AGRICULTURAL RESEARCH

New Soil Erosion Model Erodes Farmers' Patience

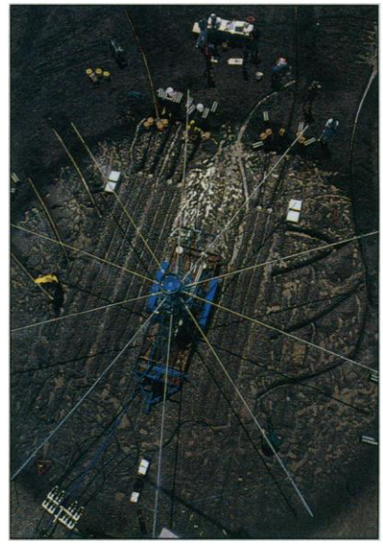
LEXINGTON, ILLINOIS—Jim Kinsella drops a spade into his farm's rich, black soil, revealing a number of worms that quickly squirm out of sight. There are a lot of worms and burrows in the untilled soil of Kinsella's farm. There are none, however, in a new government computer model designed to predict water-induced soil erosion rates on farmland. Although burrows can soak up prodigious amounts of rain—water that would otherwise wash soil away during storms—Kinsella says that many such benefits of no-till farming, in which soil isn't plowed, "aren't being plugged into the equations." That type of oversight—and Kinsella and several scientists charge the model is riddled with such blind spots—may cost U.S. farmers dearly.

The model is called the Revised Universal Soil Loss Equation (RUSLE, pronounced "Russell"). The U.S. Food Security Act, revised in 1990, mandates that by 1 January of next year, farmers must use erosion predictions like those generated by RUSLE to develop and implement soil conservation plans in the hopes of stemming the current erosion rate of roughly 1 billion tons of topsoil that ends up in U.S. waterways each year. The U.S. Department of Agriculture's Soil Conservation Service (SCS) plans to use RUSLE to calculate soil losses on individual farms; farmers would have to choose a conservation strategy that the model predicts will hold erosion below a critical level—or risk losing federal subsidies. But some of those conservation plans, such as elaborate systems of terraces and drainage, can be expensive, and with RUSLE allegedly riddled with holes, farmers don't want it dictating their choices.

Farmers and soil scientists in the Pacific Northwest, for example, charge that the model has no good data about erosion in their climate, which is produced by freezing-and-thawing mechanisms that are quite different from the raindrop impacts and flowing water that dominate erosion elsewhere in the continental United States. And the doubters aren't restricted to one region. Some soil scientists, such as Richard Johnson of the John Deere Technical Center in Moline, Illinois, say the rainfall-simulator results that make up RUSLE's core database may not reflect the true give-and-take of soil movement in nature. As a result, says Clinton Reeder, legislation chair and past president of the Oregon Wheat Growers League, RUSLE's shortcomings are "going to cause a war and not solve a problem."

Combat was not what the Department of Agriculture had in mind when its Agricultural Research Service (ARS) began to develop RUSLE more than a decade ago. The program is designed to predict water erosion across a wide variety of climates, soils, topographies, and agricultural practices, and ARS scientists say it does a pretty good job. Kenneth Renard, RUSLE's project leader at ARS's Southwest Watershed Research Center in Tucson, Arizona, says that analysis of thousands of new measurements—mainly from farm and grazing land—have yielded a highly accurate way to predict just how much soil will be eroded under a variety of conditions. "RUSLE is going to give us a better indication of where we are with respect to soil loss," says David Schertz, National Agronomist at the SCS.

Government scientists have been trying to get a handle on soil loss since the Dust Bowl, when severe drought, combined with fence row–to–fence row tillage, led to widespread destruction of cropland in the Great Plains. The ability to predict erosion by wind has steadily progressed since then and has been incorporated into a computer model—also frequently criticized—that is due for an upgrade by 1995 or 1996. Models of water erosion began to emerge in the 1960s, with early versions of algorithms developed by ARS soil scientist Walter Wischmeier, then at Purdue University in West Lafayette, Indiana. He relied on a few measurements of erosion by simulated and natural rain to cobble together these algorithms, which were applied to the entire United States. Since then, says John Laflen, director of the National Soil Erosion Research Lab on Purdue's campus, the algorithms have been "used just about every place on Earth—just not on the moon."



TIM MCCABE/ARS

A rain of data. Rainfall simulators like this one, near Cottonwood, South Dakota, provided data for a model of soil erosion that has farmers up in arms.

By 1970, the model, known as USLE, was widely used by U.S. soil conservationists to help define acceptable agricultural practices on highly erodible land. It pinned quantitative formulas on a rainstorm's erosive effect and churned out variations on those numbers if the land was terraced, tilled, tiled, left fallow, or covered with various kinds of crops, all of which affected erosion to greater or lesser degrees.

But by the 1980s, major holes had begun to appear in USLE's predictive power, says George Foster, director of the National Sedimentation Laboratory in Oxford, Mississippi, and one of RUSLE's principal developers. The equations included "almost no data from the western U.S.," he says, and the model did not account for events as commonplace as a pond forming during a storm and halting erosion beneath it. Nor, he says, could the model accurately predict erosion in fields of vegetables such as asparagus and broccoli, since there were no measurements of erosion in such fields (in fact, there still aren't).

So RUSLE was designed to fill in the gaps. Measurements at more than a thousand western sites have been incorporated into the program. Myriad effects such as soil roughness, rate of biomass decay, and seasonal changes in soil erodibility—"highest in the springtime right after you come out of the winter thaw," Foster explains, partly because the wet soil can't soak up much rain then—all have been taken into account for the first time. And researchers have dealt with the broccoli problem by treating the plant as an amalgam of other plants—such as young corn or soybeans—that offer roughly similar forms of ground cover.

But new factors keep turning up, such as worms. No-till farmers and some scientists report exploding populations of earthworms in their fields, and more earthworms, they say, mean less erosion. "We have measured 160 [earthworms] per square meter—or over 600,000 per acre," says William Edwards, an ARS researcher at the North Appalachian Experimental Watershed in Coshocton, Ohio. Edwards says that the worms help open up a network of "macropores" that allow water to infiltrate the soil instead of flowing across it and carrying away topsoil grains as it moves. "Models work fairly well in tilled ground," says Kinsella, "because tillage tends to equalize conditions—it makes all soil pretty bad in terms of infiltration." But on no-till farms like his, Kinsella thinks, such descriptions fall apart.

And farmers don't want to spend money on plans derived from fragile models. They are keenly aware that conservation plans come

with different price tags."Terracing is a major up-front cost per acre" and can interfere with basic farm operations like turning a tractor around, says Jim Porterfield, technical specialist for land and water resources at the American Farm Bureau Federation. By contrast, soil-conserving practices such as no-till farming or adding biomass "residue" to the soil surface after harvest often require purchasing a few extra attachments for standard farm machinery, he says. With farming's low profit margins, these choices can make the difference between a good year and a loss.

Foster contends that RUSLE is perfectly up to the task of making these evaluations. He says the model accommodates no-tillers like Kinsella by "lowering the erosion curve" based on actual no-till data. In the Northwest, both Foster and Renard say that recent modifications to the way climate affects erosion in RUSLE have greatly improved its accuracy. Foster admits that the freeze-thaw style of erosion there "makes the Northwest a very challenging problem to deal with." But, he says, difficult economic conditions among farmers there have left many of them unhappy with conservation regulations, resulting in attempts "to kill the erosion prediction technology behind the policy."

But Foster reserves some of his sharpest criticism for SCS, which he says has delayed implementation of RUSLE—originally scheduled for last October—until this August for fear of complaints, and possibly lawsuits, from farmers who might have to adopt more expensive plans than USLE required. Equally "embarrassing" given the delay, he says, might be cases in which farmers are told that elaborate preparations already under way can be dropped. Rumors as to how predictions of the two programs will differ have been rippling through the farm community, but Foster says that few generalizations can be made.

Schertz flatly denies the charge of stalling, saying the agency has "no real concern" about possible challenges in court and that SCS simply underestimated the time needed to take the research-scale package provided by ARS and come up with a practical tool for use in the field. But even when RUSLE is up and running in SCS offices, Schertz continues, the agency won't push farmers into quick makeovers of their plans if the old and the new predictions aren't too far apart. "A lot of conservation plans that were good yesterday are going to be good tomorrow," he says. So at this point, no one is betting the farm on major plan revisions accompanying the August deadline.

–James Glanz

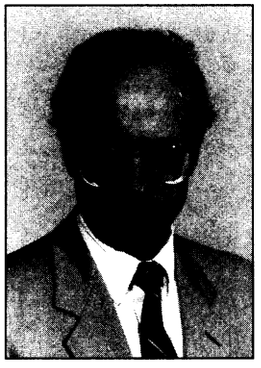
James Glanz is a free-lance science writer living in Chicago.

SCIENCE IN CANADA

Report Condemns Pressure to Publish

On 24 August 1992, Valery Fabrikant, a research professor in the department of mechanical engineering at Concordia University in Montreal, calmly walked into a university building and gunned down four faculty members. He's now serving a life sentence in prison, but repercussions from the incident are just beginning to spread through the Canadian university system.

Fabrikant said he killed his colleagues to draw attention to his grievances against the university: charges of research fraud, research contract irregularities, and his claim that he was unjustly denied tenure. Two new reports, made public over the last 3 weeks, found no basis for Fabrikant's charge of fraud, but concluded that some of his other complaints should have been taken seriously. One report notes that university officials proved incapable of dealing with Fabrikant's charges or handling his increasingly threatening and disruptive behavior. But the second report is potentially more damning. Not only does it find that some of Fabrikant's complaints had some legitimacy; it goes on to say these problems —conflicts of interest, excessive outside professional work, and misappropriation of authorial credit—extend throughout Canada's scientific and technical schools.



Aftermath of a killing. A new report bears out some charges brought by Valery Fabrikant before he shot his colleagues.

The first report, authored by John Scott Cowan, former vice-rector of the University of Ottawa, lambastes Concordia officials for allowing an increasingly aggressive campaign of charges and threats by Fabrikant to go unchecked. Concordia's board of governors fired rector Patrick Kenntiff and three other officials just after the report was released on 31 May.

The second report, "Integrity in Scholarship: A Report to Concordia University," was released on 6 June. Its authors, a three-person committee chaired by former York University president Harry Arthurs, found a prevailing culture at the university of "production-driven research" which they compare to an auto industry driven by quantity, not quality. Bigger grants and more equipment go to those with long publication records, the report notes, and these "ends are sometimes used to justify means which are highly questionable." Those means, the report says, include an abundance of inappropriate authorial credit, as well as a large amount of outside contract work by faculty that detracted from their duties as university teachers and researchers. These problems, the report says, are not unique to Concordia, but are products of "the almost inescapable pathology of the surrounding research culture, of systems...which have developed in Canada over the past 25 years, and ultimately of developments in scholarship which, if not universal, are certainly widespread."

Some of the blame, the report states, can be laid at the door of a 1970s Canadian government policy of giving private-sector bidders preference in government basic research contracts. The solution hit upon by university researchers was to privatize themselves: form private companies and bid on government work. The Arthurs report suggests that at least two of Fabrikant's colleagues, S. Sankar and T. S. Sankar, were quite successful at this. The report says they attracted research contracts, per diem payments, and profits, all the while using university facilities and students to do the work. This lead to more publications and more prestige and grants. The report goes on to note that these researchers are highly regarded scientists, and characterizes their participation in these practices as "unfortunate." All the scientists have issued public statements strongly denying any allegations of impropriety.

After the Arthurs report came out, Reginald Groome, chair of Concordia's board of governors, echoed its conclusions about the overall research climate when he told a 9 June press conference that Concordia is "merely in the same type of situation that many universities across the country are in, but we are taking the rap because of what happened." But Claude Lajeunesse, president of the Association of Universities and Colleges of Canada, downplayed the extent of the problems enumerated by the Arthurs report. "The granting councils have been paying more attention to the quality of publications," he says.

More details on the extent of these alleged improprieties may be coming this summer, after a Concordia audit on the use of research funds by the engineering and science faculty is completed on 30 June.

–Douglas Powell

Douglas Powell is a graduate student at the University of Guelph.