

MEASURE AND MANAGE

Building Soil Organic Matter

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Building soil organic matter increases the chance of producing and improving soil quality. There seems to be somewhat of a contradiction when talking about organic matter not only do we need to build it up we need to have it also break down. The action of breaking down organic matter and benefits of the by-products of that breakdown help to produce the materials necessary to form stable aggregates and release nutrients to plants...

The addition of organic materials in particular the active or “dead” organic matter stimulates bacterial action until such a time this form is depleted and turned to humus. What really matters is a continuous supply of active organic matter to keep soils productive. This is easier said than done.

The goal should be to build to target organic matter levels as indicated on AgTest Soil Reports however a management approach that maintains a continuous supply may be equally of benefit. It is difficult to build levels because approximately 75% of the added carbon will be consumed by soil microbes and respired. A diversity of organic materials is important to the soil building process. Most organic materials are made up of varying amounts of sugars, starch, cellulose, proteins, hemicellulose and lignin. The most readily degradable and of most benefit to soil aggregation are materials that contain more sugars, proteins and cellulose. Less desirable materials for soil building are materials that contain high amounts of hemicellulose and lignin (the very dead). Therefore cover crops and solid manures containing bedding materials are better at providing the materials necessary for building soil quality. Composted materials are already broken down and are not a good food source for bacteria and provide little help in building soil structure. However they should not be discounted as their higher levels of lignin and humus increase water holding capacity, reduce stickiness of clays and help sequester nutrients for slow release.

Carbon Nitrogen Ratio (C:N)

When building soil organic matter levels one of the most important measurements to be aware of is the Carbon and Nitrogen content of the amending materials or crop residues. The relationship of Carbon and Nitrogen determines the value of the material or at least indicates what management

adjustments need to happen to make the amendment valuable in building soil quality. The relationship is expressed as the Carbon: Nitrogen Ratio (C:N). Young immature crop plants may have a C:N of 15 :1 and on the other end of the spectrum is sawdust at 200:1. The C:N of soil organic matter is usually around 10 to 12:1.

The significance of this ratio is to determine the effect a material will have on Nitrogen availability to the following crop. If you apply a material high in carbon and low in Nitrogen to the soil the following crop may experience a shortage of N (immobilization of N). As soil organisms attack the carbon source they will rob available N from the soil to multiply and reduce the organic amendment. Once they have accomplished the break down the bacteria die off and release N to the crop. If a stable amendment is added, one with a ratio of 20:1 the tie up of N is reduced as this ratio provides a more favourable nutrient balance.

Most crop residues contain approximately 45 % carbon however the Nitrogen content varies greatly. The following table highlights some common materials.

C:N Ratios of Selected Materials

Material	C:N Ratio
Poultry Manure	10
Alfalfa Early cut	13
Dairy Manure low straw	17
Green Rye	36
Corn Stover	60
Wheat straw	80
Dairy Manure high straw	40
Mature Alfalfa hay	25
Fresh tree leaves	90
News paper	600

C:N ratios greater than 40 may cause problems with N availability to subsequent crops. To be safe, ratios of 20:1 are relatively stable and cause very few problems with N availability. At Agri-Food Laboratories we can test materials for their C:N ratios and inform you of possible problems in advance of application.

Application of materials with high C:N ratio maybe of benefit in mitigating leaching losses of Nitrogen. Especially in situations of high nitrate-N carryover the resulting immobilization will be desirable to reduce environmental risk.

As an example, a recent manure sample containing wood shavings was submitted for testing. The N content was 0.65 % and was consider high for beef manure. However the organic carbon was 35 %. The resulting C:N ratio was 53.

A stable material would have a C:N ratio of 20:1. To achieve that ratio with this material would require an N content of 1.75 %. Therefore to make this a stable product additional N is needed. Subtracting 1.75% from 0.65% equals 1.1% of additional N content. In a 2000 pound ton of as applied material an additional 22 pounds of N is need or 47 pounds of urea fertilizer. In a 10 ton per acre application an additional 470 pounds of urea needs to be applied to prevent N tie up in the breakdown of this material. On the flip side of this story this material would be able to immobilize 220 pounds of free nitrogen per acre.

Not all manure is equal it is therefore prudent on solid manure with wood shavings to test for the C:N ratio. This material without additional N would breakdown very slowly and is of little benefit short term to improving soil quality.

Increasing Organic Matter

It is difficult to make long lasting and permanent increase in soil organic matter. As materials are added they are broken down. In manure situations the additions of organic carbon are about equal to the losses. This not all bad as we want some breakdown to occur in order for the benefits to soil structure to occur by providing byproducts for soil aggregation.

Using an example from Fred Magdoff and Harold van Es from their book "Building Soils for Better Crops" lets look at a likely scenario to explain organic matter additions and losses.

20 tons of dairy manure per acre at 13% dry matter = 5200 pounds of solids

A soil with 2.17 % organic matter (2,000,000 pounds x 0.0217 = 43,400 pounds of OM per acre.

75 % of the manure may break down in the year of application leaving 25% or just 1300 pounds of material left after the first year.

This would raise the OM level by 0.3%.

The soil organic matter loss per year is approximately 3% or 1300 pounds per acre.

Therefore the manure additions just cover the losses the net effect on increasing OM is nil. However the benefits to the soil are important as this addition and breakdown has provided food for soil organisms and their activity will improve soil structure. Continuous application of manures over a number years, combined with crop rotation, and reduce tillage may slowly increase OM levels.

Crop Residues

Crop residues are an important component to building or maintaining soil OM levels. The follow table lists the amounts of residues left post harvest.

Crop	tons / acre
Corn 150 bus	5
Soybeans 45 bus	1.2
Wheat 80 bus	2.5
Wheat stubble	0.75
Sugar beets	2
Broccoli	3
Tomatoes	1.75
Onions	0.25
Corn silage	0.5

Estimated Root Residue

Crop	Tons / acre
Italian ryegrass	1-2
Winter wheat	1
Red Clover	1- 1.2
Spring Cereals	0.75
Soybeans	0.25 – 0.5
Potatoes	0.15 – 0.3

Decomposition Rates of various Organic Materials.

The decomposition and the effects different residues have on soil quality is a function of the different properties of the residues. Immature residues with low C:N ratios and high sugar and low fiber content decompose relatively rapidly and have little impact on soil structure. More mature higher C:N ratio materials with more cellulose and less starch are longer lasting. More mature and higher C:N ratio materials with more hemicellulose and lignin are extremely long lasting and will be slow to degrade. A mixture or diversity of residues throughout the crop rotation is most desirable and will possibly lead to a slow steady increase in OM levels.