



By Larry Reichenberger

BUILDING BETTER SOILS

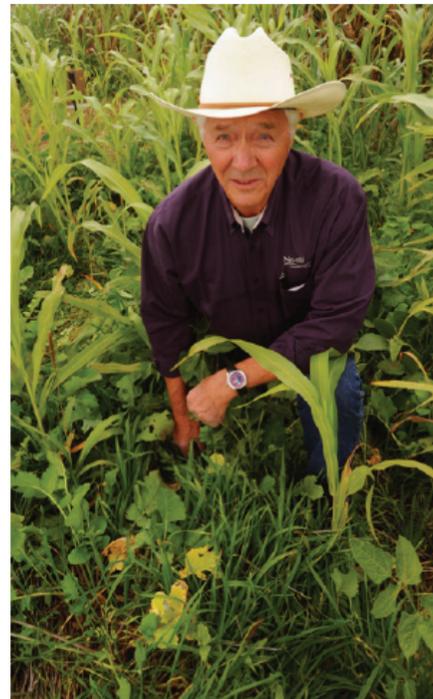


No-till and cover crops can improve soil quality and boost yields

With the determination of gold miners panning for their fortune, farmers are picking through soil profiles these days—also in search of treasure. Those riches are in the form of worms, mites, nematodes, deep-growing plant roots, aggregated soil structure and any tell-tale signs of bacterial and fungal activity. All those are indications of soil quality, and developing the management strategies that will enhance that quality is a sure way to strike pay dirt.

“Healthy soils are teeming with biological activity that increases the productivity of crops and livestock,” says Jill Clapperton, an internationally renowned soil health consultant. “However, you have to feed that soil so it can feed your crop. Planting cover crops and cover crop mixtures designed to increase the level of soil organic matter is an ideal way to provide for the millions of organisms that work together to build a quality soil.”

►**Left:** Gail Fuller credits no-till, and the use of diverse mixtures of cover crops, for the improving soil quality recently found on his Kansas farm.
 ►**Left inset:** Soil mites like this *Ametrop* species (seen through an electron microscope) process crop residue into soil organic matter.



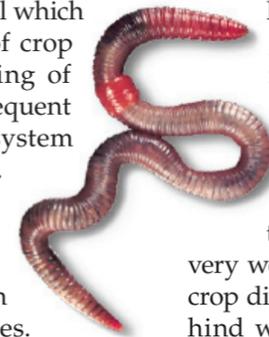
Clapperton, who formerly led the Rhizosphere Ecology Research Group at the Lethbridge Research Center in Alberta, Canada, now operates her Earthspirit Consulting service from the family ranch near Florence, Montana. Her focus is to develop and promote an understanding of how a diversity of crops enhances biological activity in the soil which spurs the processing of crop residues and the cycling of nutrients back to subsequent crops—provided the system isn’t disrupted by tillage.

This effort takes her not only to laboratories and lecture halls, but also to soil pits dug in crop fields and pastures. One such opportunity was last summer in Gail Fuller’s corn field, just outside of Emporia, Kansas.

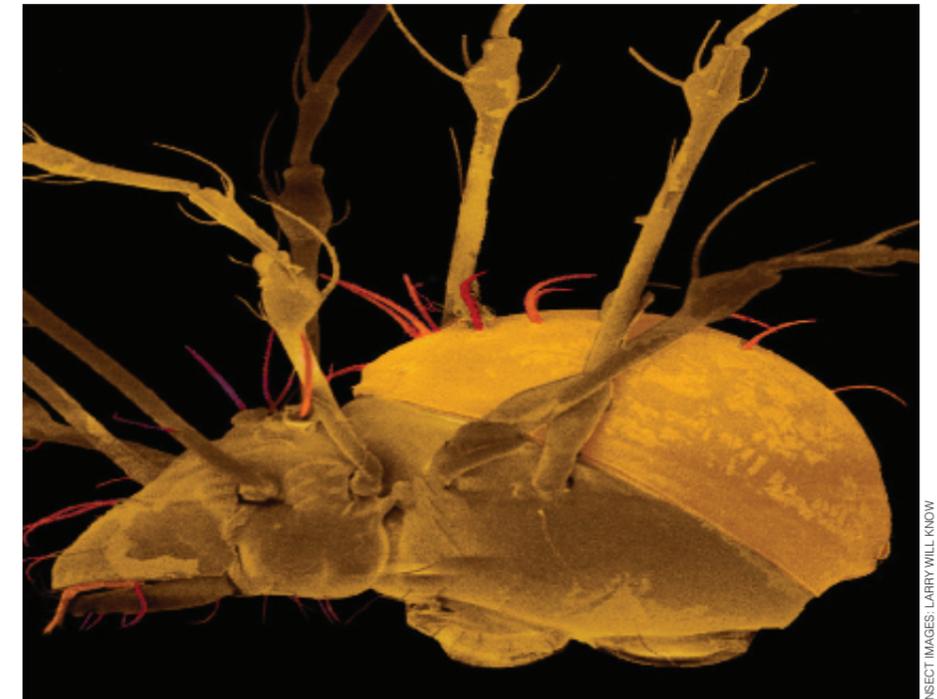
Down in that pit, Clapperton worked with USDA-ARS soil microbiologist Kris Nichols to pick away at the soil face and reveal indications of an underground biological world that most of the farmers leaning over the edge hardly knew existed. “There are millions of organisms that live in a handful of soil and they’re part of a soil foodweb that ultimately makes

nitrogen, phosphorus and other nutrients available to growing plants,” says Nichols. “Other than earthworms and a few insects, you can’t see them, but the soil structure they create to facilitate this biological community is clearly obvious in a healthy soil.”

Fuller, who had volunteered his field as a stop for a No-Till on the Plains Whirlwind Tour, was glad to see signs of that activity in his soil. “We’ve made soil health a major focus in recent years. When we started no-tilling sixteen years ago we were in a corn/soybean rotation and it wasn’t working very well, so we began adding more crop diversity by double cropping behind wheat. Now, we’ve gone even further by using cover crop blends that include multiple species and even planting companion crops with our regular crops. Our goal is to always have something growing on every acre and last year we grew 22 differ-



►**Above:** Earthworms are the most visible sign of improving soil quality. ►**Below left:** Ray Ward says carbon, supplied by crop residue, doesn’t get the respect it deserves a major crop nutrient. ►**Below:** Mites are among the millions of organisms that make up a healthy soil.



INSECT IMAGES: LARRY WILL KNOW



►Above: Dwayne Beck says no-till is allowing farmers to increase the intensity and diversity of crop rotations. ►Below: USDA=ARS soil microbiologist Kris Nichols, from Mandan, North Dakota, gathers information on soil quality by testing the stability of soil aggregates in water.

ent crops doing it," he says.

Clapperton says such crop diversity above ground leads to similar diversity below ground—a key step in enhancing soil quality. "Every type of plant exudes substances from its roots that attract specific microorganisms. These add to the diversity of the soil's biological community, making it healthier and leading to greater productivity with fewer purchased inputs, like expensive fertilizer."

"It's a little corny to say, but in talking about crop diversity—and the various organisms that make a quality soil—it's true that if you build it, they will come," she says.

Feeding the soil. Healthy soil provides many benefits, including faster water infiltration, greater water holding capacity and erosion protection, but the ability to cycle crop nutrients and provide 'free' fertilizer is a major one. Soil organic matter—made up of decomposed crop roots and residue—is the food that drives soil biology. When soil microbes consume organic matter they give off nutrients that are available for plants to use.

North Dakota farmer/rancher Gabe Brown has seen healthy soils have a major financial impact on both livestock grazing and crop production. "Thanks to no-till and cover cropping, we've improved the soil organic matter levels on our ranch from around 2% to the current level of about 4%. At today's fertilizer prices, each 1% of soil organic matter contains \$650 per acre worth of nitrogen, phosphorus, potash, sulphur and carbon," says Brown.

"This means at our level of 4%, we have \$2,600 per acre worth of those nutrients locked in the top six inches of soil. The trick, of course, is to make them available to plants, and that's where spurring the soil's biological activity comes into play. Instead of focusing on feeding the crop (with commercial fertilizer) we're focusing on feeding our soil so it feeds the crop."

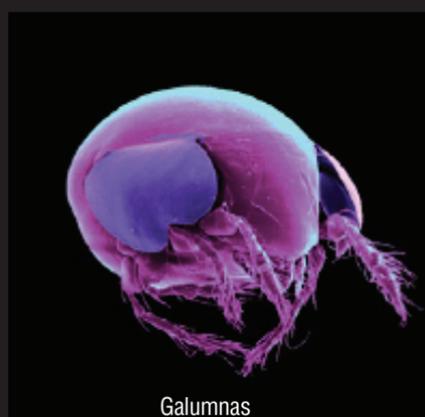
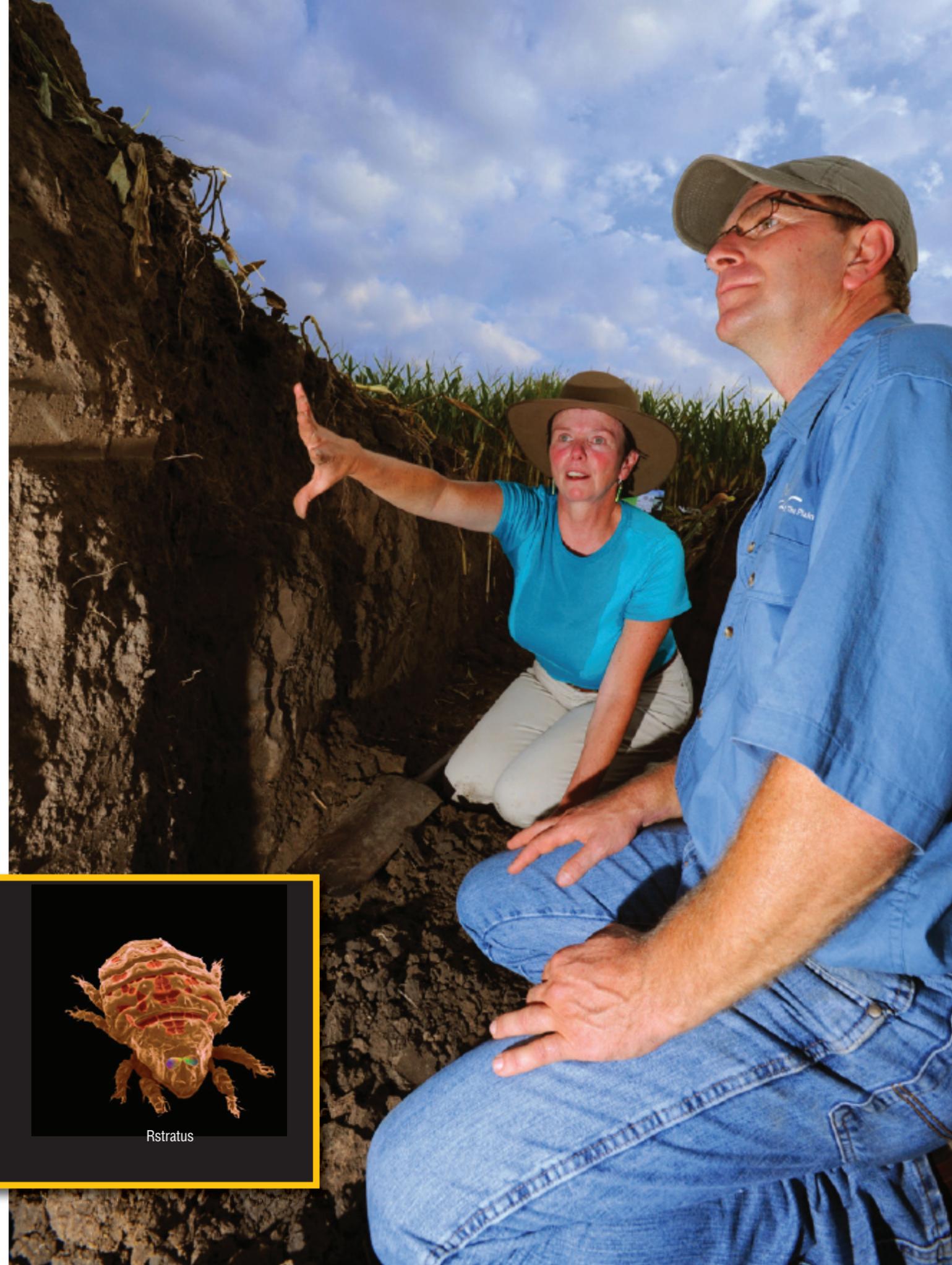
Ray Ward, founder of Ward Laboratories in Kearney, Nebr., says soil scientists don't yet know what impact stepped-up soil biological activity has on the release rate of crop nutrients from soil organic matter. "With conventional tillage, we could figure on an annual release of 1% of nitrogen for small grain crops, 2% for row crops and 4% for summer fallow. The release rate is likely higher with the increased biological activity in a healthy soil," he says.

No-till's role in building a healthy soil is a physical one—tillage destroys the soil structure and contributes to the loss of carbon that's need in the soil. "No-till isn't the end goal, it's the tool that lets us manage the soil's ecosystem," says Dwayne Beck, director of the Dakota Lakes Research Center near Pierre, South Dakota.

Beck, who spurred the adoption of no-till in the Plains, says the goal has always been to allow increased crop diversity. "We needed no-till so we had enough moisture to add soybeans to the crop rotation and that increased crop diversity. Cover crops add to that diversity and they're the next step for successful no-till programs," he says.

►Right: Jill Clapperton points out indications of improving soil quality to farmer Gail Fuller.

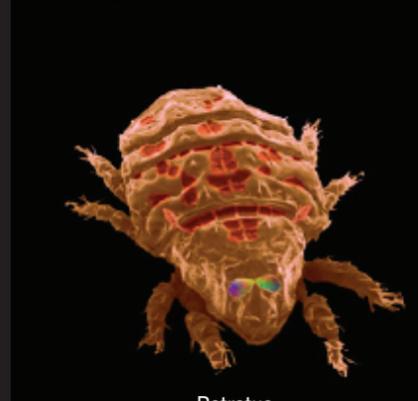
►Below: The three mites shown in these images from an electron microscope are involved in decomposing crop residue into soil organic matter. (photo credit: Byron Lee & Derrick Kanashiro.)



Galumnas



Himinothus



Rstratus