

of change but must be expanded to include environmental quality, human and animal health, and food safety and quality. Soil quality can be sustained or enhanced only if degradative processes are offset or reduced by processes or inputs that improve or rehabilitate the soil. The need for developing a soil quality index based on local and regional considerations is addressed in the paper by Granatstein and Bezdicek. The challenge according to these authors is to integrate soil parameters into a meaningful index that correlates with soil productivity, environmental quality, and health.

The paper by Sanders discusses recent international activities that have been directed toward assessing and monitoring soil degradation. Some of these studies have identified many of the practical problems of measuring land degradation, data collection, and analysis that will have to be resolved before sufficiently accurate procedures are developed. A complimentary paper on the subject of global soil degradation is presented by Sumner and Miller on how soil crusting contributes to the severity of soil erosion, nutrient runoff and impaired seedling emergence. Some interesting strategies for alleviating soil crusting are discussed.

Two papers in this special issue focus on soil biological criteria as indicators of soil quality, an area that has been somewhat neglected compared with the rather extensive characterization of soil chemical and physical properties. Visser and Parkinson discuss the potential role of soil microorganisms as indicators of soil quality, while Stork and Eggleton suggest how the diversity of soil

invertebrate fauna could also be used advantageously for this purpose.

The physical and chemical attributes needed for proper characterization of soil quality are presented by Arshad and Coen. They discuss the justification for selecting and measuring specific attributes of soil quality, and for monitoring changes in soil productivity. Karlen et al. enumerate various soil and crop management practices and how they might affect different soil quality indicators. They conclude that the most important consideration in improving and sustaining soil quality is to maintain an adequate level of soil organic carbon through crop rotations and recycling of organic wastes.

The factors that can affect the nutritional quality of crops, including soil factors, climate, the cultivar, and fertilizer management practices, are reviewed in the paper by Hornick. These and other factors are discussed with respect to food safety and quality, and their implications for human and animal health.

Finally, we wish to thank Drs. M. A. Arshad and L. F. Elliott for their assistance in reviewing the manuscripts in this special issue, as well as the anonymous reviewers who contributed generously of their time and talent. We also acknowledge and thank Dr. William Lockeretz for his excellent editorial assistance.

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OPINION

Coming full circle —The new emphasis on soil quality

John Haberern

Back in 1942, Rodale Press founder J. I. Rodale made a simple, but profound prediction about an impending revolution. A gentle revolution, to be sure. But one that would shake the very roots and foundations of our agricultural research and education system. One that would tie farmers and farming directly into our health care system.

"I believe a whole new era of agricultural research is in the making—one which will benefit the country at large far more than all the research of the past has done," J. I. said fifty years ago. "One that will clearly help create a healthy society and a country of prosperous farms and a healthy, vigorous people."

What J. I. foresaw was a soil-care revolution. A time when our agricultural leaders, scientists, farmers, and yes even consumers,

would finally wake up to the fact that for far too long we've been treating our soils like dirt. A time when agricultural research would rivet in on a new baseline—soil quality—in balance with the priority now given to production and higher yields.

But even more important than that, what J. I. and his son, Bob Rodale saw over the horizon was a willingness of the agricultural community to go even one step further: to recognize that the health of the people and the health of the soil were closely intertwined. From the moment people first scratched the earth and sowed seeds, they've had the power to improve their food, and by extension, their health, by what they did or did not do to the soil.

Unfortunately, in my estimation, the soil-care revolution is still in the starting blocks. Granted, we are taking small, but significant steps toward finally recognizing that the health of the soil is just as important as the health of our air and water. Building soil fertility

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3

and recognizing the need to monitor the health of the world's soils over time is now on the agendas of various private and public institutions.

Much credit for this must go to USDA's Agricultural Research Service, Rodale Institute, the World Sustainable Agriculture Association and other non-profits, USDA's Soil Tilth Lab, some land grant universities, and a few forward-thinking private foundations. All have come to the same conclusion: we truly have no idea what kind of shape the world's soils are in. We've been driving along in a car without a fuel gauge for far too many years now. We may have three-quarters of a tank left, or we may well be running on empty. We simply have no idea.

That will change. In less than five years, I predict we will have a soil health index, a report card documenting the gains and losses in soil quality worldwide. Such an index will help target more focused agricultural research well into the 21st Century.

But why all the fuss about soil quality anyway? Losing 24 billion tons of rich productive topsoil each year certainly would be reason enough to call a halt to business as usual. Then there are the additional costs to society resulting from the side effects of soil erosion. Certainly no drop in the bucket. No need here to go into the long litany of other abuses we've heaped on our soils.

But for me, the real reason we should all be concerned about the deteriorating health of the world's soils is directly related to the health care crisis staring us in the face today. Fifty years ago, J. I. Rodale predicted such a crisis and said then that we can head it off by preventing diseases rather than treating them. His prevention solution: Improve the quality of foods people eat by improving the health of the soils in which they are produced. He put his money where his mouth was and founded The Soil & Health Foundation— forerunner of today's Rodale Institute—to "conduct, engage in, foster, and encourage scientific research and study, teaching, training, informing and educating the public on and concerning the soil, foods, and the health of man, and their relationship to each other."

In 1987, Bob Rodale reinforced his father's conviction with this pronouncement: "Our feeling is that prevention is by far the most effective and affordable approach to health. When you think that way, when health is seen primarily as a challenge of prevention, then the solution to health problems become largely agriculture solutions. Better foods produced in a better way, in a regenerative, soil enhancing way, is essential to prevention of disease."

Actually, a USDA lab, the former Bureau of Chemistry and Soils—vintage early 1930's—came close to reaching that same conclusion. Close, but not close enough in terms of stretching the soil health—human health envelope. In 1937 a research chemist by the name of Kenneth C. Beeson was assigned by the Bureau to "begin reviewing world literature on the link between nutritional value of foods and the quality of the soil in which the food was grown." According to Beeson, a number of people in agricultural experiment stations were analyzing garden produce and finding, for example, that lettuce in Florida might have a different calcium content than lettuce grown in Mississippi.

Beeson went on to head a new lab at Cornell, called the Plants, Soils, and Nutrition Lab. Its mission: "trace the nutritional connection between soils, plants, and animals." The idea was that improvement to the soils might send beneficial ripples all the way up the food chain.

What an off-the wall idea! In fact, Beeson said, "The concept behind the Ithaca lab—the thought that soils could effect the plants

that sprouted in them—was considered quite novel in the 1930's." However, after Beeson's tenure as director, the Ithaca lab pretty much dropped the ball.

Who will come to the rescue? Farmers, I say. While the revolution J. I. predicted has yet to come to full fruition, its seeds have found fertile ground in the fields of innovative farmers and researchers who understand the importance of healthy soil. Farmers will be the soil health—human health heroes of the future. To them, sustainable agriculture means more than just maintaining nutrient levels. In the words of North Dakota farmer and sustainable agriculture leader Fred Kirschenmann, "From a sustainable perspective, the condition of the soil is at least as important as its fertility. This means being concerned not just with what is missing from the soil, but also what is wrong with it, and what can be done to correct it."

For sustainable farmers, soil management goes far beyond deciding how much fertilizer to apply. They rely on a combination of complex rotations, manure and compost applications, carefully managed tillage and other practices to insure optimum soil health. Take, for example, the practice of cover cropping. Legume cover crops can supply nitrogen to following crops, but the benefits of cover crops go far beyond simple fertilizer application.

Cover crops can also improve soil structure, helping soils drain in wet years yet hold moisture during drought. Better structure can also help reduce compaction from field traffic. Cover crops can soak up excess nitrogen in the soil preventing it from leaching to groundwater, and deep-rooted plant species can bring nutrients to the surface, making them more available to following crops. Farmers who have successfully incorporated cover crops into their cropping systems also report increases in soil organic matter and more efficient nutrient cycling. Soil microbiology research is only beginning to explain why.

Regenerative farmers are reaping the benefits of cover cropping and other practices that promote soil health, even though those benefits can't always be identified by basic soil tests or simple economic analyses.

In addition, the benefits extend beyond the farm gate. Attention to soil health helps reduce the need for chemical pesticides and fertilizers and their attendant potential for pollution. Many also maintain that, in addition to the lack of pesticide residues, the nutritional quality of crops produced in healthy soils is superior, leading to healthier livestock and healthier people.

What a novel idea! Many years ago Bob Rodale said, "Farmers are the health care practitioners of tomorrow." Bob, liking to shake the status quo, often made predictions like that. Statements that, at first glance, might seem to be a little absurd. Then, after consideration, the truth of the statement slams home!

What Bob said is becoming evident today. Because farmers are the source of the nutrients we all need every day to stay alive, let alone thrive. What they do on the lands they till effects the health and well-being of all the world's people.

Certainly, I'm not blind to the fact that there are other instrumental factors interacting to determine personal health. Yet, now is the time to position farmers on a much higher plane in terms of their role in enhancing the health of present and future generations.

