SOIL HEALTH ASSESSMENT AND MANAGEMENT:

THE CONCEPTS

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Soil health has recently captured the attention of farmers as soil degradation from intensive cultivation, mechanization, limited crop rotations, and lack of organic matter additions have reduced yield potential. This has often led to increased soil compaction, erosion, greater pest problems, and reduced crop productivity. A survey conducted in 2003 (Wolfe) to assess the state of soil quality of vegetable farms in New York State showed that soil degradation is a common problem in many fields. Often-stated problems include increased disease and pest pressure, soil compaction, decreased infiltration, reduced water holding capacity, low organic matter content, drought-prone soils, and excessive runoff and erosion. Though soil degradation was visible on many farms, a systematic approach to characterize soil health, which transcends the conventional soil nutrient analysis, was not yet available.

Soil health deals with both inherent and dynamic soil quality (Figure 1). The former relates to the natural (genetic) characteristics of the soil (e.g., texture), which are the result of soil-forming factors. They are generally represented in soil surveys and generally cannot easily be amended. On the other hand, the dynamic soil quality component is readily affected by management practices and relates to the levels of compaction, biological functioning, root proliferation, etc. The dynamic component is of most interest to growers because good management allows the soil to come to its full potential. The inherent and dynamic soil quality components do interact, however, as some soil types are much more susceptible to degradation and unforgiving of poor management than others.

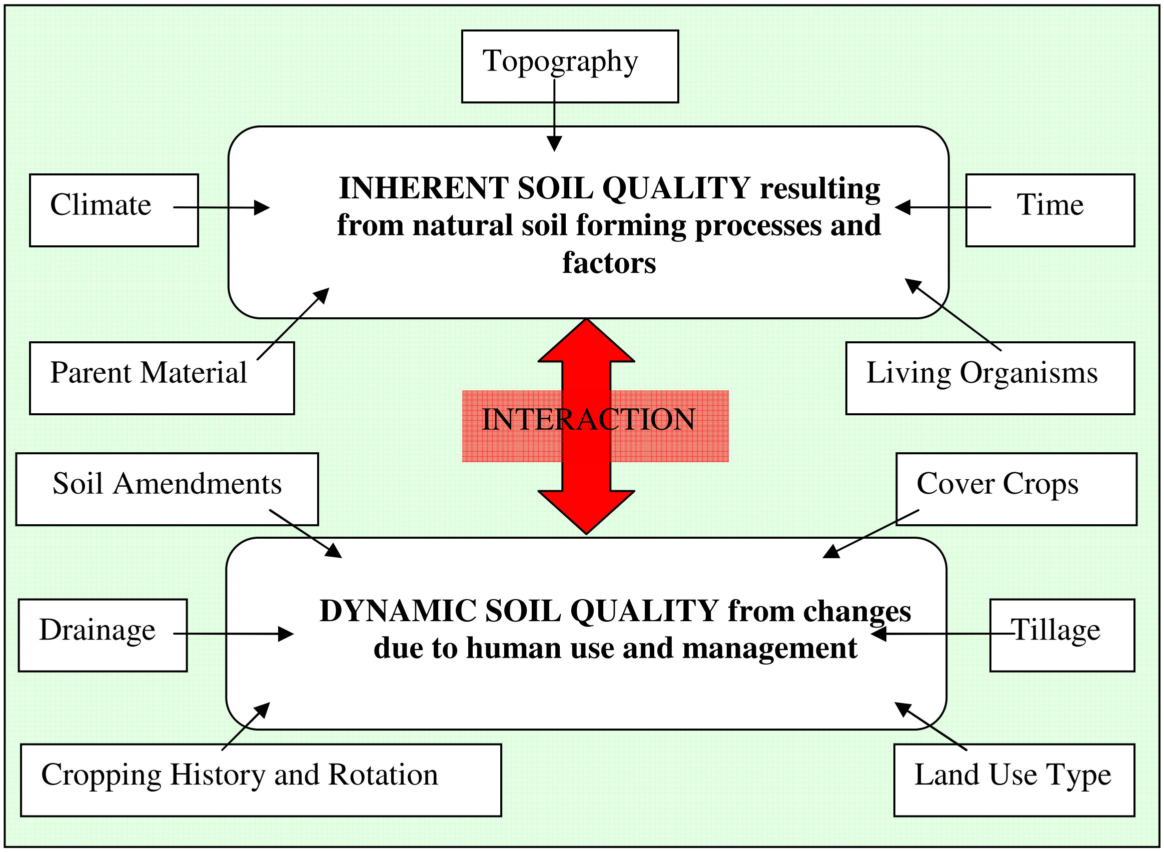


Figure 1. Inherent and dynamic soil quality and various factors affecting them.

At the heart of soil health is the integration of the soil physical, chemical and biological processes and functions (Figure 2). A healthy soil will be balanced for all three components. In order to make interpretations of the health of a soil, the various processes and function in Figure 2 need to be assessed through meaningful indicators. For years we have relied on inexpensive soil testing procedures to assess the chemical (fertility) properties, but methods for rapid assessment of the physical and biological status of the soil are not generally offered. The Cornell Soil Health Initiative, through funding by USDA-SARE, the Northern New York Agricultural Development Program, and USDA-Hatch, sought to find indicators that can be used to evaluate and integrate these different processes and functions for the purpose of improving soil health. Our approach was to:

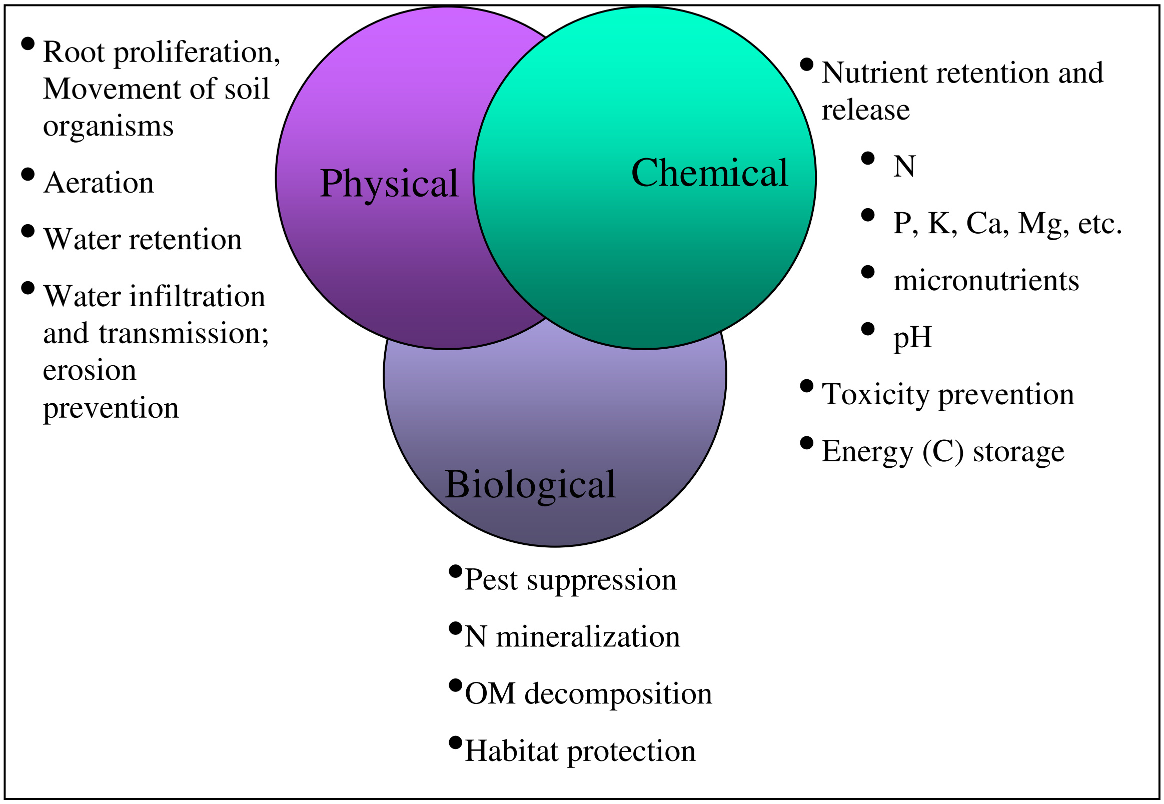
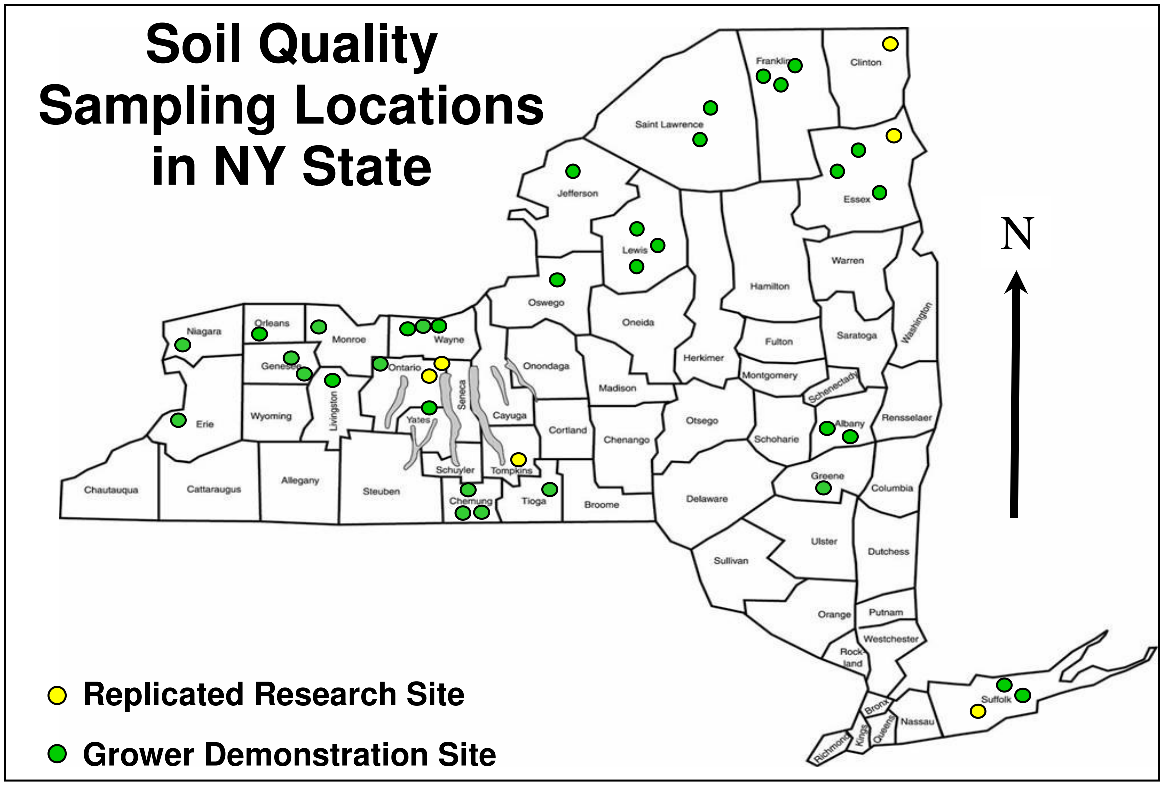


Figure 2: Soil physical, chemical and biological processes and functions

- identify the vital processes and functions of the soil needed for soil health assessment in relation to agronomic land use
- test different soil properties that can serve as potential soil quality indicators
- develop appropriate sampling and measurement protocols for soil health which can complement existing chemical laboratory and can be offered on fee for service basis
- develop criteria for interpreting soil health indicators in an agronomically meaningful way
- develop and evaluate accessible databases as repositories for high quality, reliable soils information; and
- recommend improved soil management practices based on soil health assessment that will ensure economic viability, environmental safety and social acceptability

To achieve this goal, soil samples were collected from selected sites scattered over New York State (Figure 3). In this, we took a two-pronged approach: Some of the samples came from long-term controlled research sites (e.g., 30+-years of plow vs. no-till), which enabled us to assess the usefulness of different measurements to serve as soil quality indicators. Other samples came from commercial growers' fields, which enabled us to test the sensitivity of our indicators under real-world field conditions.



The field samples collected were passed through different soil analyses in multiple Cornell laboratories. Soil physical properties measured were texture, bulk density, macro-porosity, meso-porosity, available water capacity, residual porosity, penetration resistance, saturated permeability, aggregate size distribution, and wet aggregate stability. Biological measurements taken were root rot rating using bean bioassay technique, root lesion, root knot and saprophytic nematodes, potentially-mineralizable nitrogen, decomposition rate, particulate organic matter and active carbon. Standard chemical test were also performed on the samples through the Cornell Nutrient Analysis Laboratory. In addition, we assessed in-field penetration resistance and infiltration tests as potential soil health indicators. In a next article, we will discuss results of these tests, the development of a new protocol for routine soil health assessment, and the availability of new laboratory analyses.

Reference

Wolfe, D. (2003). Summary Report of the Soil Health Grower Survey. Cornell University, Ithaca, NY.