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RICH DIRT, POOR DIRT

JUST WHEN WE WANT MORE FROM OUR FOOD, WE ARE GETTING LESS, AND THE DECLINING QUALITY OF SOIL MAY BE THE ROOT OF THE PROBLEM. **by Daniel A. Marano**

HERE'S AN IRONY TO consider: Could it be that one fallout from a century of increasing agricultural efficiency is nutrient deficiency?

In order to support ourselves nutritionally, we are increasingly encouraged to eat more whole foods, especially fruits, vegetables, and grains. We focus much concern on pesticide-free agriculture and the lag time in getting food from farm to market. All that wilted lettuce looks so unappealing.

Yet the soil itself is the key to the nutrient content of food. The nutritional value of our produce is determined more by the abundance of minerals and microbes in the soil it's grown in than by any other factor. An array of studies shows that not all soil is the same, and the widespread practice of fortifying low-grade soil with fertilizer doesn't even begin to remedy the problem. To the degree that agriculture has reached for high yield and engages in farming practices that maximize harvests, soil quality has declined.

And so has the nutritional value of many whole foods over the last 70 years. The calcium content of broccoli averaged 12.9 milligrams per gram of plant tissue in 1950, for example, but only 4.4 mg per gram by 2003.

In a landmark study published in the *Journal of the American College of Nutrition* in 2004, biochemist Donald Davis documented nutrient decline with hard numbers. Davis and coworkers at the University of Texas at Austin focused on 43 vegetables and fruits and pored over data on them from the U.S. Department of Agriculture going back to 1950.

"We found that six out of 13 nutrients showed apparently reliable declines between 1950 and 1999," he reports. Perhaps more worrisome would be declines in nutrients we could not study because they were not looked at in 1950—magnesium, zinc, vitamin B-6, vitamin E, and dietary fiber, not to mention phytochemicals."

Diminished nutrients included protein, calcium, phosphorus, iron, riboflavin (vitamin B2), and ascorbic acid (vitamin C). The declines ranged from 6 percent for protein to 38 percent for riboflavin.

The straightforwardness of the numbers belies the challenge. The researchers had to compensate for variations in moisture content, which affects nutrient measurements. And they had to factor in changes in varieties of crops planted.

Nevertheless, Davis attributes the nutritional depletion of foods to a two-pronged dilution effect. Driven by consumer demand, farmers were not selecting for nutritional value but for size uniformity, pest resistance, and yield. And they were not breeding hardy, heirloom strains that might have intrinsically greater nutritional value. In selecting for yield, crops grow bigger and faster, Davis notes, but they don't necessarily have the ability to make or take up nutrients at the faster rate.

Studies have directly traced the decline to large-scale farming and commercial agriculture methods that wind up "mining" soil. For decades, agriculture has done little more to prepare soil for food crops than stir up the surface by tilling or apply chemical fertilizers laced with nitrogen, phosphorus, and potassium (the N-P-K numbers on that bag of fertilizer you bought). But much more goes into nutrient-robust produce, and to get to the root of human nutrition, it is necessary to follow the roots of plants into the soil and recognize the deep contribution they make to its ecology and health.

TILLING SOIL IS EQUIVALENT TO **STRIPPING YOUR GUT OF GOOD BACTERIA** BY CONSUMING NO ROUGHAGE AND OVERUSING ANTIBIOTICS.

Deep root structures are able to break up and absorb nutrients that lie far beneath the surface. Trees, with their vast and complex root systems, provide ample evidence in their produce. Maple syrup, for example, in its amber earthiness is a rich source of calcium, manganese, and zinc, largely because an expansive root network draws the health-giving minerals from deep, undisturbed soil.

Tree nuts are known nutritional powerhouses thanks to far-reaching systems of roots. Take the Brazil nut tree; these Amazonian behemoths can grow hundreds of feet high with root systems that penetrate hundreds of feet below ground. The fruit of the tree is a nut with more natural zinc, magnesium, phosphorous, B vitamins, and trace elements such as selenium than just about any other food. That's in addition to all the fiber and healthy fats.

A mainstay of modern farming is monoculture, planting and growing a single crop on the same acreage year after year. Think corn, think wheat. It fosters efficiency; by minimizing plant competition it vastly increases yield. But annual crops like grains have shallow root structures that are no match for the deep roots of perennial cereal grasses. In fact, increasing concern about the contribution of extensive root systems to food quality is prompting forward-thinking farmers to turn to the planting of perennials.

Beyond root systems, soil management techniques such as plowing significantly affect the nutrient-holding capacity of land. Over decades, the annual plowing and disking of fields reduce the essential organic carbon matter of the soil.

How much is lost? The world over, 50 to 80 percent of soil's humus, or organic matter, has been lost over time. Tilling not only loosens soil but virtually earmarks it for erosion; it also disturbs the delicate balance of micro-organisms living within it.

Soil is a complex living thing. In addition to minerals, it is, like the human gut, loaded with microbes that are essential to health. The bacteria and fungi that naturally inhabit soil, in fact, function much like the gut biome: They break down the nutrients in earth and make them available to plants. Tilling soil, then, is the equivalent of stripping the gut of bacteria by depriving it of fiber-rich whole foods and overconsuming antibiotics. Without the billions of microbes in our guts, we'd be unable to absorb the nutrients in food. The ecosystem in our gut has its direct counterpart in the ecosystem of the soil.

Robbing soil of living and decaying matter impairs its ability to self-regulate. What gets tilled out of the soil has to be replaced by chemical fertilizers that are mined and, through the use of vast amounts of fossil fuels, transported from far corners of the world. Even then, they boost yield but not overall nutritional value. By not tilling soil, farmers allow their crops to die off and form a protective armor over the soil that helps retain carbon, nutrients, and water.

Loss of organic carbon matter in the soil harms more than soil health and nutrient levels of plant and vegetable matter. The earth is a closed system, and that carbon has to go somewhere. Much of it, once bound up in soil, is now in earth's atmosphere, contributing to climate change. The only way that carbon gets back into the soil is via photosynthesis.

Returning carbon to soil improves its productivity naturally. It also reduces the need for water and fertilization—to say nothing of improving the climate. Restoring the nutrient content of food, then, is about restoring the ability of soil to hold carbon, moisture, and all the bioactive fungi and bacteria that work with root systems to make nutrients bioavailable to the plants that absorb them.

"If we can restore the carbon that used to be in the soil, it's a win-win," says Richard King, a Northern California conservationist formerly with the USDA. "It takes carbon dioxide out of the atmosphere, putting it back into the soil. It improves soil productivity. It reduces the amount of irrigation water we need to apply." Increasing humus content of soil by 1 percent can improve the soil's ability to hold water by a significant average of 20,000 gallons per acre.

The transfer of nutrients is a cycle that goes not only from soil to plant but to all animals that feed off the land. No surprise, then, that ranchers are turning to sustainable methods of boosting the nutrient density of soil as a way of maintaining the health of the animals that graze on the land. On more than 5,000 acres that he and his wife own in Bismarck, North Dakota, rancher Gabe Brown has turned to holistic soil management. By planting cover crops that remain in place to nourish fields, and abandoning tilling, he has greatly enhanced mineral and water retention of the crops his herds graze on.

Brown reports that he has not used any synthetic or commercial fertilizers on his land since 2008. Yet, "through leaf-tissue analysis of cash crops, we are documenting that there are no deficiencies in any nutrients. Obviously, we are cycling more nutrients back into the soil."

Brown is quick to note that "I am not doing anything our forefathers didn't do. Thomas Jefferson's journals show that he was doing cover crop mixes just as I am. So were our grandfathers. But after World Wars I and II, with the advance of synthetic fertilizers and machines, we forgot what we had been doing."

Just as the medical world is beginning to recognize the incredibly comprehensive role the biome plays in human health—influencing processes from digestion to cognition—soil scientists are only now digging into the complex synergies between soil health, plant health, and nutrient availability. Ancient as it is, says Timothy Crews, director of research at The Land Institute in Salina, Kansas, "soil itself needs to be better understood. We are only beginning to fathom the role of soil in plant and human health."

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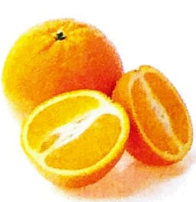
Notes from the Underground

The Mineral Content of Raw Foods: 1963 vs. 1999 (mg/100g)





	Apples, with skin		Beans, snap green		Broccoli		Carrots		Lettuce, iceberg	
	1963	1999	1963	1999	1963	1999	1963	1999	1963	1999
Calcium	7	7	56	37	103	48	37	27	20	19
Magnesium	8	5	32	25	24	25	23	15	11	9
Potassium	110	115	243	209	382	325	341	323	175	158





	Oranges		Peaches		Peas, green		Strawberries		Tomatoes, red	
	1963	1999	1963	1999	1963	1999	1963	1999	1963	1999
Calcium	41	40	9	5	26	25	21	14	13	5
Magnesium	11	10	10	7	35	33	12	10	14	11
Potassium	200	181	202	197	316	244	164	166	244	222

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