SOIL HEALTH BENEFITS OF REGENERATIVE AGRICULTURE

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Healthy Soils Improve Crop Productivity, Environmental Resilience, and Climate Mitigation

Soil is a vital natural resource. Healthy soil maintains agricultural productivity and ecosystem functioning through optimal physical, chemical, and biological properties. Healthy, productive soils are carbon-rich and teem with beneficial microbe and insect life that transform organic matter and nutrients for growing crops. Farmers and ranchers also benefit from such soils because they reduce the need for chemical inputs like fertilizers and limiting topsoil erosion due to runoff while increasing water availability.

Unfortunately, soils are not a renewable resource[1]. Cropland soils have lost up to 150 Gt[2] of carbon since the adoption and widespread use of the plow which causes carbon loss from increased microbial activity brought on by exposure to air[3,4]. In addition to this gargantuan loss of beneficial carbon, conventional farming practices like land conversion, nutrient application, and certain livestock farming practices, contribute to 9%-14% of global greenhouse gas (GHG) emissions, of which soils comprise nearly 40%![5,6].

Regenerative management practices – such as cover cropping and reduced tillage – can both reduce on-farm emissions and restore lost carbon by sequestering excess atmospheric CO_2 in cropland, rangeland, and grassland soils. These practices can also decrease net emissions of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) thanks to reduced soil erosion, reduced nutrient application, and improved biological processes. These benefits position agriculture as a viable climate change mitigation strategy[7,8]. Regenerative management practices can help growers minimize soil disturbance and improve soil biodiversity, soil cover, and living roots[9]. Unfortunately, adoption rates of regenerative practices in many regions are low; for example, <2% of US growers used cover crops and <12% practiced no-till in 2017[10]. This is due to a combination of factors, including social and cultural barriers to changing management practices, high upfront costs of regenerative practice adoption, limited access to financing, lack of technical assistance for practice selection and implementation guidance, and perceptions of low market interest and willingness to pay premiums for regeneratively-farmed crops.

In this brief, we summarize the benefits of regenerative agricultural practices which are soil health positive and are climate smart (i.e., they can support and improve soil health and the climate). We also illustrate how farm and rural economic policies can support regenerative practice adoption to help our farmers and ranchers across the nation build soil health support our climate-smart future.

[1]Lal, R., et al. Sustainability 2015, 7(5), 5875-5895; https://doi.org/10.3390/su7055875
[2]A single gigaton is equivalent to the mass of > 6 million blue whales
[3]Ruddiman, 2006, The early anthropogenic hypothesis: challenges and responses. Reviews of Geophysics. DOI:10.1029/2006RG000207
[4]Sanderman et al., 2017. Soil carbon debt of 12,000 years of human land use. Proc Natl Acad Sci USA. DOI 10.1073/pnas.1706103114
[5]Intergovernmental Panel on Climate Change 2019 Special report on Climate change and land (accessed at https://www.ipcc.ch/srccl/)
[6]EPA 2020 "Sources of Greenhouse Gas Emissions" 2020. Accessed at www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions
[7]Lal 2018. Digging deeper: a holistic perspective of factors affecting soil organic carbon sequestration in agroecosystems. Global Change Biology. DOI: 10.1111/gcb.14054
[8]Smith 2016, Soil carbon sequestration and biochar as negative emission technologies. Global Change Biology. DOI:10.1111/gcb.13178
[9]USDA-NRCS. 2018. Soil health (accessed at nrcs.usda.gov/wps/portal/nrcs/main/soils/health/)
[10]United States Department of Agriculture National Agricultural Statistics Service (NASS) (2017). Census of Agriculture (accessed May 4, 2021)

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Regenerative Practices have soil health and climate benefits

Regenerative land management practices – i.e., land management practices that improve and/or maintain soil biological, physical, and chemical properties - can improve carbon sequestration in soils, therefore increasing soil fertility and fostering agronomic and environmental benefits to growers. Benefits include increased nutrient availability, improved water infiltration, quality, and storage, and reduced pest or weed pressure (Figure 1)[11,12]. Other soil beneficial practices include diversifying crop species (such as perennials) and rotations, applying organic amendments such as mulch or compost, and landscaping approaches such as silvopasture.

The Soil Health Institute has also linked adoption of soil-beneficial land management practices with increased profitability. In-depth budget analyses of 100 farmers across 9 states found net incomes increased for 85%-88% of corn and soybean growers respectively and nearly 70% of growers reported higher yields than conventional systems[13].

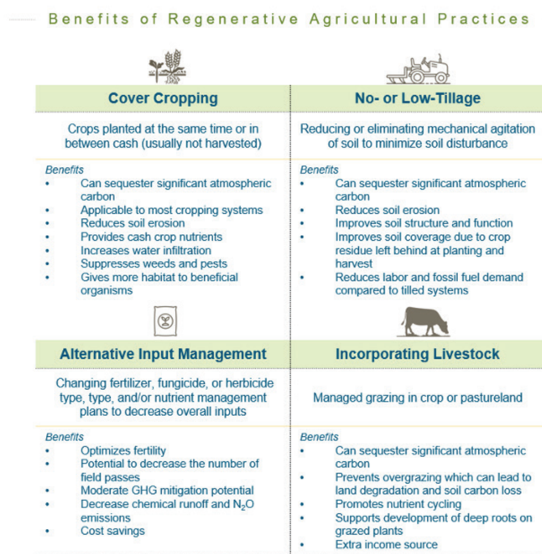

Figure 1. Selected soil and climate beneficial practices and their benefits

Recommendations

It is imperative to overcome the barriers to adopting the regenerative agricultural practices cited above as the benefits to grower productivity, prosperity and to the environment are clear. Policymakers can support their adoption to improve climate resilience, food sustainability, food security, grower incomes, and economic prosperity and competitiveness by:

- Expanding technical assistance for regenerative practice implementation. Knowledge-sharing and technical assistance are essential steps in successful implementation of novel farming practices. The United States Department of Agriculture (USDA) and land-grant universities are rich sources of expertise and technical know-how. Supporting funding of USDA conservation assistance programs and land-grant university extension services will provide crucial support to growers adopting new practices. For example, the USDA Conservation Technical Assistance (CTA) and Environmental Quality Incentives Programs (EQIP) provide technical and financial assistance to growers and ranchers.

- Investing in agricultural and climate research. Soil science, crop, and climate research advances provide location- and production system-specific nuanced understandings on how regenerative practices and systems impact GHG emissions and soil carbon sequestration. Research on technological innovations that can increase the throughput and accuracy of soil tests in the field and lab can also increase the quantity and quality of the data needed to provide insightful practice recommendations. For example, a research coalition between the Soil Health Institute, University of Nebraska Lincoln, University of Sydney, and Yard Stick are developing an off-the-shelf rapid in-field soil carbon testing system funded by the Department of Energy. Renewed and increased investment in the USDA soil conservation research and carbon monitoring systems could provide a foundational opensource soils and practice database that enables accurate and affordable soil carbon measurement at scale.

[11]Paustian et al., 2016. Climate-smart soils. Nature 532, 49–57. doi: 10.1038/nature17174
[12]Wiesmeier et al., 2019. Soil organic carbon storage as a key function of soils - A review of drivers and indicators at various scales. Geoderma. doi: 10.1016/j.geoderma.2018.07.026
[13]Soil Health Institute 2021 Economic analysis, https://soilhealthinstitute.org/economics/

Recommendations (continued)

- Supporting high-quality financial incentive programs that require regenerative practice adoption. Public and private entities are increasingly interested in agricultural carbon credits. We encourage policymakers to implement and support legislation that encourages the adoption of regenerative practices through grower and rancher enrollment in high-quality third party-registered carbon offset programs, enabling them to reap the financial benefits of their positive stewardship.

Conclusion

Degraded, carbon- and biology-poor soils negatively impact farmer economics and rural ecosystems. The danger of poor soil stewardship practices is evident in the heavy soil erosion, abrupt decline of land productivity, and financial failure experienced by growers in the dustbowl (Figure 2). In the modern age, continued GHG emissions from agricultural sources will contribute to continued atmospheric warming and climate change. Benefits of healthy soils cannot be understated; the USDA estimated that agricultural lands in the United States alone lose ~30 Mg/ha/yr of soil due to erosion . We cannot afford continued loss; farmers and ranchers need healthy soils to thrive and produce the food, fuel, and fiber we depend on.

Figure 2. Erosion gullies caused by land clearing and monocropping in an Illinois cornfield (1937). Credit: Library of Congress

There is real opportunity for legislators to enact policy that supports soil health through financial incentive programs. The USDA's prioritization of soil health through support for climate-smart agriculture and forestry (CSAF) practices . A USDA-led effort to quantify, track, and report CSAF benefi ts, strengthen education, training, and technical assistance for CSAF practices, improve research, and be intentionally inclusive of all farmers, ranchers, landowners, and communities is integral to regenerative practice adoption and implementation. Furthermore, the USDA's commitment to support new and better markets for agriculture and forestry products generated through CSAF is critical to encourage farmer and rancher participation as they seek to capture much-needed fi nancial incentives.

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[14]Borelli et al. 2017. An assessment of the global impact of 21st century land-use change on soil erosion. Nature communications. DOI: 10.1038/s41467-017-02142-7
[15]USDA 90-day Progress Report 2021