Outer space brings measures for soil moisture

BELTSVILLE, Md. — A new moisture meter can "see" soil moisture as deep as six inches below the surface of the earth, according to Thomas J. Jackson, a hydrologist at USDA's Beltsville Agricultural Research Center.

Information about the soil's water content could permit farmers to manage irrigation to best advantage, Jackson says. This means that farmers could, depending on their situation, plan to save water, save energy, or increase crop yields, he said.

Currently irrigation is planned by visual observations, computer models and by measurements with a water-detecting probe. But the extensive sampling needed to give reliable information is costly and time-consuming, Jackson noted.

"Our goal is a remote water-detecting system that could provide daily soil moisture measurements for individual farms over large areas," said Jackson. This would be a source of very accurate information for irrigation management and other agricultural uses.

Now, at the Beltsville Agricultural Research Center, soil moisture is measured with a microwave detector that is similar to a radar dish or disc mounted high above a truck, reported Jackson in a recent International Geoscience and Remote Sensing Symposium. Co-authors were Thomas J. Schmugge and James R. Wang of NASA's Goddard Space Flight Center. NASA developed the equipment for this project. Scientists of the Hydrology Laboratory, part of USDA's Agricultural Research Service, are evaluating the equipment.

The truck experiments are part of a series of tests whose goal is sensing of soil moisture and crop conditions from outer space. The intermediate step will be to use an aircraft-carried moisture meter and to compare the results with measurements from the ground. (Such comparative tests are called ground-truthing.)

Along with the microwave detector, other types of meters are used to provide valuable information to farmers. Visible and near-infrared detectors measure the amount of plant material, or biomass, to indicate the stage of development of the crops and help estimate yields. Thermal infrared detectors measure the temperature of the vegetation; this can be used as an indicator of plant stress from water shortages or other causes.

Microwave sensing for determination of soil moisture is currently used by the Soviets for irrigation management, Jackson said. Three aircraft monitor a 250,000-acre area in the USSR on a weekly basis. Their system was tested both in 1977 and 1978, and was found to be economically feasible. It has been in regular use since 1979, according to Jackson.

The moisture-sensing project of the Agricultural Research Service is part of a larger project called AgRISTARS (Agricultural Resource Inventory Survey Through Aerospace Remote Sensing), which involves cooperation between USDA and NASA, as well as the National Oceanic and Atmospheric Administration, the Department of the Interior, and the Agency for International Development. Other projects of AgRISTARS are related to detecting crop stress, estimating crop production in the U.S. and foreign countries, determining land use practices and effects of pollution on freshwater environments.

The Army Corps of Engineers plans to use the soil moisture information obtained by the moisture meter to help forecast floods. The Soil Conservation Service also is interested in this quantitative data for preparation of its weekly drought map of the United States, which is now based mostly on qualitative information.

New technique aids soybean development

ATLANTA, Ga. — A new early generation testing method, which enables soybean breeders to identify potential new varieties in half the time required by traditional techniques as described recently by a midwestern soybean breeder for the U.S. Department of Agriculture.

Richard L. Cooper, USDA-ARS scientist and professor in the Department of Agronomy at the Ohio Agricultural Research and Development Center, Wooster, reviewed early generation testing (EGT) during sessions of the 1981 annual meeting of the American Society of Agronomy.

Cooper started using EGT in his crossing and selection program more than a decade ago. While some soybean breeders question the reliability of the speed-up selection, Cooper had half a dozen new varieties released in as many years to back his conviction that EGT is faster and just as effective.

The Ohio scientist said the two traditional breeding methods used with soybeans are standard pedigree selection and single seed descent. In the older pedigree selection method, a breeder made an initial cross of parent lines then depended on visual estimates of yield in early generations to determine which plants to keep in his selection program. Actual yield date weren't available until 5 years after the cross was made (F_6 generation).

The single seed descent method, coupling greenhouse plots with field plots, permits sampling more potential lines, but still means almost 4 years elapse before the breeder gets actual yield data on a promising line.

Cooper's EGT method, which has resulted in his development and release of five new semidwarf soybeans (Elf, Gnome, Pixie, Sprite, and Hobbit) and one indeterminate variety, Amcor (for production in marginally productive fields), lets him begin yield testing the F_3 generation, or only 2 years after his initial cross. This means he's likely to be wasting time growing crosses with low yield potential. Instead, he can devote his full attention to more promising crosses based on actual yield measurements.

With the EGT method, Cooper evaluates yield potential in the F_3 and F_4 generations of his cross. Then, the following year he takes the most promising crosses based on yields and pulls single plants for future testing as pure lines. So, by the time the new line is in the F_5 and subsequent generations, Cooper is relatively certain he has pure lines significantly better than the parents with the genetic traits he originally set out to combine in his initial cross.

Cooper's faith in his early generation testing has been substantiated by yield data from commercial farmers who have grown his Elf and Gnome varieties — and by producers of both Registered and Certified class seed of two of his newer semi-dwarfs, Sprite and Pixie.

Cooper admitted that while "it's a game of probabilities," his EGT method has worked effectively in Ohio's cooperative state-federal soybean breeding program. Some private breeders have started using EGT, but it still is not widely used.

When anyone expresses doubts about the accuracy of early generation testing, Cooper just points to the five semidwarf varieties. "I used this system to pick two superior yielding F_2-derived lines in the F_4 generation which originated from a cross of Williams by Ransom. These two lines ranked first and second in yield in a test containing 100 F_2-derived lines representing 34 crosses," Cooper explained. By the time he harvested the F_7 generation, he was certain he had something!

All five of his high-yielding determinate semidwarf varieties — each with different gene combinations representing a maturity range of 2 weeks — can be traced back to the two F_2 lines he selected on the basis of early generation testing.