Chilly Research Thwarts Soil Erosion

BRIAN PRECHTEL (K7652-1)

Agricultural engineer Dale Wilkins (left) and technician Roger Goller look for water leaks along the border of a test plot under a rainfall simulator.

Nature has a perfect recipe to promote severe erosion in the wheat-growing areas of the Pacific Northwest.

First, freeze the top several inches of soil so water can't infiltrate. Then send a warm Chinook wind to melt the surface, as well as any snowcover. Finally, shower the ground with small, gentle raindrops and watch the thawed soil slide down the region's steep slopes.

"Erosion in much of the country results from heavy rainfall loosening the soil and carrying it away," says Agricultural Research Service hydrologist John D. Williams. "But in the Palouse area of eastern Washington and Oregon and western Idaho, it's melting snow and light-intensity rainfall that carry the soil downhill. That's because the water can't soak into the underlying frozen soil." Williams works at the Columbia Plateau Conservation Research Center in Pendleton, Oregon.

"Rain on frozen ground is like dumping water on a dinner plate," says eastern Oregon wheat farmer Clinton Reeder. "Finding a management strategy that keeps the soil in place is tough."

A further complication: Much of the area receives only enough moisture to support a crop every other year. So on nearly 4.5 million acres of the Palouse, farmers like Reeder grow winter wheat one year and leave the land fallow the next, to collect water. Crop stubble or residue holds the soil in place for much of the fallow period.

The soil's most vulnerable time comes right after the next winter wheat crop is planted—around September. The soil's water content is high, so it can't absorb much even before freezing, and the surface is protected only by scant residue and tiny wheat seedlings. Annual soil losses frequently reach 50 tons per acre and have been as high as 150.

A grueling new experiment on Reeder's land may help growers determine the best tillage system to hold the soil and nutrients in place.

To find accurate answers, Williams reasoned that they had to run their tests under natural—in this case freezing—conditions. The business attire for the experiment days consisted of thermal underwear; insulated rubber boots, coveralls, and gloves; ear muffs and hats; and rain gear.

They also need special equipment. Machines that simulate rainfall are commonly used for erosion experiments. But most produce high-intensity rain with large drops. So in the 1970s, scientists with ARS, the University of Idaho, and the University of Wisconsin developed special rainfall simulators for the Pacific Northwest.

"Those simulators produced the right type of rainfall, but they were designed to measure how much water infiltrates the soil over a small, 3-foot-square plot, rather than measure runoff on a long plot," says ARS agricultural engineer Don K. McCool. Based at the Land Management/Water Conservation Research Unit in Pullman, Washington, McCool worked on both the 1970s machine and Williams' new model.

The current design consists of a tentlike structure measuring 10 feet tall by 10 feet wide by 40 feet long. Inside, specially calibrated nozzles drop water on the soil below. Lines supplying electricity and water keep the nozzles, monitoring equipment, and water supply tanks running. In all, it takes 4 people 8 hours to set up the rainfall simulators and 12 people to run the experiment simultaneously on four adjacent plots.

"Everybody helps—the computer specialist, administrative officer, shop foreman, and anybody else who's available," Williams says. In addition to soil loss, ARS soil scientist Clyde L. Douglas, Jr., measures the nitrogen and phosphorus runoff.

The simulators have been run five times over the past 2 years. The experiments compare moldboard plowing and rod weeding, chisel plowing, and a new technique called mow-plow.

The mow-plow is a cross between traditional and conservation tillage. It's a moldboard plow pulled by a tractor that has a modified combine header on its front. The machine harvests the old standing straw in front of the tractor and conveys it to the rear, just-plowed area, covering the soil surface with residue. The experiment tests the mow-plow system on plots with light straw and heavy straw.

Moldboard plowing is a time-honored technique that buries the weed seeds, but it also deeply buries straw left after harvest. "In erosion-prone areas, crop residue is one of the farmer's best methods for keeping the soil in place," says ARS agricultural engineer Dale E. Wilkins. He is also at the Pendleton location.

"The chisel plow incorporates 90 percent of the residue in the top 4 inches and is a widely used conservation tillage technique. The drawback is that it leaves weed seeds on or near the surface, where they can emerge," he says. Annual weeds like downy brome can significantly reduce wheat yields—up to 90 percent in experimental plots.

Preliminary results indicate that the heavy-residue mow-plow system provides the best combination of nutrient and soil conservation and weed control.

"This system could be especially useful for farmers who have been using conservation tillage but are starting to have a problem with downy brome," Wilkins says. "The next step is to identify the best conditions for using the mow-plow system; that is, where sufficient crop residue can be cut and moved onto plowed soil to provide adequate erosion control."

Reeder, who helped out during one of the recent trials, was impressed with the research.

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Hydrologist John Williams checks a clogged or frozen water emitter in the portable rainfall simulator.

"If you farm for long in this country, you know frozen ground leads to our worst erosion problem. But when I watched the soil running off in the experiment, the problem really hit home," he says.—By **Kathryn Barry Stelljes,** ARS.

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