Fall Harvest Edition

Wise Residue Management

Good residue management is an effective way to improve soil biology, by increasing the total numbers and diversity of beneficial soil organisms necessary for building organic matter and growing vigorous crops. Wise residue management is the management of crop residues in a manner so that they decompose quickly enough to build soil humus lev-els and so that crop residue, or trash, becomes advantageous for the next crop.

The key concepts of wise residue management include:

- inoculate the crop residue with live microbes that will break down mature crop residues
- provide an environment and food sources for the organisms to thrive
- manage carbon to nitrogen ratios
- put the residue in contact with the soil

Inoculate. The residue, or "trash", left behind is the soil's most valuable asset if handled properly. And proper handling begins with inoculating the trash with live microbes and providing food sources to jump start their attack on the tons of residue many crops leave behind. Incorporation into a well aerated soil containing proper amounts of calcium will speed the results . Further acceleration of residue to humus can be obtained by sizing the residue with cutters or choppers. Based on your soil type, topography (highly erodible or not) and your climate (warm or cool) your AgriEnergy Solutions representative can customize the speed of microbial decomposition that fits your farm.

Food sources. To initiate rapid growth of carbon digesters we suggest nitrogen, sugars and traces. This combination gives some immediate nutrition to start the humus conversion process.

Carbon to nitrogen ratios. Mature crop residues such as cornstalks and wheat straw have particularly wide C:N ratios. Cornstalks can be 50 parts carbon to 1 part nitrogen. This ratio will be narrowed to 12:1 by microbes to form humus. Microbes being 60% protein require significant nitrogen. If time is short to degrade the residue, such as a late harvest, then additional nitrogen with a residue management program is important.

Tillage. Standing residue will not degrade into organic matter and humus. We need the residue at least touching the soil. Proper tillage on your farm depends on your soil type (sand, silt or clay), your topography (flat or rolling), and your climate (warm or cool). On sandy soil in the South, proper tillage might be rolling or dragging to knock residue down to the soil. On clay in the North, it might be a mini-moldboard plow. **Proper tillage is the practice that grows the most microbes per acre on your farm.**

80-30-190

80-30-190: That's the pounds of Nitrogen, Phosphate, and Potash contained in four tons of corn stover from a 180-bushel corn crop. Not to mention 16 pounds Sulfur, 35 pounds Calcium, 25 pounds Magnesium, and a host of micronutrients. To go a step further, there are 4,200 pounds of corn roots left in each acre, too.

How can we take advantage of these leftover nutrients and turn them into fertilizer for the next crop? Active microbial decomposition is the key! One of the primary functions of beneficial bacteria and fungi is to cycle nutrients. Nutrient cycles are well-known; with living organisms being essential in each step of the process that converts residue into plant-available forms.

If we let the native organisms in the soil work on their own, eventually all residues will decompose and the nutrients will either return to the soil, volatilize into the atmosphere, or be washed away by rain. But in order to make sure we efficiently cycle these nutrients and retain them for next year's crop, it is essential to utilize practices that will speed up the process.

When crop residues break down, different parts of the plant decompose at different rates. Simple sugars go first, but cellulose & lignin take longer to break down. Decomposition of these tougher substrates can only happen if there are large numbers of decomposer organisms present, and they have adequate nutrients available to them as food to stimulate activity. Rapid digestion holds the nutrients in the bodies of the microbes, keeping them from leaching or being tied up in the soil. As the microbes finish their life cycle and decompose, the sequestered nutrients are released and ready to be taken up by the next crop.

In addition to the environmental benefits of cycling these nutrients, accelerated residue breakdown helps the bottom line, too. At today's high costs of NPK fertilizers, those nutrient numbers of 80-30-190 are equivalent to more than $150 per acre in purchased inputs! Many residue management research plots over the years have shown an average yield increase of over 10 bushels/acre, which translates into more than $50 per acre in today's grain markets. When you combine the fertilizer savings with the yield increase, the concept of nutrient cycling becomes a big-time booster to the bottom line!

Building Organic Matter has countless benefits for your soil, and countless benefits for your wallet.

Soil Fungi

When some folks hear the word "fungi", images of food covered in green mold or white fuzz spring to mind. As these fungi grow in your refrigerator or on your countertop, they are doing exactly what they are designed to do: break down and decompose sugars, starches, cellulose, and lignin.

Biological relatives of these "food fungi" are commonly found in soil and they live and grow in a very similar way. These soil fungi thrive in the aerobic portion of the soil and are superb decomposers and nutrient cyclers. Beneficial soil fungi are common and widespread in biologically active soils.

If you were to scoop up a handful of soil and put it under a microscope, you'd find both soil bacteria and soil fungi. Bacteria may outnumber the fungi in terms of numbers, but when it comes to biomass (weight of living organisms), fungi often dominate the soil microbiota, at least in healthy, biologically active soil.

Fungi can't make their own food like plants do. They are dependent on organic substances for carbon. As fungi break down organic matter and residues, they recycle important nutrients that would otherwise remain locked up in dead plants and animals. These nutrients then become available in the soil and are used by microbes and plants.

Fungi are capable of breaking down all sorts of tough crop residues and hard to digest organic matter. They use nitrogen in the soil to decompose woody carbon-rich residues, which are usually low in nitrogen. Nutrients in the residues are then converted to forms which are accessible by other organisms.

Here are some of the jobs that soil fungi do in your fields:

- Decompose complex carbon compounds (e.g., crop residues)
- Improve accumulation of organic matter
- Break down hard to digest cellulose and lignin
- Retain nutrients in the soil
- Extension of plant roots (increase surface area for water and nutrient absorption)
- Solubilize phosphorus in the soil and make it available to plants and other microbes
- Improve soil tilth (help soil particles cling together)
- Break down some chemical residues (bioremediation)

Bottom line, beneficial soil fungi are workhorses and you want high numbers of them in your soil. It's especially important that they are out there and active during the Fall after a crop has been harvested. Soil with plenty of fungi will break down your crop residues and put those nutrients back in the soil, making them available for next year's crop.

Case Studies

Study #1 - Background information from USDA

Back in 1938, USDA studied prairie soils and calculated that the organic matter in the root zone contained 8,000# of nitrogen. That would have been soil with about 8% organic matter. Timber soils (about 2% organic matter) had about 2,000# of nitrogen. **Conclusion: every 1% organic matter = 1,000# of nitrogen in the root zone.**

Study #2 – Nitrogen Rates on Corn on Iowa Research Farms

Dr. Jerry Hatfield, USDA-ARS (retired), who headed the National Laboratory for Agriculture and the Environment (formerly the National Soil Tilth Lab) at Iowa State University, reported the same experience on research farms where they have active soil biology: They don't need as much purchased nitrogen to raise high-yielding corn. He cites a farm where they've **raised 308-bushel corn with only 80 pounds of added nitrogen**.

1% Organic Matter equals:

- ***1,000# or nitrogen / acre***
- ***650# of phosphate / acre***
- ***115# of potash / acre***
- ***700# of calcium / acre***

And … 1% OM allows the soil to store another 10,000 gallons of water / acre

Study #3 – Nitrogen Rates on Corn at our Research Farm

In Princeton IL, we've found in many field trials over several years that **we need only 0.6# of added nitrogen to produce a bushel of corn following corn**. University research for years has said it takes 1.2# N on corn-after-corn. In other words, **we grow a 250 bushel corn crop with 150# N** rather than the university's recommended 300# N.

Following soybeans, we need only 0.37# of added nitrogen to grow a bushel of corn. Adding more nitrogen beyond this rate wasn't economic. University research recommends 0.7# N per bushel on corn-after-soybeans. In this case, **we can grow a 250 bushel corn crop with 92# N** rather than the university's recommended 175#.

Our most economic rate of added nitrogen was in corn-on-soybean stubble: **0.17#/bu – or 35#/acre – of added N produced 203 bushels per acre!**

Whether it's corn after corn, or corn after soybeans, we can raise a bushel of corn with dramatically less purchased nitrogen than conventional recommendations. Our data shows that we're saving about 115# of purchased nitrogen to consistently raise 250 bushel corn. At today's prices, that is **over $50 per acre saved!**

Study #4 – Phosphate Use at our Research Farm

It is accepted that the maintenance rate for phosphate in corn production is 0.43# phosphate per bushel harvested. So, for a 250 bushel corn crop, we would need to add back 107# of phosphate per acre per year.

During a 28-year period (1981-2009) at our research farm we maintained 200 bushel corn yields while adding only 15# of phosphate per acre per year.

Let's do some math:

Accepted Maintenance Rate
86# x 28 years = 2,408#
Actually used @ our farm
15# x 28 years = 420#
Amount "saved" (not used) 1,988#

Convert 1,988# phosphate to DAP and that is 4,300#/acre of DAP that was never purchased!

So, surely the soil tests dropped. Well …
1981 P-1: 146
2009 P-1: 190

At today's prices, this is **another $50 per acre saved!**

We are NOT mining the soil!
On the contrary; because of wise residue management we are adding new humus every year by aggressively recycling leaf, stalk, and root residue.

Bio Sanitation in IPM Systems

Sanitation, the physical removal of infected tissues, is a standard practice for growers who fight diseases such as Apple Scab, Pecan Blight, or Cherry Leaf Spot. Orchardists take great care each season to remove as much of the leaf litter in the fall as they possibly can. They need to minimize the amount of inoculum on the orchard floors that threaten the next crop.

It's not as common to talk about sanitation in row crops. But with many diseases sweeping across the Midwest, universities and consultants are once again talking about it. Historically this was taken to mean one should get out there and moldboard plow their trash; and that works. But NRCS and others have persuaded or coerced many growers to stop that practice. Indeed we at AgriEnergy do not think complete inversion of residues is justified.

So what do we do in corn-on-corn where Northern Leaf Blight, or Gray Leaf Spot, or the like is present on our residues and a threat to next year's crop? Rotate out? Ok, maybe in corn ground, but that's a hard choice when corn is more profitable than beans. With perennial crops such as an orchard, rotation is not an option. So what can we do? We engage in active and vigorous residue decomposition.

An ARS microbiologist once stated that the fungal inoculum on fallen and dead tissues will not survive if the infected tissue is consumed by microorganisms. Thus ***bio sanitation is the practice of using microorganisms to eat residues as quickly as possible.*** And not just relying on and waiting on the native organisms to get cranked up, but actually spraying bugs onto the residues and getting those residues into contact with the soil.

Most definitely you should continue all good sanitation practices. It is impossible to get every little scrap of fallen plant material picked up in an orchard or buried deep in a field. But it is not impossible to inoculate every bit of what is on the orchard floor or in your fields.

The Benefits of Wise Residue Management

Faster Warm-Ups - Less residue allows faster soil warm-up for earlier planting

Easier Tillage – Soils that are alive require less horse-power and fewer tillage trips

Easier Planting – Less residue means less hair-pinning and less risk of plugging

Biosanitation – Use microorganisms to "clean up" residues as quickly as possible

Increase Diversity – Many different kinds of organ-isms means healthy competition

Increase Numbers of Microbes – More microbes per acre means more fertility

Water Holding Capacity—Better tilth, more organic matter means more stored water for those non-rainy days

Improved Tilth – A "coffee grounds" structure at the surface provides a beneficial mulch

Improved Gas Exchange – Improved tilth means keeping soil air pore space more like atmospheric air

Recycle – Recycling nutrients in residue reduces costly purchased inputs

Build Organic Matter – Faster cycling of residues means capturing more carbon in the soil

Sequester Nutrients – By building organic matter we are anchoring nutrients to our farm

1% Organic Matter =

1,000#	nitrogen per acre
650#	phosphate per acre
115#	potash per acre
700#	calcium per acre
	And much more …

Building Organic Matter is what Really Matters!

When your residue decomposes to the point you can't recognize what crop it came from, that's a "harvest" of raw organic matter. Live microbes speed this "harvest" along, sequestering/capturing/ storing more of your recycled crop nutrients.

A couple years ago we measured organic matter on several farms across the Midwest which have used our AgriEnergy system for a number of years. With permission from neighbors, we pulled samples from biologically farmed fields and adjoining conventionally farmed fields with the same soil types.

Our soil samples were segmented into (a) the top three inches, (b) three-to-six inches, and (c) six-to-12 inches. Soils were tested by Midwest Laboratories, and ***in every instance the organic mat-ter was higher on the biologically farmed field than on the neighboring conventionally farmed field.***

The first set of samples we pulled comparing our biologically farmed soil with the conventionally managed soil to the south, showed the biologically farmed soil had:

23% more organic matter in the top 3 inches
26% more organic matter in the 3-to-6 inch profile
10% more organic matter in the 6-to-12 inch profile

The difference across a line where a fence once stood was amazing! The biologically farmed soil was dramatically higher in carbon content. So, we checked another side of the same farm.

This time we compared our soils to the conventionally-farmed soils adjoining our west boundary. These tests showed we have:

40% more organic matter in the top 3 inches
49% more organic matter in the 3-to-6 inch profile
10% more organic matter in the 6-to-12 inch profile

Even more dramatic! Averaging these two sites, the biologically farmed soil has 3.9% organic matter compared to 2.9% on con-ventionally farmed soils.

Building organic matter/sequestering carbon on your farm is "true fertility" gained. The additional carbon has countless bene-fits for your soil. The sequestered nitrogen and other nutrients have countless benefits for your wallet.

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