BIOCHAR:

Have you ever gotten ready to light your charcoal for the summer barbecue and thought, "I bet this stuff would be great for my garden soil."

If you have, you're not alone! For the last 50 years scientists have been interested in using biological-charcoal, aka biochar, to improve soil. More importantly, farmers have been modifying soil with biochar for thousands of years. The question is, does biochar improve soil health and crop yields or is it an old wives' tale?

Defining biochar

Biochar is made from heating organic materials, like dead trees, construction waste, poultry litter, and wheat straw, at high temperatures (from 550-1,290 F) under anaerobic (no oxygen) conditions resulting in a carbon-rich, porous biochar product. The resulting biochar is different depending on the source material and how it was heated and handled.

Why add to soil?

Slash and burn agriculture is a common practice in South America and has resulted in the accumulation of biochar in farm soils. The decades of slash and burn farming resulted in the continual buildup of biochar in infertile soils producing unique regions of fertile Amazonian Terra Preta soils.

These soils are rich, black soils, high in organic matter and fertility. While slash and burn farming has many negative consequences, the discovery of these Amazonian Terra Preta soils in 1969 sparked scientific interest in biochar as a soil amendment. In the last 20 years, the interest in carbon capture has further increased interest in using biochar as a soil amendment.

How biochar is made

There are three main ways to make biochar. The first, and oldest, is through the slow burning of piles of wood in pits with limited oxygen. This process results in a lot of smoke and almost half the carbon being released. The second, and slightly improved technique, is to use a kiln, which serves the same purpose as the pits but is more efficient with less pollutants added to the atmosphere.

The third and preferred method is through pyrolysis, which is essentially a waste-free system. Biomass pyrolysis was used initially to produce chemical energy. The process creates three products: non-condensable gases, combustible bio-oil, and biochar.

The gases are captured and combusted to re-heat the system, the bio-oil is used as fuel, and historically biochar was the waste product. Biomass pyrolysis was replaced by coal and then fossil fuels as a cheaper energy alternative in the 1800s. Biomass pyrolysis is seeing renewed popularity with increased interest in renewable fuel sources and carbon capture. But now, instead of being a waste product, biochar is one of the high value products of the process.

What is it and what does it do?

Does biochar added to soil do any good?

A quick internet search results in a plethora of biochar claims, including combating climate change, immobilizing soil pollutants, increasing soil fertility, improving crop performance, and more!

There is some truth to the benefits of biochar added to soil, but unfortunately not all biochar is created equal, and using biochar is not as straightforward as using standard fertilizer or even compost.

Feedstock type, quality, moisture, production method, and post-production handling impact the type and qualities of the biochar.

The application rate of biochar to the soil has varying effects, with too little being ineffective and too much being toxic. As if that weren't complicated enough, the type of biochar, soil type, climate conditions, and crop type all factor into the equation. What do we know about using biochar as a soil amendment?

Claim 1: Biochar sequesters carbon in the soil forever.

YES, but also NO. Producing biochar does capture carbon and contains it in a stable form that can help reduce atmospheric carbon. Biological organisms are made up of carbon. When they die, that carbon decomposes and is added to the atmosphere and soil system. When biochar is made, the carbon is transformed and has the

potential to remain in a stable state for a long time before returning to the atmosphere. However, the pit and kiln methods still contribute significant pollution to the atmosphere. Additionally, the amount of stable carbon produced and life expectancy of biochar in the soil depends on source material, production methods, and post-process handling. So biochar does sequester carbon (sometimes for a very long time), but not forever.

Claim 2: Biochar "sucks up" pollution from the soil.

YES! Well, some pollution. Biochar has been found to immobilize certain soil contaminants when used for site clean-up. Once again, not all biochar has the same absorption ability, and there are still many questions surrounding how and when to use it. There is great potential to use biochar to help restore soils that have been contaminated return to productivity.

Claim 3: Biochar improves soil fertility and increases crop yields.

MAYBE! The effect of biochar on soil fertility is dependent not only on the biochar, but also on the soil type and nutrients of interest. Biochar feedstock determines nutrients in the biochar. Feedstocks like poultry litter typically produce biochar with higher nitrogen, phosphorous, and potassium than biochar produced from wood. Biochar has been found to increase cation exchange capacity and change soil pH, which affects which nutrients are available to crops. However, not all biochar in all soil has the same impact. Some changes in available soil nutrients can have toxic effects on plant growth, and our ability to predict the effect of biochar is still limited.

Biochar can also change the physical properties of soils. Its porous structure increases water holding capacity and how fast water can infiltrate. Both of these improvements would be very beneficial to Wyoming agriculture. An item of concern is how much biochar needs to be added to change the water holding capacity and if that amount is in balance with what is needed for good crop nutrition. Numerous studies document yield increases from biochar soil amendments, but there are also many studies that find no benefit or even reduced yields with biochar.

Does biochar make CENTS?

The complete economic picture for biochar use for soil and crop improvement is complex. The economic analysis starts with production of feedstocks, includes transportation to and from production plants, the cost of production, the value of co-products, storage and handling costs, and ends with assessment of soil improvement, crop yield gains, carbon credits, and land restoration value.

Currently, large applications of biochar to improve crop yields are not economically viable. Even at a very low application rate of 1 percent per volume, you would need to apply about 8 cubic yards/acre, which would cost an estimated $2,000. Such low amounts are unlikely to have positive effects on crop yields. But there is work being done on designer biochars that could be produced to treat specific soil issues. We may find the economics around specialized uses are more reasonable as the understanding of designer biochar increases.

Take home message

Biochar still shows great potential for capturing carbon and storing it in the soil to improve farm ground. Unfortunately, there is still a lot to learn about production and use of biochar as a soil amendment to be confident in the effect it will have on soil properties and crop performance. There is strong evidence biochar is a beneficial soil amendment, and we are working hard to fully understand and unlock its potential. The University of Wyoming has multiple researchers exploring how we can best use biochar in the state.

Carrie Eberle *is the agronomy and cropping systems specialist with the University of Wyoming Extension. She can be reached at (307) 837-2000 or at carrie.eberle@uwyo.edu.*