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Pay Dirt

Could California farmers and ranchers help fight global warming by burying a key greenhouse gas in the dirt of their fields? UC Davis scientists say yes—and they might even make money at it.

By Sylvia Wright

Charlie Rominger ’79 in his recently planted no-till field. (Photo: Karin Higgins)

In the endless fields of California’s Central Valley, the sun rises and sets on tractors moving dirt. The rumbling diesel machines crumble the soil to make it penetrable by fertilizers, pesticides and plant roots. They pile up seedbeds and dig irrigation furrows. They weed out unwanted competitors, harvest finished crops, and rake up leftover stalks, stems, leaves and straw.

On some farms, however, growers are giving their tractors, and their soil, a rest. Slowly adopting a new regimen of farming operations called conservation tillage, they are learning that making fewer tractor passes can increase profits, keep the land productive and help them meet new environmental regulations. What’s more, say UC Davis agricultural and environmental scientists, it may help slow climate change.

Conservation tillage reduces the amount of greenhouse gases in the Earth’s atmosphere two ways—by burning less fossil fuel and by sequestering carbon in soil. Carbon, nitrous oxide and methane form an unholy trinity: They are the three major greenhouse gases in Earth’s atmosphere. Climate scientists have talked for decades about reducing warming by socking away carbon atoms in soil or other long-term

storage banks, such as trees, oceans, aquifers and even (ironically) depleted underground oil and gas fields. They focus on carbon because, although carbon dioxide traps the least heat of the three gases, it is the only one with great potential for being collected from the air and held benignly in some sort of sink.

Johan Six, a UC Davis assistant professor of plant sciences, cites the work of Ohio State University Professor Rattan Lal, who says that 80–200 million metric tons of carbon per year could be hoovered out of the sky through a variety of changes in the way American farmers work their land. (Lal estimates total U.S. carbon emissions total about 1,900 million metric tons per year.) Jeffrey Mitchell, M.S. ’88, Ph.D. ’94, a UC Davis associate cropping systems specialist in the Department of Plant Sciences based in the San Joaquin Valley, says those dramatic land-management changes are “constructing the new culture of agriculture.”

The foundation of those changes is conservation tillage, and it is the first strategy that UC Davis researchers are assessing for its potential to reduce greenhouse gas emissions in California. Tillage, Mitchell explains, is simply the working of the soil. It was one of the technologies that led to the huge leap in productivity in American agriculture after World War II and helped make California the top agriculture state in the country. But as the decades passed, it became evident that tillage was also taking such a toll on the soil that those production levels were unsustainable. For starters, tillage was venting massive amounts of carbon, the essential building block of plant life, into the air, so that farmers had to replace it with animal manure or composted plant matter. Plus, all those tractor passes over the fields were sending up tons of dust particles, making the air unhealthy for plants and people, as well as compacting soils, which led to even more tillage.

The practice of conservation, or reduced, tillage first arose in the Midwest. Farmers began drilling individual holes for seeds, leaving plant residues on the ground and (not without controversy) adopting plant varieties like Roundup Ready corn that were weeded chemically instead of mechanically. Charlie Rominger ’79, of Rominger Brothers Farms in Winters, recalls the trip to a cousin’s farm in Indiana 10 years ago when he first saw the wheat planter that is now his favorite tool. It was a John Deere 750 No-Till Drill. In 1988, a group of UC Davis scientists started the first studies in the state exploring alternative agricultural practices. Professor Will Horwath of the Department of Land, Air and Water Resources, who came to the project in 1996, says one of the main goals of the project was to increase soil carbon with cover crops (“green manures”), in experimental fields at what was then the Sustainable Agriculture Farming Systems (SAFS) site in Davis. (The SAFS project has since been consolidated with the Long-term Research in Agricultural Systems project into the Center for Irrigated Agriculture; Horwath is associate director.)

Mitchell came to work on SAFS in 1991 while earning his doctorate, then took his

current position in 1993. In 1995, he began the first studies of conservation tillage in California, assessing dust reduction with UC Davis soil science professor Randal Southard and then, in 1999, comparing standard and conservation tillage systems with and without cover crops. The tillage comparisons were done in fields at the UC West Side Research and Extension Center in Five Points and on private land nearby, in collaboration with growers such as John Diener ’74 of Red Rock Ranch.

In general, the scientists found that growing cover crops and incorporating them into the soil increased soil carbon, while conservation tillage reduced the amount of carbon dioxide emissions by decreasing the use of fossil-fuel-burning farm machinery. Specifically, use of a winter cover crop added 0.2 to 0.3 metric tons of carbon to an acre of soil per year, say Six and Horwath.

Some growers took to the new systems right away. Since the late 1990s, Charlie Rominger and brothers Rick ’76 and Bruce ’80 have seen carbon in their soil samples increase from 1 percent to as much as 1.5 percent. Plus, says Charlie, “We are saving probably 30 to 40 bucks an acre on tractor fuel and upkeep, are using fewer herbicides, and are getting roughly the same yields.” Today they farm 2,500 acres in Yolo County with as little tilling as they can manage, raising tomatoes, corn, rice, wheat, oats, barley, alfalfa, sunflowers and wine grapes with low-till or no-till practices.

“The more we get our business processes to mimic nature, the more benefits we find,” says Charlie. “Carbon sequestration is one of the bonus synergies we get by doing things in harmony, rather than in conflict, with natural processes.”

Tom Barcellos of Barcellos Farms in Tipton and T Bar Dairy in Porterville, who in 2001 was one of Mitchell’s earliest adopters of the new techniques, said he has cut the costs of fuel, labor and machinery maintenance. “In our first reduced-till year, we had all of our corn planted sooner, fewer bug pressures and no loss in yield. We did spend a bit more on herbicides because we grew Roundup Ready corn. We made 5 percent to 10 percent more profit that year.” And this year, with 800 acres no-till—still in “the baby-steps stage,” says Barcellos—profits are up 15 percent over 2000.

Meanwhile, the notion of carbon sequestration has been getting increased attention in international climate-change discussions. While talks at Kyoto and elsewhere focused on reducing greenhouse gas emissions at the sources, some academic and industry scientists proposed storage as an adjunct or alternative solution. In fall 2003, the U.S. Department of Energy gave $145 million to seven regional research partnerships to identify sequestration opportunities and write plans for pilot tests. The regional partnership that includes California and five other states is named WESTCARB, and the University of California is a member.

So far, most sequestration research has been assessing the potential of enormous geologic repositories, such as the nine-year-old Sleipner Project, where carbon dioxide removed from natural gas is pumped into a layer of sandstone 3,000 feet below the bed of the North Sea. But agricultural producers' early, positive experiences with conservation tillage have them thinking much more about carbon cycles in their operations. Some, like the Romingers and Barcellos, are asking if there is a modest role in the sequestration matrix for them.

Kate Scow thinks there may be. She is professor of soil microbial ecology in the Department of Land, Air and Water Resources at UC Davis and director of the Kearney Foundation of Soil Science. The foundation's current five-year mission is the study of soil carbon in California terrestrial ecosystems. In September, Scow and Mitchell hosted the first workshop on carbon sequestration for California growers. It was held at the UC West Side Center, and about 60 farmers and others from the ag community attended.

After a primer on greenhouse gases and climate change, UC Davis' experiments with conservation tillage were described by Scow, Mitchell, Six and UC Davis soil and root ecologist Louise Jackson. From the California Energy Commission, Guido Franco summarized how climate change is predicted to alter California temperature and precipitation patterns over the next century and discussed how carbon sequestration fits within the state's response to those changes.

Next the director of the state Office of Agriculture and Environmental Stewardship, Steve Shaffer, outlined the implications for farmers of a June 1 executive order from Gov. Arnold Schwarzenegger, which set state greenhouse gas reduction goals for the next 45 years. "The strategies for reaching those goals are scheduled to roll out by January 2006," Shaffer told workshop participants. "There may be new incentives for big industry to support carbon sequestration in novel ways. And greenhouse gas emissions from agriculture may even be regulated in the future. It behooves you to learn what the California Environmental Protection Agency and its new Climate Action Team are doing."

As the lunch break approached, UC Davis economist Stephen Vosti, associate director of the Center for Natural Resources Analysis, explained that one thing that might help promote soil carbon sequestration is the establishment of a market for trading of carbon credits: "Society wants to reduce carbon dioxide and other greenhouse gas emissions. We need a mechanism to do that. And a market-based system is the most efficient way to go about it." What exactly is traded? Permits to pollute, basically. Large-scale emitters of greenhouse gases, such as petroleum-based power-generating utilities and manufacturing industries, could meet reduction mandates by paying farmers to adopt carbon-sequestering practices.

There's no such carbon trading market in California yet. But there is one at the Chicago Climate Exchange, where members who surpass agreed-upon emission reductions can sell credits to other members who fall short. The "CCX" started in 2003 with 14 members; today there are more than 100, including Ford Motor Co., Dupont, the cities of Oakland and Berkeley, and the universities of Iowa, Minnesota and Oklahoma.

Shaffer advised the growers to follow the example of big California businesses (including BP, Southern California Edison and PG&E) by documenting their current levels of greenhouse gas emissions (and any hard-earned reductions) in the California Climate Action Registry. If carbon trading ever does come to California, that record will act as a bank balance of carbon credits that may be profitable.

By this point the discussion had plowed a great deal of new ground. Lunch was served, then dessert: a bona fide farmer already making money by burying carbon in his soil.


Wheat grower Karl Kupers made one of the first farm carbon-sequestration deals. (Photo: Sylvia Wright)

The farmer was Karl Kupers, a wheat farmer from Reardan, Wash., who told how, in 2002, he and 76 of his neighbors made one of the nation's first farm carbon-sequestration deals. Organized as the Pacific Northwest Direct Seed Association, the growers offered to farm for 10 years using no-till practices that would sequester a total of 3,000 metric tons of carbon, or 0.55 metric tons of carbon per acre per year. The nonprofit group Environmental Defense shopped their offer to energy companies. And Entergy, an energy supplier in Louisiana, Texas and Arkansas, leased those 3,000 tons from the farming association for $2.50 per ton, for a total of $75,000, cash in advance.

It was not a great deal of money to the growers, Kupers said. But it was a major step toward a new agribusiness model in which farmers get paid to do things that are good for their operations anyway, while emitters get credit for the farmers' carbon sinks.

And there was more. Kupers also profits by promoting his "Shepherd's Grain" carbon-storage activities to environmentally conscious buyers. "My business is marketing this verifiable environmental aspect of our management practices," he concluded. "We tell people, 'You're a food activist when you buy our product.' That sells. And it's real."

In the audience, Mari and Gary Martin, third-generation farmers from Pikalok Farming in Firebaugh, were listening carefully. On their 1,200-acre farm, they and son Daniel, age 17, have been raising cotton using reduced-till techniques for eight years. "First

we found conservation tillage to be a viable business practice, with quantifiable savings of fuel and labor," said Mari. "Then we realized our reduced fuel emissions were also a benefit to air quality. Now it appears conservation tillage might have a carbon sink potential."

Martin said her family would continue to study the potential of carbon sequestration. "Our goal is to keep our family land sustainable for the fourth and future generations. We're always looking for new ways. As stewards of the land, we feel we need to use the best management practices possible."

Sylvia Wright writes about the environmental sciences for UC Davis.

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