SOIL QUALITY INVESTMENT PRIORITIES

A Report to Washington State University’s
Center for Sustaining Agriculture and Natural Resources

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EXECUTIVE SUMMARY

The continued capacity of soil to be productive is essential to meeting the world’s needs for food and fiber. Producers in Washington State are keenly interested in managing their soils effectively. Specific industry needs as well as general soil-related constraints on productivity will require an investment in identifying farming practices that can replenish degraded soils and increase productivity. Efforts that focus on solving agricultural problems are most likely to produce changes in grower practices.

Many WSU faculty and staff are currently engaged in soil quality research and education. This work covers farming systems, soil-borne disease management, methods to evaluate soil quality, adaptation to climate change, organic amendments, economic value of improved soil quality, and soil quality education. These on-going efforts are commendable yet more capacity and statewide coordination is required. The WSU Center for Sustaining Agriculture and Natural Resources is well positioned within Washington State to facilitate improvements in soil quality through specific research projects, encouraging adoption of known beneficial practices, and facilitating educational opportunities that convey principals of soil quality improvement.

Following are recommendations for specific activities and general strategies related to soil quality that the Center could undertake in the next 12 to 18 months:

1. Advocate for increased capacity in soil science research and extension faculty at WSU.
2. Support or fund research projects that address specific production problems and account for the net economic effects of soil improvement practices.
3. Support adoption of soil improvement practices through on-farm research and demonstration projects.
4. CSANR should connect and coordinate with other State agencies and non-governmental organizations to formulate a cohesive approach to increasing adoption of practices that address specific soil-related problems.
5. Produce publications to make existing data available in layman’s terms.
WHY INVEST IN SOIL QUALITY?
Agricultural soils support plant growth by providing structure and a medium for water, nutrient, and gas exchange. The physical, chemical, and biological properties of a particular soil affect the ability of plants to grow. The simple definition of soil quality is the “the capacity of soil to function”, and therefore, soil quality is a human construct that depends on the intended purpose for a particular soil. There is natural variability in terms of soil parameters across the landscape and this variability becomes important insofar as it affects crop yield or the environment.

The longer definition of soil quality is “the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Karlen et al. 1997). The continued capacity of soil to be productive is essential to meeting the world’s needs for food and fiber.

The importance of soil in food production, the integration of soils in global carbon and nitrogen cycles, and past and current degradation of agricultural soils has increased interest in improving and maintaining soil quality. Addressing soil-related constraints on crop productivity will require a “brown revolution”, an investment in farming practices that can replenish degraded soils and increase productivity (Evans 1998, cited in Lal 2000).

There is often a disconnect between research, education, and the public interest in terms of soil quality and what producers should and could do about soil quality. Growers have expressed a need or desire to improve soil quality on their farms, but frequently are not sure why this is needed, what specifically they need to do, or how to measure the economic viability of recommended practices to improve soil quality. Instead of focusing on “Why improve soil quality?”, it may be better to consider “What agricultural problems can be solved, or what benefits can be gained, through improved soil quality?” Answers may include improved yields, water holding capacity, and/or nutrient use efficiency, as well as reduced adverse environmental impacts.

Stakeholder interest in soil quality
Within Washington’s agricultural community there is an increasing interest in soil quality. Recent soil quality symposia were offered for producer audiences in northwestern Washington (Soil Quality Network, Mount Vernon, WA, 28 February 2014; 100+ attendees), the Columbia Basin (Soil Health: Its role in today’s orchard systems, Wenatchee, WA, Dec. 5, 2013, 200+ attendees; Building Soils for Better Crops, Moses Lake, WA, 27-28 November 2012; 200+ attendees), and the Palouse (NRCS soil quality workshops, winter 2013; 200+ attendees). The Center for Sustaining Agriculture and Natural Resources (CSANR) Advisory Board, composed of producers and professionals across the State, was queried in Jan 2014 to identify specific priority areas within the context of soil quality. The top two priorities were: 1) identifying the economic value of soil quality; and 2) understanding the relationship between soil biological activity and disease pressure (see http://csanr.wsu.edu/prioritizing-soil-quality). Other topics that were also identified as priorities included soil-water relations, soil organic matter, indicators of soil quality, the relationship between soil and nutrient density in food, and soil physical attributes.
Specific industry needs
There are also specific agricultural industry interests in soil quality within the State. Fumigation is a common pre-plant production practice for several high-value crops, including potatoes, onions, carrots, cane berries, strawberries, and tree fruits. By design, fumigation eradicates or reduces pathogen inoculum but also affects beneficial nematodes, fungi, bacteria, and insects adversely. Soil functions, such as nutrient transformations, are mediated by these soil microflora that produce specific enzymes. Enzyme activity has been shown to be decreased by soil fumigation (Klose et al. 2006).

There is a large body of evidence that demonstrates that organic amendments can increase soil nutrients, improve physical properties, and reduce soil-borne diseases (Litterick et al. 2004; Evanylo et al. 2008). Compost producers are particularly interested in evaluating the extent to which composts and other amendments can reduce the need for other inputs such as fertilizers or pesticides in specific production systems.

Recent reduced yields in spinach and beet seed production in northwestern Washington are thought by producers and researchers to be attributed to a degradation in soil quality in that region, as a result of intensification of soil preparation practices over the past 10-15 years. Seed crop production practices that have been successful in the past are no longer resulting in the same yields, putting Washington seed growers at a competitive disadvantage to other regions around the world.

For most producers, an investment in soil quality will either need to solve a specific problem or enhance overall farm performance (e.g., reduce specific disease pressure, or generally increase crop yields). The willingness and ability of many producers to invest in soil quality is dependent on their perception or measurement of the relative costs and returns. Thus, practices that reduce disease and, therefore, fungicide costs and/or increase marketable yields will be adopted more readily than practices that increase soil organic matter without obvious short-term benefits. Understanding these economic factors is critical for producers, the companies providing soil improvement materials or services, and policymakers who wish to enhance the long-term integrity of soils.
DIRECTION FORWARD

The WSU Center for Sustaining Agriculture and Natural Resources is well positioned within Washington State to facilitate improvements in soil quality through specific research projects, encouraging adoption of known beneficial practices, and facilitating educational opportunities that convey principals of soil quality improvement. Faculty members currently associated with the Center are integrated within research departments and Extension, and they interact with a range of producers across the State. However, WSU currently lacks adequate capacity to investigate soil management strategies across the breadth of Washington agriculture.

The Center director, through consultation with faculty, can support research and extension activities through the competitive Biologically Intensive and Organic Agriculture (BIOAg) grants program and with a smaller pool of funds directed toward specific projects. Furthermore, by providing meaningful direction, the Center has the potential to influence initiatives from other natural resource agencies. Just as the BIOAg grants program is designed to provide seed monies that support competitive proposals to other agencies, CSANR can enhance adoption of soil quality improvement strategies by working with partners.

Following are recommendations for specific activities and general strategies related to soil quality that the Center could undertake in the next 12 to 18 months:

1. **Advocate for increased capacity in soil science research and extension faculty at WSU.**
   Washington State, including WSU, must invest in increased statewide capacity in well-rounded Soil Science positions in both research and Extension. The need and call for soil quality knowledge and management options are loud and clear. The specific issues across Washington State are diverse. Capacity is needed to guide participatory research and application of basic knowledge to address agroecosystem-specific soil quality management issues. Additional faculty with a directive to lead projects that apply soil management strategies to address specific production problems are needed across the state. The long-term success of current and emerging soil quality initiatives hinges on access to soils expertise. CSANR should formulate a hiring plan strategy that integrates with strategic hiring plans of the Department of Crop and Soil Sciences, WSU Extension, and those of the Research and Extension Centers.

2. **Support or fund research projects that address specific production problems and account for the net economic effects of soil improvement practices.** To that end, research trials should document costs associated with soil improvement activities as well as quantifying the benefits. The net impact on grower’s time, amendment and chemical expenses, and the value and quantity of saleable products should be determined. Specific research projects could include:
   a. Meta-analyses or data mining of previously published work.
   b. Examine alternatives to fumigation for control of soil-borne diseases. Non-organic growers need alternative practices and alternative fumigants because fumigants such as methyl bromide are targeted for phase out. Also, organic growers (e.g., potato, carrot, and onion growers) need alternatives to fumigation for soilborne disease management. Possible research questions include: i) What is the effect of fumigation on beneficial organisms?; ii) What is the effect of fumigation on soil tilth (i.e., soil physical properties)?; iii) biofumigation using mustard cover crops and seed meals; iv) biological control; v) pre-plant soil treatments in perennial crops; and e) cover crops.
c. Define and measure the public value of soil quality improvement programs and possible economic benefits (credits) for farms, including: i) carbon sequestration / credit; ii) Conservation Reserve Programs (CRP) which take highly erodible lands out of production; iii) Environmental Quality Incentive Program (EQIP) which incentivizes growers to adopt new practices with environmental benefits (e.g., cover cropping for 3 years); iv) Conservation Stewardship Program (CSP) which pays for working fields where beneficial practices are being implemented.

d. Survey growers in different sectors to ascertain what amendments or practices they employ that are known to improve soil quality. Follow-up with a round table from Snohomish County compost project with growers and composters to identify growers and industry needs.

e. Support research on soil building practices that facilitate intensification of crop rotations (increasing the frequency of high-value crops, such as potato, carrot, or onion) without adversely affecting soil quality. In the irrigated Columbia Basin, this seems to be a primary motivation of growers using mustard green manure crops preceding potato crops.

f. Identify key knowledge gaps that can be filled by the level of funding CSANR can provide through BIOAg funding, and specific research questions that are unlikely to be funded by other sources but are of demonstrated importance to Washington growers.

3. Support adoption of soil improvement practices through on-farm research and demonstration projects. When farmers see positive results on their own farms, or on farms typical for their region, they are more likely to try new practices for improving soil quality. Producer-to-producer education activities should be supported, e.g.,: listening to growers to learn what has worked for them, and encouraging growers who are viewed as leaders in their agricultural communities to adopt soil quality improvement practices. Such projects likely will need to occur over multiple years.

a. Efforts to increase compost use are underway in Snohomish County, and ideas to enhance and extend this work include: i) subsidized compost purchases; ii) support for equipment rental or loans for purchases, especially loaders & spreaders; iii) reduced plastic contamination of commercial compost through extra screening; iv) production of composts registered for certified organic use (residential food waste is now prohibited in certified organic production due to compostable plastics).

b. Encourage adoption of cover crops. For example, compile results of cover crop trials and develop a variety selection tool. Be aware of complicating interactions, e.g., brassica cover crops are being used extensively and pose a risk of introducing black leg (*Phoma lingam* if the seed is not tested and certified to be free of such pathogens), as occurred on a widespread basis across the Willamette Valley recently. Growers should only plant certified pathogen-free cover crop seed lots. Outreach efforts are needed to increase awareness of the risks of introducing pathogens on poorer quality seed lots.

c. Support field days and strategic demonstration plots that encourage observation of the effects on soil properties from “ideal” practices. What is possible for soil quality? What does improved soil quality look like? One strategy could be to implement BIOAg-funded demonstration sites. The advent of GPS equipment and GIS approaches could make the original concept of BIOAg demonstration sites more readily accomplished.

4. CSANR should connect and coordinate with other State agencies and non-governmental organizations to formulate a cohesive approach to increasing adoption of practices that address specific soil-related problems. Additional coordination with national and regional soil
quality efforts such as the Soil Renaissance project of the Noble Foundation, the Soil Quality Network based in Oregon, and the USDA Sustainable Agricultural Research & Education (SARE) program on regional and national efforts should also be pursued.

a. Work with partners such as NRCS to direct funding from Conservation Innovation Grant projects, e.g., to validate research efforts and build grower confidence in soil quality practices. Soil quality is a priority for NRCS nationally, but translation of this priority at the state level is variable.

b. Members of a cohesive soil quality network could organize and support educational events that address both the principles of soil quality and evaluate specific products that may or may not improve soil quality. Examples include workshops or forums such as the recent Soil Quality Network event in Mount Vernon, Soil Quality Symposium in Moses Lake, and Washington Horticulture meeting in Wenatchee.

5. **Produce publications to make existing data available in layman’s terms.** For example:
   a. How to evaluate soil quality (e.g., measuring parameters over time, at the same time of year, and using the same lab).
   b. Cover crop guidelines for different agricultural industries.
   c. Cost/benefit analyses of soil improvement practices.
   d. Use of organic amendments in production agriculture (e.g., important attributes of amendments that should be scrutinized).
   e. Use of reduced tillage.
   f. Specific problems that can be solved with improved soil quality, such as poor infiltration, low water holding capacity, and surface crusting.
REFERENCES


