

What is Biochar?

To make biochar, biomass (organic material) is pyrolysed (heated with limited oxygen). The result is a porous carbon structure. The pores have a huge overall surface area and a negative charge.

The quality of biochar can vary based on the biomass and production method used.

Biochar is the perfect soil enhancer!

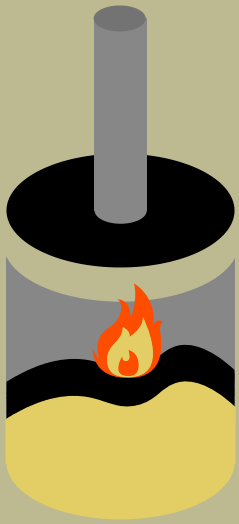
Biochar Practical Guide

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...for the positivity and support from the biochar community.

...for the curiosity of the members of the Biochar Network Africa.

Thank you!



Kiln

In a kiln, the biomass is in direct contact with the fire. A kiln can be built from a 200l oil drum. Check out warmheartworldwide.org for simple instructions.

Kilns work best for light biomass! Corn cobs, nut shells, bamboo... Dense biomass like saw dust or rice husks may suffocate the fire.

Only use untreated wood, avoid chemicals like paint or varnish.

For the best results, use one type and size of biomass only. Make sure it is completely dry or there will be a lot of smoke!

Earth Pit

- Dig a cone shaped pit and light a small fire.
- First the wood turns black (char) then white (ash).
- When a layer turns black, add wood on top so the layer below has no oxygen to burn to ashes.
- Extinguish the char in the end by covering it with soil or water.

A Kon-Tiki kiln is operated the same way. You can find open source designs for it online.



This works best for woody biomass. Light biomass burns to ashes easily.

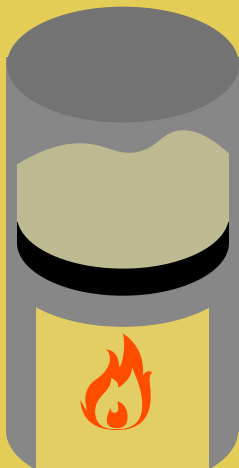
Making

In a retort, the biomass isn't in direct contact with the fire. There is a separate fire chamber. It needs additional fuel to make the biochar but the biochar output and quality will be higher.

Retorts can be much larger as there is no ashing over time. The larger they are the longer it takes.

There are free designs for small retorts online. If you need a large retort, check out the "Adam Retort" (3 cubic meter).

Retorts can make biochar from any biomass...

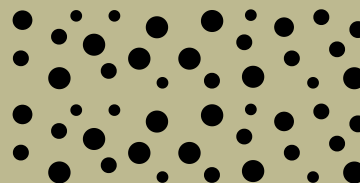


Retort

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Yes, regular charcoal can be used like biochar.

Charcoal powder is a waste product. You might get it for free or very little money. When working with charcoal powder, add water to prevent dusting and wear a mask to protect yourself.



Charcoal is more expensive and less sustainable than biochar from waste biomass. If you decide to use charcoal, make sure that it has no chemical fire starter on it.

Charcoal

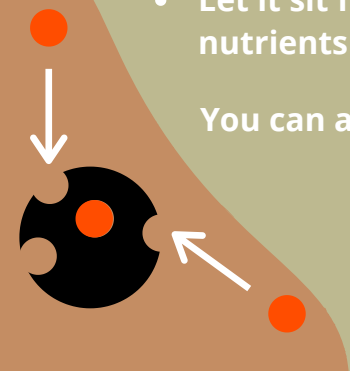
Charging with Solids

It is crucial to charge (add nutrients to) your biochar before applying it to the soil. Examples are fresh or matured manure (from any livestock) and compost. You can also mix them.

- Pile up your char and add water until it leaks out.
- Mix in your solid nutrient source in a ratio around 1:1.
- Let it sit for 14 days and keep it moist to help the nutrients move.

You can also simply add the char to your compost pile.

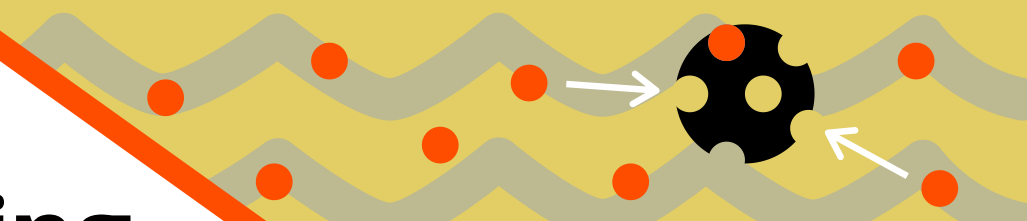
Charged biochar can be stored. Keep it moist and in contact with air so the microbes stay alive.



Charging with Liquids

Examples are urine, compost tea or dissolved fertilizer (use half the fertilizer that you usually apply to the area and dissolve it in water).

- Fill the biochar in a container.
- Add your liquid until the biochar starts floating.
- Don't let it dry out and stir it from time to time.
- Charging with liquids is faster (~3 days total) but you can also let it charge or store it for longer.



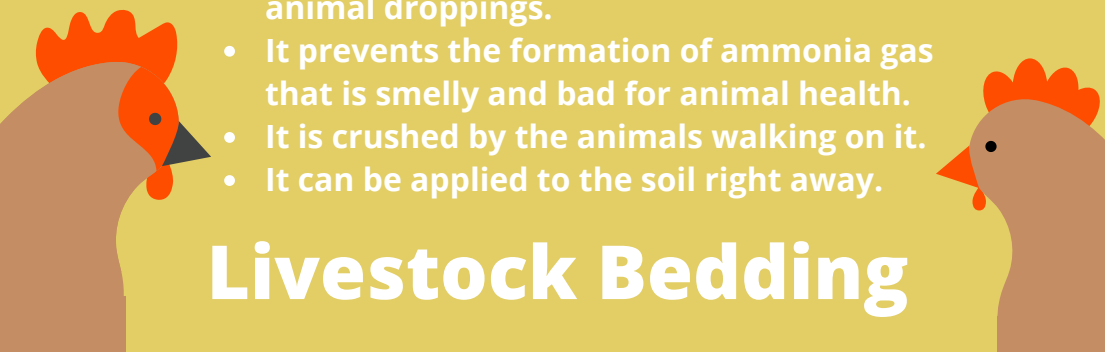
Charging

Biochar can be used as a bedding for any livestock; poultry, pigs, cows, goats, rabbits... or even for fish tank filtration.

Add biochar to your usual bedding or use it by itself. What are the advantages?

- It can take up more liquid, so you need to change the bedding less often.
- It gets charged with the nutrients in the animal droppings.
- It prevents the formation of ammonia gas that is smelly and bad for animal health.
- It is crushed by the animals walking on it.
- It can be applied to the soil right away.

Livestock Bedding



- Mix biochar and grass clippings or leaves in a ratio of 1:10 (by volume).
- Add a thin layer around your plants as mulch.

The nutrients will slowly move into the pores of the biochar as the mulch decomposes. Over time, the biochar is incorporated into the soil by worms and microbes.

Mulching



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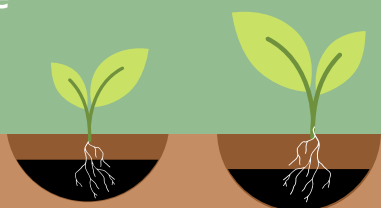
Root Zone Application

Root zone application needs the least biochar per area. The roots have immediate access.

- Dig your planting holes
- Fill the bottom with some biochar
- Cover it lightly with soil
- Plant on top of it

Because the biochar is not distributed evenly, it has to be reapplied the next year for the same results.

Root zone application is great for all plants. Especially for deep rooting ones like tomatoes or squash.

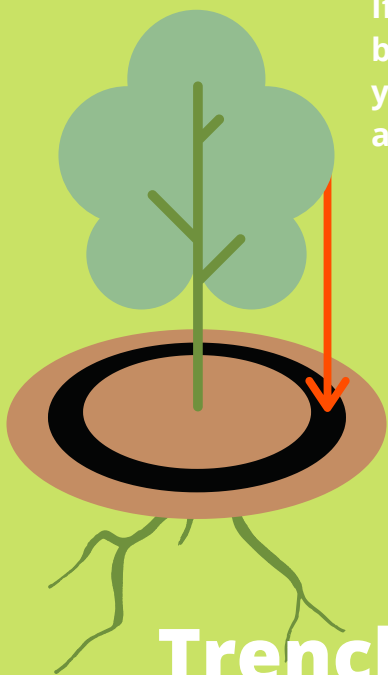


Applying

If you missed adding biochar during the planting, you can use this method to apply biochar to perennial plants.

- Dig a trench around your plant at the drip line (arrow)
- Fill it with charged biochar
- Cover it with soil

For bushes and vines (e.g. grapes or tea) you can also dig straight trenches between your plants. The roots will grow towards the biochar.



Trench Application

Full Field Application

Incorporate (by tilling or plowing) the biochar into the topsoil as deep as the roots will be (~20cm).

This application is great if all of your soil needs structural improvements (sandy soil or clay soil).

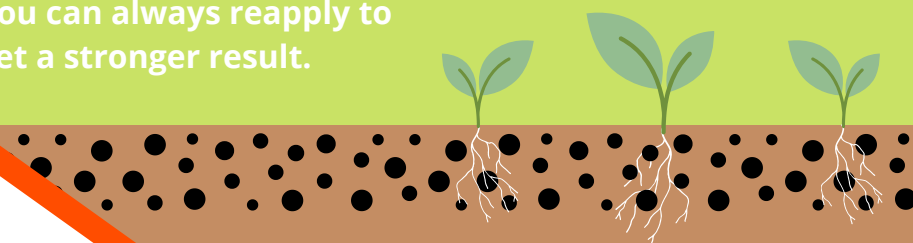
Light 0.1kg/sqm = 0.25l/sqm

Medium 0.5kg/sqm = 1.25l/sqm

Strong 1kg/sqm = 2.5l/sqm

For potted plants and nursery trays you can mix biochar and soil 1:10.

You can always reapply to get a stronger result.

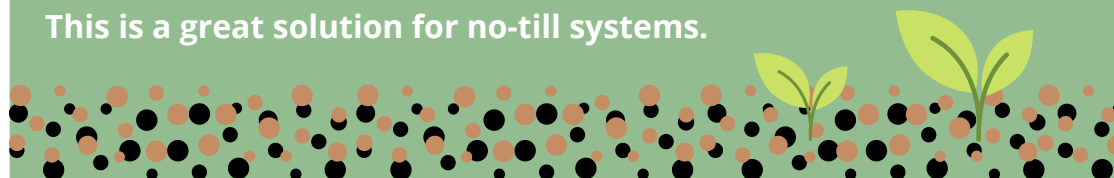


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Apply the biochar at the base of your plants or over the whole area. Combine the biochar with mulch or compost to prevent it from running off with rain water or being blown away.

This type of application might not show results right away. Biochar is most effective at the roots of plants... it will take time for worms and microbes to fully incorporate the biochar.

This is a great solution for no-till systems.



Top Dressing

Benefits

Crop Yield - All these benefits combined lead to faster plant growth and a higher crop yield.

Natural - Biochar is also found in nature after wildfires.

CEC - The potential of soil to bind positive ions is called CEC (cation exchange capacity). The negative surface charge of biochar increases the CEC.

Nutrients - The negative surface charge attracts nutrients like K^+ , Mg^{2+} or Ca^{2+} . Biochar stores the nutrients until they are taken up by roots or microbes. No nutrients are lost... so less fertilizer is needed!

Universal - The effect of biochar is not specific to any plant. Biochar improves the soil and all plants benefit from good soil!

Permanent - Biochar is a fixed carbon structure that stays in your soil and improves it for several hundreds of year.

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Water - Water likes sticking to surfaces (adsorption). Biochar pores have a huge overall surface area. Therefore, biochar can hold around 3x its weight in water. No water is lost... so less irrigation is needed!

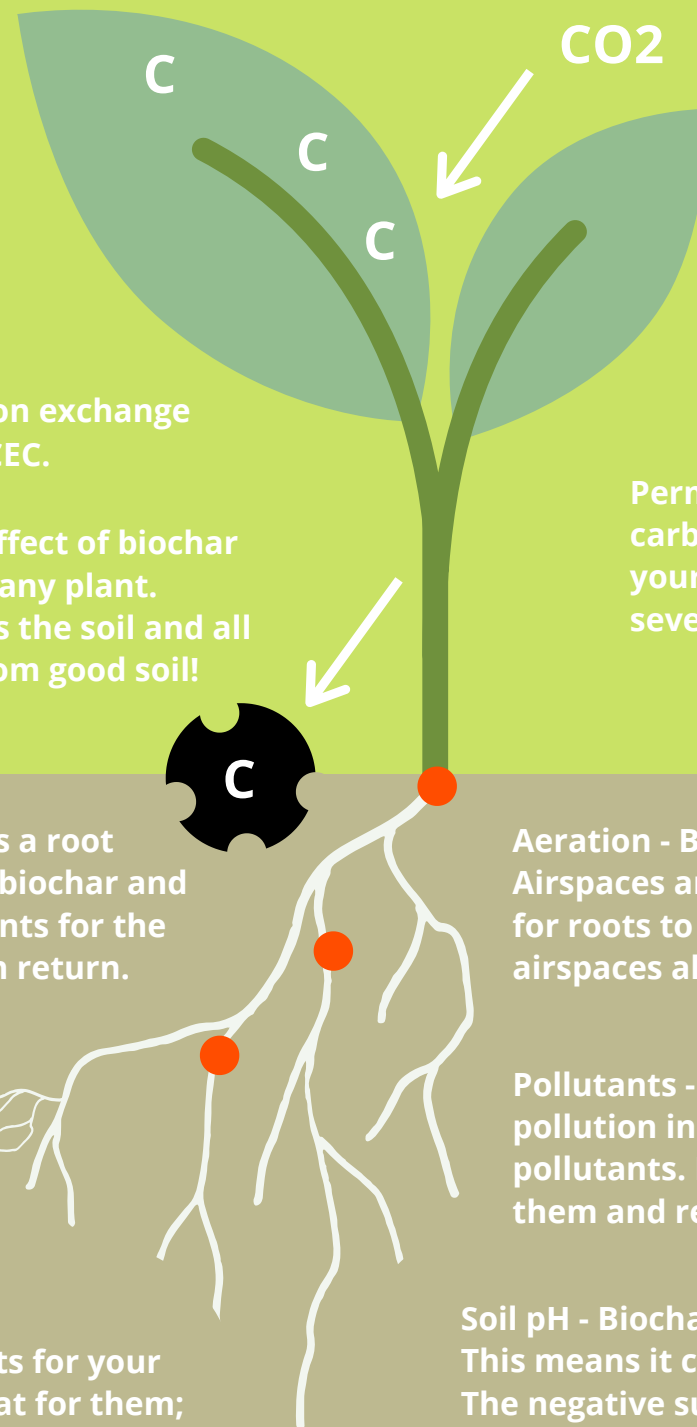
Fungi - Mycorrhizal fungi act as a root extension. They grow into the biochar and extract and process the nutrients for the plant. The plant gives sugars in return.

Aeration - Biochar lightens your soil. Airspaces and oxygen make it easier for roots to grow. Having more airspaces also prevents waterlogging.

Pollutants - Biochar lowers the pollution in the soil by binding the pollutants. Microbes can then process them and render them harmless.

Microbes - Soil microbes process nutrients for your plants. Biochar pores are a perfect habitat for them; there is water, nutrients and oxygen. The effect of biochar increases over time as the microbes multiply.

Soil pH - Biochar is generally alkaline. This means it counteracts acidic soil. The negative surface charge can bind hydrogen ions that make your soil acidic. The ash content also raises the pH.



Re-Charging

Think of biochar as a nutrient storage in your soil. If the storage is empty it will take up nutrients from the soil. By fertilizing your soil you re-charge your biochar, indirectly.

This is also why you need to charge biochar before applying it! Uncharged biochar takes up nutrients from your soil and temporarily depletes it.



You don't have to crush your biochar... Coarse biochar saves a lot of time and gets broken down in the soil eventually.

Crushed biochar has a larger surface area and can hold more water and nutrients.

Biochar from light biomass is easier to crush. If you don't have an electrical shredder or grinder... put the biochar in a bag and walk or drive over it. For small amounts you can use a bucket and spade.

Make the biochar wet to prevent dusting and wear a mask to protect yourself.

Crushing

Soil Enhancer

Soil enhancer and fertilizer have two completely different roles:

Biochar is a soil enhancer. Soil enhancers add structure to permanently improve the soil. They have no nutrients!

Fertilizers add nutrients to temporarily improve the soil.



FAQ

Biochar contains ash, but ash alone is not biochar! Ash is burned char. It no longer has the fixed carbon structure that makes biochar so special.

Ash is mostly calcium (liming agent) that can be used to counteract acidic soils. Ash also contains some nutrients (P, K, Mg).

Ash

Soils

Biochar improves and restores any soil. The worse the soil, the bigger the effect!

Sandy Soil - Biochar helps to store more nutrients and water in sandy soils.

Clay Soil - Coarse biochar adds the largest airspaces and improves drainage.

Acidic Soil - Biochar counteracts acidity.

Alkaline Soil - With biochar, your soil can get too alkaline. Try it on a small area or look for "Designer Char" for alkaline soils.

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I hope this guide shows that there is not just one way to make biochar.

Don't get overwhelmed by the mass of information out there. Use the resources you already have and find out over time what works best for you. Start small if you feel unsure.

Everything we don't know is an opportunity to learn:

JUST DO IT!