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Can I Increase Soil Organic Matter by 1% This Year?



60

January 15, 2018 | Posted in [Residue Management](#), [Soil Health](#)

Source: [Penn State University Extension](#)

By Sjoerd Willem Duiker

This fall, I participated in workshops where a farmer claimed his soil organic

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matter increased by 1% per year. Is this a realistic goal to shoot for?

The source of soil organic matter is photosynthesis resulting in plant growth – either root or aboveground. Therefore, the organic matter content cannot increase more than the amount of plant growth that can be produced in a year. Let's just do some basic math assuming all the plant matter gets converted into soil organic matter. First, we need to know what one acre of soil can produce. Let's assume a highly productive corn crop – producing 200 bushels per acre. That is 200 bushels per acre x 56 lbs/bushel x 0.845 (to correct for 15.5% moisture in grain) = 9,464 lbs of dry grain per acre. Typically, the harvest index of corn (the proportion of stover to grain) is 1, so the amount of residue produced is also 9,464 lbs/A. The root mass produced by corn is on average 20% of the above ground, so if we add that it makes 11,357 lbs/A.

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Let's assume you also grow a cover crop of rye and that it is terminated with 5,000 lbs of above-ground dry matter per acre and 1000 lbs of below-ground root mass. The total is 17,357 lbs of plant matter from roots and stover from corn and rye. Let's convert all that to carbon for greater accuracy. The carbon content of stover is typically 40%, so that is 6,943 lbs of carbon produced per acre in roots and stover. Is that enough carbon to increase soil organic matter 1%? Let's calculate how much carbon is in 1% of soil organic matter. We assume one acre slice of soil (to a depth of 6.7") weighs 2,000,000 lbs. So one percent of 2,000,000 is 20,000 lbs. Soil organic matter contains roughly 58% carbon. So one percent organic matter in soil to 6.7 inch depth equals 11,600 lbs of carbon. That is a lot more than the amount of carbon that is produced by a highly productive corn crop plus rye cover crop!

I hope you agree that this calculation shows that it is not possible to increase soil organic matter at a rate of 1% per year with current production constraints. And we didn't include the conversion of plant residue in soil organic matter yet! That conversion has been shown to be only 10-20%. So if you add 6,943 lbs of carbon in plant roots and stover, that would end up in only 1388 lbs of soil organic carbon, or 2393 lbs of soil organic matter. That is 0.1% of 2,000,000 lbs of soil. Therefore, if you increase organic matter content by 0.1% per year you are doing a superb job with your management. To expect 1% increase is unrealistic.



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This discussion assumes there is no input of organic matter from other fields or farms. If manure or compost have been applied that would change the story. Fred Magdoff and Harold van Es include a calculation of the effect of dairy manure application on soil organic matter in the book "Building Soils for Better Crops (2nd Ed)". They calculate that applying 20 T/A/yr of solid dairy manure would increase organic matter content 0.065% per year. So if we add relatively high applications of manure to the equation it might be possible to increase organic matter content 0.17% per year.

Incorporating a combination of no-til, cover crops, residues and manure can improve soil organic matter over time. We have to be patient.

Listen to Penn State University no-till and cover crop researcher Sjoerd Duiker to discuss this thought-provoking topic of increasing soil organic matter in our latest *No-Till Farmer* podcast.
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increasing organic matter

Mark Vahling
January 20, 2018

I understand the simple math you calculated in the article above. However, you forgot to mention or add any carbon from photosynthesis, the carbon that the plant breathes in in the form of carbon dioxide and feeds to the Arbuscular Mycorrhizal Fungi in the soil through root exudates. You know, the liquid carbon pathway (I thought everyone in academia understood this by now). In your example above you may very well be correct assuming conventional tillage and fertilization practices, where the soil is being disrupted by lots of tillage and the use of liberal amounts of synthetic fertilizers, where the soil is DEAD, and there is zero Mycorrhizal activity. However in a mostly no-till situation, with a diverse cover crop mix and totally healthy soils, where there are massive amounts of Mycorrhizal activity, where the plant is breathing in tons of CO₂ and feeding lots of it to the Mycorrhizal Fungi in the form of sugars through the liquid carbon pathway. It may only be God who could do the calculation to determine how much Carbon can be added to the soil profile per year!

[POST COMMENT](#)

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Increase SOM over time

Bob Kremer
January 20, 2018

I agree with Dr. Duiker that it is highly unlikely to increase SOM by 1% within a year cycle and the calculations presented are a good illustration to put the dynamics of decomposition and C conserved as actual organic residue relative the amount lost as CO₂ in perspective. However, a major component that contributes to soil C

that is not discussed in this article is the microbial biomass present in the soil that drive the decomposition process that also are a source of C for SOM produced. As the microorganisms are decomposing the organic residues returned to the soil, they are in a cycle of reproduction and death. As microorganisms die off (some life cycles of bacteria, for example, may be as short as 24 to 48 hours), these become vulnerable to decomposition by the living biomass. So whatever value one may assign for amount of biomass per acre, this needs to be accounted for as 30 to 40% of microbial biomass C may be added to the SOM pool that is accumulating during the decomposition process.

POST COMMENT

REPORT ABUSIVE COMMENT

Organic Matter

Wayne Fredericks

January 20, 2018

I am taking a guess that there was a misunderstanding of the presentation and that the organic matter change was .1% per year. That is about what I am seeing on our northern Iowa farm utilizing no-till soybeans, strip-till corn and just recently cereal rye cover crops. Change is doable once full width tillage is discontinued.

POST COMMENT

REPORT ABUSIVE COMMENT

Can I Increase Soil Organic Matter by 1% This Year?

CactusWest

January 20, 2018

If one has been applying Glyphosate consistently over the years, by eliminating it totally, one might be able to achieve a 1+ % increase in organic matter by this action alone. Microbes do not like this stuff. More research needed on the subject matter for validation.

POST COMMENT

REPORT ABUSIVE COMMENT

Building Organic Matter

Bruce Danckwerts

January 21, 2018

Thanks very much for putting this into perspective. The vast majority of your readers are from temperate climates where building Soil Organic Carbon is a challenge, but at least possible. I wonder how many of your tropical readers can comment, and especially can give figures of proven SOC gains? In Zambia our best no-till

farmer who has been practicing zero-till with cover crops for 12 or 13 years has not been able to improve his SOC by any measurable amount. I believe our long hot dry season of 7 or 8 months is part of the problem. I would be very interested in hearing from other tropical farmers, and particularly any suggestions as to what we might be doing wrong. Sincerely, Bruce Danckwerts CHOMA, Zambia

POST COMMENT

REPORT ABUSIVE COMMENT

Organic Matter

Todd

January 22, 2018

I have seen the 1% claims, and I have seen the tests that proved it. Does it happen all the time, no, but it has happened. Most of the cases were where a farmer planted a forage/cover crop for grazing purposes, grazed that, and followed it either in the warm season, or over the winter with another forage/cover crop to graze. The cases I know of used very diverse mixes, whether necessary or not. The grazing typically stimulates extra root growth if managed properly. So you have increased production of carbon from the roots, increased microbial activity from the feces and urine, and saliva from the animals. So there are all possible increases that are not taken into account in this article.

POST COMMENT

REPORT ABUSIVE COMMENT

Organic Matter Increases

Skeptic

January 22, 2018

Based on your assumptions, you are assuming that the plants exude absolutely NO carbon into the soil throughout the growing season. Exudates can account for 20-80% of a plant's carbon fixation, depending on the growth stage of the crop, with an average of about 40%. That carbon is converted quite efficiently by soil microbes directly into stable carbon compounds. We need to start paying attention to what microbes really do and be much more cognizant of our management practices so that they can perform their functions efficiently.

POST COMMENT

REPORT ABUSIVE COMMENT

Increasing Soil Organic Matter

Stephen Steyn
January 24, 2018

Thank you for an interesting article. With soils that have been mined of organic matter over time by poor practises such as excessive tillage, burning of residues and excessive nitrogen applications, markedly increasing soil organic matter in a short period may be possible with better management. In an arid climate like mine there is a upper limit to organic matter that is determined by the environment that seems difficult to exceed unless organic matter is imported from outside the system (such as applying chicken litter or manure), However this is probably not sustainable over time and difficult for us to justify economically. Your article remains valid and useful however. Many thanks.

[POST COMMENT](#)

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Increasing organic matter

Mart Farina
January 30, 2018

Many thanks for your interesting article Mr. Duiker. 1% per year certainly seems a great deal to us in KwaZulu-Natal, South Africa. Most of our no-till farmers are happy just to get to 1.5 to 2% organic carbon over 20 or so years. However, grazing maize stubble and cover crops is common. I and my colleagues recently conducted a five-year study on the effects of cover crops on earthworm numbers and infiltration rates in a summer maize no-till system. No residues were grazed and over the period of experimentation the best (highest yielding) treatments increased the organic carbon content by just under 1%. HOWEVER, we measured organic carbon in the surface 50 mm beneath the residue layer, which is very different from the depth of sampling you refer to. The best performing treatments were those producing at least 10 t/ha of maize stover annually and a similar amount of black oat residue in the winter. The soil cover was 100% at the start of each maize cycle and plots with 40 % cover, the popular norm, produced significantly lower grain yields. Thanks again for your article. Mart Farina.

[POST COMMENT](#)

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5% in 5 years

Calvin Lewis
January 31, 2018

I disagree with the dead end answer of 1% OM cannot be achieved.

I do agree with the calculations that determine a very simple return of what we as humans are capable of in our management. What I don't see and don't expect to see is calculations done that are inclusive of the many other carbon sources besides root and plant mass. There are reports that suggest root extrudates, sugars, fungi, biological microbial activity and other carbon based lifeforms produce 10 times more carbon into the soil than what's above their soil. This system of carbon flow shuts down when you use fertilizers because it sends signals to the plant to alter its physiology to not make high carbon flow into the soil because it satisfied. I would like to see calculations of a biological system included because we all know fertilizer and current practices can only go so far. I've got a soil test in front of me of increased OM by 1% every year when using biological methods. So it is possible, but it is not possible with the short sighted calculations that excludes carbon based biological activities.

POST COMMENT

REPORT ABUSIVE COMMENT

OM Increase

Derek

January 31, 2018

The higher end of gains in OM I've believed were possible were described to me to be in more northern climate is above I-80. They did .75% gain in three years with rotational mob grazing of livestock with high biomass crops. I saw a presentation once where they showed an experiment in a relatively healthy soil that raised .75% in a year. From the best of my recollection, they showed pictures a massive biomass sorghum crop based multi species summer cover. Then a high biomass cereal based cover following. I can't remember if they were grazing. In my experience with row crop rotations at my 37 degree latitude .1% gains are more real (1% per decade). if your doing really well, .2% or 1% in 5 years. It is easier to keep OM from falling than raising with row crops. Pasture will generate OM faster if managed intensively or with short 3-year or so periods of pasture.

POST COMMENT

REPORT ABUSIVE COMMENT

Role of the soil biological community

Ben Lambeck

January 31, 2018

In addition to the contribution of microbial biomass explained in Bob

Kremer's comments, there is some OM contribution from soil fauna. Also importantly, the 10-20% conversion rate cited does not give credit to a healthy, biologically active soil, which will convert residues more quickly than a "stale" soil - this is a highly variable number that changes the calculation significantly. 1% per year is an aggressive target but cannot be dismissed until all the variables are considered...

[POST COMMENT](#)

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SOM

-Tracy Eriksen
March 13, 2018

The depth to use for calculating SOM has been a question in my mind for years. I have people telling me 2" is adequate. Others claim 3" and 8", and 12". In the past we have assumed 12" because we took samples by the foot down to 6' for winter wheat. On nearly every farm 2" depth is going to show a lot higher SOM than if you use 12" depth. The depth used for the calculation above has used 6.7". Other than the obvious that 3% SOM over 12" is better than 3% SOM over 2", what is the reason for using 6.7"?

[POST COMMENT](#)

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SOM

Sid
March 14, 2018

I have heard farms saying the same thing with increasing their organic matter. I want to say they are talking about particulate organic matter, and not the more stable form of humus. As the math shows above, you need a huge amount of material to create humus, which we can't get in an annual system and no animals.

[POST COMMENT](#)

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Why 6.7 inches?

Mark Vahling
March 26, 2018

The 6.7 inches has long been considered a "Plow Layer." The Plow Layer is figured as the depth to which people used to plow. That has also been calculated to equal 2 million pounds. Most soil tests from the land grant universities figure their results in pounds per acre/plow layer. So if test results come back in PPM (parts per million), you have to double the figures to get pounds/acre.

[POST COMMENT](#)

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Building SOM

Jim Martindale

March 28, 2018

Actually you are able to measure the most important element in SOM increases with measures of soluble or active carbon with Haney, PFLA and Cornell Soil Health Assessment. Very important element is dm in root mass which makes for more area to leak carbon and colonize. Then must have gas exchange in the soil for the decomposition cycle. Get that with water management in the plow layer and beyond.

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