HEALTHY SOILS PRACTICES

Farmers who use healthy soil practices can produce economically and environmentally sustainable healthy food, while sequestering carbon that will help address climate change. While there is no commonly accepted definition of "healthy soil," there are scientifically sound practices that develop healthy soil. While there still is much to be learned about healthy soil development, there is widespread agreement that soil rich with living organisms and able to function as a biological system is a key component for healthy soil and sequestering carbon. [1]

"We are at the most critical moment in the history of our species, as man-made **changes to the climate threaten humanity's security on Earth**... **The solution is farming**. Simply put, we could sequester more than 100% of current annual CO_2 emissions with a switch to widely available and inexpensive organic management practices, which we term 'regenerative' organic agriculture. Regenerative agriculture has demonstrated that these practices can comfortably feed the growing human population while repairing our damaged ecosystem... **Even if modest assumptions about soil's carbon sequestration potential are made, regenerative agriculture can easily keep annual emissions to within a desirable range."**
-- Rodale Institute

A major report by the Obama Administration found there is a big role for carbon storage in soil, noting that USDA-funded research at Michigan State University's Kellogg Biological Station found soil accumulates significantly more carbon with organic farming, than with conventional farming practices.[1] A 2017 Northeastern University study found that organic farm soils had 26% more potential for long-term carbon storage than soils from conventional farms. [2] It also concluded that such soils have 13% more soil organic matter.

"Soil is the biggest sink of carbon, bigger than the atmosphere and the oceans," said Geoffrey Davies, a chemist who analyzed soil samples from over 700 convention farms in 48 states. "We already know that [conventional practices] like using [synthetic] fertilizers contribute to climate change," said Davies, "they deplete soil of carbon, which is then released into the atmosphere."[i]

The following practices are recognized as contributing to, or required for, healthy soils.

- ✓ Engaging in practices to increase organic matter, soil structure and nutrient and water holding capacity
- ✓ "No-till" and "low-till," in lieu of deep tillage
- ✓ Refraining from applications of: synthetic fertilizers (especially nitrogen and phosphorus)[3], synthetic herbicides[4], synthetic fungicides and pesticides, unless they are demonstrated not to kill or otherwise impact soil micro-organisms, biota or beneficial insects[5]

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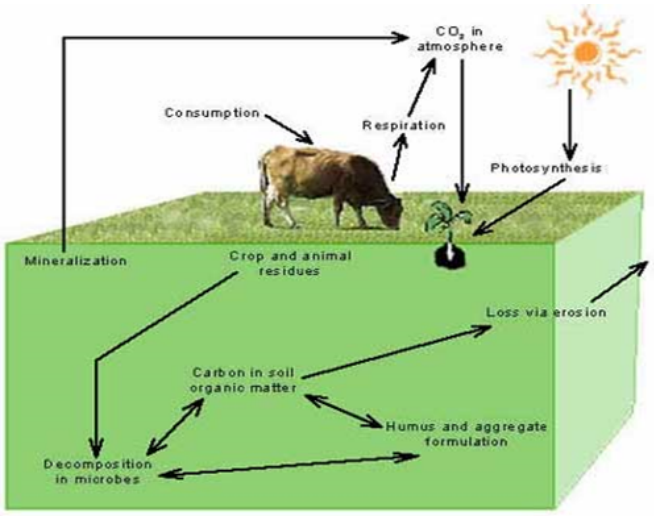
[1] Soil Carbon Storage: A Big Role for Microorganisms" 2015 https://www.globalchange.gov/about/highlights/2016-soil-carbon-storage-a-big-role-for-microorganisms
[2] http://www.sciencedirect.com/science/article/pii/S0065211317300676?via%3Dihub
[3] Yayeh Bitew and Melkamu Alemayehu, 2017 "Impact of Crop Production Inputs on Soil Health: A Review" Asian Journal of Plant Sciences 16: 109-131) (See E.K. Bunemann, G.D. Schwenke and L. Van Zwieten 2007 "Impact of Agricultural Inputs on Soil Organisms- A Review", Australian Journal of Soil Research 44: 379) (See Heide Hermary, 2007 "Effects of Some Synthetic Fertilizers on the Soil Ecosystem"
[4] Yayeh Bitew and Melkamu Alemayehu, 2017 "Impact of Crop Production Inputs on Soil Health: A Review" Asian Journal of Plant Sciences 16: 109-131.) (See E.K. Bunemann, G.D. Schwenke and L. Van Zwieten 2007 "Impact of Agricultural Inputs on Soil Organisms- A Review", Australian Journal of Soil Research 44: 379)
[5] See Yayeh Bitew and Melkamu Alemayehu, 2017 "Impact of Crop Production Inputs on Soil Health: A Review" Asian Journal of Plant Sciences 16: 109-131.)

Continued… practices recognized as contributing to, or required for, healthy soils:

- ✓ Refraining from application of synthetic fungicides and pesticides, unless they are demonstrated not to kill or otherwise impact soil micro-organisms, biota or beneficial insects[6, 7]
- ✓ Establishing or applying beneficial micro-organisms and fungi, such as mycorhhizal fungi[8, 9]
- ✓ Periodic mineralization of the soil, rather than a limited N-P-K focus
- ✓ Annual planting of winter cover crops terminated by light incorporation, roller-crimping, or grazing – rather than application of an herbicide which impacts soil biota



- ✓ Establishing on-farm biodiversity, by such measures as meaningful 4-to-5-year crop rotations and/or implementation of rotational or permanent vegetative field buffers, filter strips, tree and shrub buffers, warm season grasses, woodlands, grasslands, wetlands, habitats, pollinator habitat and other best management practices defined by USDA
- ✓ Rotational grazing of ruminants (cattle, goats, bison, sheep), and other animals (hogs and poultry)[10]
- ✓ Maintaining and expanding cover on soils – beyond cash and winter cover crops – at all times, such as by application of organic composts and mulches, either to cropland, grassland or pastureland, e.g., fall application of hay mulch, planting of intra-seasonal cover crops, etc.
- ✓ Additional practices supported by science, such as sequestering net carbon, e.g., the creation and application of biochar.

(M.A. Locke and R.M. Zablotowicz "Pesticides inn Soil-Benefits and Limitations to Soil Health" USDA-ARS Southern Weed Science Research Unit ars.usda.gov) (See E.K. Bunemann, G.D. Schwenke and L. Van Zwieten 2007 "Impact of Agricultural Inputs on Soil Organisms- A Review", Australian Journal of Soil Research 44: 379

[6] M.A. Locke and R.M. Zablotowicz. "Pesticides in Soil-Benefits and Limitations to Soil Health" USDA-ARS Southern Weed Science Research Unit ars.usda.gov

[7] E.K. Bunemann, G.D. Schwenke and L. Van Zwieten 2007 "Impact of Agricultural Inputs on Soil Organisms – A Review", Australian Journal of Soil Research 44: 379

[8] See Peter Jeffries, Silvio Gianinazzi et al 2003 "The Contribution of Arbuscular Mycorrhizal Fungi in Sustainable Maintenance of Plant Health and Soil Fertility" Biology and Fertility of Soils Volume 37, Issue 1, page 1) (Erik Verbruggen et al 2010 "Positive Effects of Organic Farming on Below-Ground Mutualists: :Large-Scale Comparison of Mycorrhizal Fungal Communities in Agricultural Soils" New Phytologist Vol 186 Issue 4 pages 968- comparing conventional, organic and pasture lands

[9] E. Verbrugen et all 2010 "Positive Effects of Organic Farming on Below-Ground Mutualists; Large-Scale Comparison of Mycorrhizal Fungal Communities in Agricultural Soils" New Phytologist Vol 186 Issue 4 pages 968 – comparing conventional, organic and pasture lands

[10] See Maria Silveira, Ed Hanlon, Mariana Azenha and Hiran M. da Silva, Sept. 2015 Carbon Sequestration in Grazing Land Ecosystems" University of FLorids IFAS Extension Pub SL373