process is called **evaporation**. Water surfaces in contact with the air—like lakes, moist soils, and even plant leaves—all evaporate water.

Evaporation from plants is called **transpiration**. Plant leaves evaporate water through tiny, adjustable openings called stomates that are scattered across leaf surfaces. Water moves from the moist soil into plant roots, through the plant, and finally out through leaf stomates.

Evapotranspiration is often abbreviated ET. It is loosely called **crop water use**. Water is lost to the air both from moist soils and from plants as the final step of the transpiration process. This combination of evaporation and transpiration common to crops is often shortened to one term, evapotranspiration.

Early in the season, when plants are small, most water loss is from soil evaporation. When plants are large, most is from plant transpiration.

Why is crop water use important?

Crop water use determines how much water is needed by rain or irrigation. Too little water can reduce crop yield. Too much irrigation can:

- waste energy,
- waste water,
- waste nutrients, and
- unnecessarily deplete the aquifer.

Smart irrigation management begins with knowing crop water use. The goal is to give the plants exactly what they need when they need it. If a crop does not get enough water to meet its maximum demand, yield will decline. In fact, crop yield increases as water availability increases to the level of peak crop water use. More irrigation beyond this level does the crop no good, and may actually cause harm. Increased pumping and water costs erode profits. Excess irrigation water may run off or percolate below the root zone, removing nutrients and chemicals from where they are needed.

The increased operating costs and fertilizer costs from too much irrigation can add $4 to $17 per acre for each excess inch of irrigation. Irrigating at a level less than maximum crop water demand lowers operating costs, but it also can reduce corn yields by 6 to 10 bushels per acre, leading to losses of $10 to $21 per acre for each inch of irrigation. To attain the highest profits, irrigation must be managed according to crop water use, or ET.

How do plants use water?

Water has three functions in plants:

- *cooling*—evaporation cools leaves,
- *nutrient transport*—dissolved nutrients move through plants along with water, and
- *hydration*—water in plant tissues keeps stems, leaves, and fruit firm.

Crops use water for several purposes. During hot periods, the most important use is to cool the plant. Water that evaporates from your skin (as sweat) cools your body. In the same way, water that evaporates from a plant cools the plant. Without evaporative cooling, the sun's energy would quickly overheat plant leaves. Cooling is such an important function that plants evaporate more than 99 percent of the water they absorb during their lifetime.

A second function of water is to transport nutrients throughout the plant. As water moves from the soil into the roots and to the leaves, nutrients are carried along as well. Though nutrients are very important for crop growth, nutrient transport is considered a secondary function of water movement, since much more water is needed to meet the cooling needs of a plant than to meet the nutrient transport needs.

Finally, a very small portion of water, less than 1 percent for most crops, remains in the plant tissue. This may be surprising since water makes up more than 90 percent of the weight of most crops. This shows how much water plants use for other purposes.

How does weather affect ET?

More water evaporates from plants and soil with:

- *higher* air temperature,
- *more* solar energy,
- *lower* humidity, and
- *faster* wind speed.

Plants and soil usually maintain surface temperatures very near to air temperature. But how can they do this when they receive so much heat from the sun? Why don't they overheat? The answer is ET. Evaporation of water uses energy, whether the evaporation is from a pan of water, a moist soil surface, or a leaf. Energy from the sun or a hot, dry breeze is used to evaporate water instead of increase the leaf or soil temperature. Brighter sunlight means the plant needs to evaporate more water through ET to keep leaf temperatures near normal. Drier air, hotter air, and stronger winds also pull water away from crops at a faster rate.

Does ET change as the crop grows?

Crop ET changes depending on:

- canopy cover,
- crop type and variety, and
- plant maturity.

The *crop coefficient* reflects these differences and is used to estimate ET by comparison with ET from a specific reference crop.

Different types and varieties of plants are capable of moving water at different rates. They also have different maximum rates of ET demand. Even the same crop may have very different water-use rates depending on the stage of growth or the relative amount of canopy cover.

Many of these differences are included in a term called the crop coefficient. The crop coefficient reflects how the ET of one crop compares with the ET of a reference crop. For example, alfalfa is often used as a reference crop; and ET from a full canopy of alfalfa is given the term reference ET. Compared to the reference crop under a specific set of conditions, a corn crop typically evaporates some percentage less water. The exact percentage changes for different crops and canopy characteristics. Thus, if reference ET is known, we can use crop coefficients for corn or other crops to quickly estimate crop ET.

Are soil water and crop water use related?

The amount of available soil water is determined by:

- soil water storage capacity,
- soil water availability,
- root zone depth, and
- crop and residue cover.

If water is not available in the root zone, no ET can occur.

Soil, water, and plant relations are very important to crop ET, and they are critical to effective irrigation management. These relationships are discussed in detail in K-State Research and Extension Bulletin L-904, *Soil, Water and Plant Relationships.*

Soil characteristics determine how much and how tightly water can be held in the soil and how quickly water can move to plant roots to replace absorbed water. Rooting depth determines the volume of soil water the plant can access. Together, these factors control the amount of water available to the crop for ET.

The goal of irrigation is to keep soil water availability from limiting crop ET.

How is ET estimated?

Many formulas have been developed to calculate ET.

Crop ET is often estimated as a percentage of either a reference ET, as previously discussed, or a potential ET value. In either case, the rough estimate of ET found for a given set of weather conditions is fine-tuned using specific crop factors.

Obtaining potential ET values is becoming easier in the major irrigated areas of the state. Radio, newspapers, and computer network services often report potential ET. Computer software programs also are available to help individuals with personal computers make their own estimates. County extension agents can provide additional information on how to obtain or calculate potential ET.

Summary

1. Evapotranspiration, or ET, is a term that describes crop evaporation from both plants and soils. Another term for ET is crop water use.
2. Plants need water to meet their ET requirements. If ET demand is not met, crop yield suffers. ET is an important factor in determining when and how much to irrigate.
3. Weather conditions determine how fast water evaporates from a crop. Different crops may have a different ET for the same weather conditions.
4. ET can be determined on a daily basis to help producers make irrigation decisions.

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