Way sought to measure irrigation water needs

As the demand for water and the cost of irrigation continue to increase, agriculture must increase its efficiency of water use. As farms become larger and skilled irrigators more scarce, good irrigation water management becomes more difficult. Even though scientific research has developed many principles that can greatly improve irrigation water management, determining when to irrigate has not changed significantly. A solution to this need is a method of determining how much water is used each day in plant transpiration and soil evaporation from easily obtainable meteorological data. The sum of evaporation and transpiration is commonly called evapotranspiration. At the Snake River Conservation Research Center, we are developing such procedures from studies of evapotranspiration as related to weather conditions, the type of crop, the amount of plant growth, the stage of growth, and the wetness of the soil surface.

The loss of water from the soil by evapotranspiration is much like withdrawing money from a bank account. When the balance of water remaining in the root zone of the crop approaches a certain minimum level it is time to irrigate. Allowing the soil to dry too much adversely affects the yield and quality of most crops. On the other hand, irrigating too early can lead to wasted water, loss of fertilizer by leaching, increased operating costs, increased drainage problems, and sometimes decreased crop yield or quality.

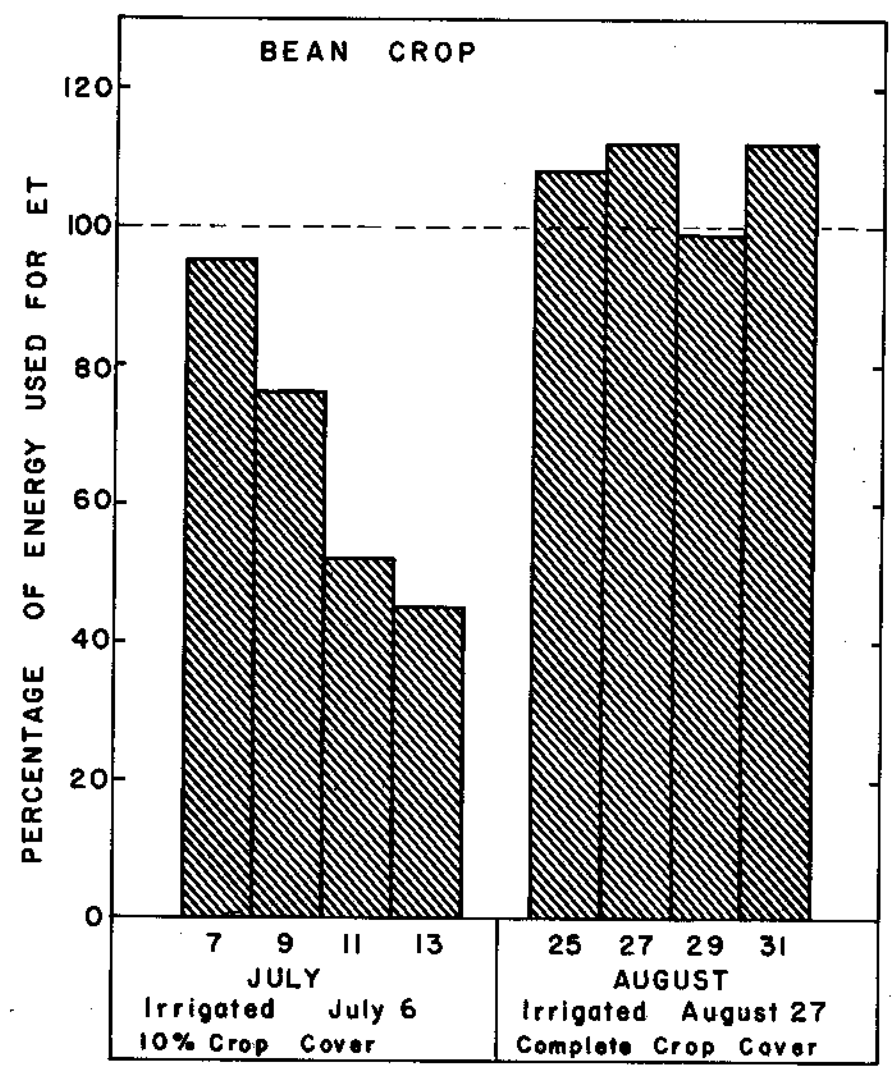
Unfortunately evapotranspiration is something that cannot be accurately measured by every farmer. So we are developing procedures to calculate evapotranspiration from more easily obtainable information about the weather and crop and soil conditions. To test the proposed procedures, we measure evapotranspiration directly with a weighing lysimeter. A lysimeter is a large tank mounted on a sensitive weighing mechanism placed in a pit in a field. The tank is filled with soil so that the surface of the tank is at field level. Both the soil in the tank and field are planted to the crop being studied. As water is lost by evapotranspiration the decrease in the weight of the tank is recorded electronically.

We are also determining evapotranspiration, indirectly, in large fields by an energy-balance method. This method, based on the principle of conservation of energy, can be used because energy is required to evaporate water, to heat the air and soil, and to grow the crop. Most of the energy used in a field is received directly from the sun. But under the arid conditions typical for many irrigated areas, some energy for evapotranspiration may also be derived from warm air passing over the field. This evaporation, in turn, cools the air.

We found that the total seasonal evapotranspiration for a crop of alfalfa at Kimberly, Idaho, for the period from May 1 until September 30 ranges from 36 to 40 inches of water, depending on the climate and management factors. For sugarbeets, the amount is 25 to 30 inches of water.

Early in the season when a crop covers only part of the ground surface the amount of evapotranspira-

Percentage of energy used for evapotranspiration. The young crop had about 10 percent cover. Percentages greater than 100 mean some energy was also obtained from air passing over the field.



tion is greatly influenced by the wetness of the exposed soil between the rows. At such times on a sunny day following an irrigation or a rain when the soil surface is completely wet, evapotranspiration may be ¼ inch per day and require practically 100 percent of the absorbed solar energy. As the surface dries, this can drop within a few days to ⅛ inch per day, requiring 50 percent or less of the absorbed solar energy.

Later in the season, when the crop completely covers the ground, the amount of solar energy used in evapotranspiration is not influenced very much by the surface soil wetness or time of irrigation. Furthermore, with a high degree of crop cover, under arid West conditions, 25 percent or more of the energy for evaporation may be extracted from the warm air passing over the field. Daily evapotranspiration under these conditions is generally ¼ inch or more, and may approach ½ inch on windy days.

Our results show that we can calculate with sufficient accuracy the amount of evapotranspiration for a given crop at a given location from pertinent information on the weather, crop, and soil conditions. We are continuing this research to develop procedures for improving irrigation management practices. These studies will permit greater use of irrigation knowledge and scheduling procedures that have been developed and are being put into use in some areas. As future demand develops, evapotranspiration forecasts may become routinely available.—JAMES L. WRIGHT, *research soil scientist, USDA, Kimberly, Idaho.*

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