The Land Institute
2440 E. Water Well Road
Salina, KS 67401
(785) 823-5376
(785) 823-8728 fax
theland@landinstitute.org

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Fertility and the Age of Soils

Wes Jackson

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Professor Tim Crews of Prescott College in Arizona described his undergraduate experience with the famous intensive vegetable gardens established by Alan Chadwick at the University of California-Santa Cruz. Although Tim was much taken with what was under way in that beautiful setting, he found one disconcerting activity impossible to get off his mind — there were frequent pickup runs for manure for these lovely and productive gardens. "They may not use chemicals," he concluded, "but they certainly are not sustainable."

Tim experienced an intellectual epiphany of sorts. I, too, had one in California during a three-day field trip in Mendocino County. Hans Jenny, America's foremost soil scientist at the time, and his friend Arnold Schultz, a forestry professor

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Arnold Schultz, a forestry professor at the University of California-Berkeley, led Canadian ecologist J. Stan Rowe and me up and down what is called the ecological staircase of Mendocino. Any penchant toward eco-fundamentalism was sure to suffer. Mine did.

To understand an ecological staircase, imagine you are on the beach looking inland with your back to the Pacific. If you were several hundred feet tall, if no vegetation were in the way, you would easily see five stair treads, geological uplifts 100,000 years apart. Before I started up the staircase, I believed any natural ecosystem improves over time, that roots would hold the essential soil minerals and add topsoil, increase in stability and maybe increase diversity. Or if the ecosystem should happen not to improve, at least it would stay constant indefinitely. By the time we headed back to Berkeley, the pillars of my ecological understanding had been shaken. In the younger first and second terraces away from the ocean, the redwood and Douglas fir forest loomed up around us. Terrace three was a transition zone that included Jeffrey pine, and terraces four and five (the older) were pygmy forest, severely stunted in appearance.

Over the next several weeks, letters were exchanged, and finally, about four months after the field trip, a letter came from Hans saying he was unaware of such a concept as steadily improving ecosystems. He said such a "sunshiney belief rests

on a neglect to appreciate the soil as a dynamic — either improving or degrading — vital component of land ecosystems." There was little comfort in the fact that I had had it half right.

In that same letter he expressed concern whether he and Arnold had presented Stan and me with "sufficient physical evidence that the decline in soil and vegetation from the redwood-fir forest on the second terrace to the pygmy forest is a natural sequence." Plant ecologists had, in fact, designated the redwood-fir forest a climatic climax (so long as the climate was constant the vegetative structure would not change), and the pygmy forest an edaphic climax (relating to soil). In Hans's view, ecologists had designated two different worlds, two different ecosystems, "not realizing that the two ecosystems might be on the same time arrow, merely separated by a long time interval."

Fundamentalism sometimes dies hard. Staring into a soil pit dug into the fourth terrace, I could sympathize with the churchmen who refused to look through Galileo's telescope. Even there, with the evidence before me, I protested, saying that good farming *can* improve the soil. "Yes," Hans said, but "the extent depends on what kind of a soil, virgin or depleted, the farmer begins with." He thought it would be difficult to improve a good virgin Iowa prairie soil by management techniques, except perhaps by applying nitrogen, phosphorus, and potassium.

This was the beginning of an important lesson for me. Since then I have burdened myself and my students with the question: Why should a look to nature, as we work out our relationship to the earth, provide us with easy absolutes? Nature may or may not share human interests. We choose to make nature our standard for agriculture instead of trying to understand agriculture on its own terms. We, not nature, have concepts and notions of good and bad. Most humans comparing the luxuriant redwood-fir forest to the pygmy forest would call the pygmy deteriorated or declining. Yet Hans insisted that "nature might call it a biological improvement, an adaptation of vegetation to a changing substrate." This then raises the most important question of all: Why are there not pygmy forests or pygmy prairies or pygmy whatevers all over the world? The answer is: because we have glaciers, volcanoes, mountain building due to uplift — disturbances that seem destructive yet are sources for the raw materials of soil formation. This requires *very long* time periods, so soil is as much of a nonrenewable resource as oil. What right have we to expect those nosing roots to absolutely hold all nutrients from any downward leaching?

Tim Crews told his story to our 14 Graduate Research Fellows when they assembled with us for a week in Matfield Green. Discussion continued among staff, visitors and graduate students. Our session reviewer was Dr. Ted Lefroy, a scientist from the University of Western Australia in Perth. During

one coffee break Ted turned to me and said, "the United States has a ?manure pile' this high" (and he held his hand some five feet from the floor) "and Australia has a manure pile this high" (holding his hand less than a foot from the floor). "The last benefit we got from tectonic plate movements," Ted said, "was 65 million years ago; our nutrient pool, our manure pile, has mostly run down. You had an ice age in the last 2 million years plus major mountain formation in the Rockies in the last 15 million years. The Sierra Nevada and Coast Range are young. You live on a young continent."

When we look around the world at the places with a bountiful agricultural production, we are struck with the importance of recent geologic events necessary to sustain them.

The Greek historian Herodotus once said, "Egypt is the gift of the Nile." True enough, but that is only part of the story. The Blue Nile carries nutrients from Ethiopia's volcanic highlands, thanks to the predictable monsoon rains arriving from the Indian Ocean each year. The White Nile, with its jungle origin and swampy places, contributed its organic matter, which also had to be nutrient-sponsored, of course. Fertility from two parts of the world converged at the confluence. Prior to the dams on the Nile, these fresh nutrients and organic matter spilled over to deposit a layer one millimeter thick each year to be turned into crops by Egyptian farmers. Or, put otherwise, the volcanoes of Ethiopia and the swampy jungles of Africa

built the pyramids using humans as agents.

The gardens at the University in Santa Cruz are beneficiaries of what we might call an acceptable theft, for otherwise the manure would likely go unused. Where those nutrients came from before becoming manure is important to know. The likelihood is they had their origin as horizontal fertility from across a broad landscape, perhaps from hay and grain grown in a California valley. Transformed into manure piles in the livestock barns, the grain became vertical fertility in the Santa Cruz garden.

As you can see, this is a story that lends itself neither to sound bites nor bumper stickers. It is not a story to discredit organic gardening, but it is a story that illustrates, for all practical purposes, that soil is as much of a non-renewable resource as oil. This is where our work at The Land comes in, for when we watch topsoil slip into the sea, we are watching the disappearance of the faces of unborn children. The Land Institute's paradigm, featuring a diversity of perennial roots modeled after nature's arrangements, we think represents the best bet to hold the soil that will support with dignity healthy children of the future. Perennial roots hold those nutrients whether made available by the likes of Pleistocene glaciers or mountain creation.

Agricultural time, 10,000 years, is not even a blink compared to geological time. Yet it is during that blink that we humans have been

creating horizontal open mine shafts called plow furrows in the most wasteful mining operation in the history of the planet. We don't have another 10,000 years to correct the problem, and we need to get going while we still have the slack with which geology has blessed us. ■