Cover Crops For Soil Health

Richard Kersbergen
University of Maine Cooperative Extension
992 Waterville Rd. Waldo, Maine 04915
Tel: 207-342-5971 Email: richardk@umext.maine.edu

Cover Crop Resources

Northeast Cover Crop Handbook, 1994
Marianne Sarrantanio
Rodale Institute

Managing Cover Crops Profitably
Bowman, Shirley and Cramer
Sustainable Agriculture Network
www.sare.org

Building Soils for Better Crops 2nd edition
Fred Magdoff and Harold van Es
Sustainable Agriculture Network
www.sare.org

Sustainable Vegetable Production
Vern Grubinger
NRAES 152 Riley-Robb Hall
Ithaca, N.Y. 14853

When defining soil health, most scientists will now describe chemical, physical and biological properties as key parts of a productive sustainable soil system. A key component of a health soil cropping system includes ways to increase and manage soil organic matter, by either additions to the system through diverse organic amendments and cover crops or methods to reduce losses of organic matter through conservation practices that reduce erosion or minimize tillage. Cover crop systems work to do both in a well-designed system.

Traditionally, cover crops are delineated in three ways:
Green Manures –Crops for soil improvement including organic matter additions and/or nitrogen fixation with legumes.
Catch Crops –Crops for retaining nutrients after the cash crop has been harvested or after nutrient applications (primarily nitrogen)
Fall Cover Crops –Crops for reduction of erosion from bare or fallow soil.

For this presentation, I have will categorize cover crops by their impact on improving soil health.

Soil and Water Management: When selecting cover crops for soil and water management, one should always consider the impact of rainfall events on bare soil. When soil erodes, it not only represents a loss of soil and nutrients, but also a loss of organic matter as this component of soil is easily detached and lost. Having a crop to intercept rainfall and improve water infiltration is extremely important to long-term soil health. Physical damage to soil structure is prevented with the use of cover crops (improved aggregation and a reduction in soil crusting). Since heavy rainfalls often occur in early spring and late fall, winter cover is extremely important to maintaining soil quality. Cereal Rye (*Secale cereale*) is the most common fall cover crop due to its ability to germinate and grow in cool weather. Heavy soils also benefit from a rye cover crop in the spring, as these soils will dry out faster than bare ground due to the root system of the rye

and evapotranspiration by the plants. Many producers choose Oats (*Avena sativa*) as an alternative to rye due to its lack of winterhardiness. It too will grow well in the fall, but will be a dead matt of organic matter in the spring and will facilitate soil preparation for early small seeded crops.

Soil Organic Matter: Growing and incorporating material back into the soil will improve organic matter levels, increase soil biological activity and increase nutrient holding capacity of the soil (Cation Exchange Capacity or CEC). Cover Crops vary greatly in the amounts and types of organic matter they add to the soil system. Buckwheat (*Fagopyrum esculentum*) will produce much less biomass then most other cover crops and also contain very little lignin. Its rate of decomposition in the soil is rapid, so the change in organic matter is small and short lived. Sorghum-Sudangrass or Japanese Millet on the other hand produce copious volumes of carbonaceous material that can be highly lignified if left until maturity before incorporation and can add significantly to the active carbon pool in the soil. When choosing cover crops or rotations that include long term soil cover (sod), it is important to realize the impact of the carbon source, the nitrogen content and the volume and type of root mass on long term organic matter improvement. Sod crops, such as grass legume mixes can significantly improve organic matter in soils due to the large root system these crops develop over the course of one or two years.

Physical Enhancement of Soil: Growing and utilizing cover crops can alter many physical properties of soil. Parameters such as water holding capacity or drought tolerance (organic matter), soil structure (aggregation due to biological activity), improved drainage (organic matter), and reduced compaction (organic matter and plow pan disruption) are all qualities potentially impacted by cover crops. Soils high in organic matter can withstand stressful periods and abuse better than low organic matter soils. Cover crops with deep taproots such as alfalfa (*Melitotus satvia*) and Sweetclover (*Melitotus officinalis*) have the ability to disrupt compacted soils or plow pans and leave large pores in compacted soil layers when the roots die off.

Soil Fertility: Cover crops add and retain plant available nutrients in various ways and forms. Legumes and their ability to “fix” atmospheric nitrogen through a symbiotic relationship with rhizobia bacteria will add nitrogen to the soil when the crop is incorporated. The amount of N can vary greatly depending upon how much biomass is included when the cover crop is turned into the soil. Legume cover crops have also been shown to help promote the development of mycorrhizal fungi in the following crop. These fungi help plants take up nutrients, improve nitrogen fixation, and help to form and stabilize soil aggregates. Roots with large amounts of mycorrizae are better able to resist fungal diseases, parasitic nematodes and drought.

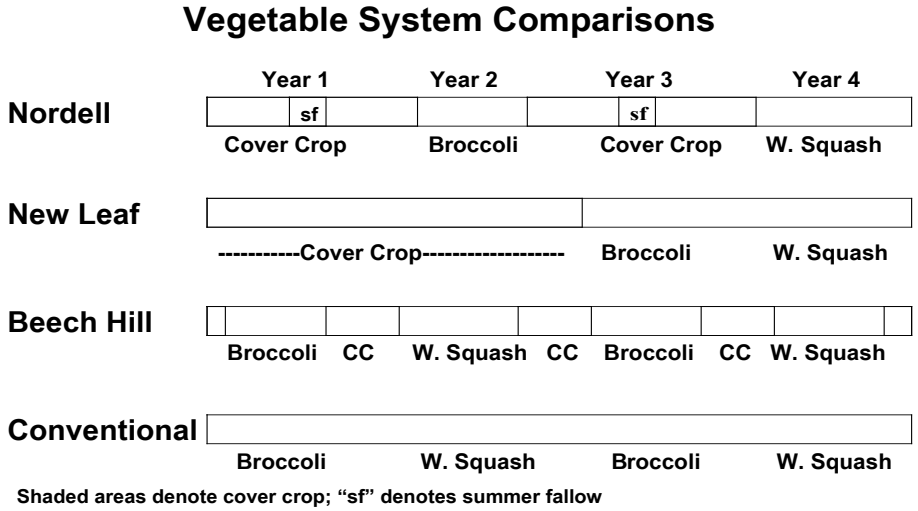
Any cover crop that is incorporated when green (green manure) will provide a flush of plant available nitrogen. The rate and amount of nitrogen release will depend on several factors, including the maturity of the crop (carbon to nitrogen ration increase with increasing maturity), the time of year and the soil temperature when it is incorporated. Highly carbonaceous crops (mature rye for example) will actually cause a period of “nitrogen lockup” due to immobilization of the nitrogen by microorganisms consuming the carbon.

Cover crops are also useful in “catching" excess plant nutrients, especially nitrogen, in the fall to avoid losses due to leaching during the winter. Cereal rye and oilseed radish seem to be the most effective at scavenging nitrogen with cereal rye potentially capturing up to 70

pounds of N per acre in a September seeded crop. Other traditional fall crops such as oats that are winterkilled, loose their ability to hold nitrogen as they die and 'leak" nutrients as cell walls deteriorate. Capturing of N in the fall is increasingly important to organic growers who may be applying manures in the fall to vegetable ground to meet harvest restrictions under the new National Organic Program (NOP).

Weed Suppression: Although not directly related to soil health, cover crops do play a role in weed suppression. Competition for nutrients and light, smothering by cover crop residues and allelopathy all can play a role in reducing weed pressure in succeeding cash crops. No-till vegetable systems use smothering as a key part of weed and moisture control. Fast growing crops such as buckwheat out compete weeds for light. Various cover crops release chemicals during decomposition that inhibit small seeded weeds from germinating. This allelopathic effect is most common in cereal grains, but research is on going with other cover crops as well. A Maine study by Dyck and Liebman (1994) demonstrated that crimson clover residue was able to suppress lambsquarter emergence by 27%. More recently, researchers have turned their attention to the use of brassicas as crops to reduce weed seed viability.

One of the issues related to soil health and cover crop systems is the impact of tillage operations. Often, growing a cover crop will mean additional tillage, which may have negative impacts on soil quality. Currently in Maine, researchers Gallandt and Sarrantonio are conducting a SARE project entitled "Diversity and Intensity of Cover Crop Systems: Managing the Weed Seed Bank and Soil Health." This project is comparing 3 different cover crop systems currently being used by farmers in the northeast with a conventional rotation to evaluate the impacts on weed seed bank changes and soil quality over a three-year period. One of these systems includes a period of summer fallow (Nordell system).



Another area of research in Maine with cover crops and soil health is focused on the role of brassicas and their potential impact on weeds (Haramoto and Gallandt), and their role as a "biofumigant" for soil diseases (Griffin, ARS). Brassicas contain glucosinolates, which are responsible for the potential beneficial effect. Research in Aroostook County has shown promise that brassica crops (canola) in rotation with potatoes reduce the severity of Rhizoctonia infection during the potato rotation. Ida Gold, a yellow condiment mustard seems to have one of the higher

glucosinolate concentrations among the brassica species. Researchers are also investigating the potential negative impacts that these cover crops may have on beneficial soil microorganisms.

Cover crop systems must be chosen with numerous parameters evaluated in the decision. Producers should choose a system that meets their production schedules, matches their rotations and equipment and helps them improve soil quality over time.