

The Roots of Soil Health in Organic Farming

BY WILL BRINTON

One hears the phrase “soil health” so often these days it seems to be reaching a crescendo. Recently, the U.S. Department of Agriculture (USDA) formed an entire Natural Resources Conservation Services (NRCS) division for it. Around the same time, the Soil Health Institute (SHI) was formed, including sponsorship by USDA, agribusiness and the Nature Conservancy. My thesis is that the organic farming community set the idea of soil health in motion – but it’s a convoluted trail to demonstrate this.

In 2017, SHI released a report concerning adoption of “soil health practices” in the U.S., titled “Progress Report: Adoption of Soil Health Systems.” Organic farming did not even make the list. I found this curious and contacted the principal author, a land-grant university agronomist with ties to the Sustainable Agriculture Research and Education program (SARE). His response, in a nutshell, was that organic farming is too insignificant to count. Organically farmed land in the U.S. stands at 6 million acres, certainly a small fraction of the 900 million acres of total farmland. But what are organic farmers being measured against?

The SHI report is based on data from the 2017 U.S. Census of Agriculture and states that, in regard to soil health practices, the census collects information on cover cropping and tillage – including no-till, conservation tillage and conventional tillage. While it is not explicitly defined in the report, the 2017 Census of Agriculture Highlights explains no-till as follows: “Crops are planted directly into the vegetative cover or crop residue of the previous crop.” This definition doesn’t, however, mention the high-strength inorganic prill (pelleted) fertilizers and herbicides common to conventional no-till agriculture.

With an emphasis on no-till acreage (which accounts for 104 million acres in the U.S.) and cover crops (which accounted for roughly the same acreage as organic production in 2017), the report implies that these prac-

tices are the gold standard for soil health. Excluding organic, therefore, seems unfair.

Another puzzlement regarding soil health’s origin story comes from NRCS itself, which states that the roots of soil health lie in the 1973 oil embargo. It is well-known that the oil embargo brought conventional, energy-intensive farming to crisis, but what’s the connection to soil health? The effect was an enormous impetus for no-till farming – reducing fuel costs for land preparation.

It’s concerning in that attributing the origins of soil health to no-till and an oil embargo results both in over-estimating accomplishments while also undervaluing organic farming contributions. To dig deeper, we are going to have to unbundle many assumptions.

Defining Soil Health

Harry S. Truman once stated, “There is nothing new in the world except the history you do not know.” This is what I intend to explore.

Let’s start with how soil health is defined. John Doran, a well-known Nebraska USDA-Agricultural Research Service (USDA-ARS) agronomist, described soil health in 1994 as “the capacity of a living soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health.” Actually, Doran did not compose this definition for soil health, but for “soil quality.” It’s an important technical distinction. Between 1994 and 1996, Doran edited two books on soil quality by the Soil Science Society. Soil health was on people’s tongues, but sort of parenthetically. A 1995 article in *Soil and Water Conservation* suggested that, from a farmer’s perspective, soil health is a set of sensory traits – like the scent of soil.

Soil quality virtually became a new discipline by 1997. In an editorial in *Soil Science of America Journal*, the author cautioned, “A great deal of study and education



Early research at FiBL in Switzerland established that leafy greens treated organically were likely to have significantly less tissue nitrate at equal or greater yields than conventionally grown greens. Photo from fibl.org

While scientists, with their good intentions, exposed the hazards of quantifying soil quality – surely an oxymoronic undertaking – somehow the term soil health survived and multiplied. The phrase is certainly more powerful, being holistic and open to intuitive interpretations. Yet it is more than this. Darwin once summarized how his own ideas could overthrow many Victorian-era beliefs as follows: “As soon you realize it, the whole structure wobbles and collapses.” Analogously, this could explain USDA placing such heavy emphasis on soil health at a time when our nation’s soils and agriculturally impacted waterways are increasingly recognized to be at risk – a result of a century of beliefs in intensive, chemically-augmented, yield-focused agriculture.

The Watershed Moment for Soil Health

Writer Philip Guedalla said that the curious thing about history is that it happened. Examining earlier events, some of which I lived through personally, it is not difficult to uncover the watershed moment of soil health in biological, organic and biodynamic initiatives that did occur. The problem today may be persons and organizations having ignored these earlier events, imagining they do not exist.

In the summer of 1991, the Rodale Institute sponsored an influential symposium on soil quality in Emmaus, Pennsylvania. The next spring, Rodale president John Haberern wrote a guest editorial in *Soil and Water Conservation* where he proposed a soil health index as “a report card that documents the gains and losses in soil quality.” This, though, is not evidence enough.

In the prior decade, “alternative farming” had forced itself into the American scientific lexicon. With it came a new scientific publication: *Journal for Alternative Agriculture* (Doran served as editor along with Molly Anderson of Maine’s College of the Atlantic). Speakers at the early Emmaus event did suggest a link between soil quality and soil health – tentatively at first. Authors on this list include persons well-known from Washington State University (WSU), a hotbed of alternative farming science in the ‘80s. And if you read these early papers, many citations segue to Europe where we find the real watershed.

As one of the few Americans (along with Willie Lockertzt) in attendance at the first International Federation of Organic Agriculture Movements (IFOAM) conference in 1978 in Sissach, Switzerland, I witnessed the founding of the Research Institute for Organic Farming (called FiBL, its German acronym), now the world’s largest organic farming research center. That year, Otto Buess, a microbiologist at the Sissach-Ebenrain Agricultural College, which hosted the IFOAM event, published



In a 1995 article, farmers’ view on soil health was related to subjective features, such as a pleasing aroma. Reproduced with permission of the Soil and Water Conservation Society



The Research Institute for Organic Farming (FiBL) was founded in 1973 in Switzerland with a focus on soil health and plant quality. Today it is the largest research institution dedicated to organic farming. Photo from fibl.org

his remarkable essay, "Soil and Plant Health in View of Alternative Farming."

FiBL grasped at the very beginning that the future of organic agriculture depended on science demonstrating soil and plant health. They setup the now famous long-term D-O-C (bioDynamic-Organic-Conventional) field trials comparing different agricultural practices. FiBL lead scientist Paul Mäder considers the report on this trial, accepted by the journal *Science* in 2002, his most significant work.

Plant Health Depends on Soil Health

If this is not evidence enough, just across the border, the German Ministry of Agriculture released an 84-page comparison of biological and conventional farms in the spring of 1977. The battery of selected analytical traits used to compare the farms' physical, chemical and biological conditions is uncannily similar to the "soil health indicators" we hear so much about today in the U.S. A University of Giessen graduate at the biodynamic research center told me at the time that agreeing on the range of tests as well as the farm selection was a grueling process for a large committee of stakeholders. To get a sense of the tension, the agricultural official who wrote the preface of the report said, "We are confronted with either stubborn denial of, or unreasoned belief in, biological farming – hence this study." I recall offering to translate the hefty report, which drew dissension. It could embarrass the Ministry, which reluctantly agreed to the study, or the farmers who trustfully opened their books. Now I grasp what Norman Cousins meant by saying, "History is a vast early warning system."

It reminds me of Maine, circa 1977, as MOFGA was negotiating recognition of organic approaches. University of Maine Professor Frank Eggert announced field plots to scientifically test organic methods. The news circulated like hot energy. Chaitanya York, MOFGA's executive director at the time, suggested that "everyone show up" at the field day. But word got out that crashing the event might embarrass Eggert and ourselves. Eggert and his student went on to publish their favorable results for the 1981 special session on organic farming as part of the American Agronomy Society annual meetings. In presenting the paper, Eggert cited earlier Euro-

German Ministry of Agriculture 1975

Relative Values for Farm Comparisons

Factor	Conv.	Biol.	p
<i>Soil Health Traits</i>			
Phosphates	100	54	*
Potash	100	61	*
Total Carbon	100	99	ns
Microbial CO ₂	100	119	*
D-enzymes	100	140	ns
U-enzymes	100	176	*
Azotobacter	100	260	*
Worms	100	235	*
<i>overall farm performance</i>			
Nutrient Imports	100	22	
Farm Yields	100	94	
Hay Quality	100	106	
Milk Efficiency	100	94	
Milk Income	100	130	

p= * statistically significance; n.s. not sign.

Table 1. Relative Values of Farm Comparisons.
From German Ministry of Agriculture, 1975

pean field plot studies in which the soil health to plant health connections were scientifically investigated.

Incidentally, the German findings published in the 1977 report were that the soils on the biological dairy farms had significantly more soil life including more roots, earthworms, enzymes, respiration and legume nodules (but not more organic matter) than their conventional counterparts. With one-quarter the nutrient inputs, yields lagged by about 17% (see Table 1). Presently, it is increasingly recognized that the 10-20% yield penalty in organics may be worth the soil health benefits the methodology delivers.

Plant health is synonymous with soil health. At FiBL, an early published report revealed that organically grown greens do not accumulate excessive nitrate as do conventionally fertilized crops. Today we know this trait is mediated by the phytobiome: plants, their environment and their associated communities of organisms. This ecosystem function is absent when the soil is damaged or when it's removed altogether. In 1977 such findings had large implications for Europe, which by the 1960s was already struggling with "leaky nitrate" due to heavy reliance on chemical fertilizers leading to reports on dangers of excessive nitrate in vegetable greens.

A Reverence for Soil

Since this time, things have come full course – scarily. A series of current National Academy of Sciences seminars on "the nitrogen problem" have disclosed large tracks of America under a nitrate threat – essentially the entire Midwest. It is now officially affecting the health of people, particularly poorer, rural communities; in 10 states nearly 2 million people are being exposed to high nitrates in water due to chemical fertilizer and unhealthy soils.

History happens singularly, but interpretations are many. Clearly, NRCS and SHI believe no-till is synonymous with soil health – most agree less tillage is good – yet this connection is not universal. Around the same time that the report on soil health practices appeared, I sat in on a presentation on groundwater pollution in Ohio. The ARS researcher explained that it is causally linked to no-till. His published data shows that harmful algal blooms in Lake Erie coincide with the very rapid rise of no-till farming. The problem appears in regions of the country with heavy soils that are drainage-tilled – in the U.S. we now have 65 million tile-drained farm acres. The complex causal-pathway includes over-reliance on herbicides (leaving soils bare), surface washing of fertilizer (which is often broadcast in no-till) and cracking of clayey soils, which permit chemicals to easily reach drainage tiles since the soil is not being cultivated. Environmental Working Group (EWG), a sponsor of the National Academy of Sciences sessions, estimates the algae problem has already cost Ohio \$815 million.

One way forward, which I believe would put organic back up on the soil health radar, would be to redo the SHI survey of adoption of soil health practices – this time accounting for the forms of no-till which are damaging, in a manner similar to which organic growers are being scrutinized for their tillage. The SHI report presents that no-till preserves and improves conventional, chemical farming. To correctly attribute gains in soil health to conventional no-till practices, one should count the portion of those no-tillers – about 10% – who are experimenting with cover crops while also reducing chemical inputs.

Another scenario, which according to the recent National Academies of Sciences nitrogen symposium is currently being seriously discussed, is a farm nitrate cap-and-trade system, essentially a Payment for Ecosystem Service (PES) approach. Based on the early FiBL nitrate studies and published evidence in the *Journal of Alternative Agriculture* in 1998, which showed tenfold differences in drainage-tile nitrate between conventional and organic farms under similar cropping patterns, organic farming would trade very well.

A recent paper from Canada, published in *Soil Biology and Biochemistry*, cautions that "the usefulness of the soil health metaphor depends, not on whether or not we can finally entrap it numerically, but whether it propels us to greater reverence for soil, deeper insight into its beneficial processes, and wiser ways of managing it." The organic farming community, which first brought the theme of soil health to light, has been fulfilling this deeper mandate for 50 years and there's no reason this should stop.

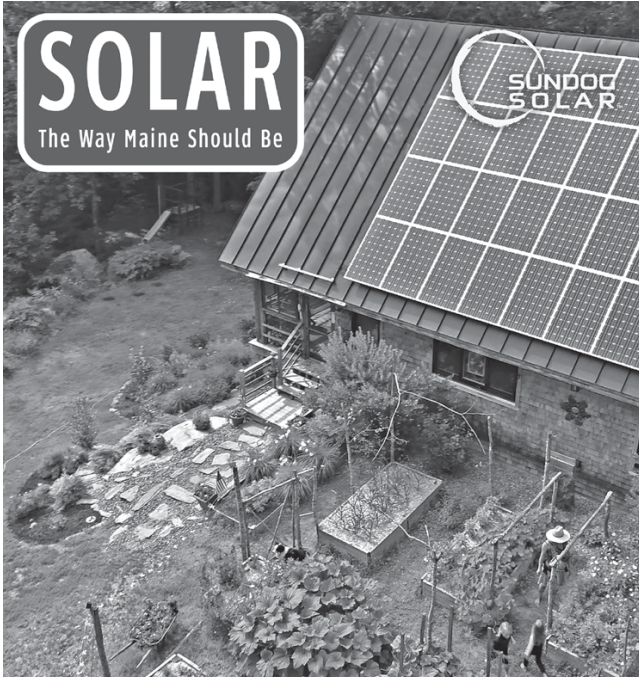
About the author: Will Brinton founded Woods End Laboratories, a soil testing lab situated in Mt. Vernon, Maine, in 1974, and serves on the Advisory Council for the Organic Materials Review Institute (OMRI) and is science advisor on the Real Organic Project Standards Board.



Will Brinton wishes to dedicate this article to Amigo Bob Cantisano who passed away Dec. 29, 2020, after battling cancer. Amigo Bob was an early pioneer in organic farming and a founder, in 1973, of California Certified Organic Farmers (CCOF). Image of Cantisano at the Eco-Farm Conference in Monterey, California, in January 2018. Photo by Will Brinton

SOLAR

The Way Maine Should Be



Contact Sundog Solar today about solar energy for your home or business!

Grid Tied Solar Electric Systems

222 East Main St. Searsport, ME - 207-548-1100 - www.sundog.solar

THE ROOTS OF SOIL HEALTH IN ORGANIC FARMING.

MOF&G, Summer 2021. Vol2 pp 22-23

WILL BRINTON

(BIBLIOGRAPHY)

1. Bastida, F., A. Zsolnay, T. Hernández, C. García (2008). Past, present and future of soil quality indices: A biological perspective. *Geoderma* 147:159–171 <https://doi.org/10.1016/j.geoderma.2008.08.007>
2. Bergland B. (ed) 1980. Report and recommendations on organic farming. USDA Govt Publications.
3. Buess, O. (1978) Die Gesundheit von Boden und Pflanze aus der Sicht des alternativen Landbaues. Deutscher Rat für Landespflge. Vol 31: 43-50
4. Cousins, N. *in* Saturday Review. 15 April 1978
5. Desmond, A & J Moore (1994) Darwin: The Life of a Tormented Evolutionist. Norton Books
6. Dlouhy, J. 1977. Alternativa Odlinsformer-vaxprodukters. Kvalitet vid konventionell och biodynamisk odling. Swed. Univ. of Agric. Sci., Rapport 272, Uppsala
7. Doran J W, D.C. Coleman, D.F. Bezdicek, and B.A. Stewart. 1994. (I) Defining Soil Quality for a Sustainable Environment. Proceedings of a symposium sponsored by the Soil Science Society of America and the North Central Region Committee on Soil Organic Matter (NCR-59) in Minneapolis, MN, 4-5 November 1992.
8. Doran JW, Parkin TB (1994) Defining soil quality. In: Doran JW, Coleman DC, Bezdicek D F, Stewart BA (eds) Defining soil quality for a sustainable environment. Soil Sci Soc Am Spec Publ 35, Madison, Wis, pp 3-21
9. Doran, JW & AJ Jones (1996) (II) Methods for Assessing Soil Quality. Soil Sci Soc Amer. Madison
10. Douglas R. Smith, Kevin W. King, and Mark R. Williams. 2015. What is causing the harmful algal blooms in Lake Erie? *Journal of soil and water conservation* 2015—vol. 70, no. 2
11. Eggert F.P, L. Kahrman 1984. Response of Three Vegetable Crops to Organic and Inorganic Nutrient Sources *in*: Organic Farming: Current Technology and Its Role in a Sustainable Agriculture. ASA Special Publication 46, Amer. Soc Agronomy
12. Eshel, G. (2020) AgroEcology and feeding ourselves: Tensions, promises and future potential. IMA winter workshop, Hawthorne Valley, NY
13. Goldstein, W.A., M.J. Scully, D.H. Kohl, G. Shearer. 1998. Impact of agricultural management on nitrate concentrations in drainage waters. *American Journal of Alternative Agriculture* 13:105-110.

14. Janzen H.H., D. W. Janzen, E. G. Gregorich. The 'soil health' metaphor: illuminating or illusory? Soil Biology and Biochemistry Available online 11 February 2021, 108167
<https://doi.org/10.1016/j.soilbio.2021.108167>
15. Kennedy A.C., and R.I. Papendick. 1995. Microbial Characteristics of soil quality. Journal of Soil and Water Conservation. Vol. 7: 244- 248
16. Kling, Katherine 2021. Cornell University. Transferring Costs Downstream... NAS Nitrogen Symposium. In USA 65 million acres drainage tiled.
<https://www.youtube.com/watch?v=sOXNNRdA04s&t=4s>
17. Kral, D M, S L Hawkins (eds) Organic Farming: Current Technology and its Role in a Sustainable Agriculture. 1984. Proceedings of a Symposium. Atlanta, Ga., 29 Nov.-3 Dec. 1981. ASA Special Publication Number 46. Soil Science Society of America. Madison
18. Larkin, R. (2017) ARS-Maine, speaking at the 2017 Soil Health Institute Meeting. At: St Louis.
<https://www.youtube.com/watch?v=Vfedloam0ul>
19. Lori M, Symnaczik S, Mäder P, De Deyn G, Gattinger A (2017) Organic farming enhances soil microbial abundance and activity—A meta-analysis and meta-regression. PLoS ONE 12(7): e0180442. <https://doi.org/10.1371/journal.pone.0180442>
20. Mäder, P., Fließbach, A., Dubois, D., Gunst, L., Fried, P. and Niggli, U., 2002: Soil fertility and biodiversity in organic farming. Science, 296: 1694-1697 <https://science-sciencemag-org.wv-o-ursus-proxy02.ursus.maine.edu/content/sci/296/5573/1694.full.pdf>
21. Marty, C. 2009. Darwin on a Godless Creation. Scientific American. February 12.
22. Meyers, R (22 July 2019) personal communication. Regional Director of Extension Programs NCR-SARE University of Missouri.
23. Ministry of Agriculture and the Environment. (1977) Auswertung dreijähriger Erhebungen in neun biologisch-dynamisch wirtschaftenden Betrieben. Ministerium für Ernährung, Landwirtschaft und Umwelt, Baden-Württemberg, Germany
24. Morgan C L, J.S. Coggins, V.R. Eidman. 2000. Tradable Permits for Controlling Nitrates Journal of Agricultural and Applied Economics, 32,2(August 2000):249-258
25. National Academies of Sciences, Engineering, Medicine. 2021. Reducing the Health Impacts of the Nitrogen Problem. <https://www.nationalacademies.org/event/02-25-2021/reducing-health-impacts-of-reactive-nitrogen-in-ground-and-surface-water-from-agricultural-sources-an-environmental-health-matters-workshop-to-identify-opportunities-for-leadership-workshop-series-5>
26. National Research Council 1989. Alternative Agriculture, National Academy Press Wash DC

27. Nevins, A. 1954 Should American History be Rewritten? In Pro and Con., Matlaw, M & J B Stronks. Houghton Mifflin Press
28. NRCS, 2019. Soil Health Manual 450-03 on-line at: USDA-NRCS Soil Health Division:
<https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcseprd1315420>
29. Oelhaf, R. C. Organic Agriculture. Allanheid, Osmun, Montclair, 1978.
30. Papendick, R 1993. Revisiting the USDA reports: Some additional observations. American Journal of Alternative Agriculture, Vol. 8:4, pp. 154-155 (Mentions Rodale Conference and Name Changes)
31. Reganold J P, A S Palmer, JC. Lockhart, AN Macgregor. 1993. Soil Quality and Financial Performance of Biodynamic and Conventional Farms in NewZealand. Science. Vol. 260, No. 5106, pp. 344-349
<https://www-jstor-org.wv-o-ursus-proxy02.ursus.maine.edu/stable/pdf/2881061.pdf>
32. Reganold J P., A S Palmer. 1995. Significance of gravimetric versus volumetric measurements of soil quality under biodynamic, conventional, and continuous grass management. J. Soil and Water Cons. 50(3) 298-305
33. Rodale Institute: 1991. The Assessment and Monitoring of Soil Quality. The papers from this conference were published in American Journal of Alternative Agriculture, Volume 7, Nos. 1-2, 1992.
34. Romig, D.E, M.J. Garlynd, R.F. Harris, and K. McSweeney. 1995. How farmers assess soil health and quality. Journal of Soil and Water Conservation 50(3):229-236.
35. Schinner F, R. Ohlinger and E. Kandeler 1993. Bodenbiologische Arbeitsmethoden 2nd Edition [Soil Biological Test Methods] Springer-Verlag Berlin Heidelberg
36. Schudel, P.; Eichenberger, M.; Augstburger, F.; Klay, R.; et al.1979 Uber den Einfluss von Kompost- und NPK-Dungung auf Ertrag, Vitamin-C- und Nitratgehalt von Spinat und Schnittmangold [1979 - "Influence of compost or NPK [nitrogen, phosphorus, potassium] fertilization on yield, vitamin C and nitrate content of spinach and spinach beet"]
37. Schuphan, W. 1972. Effects of the application of inorganic and organic manures on the market quality and on the biological value of agricultural products. Qual. Plant Mater. Veg. 21(4):381-398.
38. Vogtmann, H. 1984. Accumulation of Nitrates in Leafy Vegetables Grown Under Contrasting Agricultural Systems. Biological Agriculture & Horticulture. 2: 1-51