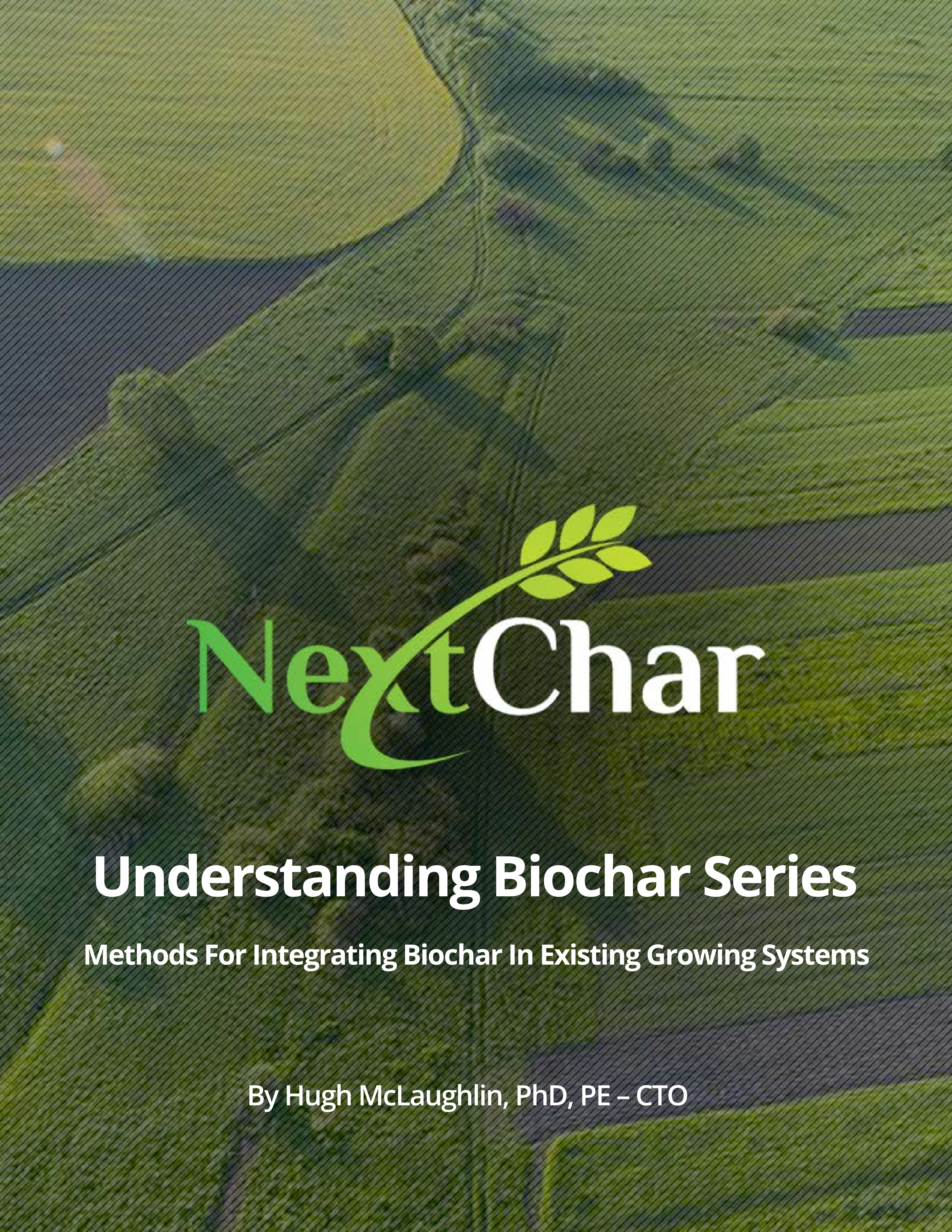

Understanding Biochar Series

Methods For Integrating Biochar In Existing Growing Systems

By Hugh McLaughlin, PhD, PE – CTO

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Biochar is an amazing material and brings properties to soil that cannot be achieved with other traditional soil amendments. However, it is part of a dynamic living system and needs to perform in conjunction with the other soil constituents, the soil microbiology and, above all, the growing plants. This guidance is intended to describe how those synergistic relationships can best be established when adding biochar to an existing growing system.

No matter how it is presented, adding biochar to an existing soil introduces "change" into the existing soil and any ongoing plant growth. While the ultimate benefits of adding biochar will manifest over time, there are some practices that allow any drawbacks to be avoided and the benefits to be realized sooner. Unfortunately, much of the advice provided on the web is often wrong or misleading.

The transformations from raw biochar, as produced, into the long-term resident component in a synergistic soil-plant growing system fall in three basic changes, which we will call "Conditioning", "Charging" and "Stabilizing". They all happen in parallel and always happen given enough time, but they are really separate phenomena and can be understood as such.

"Conditioning" is the equilibration of the biochar with the soil water. It basically involves any excess water-soluble elements of the biochar dissolving in the adjacent soil water and being either taken up by the plant, in the case of plant fertilizers, or consumed by soil microbes, in the case of leachable sugars and "mobile matter", or being flushed away by migrating soil water over time, as in the case of excess total dissolved solids (tds) and common salt (sodium chloride). Understanding Biochar #3 covered this in detail. The bottom line is the biochar has to stop adding dissolvable residues into the soil water, which happens when the biochar is initially becomes wet upon being introduced into the soil or mixed with compost.

“Charging” is the equilibration of the biochar with plant nutrients, such as NPK, in the soil and it is a seasonally variable level. One of the major benefits of biochar is the avoidance of leaching of soluble NPK, and this is done by having the biochar take up excess NPK from the soil water any time there is an excess, which is whenever plant residues are decomposing, like during fallow periods after the crop is harvested, or when additional compost or chemical fertilizer, is added to the soil.

The only problem that arises is if the biochar comes in completely “uncharged”, then it will take up any NPK that is available until it reaches some intermediate or equilibrium level of storage or charge. If uncharged biochar is introduced into a soil that has plants actively growing and requiring a steady supply of NPK (or, more typically, raw biochar is put in the soil and a growing plant is transplanted into the same soil at the same time – before the biochar charges up), the biochar will take up the available NPK, and the plants will suffer a short-term deprivation of NPK and exhibit stunted plant growth. Depending on how severe and long the competition, the plant may not survive, which makes the biochar appear to have performed badly. When that happens, while it is an unfortunate outcome, it is actually just the biochar doing what it always does, but in an poorly designed application where the biochar competed with the crops over a limited amount of soluble NPK.

“Stabilizing” is the equilibration of the biochar with the soil microbiology, which is another level that ebbs and flows seasonally within the biochar. In particular, the populations of microbes evolve over time, in response to the level and sources of available carbon the microbes use as food. The major sources of the carbon for microbes are plant extrudates, when the plants are “paying” the microbes to deliver something else the plant wants, like NPK, micronutrients and water.

Another period of elevated levels of soluble soil organic carbon occurs during periods between actively growing crops and/or periods of fallow. These intercrop sources are due to decomposing detritus, yielding soluble humic and fulvic acids, and other humates, in the soil water. Biochar takes up the excess humates, and prevent them from leaching away during excess precipitation events. The humates are then available and can be released by the biochar to sustain the soil microbiology until the next growing season, while the stored humates increase the CEC (cation exchange capacity) of the soil, further avoiding loss of soluble NPK.

The issue is that raw biochar has countless sites for both soil microbes and storage of excess humates, but it starts out with these sites unoccupied. Stabilization is the process of developing the presence of microbes and stored humates – which basically takes time and/or access. In general, biochar will incorporate the soil biology whenever it is brought into contact with it – either upon being mixed with living soil or with compost as it is passed through a composting process.

Stabilization is a subtle variation on the concept of innoculation, such as encountered in compost tea applications, etc. The addition of compost teas provides a source of soil biology that flows into the biochar, and certainly achieves stabilization, but that is not the only technique for loading the biochar with soil biology. If there is minimal soil biology, either due to historic crop practices or a recent application of chemicals, this phenomenon does not happen and the biochar still functions within the abiotic soil - but without any synergism with the soil biology, since there is “too little” of that present to be of significant benefit.

Once the biochar has achieved conditioning, charging and stabilizing, it will participate in the ongoing soil dynamics for a very long time, as in millennia. Biochar’s longevity is limited only by natural phenomena that either disperse soil, such as earthworms, and/or erosion, where soil is relocated by weather and seasonal effects. So, what are the recommendations for achieving this state of biochar-in-soil “perfection”. The essence comes down to one of three things: **Homework, Time, or Space**.

Homework basically means you prepared the raw biochar prior to mixing it into a living soil well ahead of when the plant needs the biochar on its team – like passing the biochar through a composting process. This is really an excellent method, since it also makes the composting process more efficient. It is important to appreciate that biochar provides only minimal benefits (just moisture modulation) during seed germination, since the seed contains its own food to get started and grow into a seedling. Biochar benefits the plant largely during the period of active growth of biomass, after germination and before the plant turns its resources to the dispersal of seed and storing resources (such as sending sap down into roots for storage until the next crop). In addition, biochar stabilizes the soil biology to enhance survival of the microbiology between crops by the mechanisms discussed under “stabilization” above.

Homework also means you tried it before and liked the results. Biochar is a very versatile and forgiving material, and it can be integrated into a wide variety of current agricultural practices. In general, any time the grower interacts with the land or the crop is an opportunity to introduce biochar into the soil. While every practice is not without its potential side effects, as discussed above, many are and virtually all will correct any excesses and shortcomings after a growing season at most. As such, trying the addition of biochar into current practices, or trying a new source of biochar, will be without complications most of the time. Having said that, trying the new method on a small plot or trial of plant, especially when trying a new source of biochar or a new sequence that eliminates some steps from historic practices, is one prudent method of averting a large scale issue before it surprises you.

Time is another strategy for getting the biochar to be acclimated into the existing soil and subsequently the growing crops. Either introducing the biochar at the end of the active growing season, and allowing it to meld with the existing soil until the next planting, is a good strategy for getting something for little effort. Formal fallow periods or cover crops are usually not necessary, unless there is a dramatic change being attempted in the soil, such as the remediation of poor or marginal land, in which case the time may be well spent by not having the biochar fixing the soil at the same time it is supporting a growing cash crop. Any time spent in the soil is time well spent by the biochar as it modulates the soil conditions for the soil microbes between crops in the same manner it benefit the subsequent growing crops.

Space is the final option when introducing biochar and the most common one used during the growing season. Top-dressing existing soil with biochar, even raw, wetting it down and letting the plants grow to the biochar over time lets the plant moderate how fast the biochar effects are imposed on the crop. The plant roots will avoid the biochar until any conditioning and charging requirements are accomplished. Over time, natural processes in the soil, especially earthworms, will mix the biochar throughout the root zone and improve the entire soil volume.

In conclusion, don't be afraid of biochar, but do proceed with the natural instincts and observational prowess of any seasoned grower. The crops will tell you if something is excessively wrong and generally an extra watering or a bit of organic compost will correct any issues in short order.

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