Farm Management Practices for Reclaimed Cropland: Addendum One

I. Cover Crops and Soil Health Management Systems on Reclaimed Mine Land*

The process of strip mining coal results in many changes to the natural structure of the soil. The most common impacts to soil health are loss of pore space, loss of permeability, changes in the capability of the soil material to provide moisture and air for plant growth, loss of living organisms, and reduced organic matter.

Soils reclaimed after mining are considered drastically disturbed, however it is possible to restore the productivity of the soil using soil health practices, such as cover crops, no-till, and nutrient management. It is important to understand that any of these practices can improve the soil, but for long-term productivity and sustainability the practices need to be used as a "system."

Cover crops are an excellent option for producers to consider as they begin the soil restoration journey on reclaimed land. This publication briefly describes the benefits of growing cover crops as part of a soil health management system to improve the properties of these soils while increasing the productive capacity of the soil for succeeding years.

Dr. Eileen Kladivko, Professor of Agronomy at Purdue University, and Barry Fisher, Soil Health Specialist with USDA Natural Resources Conservation Service outlined the benefits of cover crops in publications such as Cover Crops For Prevented Planted Acres https://ag.purdue.edu/agry/extension/Documents/PreventedPlantingCovers.pdf and Cover Crops For Modern Cropping Systems http://ag.purdue.edu/agry/extension/Documents/CoverCropsOverview.pdf.
These same principles apply to using cover crops on reclaimed lands in increasing organic matter, increasing aggregate stability, increasing water infiltration, increasing water-holding capacity, increasing nutrient use efficiency, balancing and diversifying soil biology, reducing compaction and reducing erosion.

Increasing organic matter

Most reclaimed soils are low in organic matter content as many of these soils had little organic matter prior to mining and the mining process further reduced that content. Both the root growth and top growth of cover crops will contribute to building soil organic matter faster than if the soil is left bare or allowed to naturally re-vegetate. Soil organic matter serves as a reservoir of nutrients for crops, provides soil aggregation, increases nutrient exchange, retains moisture, reduces compaction, reduces surface crusting, and increases water infiltration into soil. The use of cover crops along with maintaining crop residue on the soil's surface will increase the organic matter content of reclaimed soils. Adding manure or other waste materials is also an effective method to increase organic matter in the soil and works well when used with a cover crop which will keep the manure and nutrients in the field

Improving aggregate stability

Mining changes the natural structure of the soil, making the soil more subject to crusting and erosion. Cover crops that produce high biomass help build soil organic matter, improve soil aggregation, and stimulate soil biological activity by adding their roots and shoots to the soil.

Fibrous roots enmesh soil particles and provides food for microorganisms which in turn produces polysaccharides and other "sticky" substances which stabilize soil aggregates. Adding organic matter and roots to reclaimed soils will rebuild soil structure, which enables these soils to hold more water and nutrients and be less subject to erosion.

Increasing infiltration and permeability

Reclaimed soils may have slower infiltration of water and slower permeability or movement of water through the soil. The roots and soil biological activity provided by cover crops increases soil porosity and decreases density near the soil's surface leading to improved water infiltration into the soil. Deep-rooted cover crops can penetrate compacted layers and provide deep, continuous channels for water percolation and root penetration of subsequent cash crops. Increasing infiltration of water into the soil reduces runoff and erosion and will increase the water available for plants.

Increasing water holding capacity

Reclaimed soils have reduced pore space and reduced capacity to store water for plants. Crops grown on mined soils often shown signs of moisture stress during dry periods. Using cover crops and crop rotations increases organic matter, pore space, aggregate stability and infiltration, which all help to increase the available water capacity of these soils. Keeping residue on the soil surface helps to reduce the soil temperature. Cooler soil temperature conserves soil moisture and slows the rate of organic matter decomposition.

Increasing nutrient use efficiency

As mentioned earlier, most reclaimed soils are in low organic matter content, which reduces their capacity to store nutrients. Adapted nutrient management can increase plant nutrient uptake and improve the chemical, biological and physical properties of the soil. Cover crops recycle or scavenge nutrients that can be used by succeeding crops.

Improving biological activity

The mining and reclamation process reduces biological activity in reclaimed soils. These soils need a jump start to help get microbial activity working again. Cover and green manure crops increase the available food supply for microorganisms resulting in increased biological activity. Cover crops provide additional food for soil creatures such as earthworms. Keeping plants growing throughout the year helps to feed the soil microorganisms, keeps the soil surface covered and helps keep the soil and its nutrients from washing away. Using cover crops and crop rotations increases plant diversity and increases the diversity of organisms in the soil. Grazing will add manure and biological activity to the soil as well.

Decreasing compaction

Mined soils frequently have higher bulk density and layers of compaction. Deep rooted cover crops can penetrate compacted layers and provide continuous channels for water percolation and root penetration of subsequent cash crops. If fields have so much compaction that deep tillage or sub-soiling is required to remediate the condition, planting a deep rooted cover crop after the tillage operation will help stabilize the gains in permeability, rebuild soil structure, and stimulate soil biological activity along root channels. The roots and soil biological activity provided by cover crops will increase soil porosity and decrease bulk density.

Reducing erosion and runoff

Reclaimed soils often have long slope lengths that are subject to water erosion. Cover crops protect the soil from further erosion by both water and wind. Cover crops that produce high biomass help build soil organic matter, improve soil aggregation, and stimulate soil biological activity by adding their roots and shoots to the soil. Using a quality no-till or strip till system for growing crops helps minimize disturbance to the soil and reduces erosion. The use of a quality system maintains a high level of crop residue on the soil surface to protect the soil from erosion and reduce runoff.

Soil Health Management System

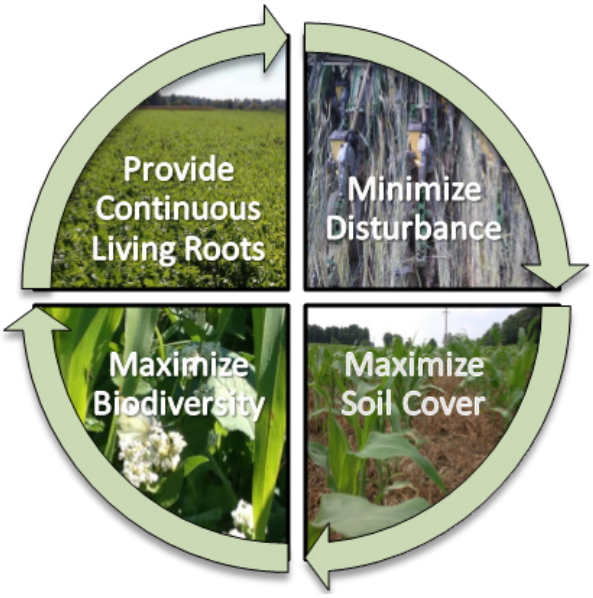
Using these four basic principles is the key to improving the health of any soil, especially those drastically disturbed by coal mining.

- Minimize Disturbance
- Maximize Soil Cover
- Maximize Biodiversity
- Continuous Living Roots

Improving soil function is about optimizing and understanding all aspects of the Conservation Cropping System so that soil health is the central focus with every operation. A Conservation Cropping System includes quality no-till (or never till), cover crops, diverse crop rotations, integrated pest and weed management, and adaptive nutrient management. These practices work together to complement and enhance each other as they restore and build the soil and will result in a profitable and sustainable system.

Quality No-Till or Strip-Till

A quality no-till or strip-till system grows crops without disturbing the soil through tillage. The soil surface is disturbed minimally while maintaining a high level of crop residue on the soil surface. Such systems increase water holding capacity, increase organic matter, reduce soil erosion, and reduce energy use.



Diverse Conservation Crop Rotation

Diverse conservation crop rotations include growing a diverse number of crops in a planned sequence to increase organic matter and biodiversity in the soil. Crop rotation increases nutrient cycling and nutrient use efficiency, manages plant pests, reduces sheet, rill and wind erosion, and holds soil moisture. The diversity of plants increases the diversity of soil microbes.

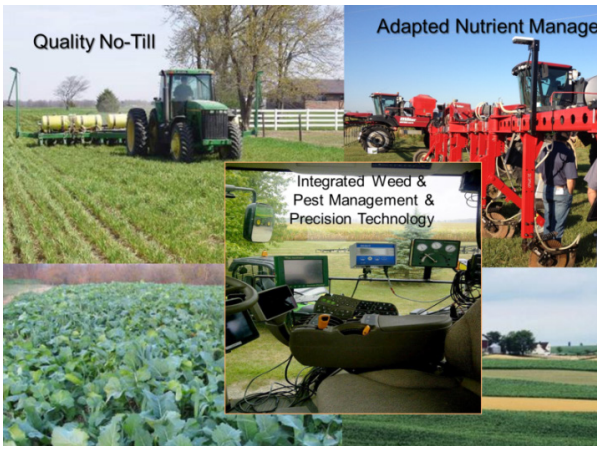
Strategic Use of Cover Crops

Strategic use of cover crops, as an un-harvested crop and grown as part of a planned rotation provides conservation benefits to the soil. The right cover crops grown as part of a crop rotation and integrated at the right time increases organic matter, prevents soil erosion, conserves soil moisture, increases nutrient cycling, provides nitrogen for crop use, suppresses weeds, and reduces compaction.

There are several tools to help producers select cover crops for their situation in Indiana. The Midwest Cover Crops Council has a selector tool that was built starting with Indiana conditions and farmer experiences http://www.mccc.msu.edu/selectorINTRO.html. Producers enter their state and county, and are provided with a chart of various cover crops and their planting date windows. Producers can further narrow the choices by inputting up to three desired purposes of the covers, such as N scavenger or soil builder, and then selecting from that list. A few common cover crop mixes are also included in that chart as potential choices.

The Indiana NRCS Seeding Tool (www.nrcs.usda.gov/technical/efotg/) also provides guidance on cover crop species and allows more flexibility in determining mixes. Both tools provide the dates and seeding rates for planting the various cover crops.

Often a mix of cover crops provides more benefits than a single species, so producers should consider a mix that includes two or three of the plant classes. These species mixes stimulate the



soil's biological activity more quickly due to varied plants and root types. For example, a mix of a fibrous-rooted grass and a legume or brassica with a tap root will produce improvements throughout the soil profile.

A diverse cover cop mix for reclaimed land should be available at a cost of $30 to $40 per acre, depending on species selected and the method of application. Check prices and sources of different cover crop species regularly as prices and availability can often vary widely. To learn about technical and financial assistance available through USDA conservation programs, visit www.nrcs.usda.gov/GetStarted or contact your local NRCS District Conservationist http://www.nrcs.usda.gov/wps/portal/nrcs/main/in/contact/local/.

Adapted Nutrient Management

Adapted nutrient management is managing soil nutrients to meet crop needs efficiently, while minimizing the impact on the environment. Adapted nutrient management:

- increases plant nutrient uptake,
- improves the chemical, biological and physical properties of the soil and
- budgets, supplies and conserves nutrients for crop production.

Managing nutrients for the 4 Rs (Right Placement, Right Rate, Right Timing, and Right Formulation) can be different for a Conservation Cropping System than a conventional tillage system. Adapting nutrient management for no-till and cover crop integration is vital for success. For more information, see NRCS Agronomy Technical Notes references below.

Integrated Pest Management

Integrated pest management is managing pests by following an ecological approach that promotes the growth of healthy plants with strong defenses, while increasing stress on pests and enhancing the habitat for beneficial organisms. Integrated pest management reduces pesticide risks to water and air quality, decreases pesticide risks to pollinators and other beneficial organisms.

Conclusions

Using a system of soil health practices will result in the improvements for reclaimed mine soils. A soil health management system can help restore the key functions of reclaimed soils to regulate water, sustain plant and animal life, filter and buffer potential pollutants, cycle nutrients, and provide physical stability and support.

II. Additional Resources

Indiana Soil Health
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/in/home/?cid=nrcs144p2_031079

Indiana Conservation Cropping Systems Initiative (CCSI)
http://ccsin.iaswcd.org/

Midwest Cover Crops Council selector tool
http://mccc.msu.edu/

Nitrogen Management Guidelines for Corn in Indiana
http://www.agry.purdue.edu/ext/corn/news/timeless/nitrogenmgmt.pdf

A Strategy to Improve Soil Health in a Midwest Corn-Soybean Cropping System
http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1244796&ext=docx

USDA-NRCS-IN-FOTG Section I-Agronomy Technical Notes
http://efotg.sc.egov.usda.gov/treemenuFS.aspx

Recommended Cover Crop Seeding Methods and Tools
http://efotg.sc.egov.usda.gov/references/public/IN/Technical_Note_Agronomy_Cover_Crop_Seeding.pdf

Residue Management and Waste Utilization
http://efotg.sc.egov.usda.gov/references/public/IN/Res_Mgmt_Waste_Utilization_technote5.pdf

Conservation Crop Rotations for Soil Quality and Soil Health
http://efotg.sc.egov.usda.gov/references/public/IN/Technical_Note_Agronomy_Crop_Rotations_for_Soil_Health.pdf

Cover Crops for Modern Cropping Systems
https://ag.purdue.edu/agry/extension/Documents/CoverCropsOverview.pdf

Cover Crops for Prevented Planting Acres
https://ag.purdue.edu/agry/extension/Documents/PreventedPlantingCovers.pdf

Soil Quality Indicator Sheets
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/assessment/?cid=stelprdb1237387