Soil Health–*Economic Background*
Updated 041316

Soil Health has become something of an umbrella concept, with many aspects. Some of these include biology, chemistry, hydrology, mineralogy, crop and livestock production and cycles. The focus of this discussion is the economics of soil health.

From a private perspective, it is a relatively straightforward process to determine the market benefits of various levels of soil health and the associated costs to attain those options. Where there are positive net benefits, it is efficient for the manager to make decisions that incur costs in order to achieve soil health benefits. From a social perspective, where both market and non-market costs and benefits are considered, however, complexities abound. What are the short and long-term benefits and costs downstream (externalities)? What are the benefits and costs to future generations? Are there temporal interactions upstream and downstream that would influence where, when, and how collaboration would enhance short and long-term benefits or minimize costs? What are the economic trade-offs and cultural limitations to expanded government involvement? Do we have sufficient knowledge about related cycles, such as air, water, nutrients, and carbon, to have confidence in assumptions and findings related to soil health? Do we sufficiently understand the long and short-term ecosystem services derived from soil health? Do voluntary government programs help (CRP and EQIP) or harm (crop insurance and commodity programs) soil health?

Lichtenberg (University of Maryland) has posited a model to manage the landscape to maximize the expected present value of both agricultural and environmental returns.[1] To be included in the model, he suggests crop productivity, generalized environmental services, price-induced changes in crop mix over time, climate change-induced changes to crops over time. He further suggests that the mix of physical, chemical and biological soil properties are critical, and may need sensitivity analysis. As time is considered in the model, he asks if steady state or cyclic exploitation is optimal. He recognizes that soil health is as variously defined as the various perspectives engaged in the discussion, and that the definition is evolving as more science and policy is applied to it.

Farnsworth (NRCS, USDA) bases his exploration of soil health economics on the NRCS definition: "...the continued capacity of soil to function as a vital living system that sustains plants, animals, and humans".[2] [3] His focus is to establish a causal relationship between field soil health and crop yields and yield variability, profitability and its variability. Soil science has established a degree of confidence in soil health indicators relative to practices (tillage, cover crops, etc.) and related agronomic processes. Such indices suggest management options, perhaps moving toward best management

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[1] Eric Lichtenberg, "Economics of Soil Health: A Conceptual Framework", Economics of Soil Health Conference, Farm Foundation, Washington, DC, September 21, 2015.

[2] Richard L. Farnsworth. "Evconomics of Soil Health: Existing Research", Economics of Soil Health Conference, Farm Foundation, Washington, DC, September 21, 2015.

[3] Natural Resource Conservation Service, 2014.

practices (improve organic matter, change tillage, etc.). However, there has been very little research on the economics related to alternative index levels. Additionally, the soil science research suggests little consistent evidence from study to study that adoption of soil management practices (rotation, tillage, organic matter enrichment, etc.) has predictable impacts on soil health. There is anecdotal evidence of improvement with respect to specific crops and specific fields in specific regions, but it is not clear if such can be generalizable (transferable). This makes determining the economics of soil health management even more challenging. Karlen et al. looked at a specific ISU farm over 30 years. They found no crop yield difference among tillage practices, but net returns for no-till were higher than other tillage practices. [4] Other studies, few in number, have found mixed results. While the anecdotes foster enthusiasm for improved soil health resulting from less soil disturbance, more organic matter, and cover crops, the findings of scientific research are thin and spotty. That does not suggest such practices are not worthy of adoption. Rather, it suggests the need for more research and expanding the focus to benefits that accrue to society. The payments from participation in government programs such as CRP, EQIP and conservation plans may provide proxy tests for what society is willing to pay for soil health benefits.

Tyner has noted that, while the technical soil impacts of soil health management are often known, their value to the producer, landowner and society are not known.[5] Site-specific studies suggest cover crops have environmental benefits, cover crop benefits vary by rotations and tillage practices, and social benefits of cover crops exceed the https://www.soils.org/homecosts for high residue harvest. He concludes that, because producers typically have a more limited choice set that researchers, it may be cost-effective to conduct on-farm experiments and find a set of practices that both improve soil health and profitability.

There remains a scientific stream that insists the benefits of soil health are obvious. Baveye suggests "we don't need to put a monetary value on soil to prove its value and allow decisions to be made about protecting it".[6] He frames the attitude of many in and out of the scientific community in perceiving soil as somehow rising above monetary considerations. The reality remains, however, that producers and landowners, as well as Congress and taxpayers must decide how much to spend and where. In times of low profitability and tight state and federal budgets, these choices are not trivial.

Carlisle reviewed the scientific literature in 2015 and found that producer decisions cannot be fully explained by rational actor models.[7] She suggests, in explaining farmer

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[4] Karlen, DL, Kovar, JL, Cambardella, CA, and Colvin, TS. "Thirty-year tillage effects on crop yield and soil fertility indicators", *Soil & Tillage Research*, 130, pp. 24-41, 2013.

[5] Tyner, W. "Data Needs and Empirical Difficulties for Economic Analysis", Economics of Soil Health Conference, Farm Foundation, Washington, DC, September 22, 2015.

[6] Baveye, P. "The Economics of Soil", Soil Science Society of America, https://www.soils.org/discover-soils/story/economics-soil

[7] Carlisle, L. "Factors Influencing Farmer Adoption of Soil Health Practices in

soil health practices, that researchers "utilize interpretive frames that elucidate interactions among groups of people and take account of multiple forms of capital". If soil health is valued by society, she recommends "education, research, policy measures to overcome equipment barriers, and efforts to address farm and food system context". In essence, her review supports the concept that "one-size-fits-all" isn't appropriate? and transferability of field studies are inappropriate. Instead, regionally- and locally-targeted analysis and programs that encompass a broader culture than the soil or farmer will be needed to increase farmer adoption. She concluded "farmers often act on non-economic motives, but economic factors can be important in removing barriers." While the role of economic factors is often "secondary", it is not trivial.

To summarize the state of economic analysis of soil health practices, there is a dearth of scientific research. Both private and societal benefits and costs need more focus. Many on-farm and site-specific studies have been conducted to improve the technical physical parameters related to soil health, as well as the correlation to yields, erosion, moisture and related factors. A limited number of studies have been conducted to further correlate these factors to economic benefits and costs on the farm or field. A few have attempted to evaluate the social benefits and costs off-farm. There is substantial scientific research, however, to suggest that government soil conservation programs do result in measurable benefits. To date, there have been few studies to integrate these findings into the soil health research.

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the United States: a Narrative Review", *Agroecology and Sustainable Food Systems*, 2016. DOI: 10.1080/21683565.2016.1156596