BIOCHAR

UNIQUE FERTILIZER AND RENEWABLE ENERGY RESOURCE
Biochar - definition and properties

• Biochar is a biomass that is thermally converted in the absence of oxygen, i.e., it is torrefied without burning, with the release of combustible gases (hydrogen, CO).

• Heat turns plant carbon (found in cellulose and lignin) into condensed aromatic carbon rings that are very stable.

• A biochar obtained from different types of raw materials at different temperatures can have very different physical and chemical properties.
Biochar is a torrefied biomass that can be added to the soil.
Benefits - Economic and Social

• Soil improvement
• Prevention of climate change and pollution
• Waste management
• Power supply
• Development of bio-charms markets
Soil improvement biochar

Growth stimulator

Soil conditioner

Soil supplement
Soil biochar benefits

- provides constant heating of the soil, therefore, accelerates the growth and development of plants;
- removes agricultural chemical residues from the soil (herbicides, pesticides, other chemicals);
- supports the functioning of soil microorganisms (bacteria, fungi, algae and protozoa), which increase soil productivity;
- increases soil porosity and provides air circulation and oxygen access to plant roots;
- improve the content of badlands (alumina, sandy soils);
- neutralizes soils with high acidity;
- protects the soil from certain types of parasites (nematodes, wireworms);
- prevents root rot in the soil;
- accumulates and supports the need for nutrients and microelements in the soil, eliminates the problem of leaching of nutrients.
Terra Preta – artificial soils in the Amazon

Soil without bio-enchantment

Soil with bio-enchantment
Recovery of mine dumps in the USA

Hope Mine near Aspen, Colorado USA
100-year-old dumps contaminated with heavy metals, one year after the biochar is introduced into the soil
## The overall effect of biochar on the soil

<table>
<thead>
<tr>
<th>Factor</th>
<th>Impact</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cation exchange capacity</td>
<td>50% increase</td>
<td>(Glaser et al., 2002)</td>
</tr>
<tr>
<td>Fertilizer use efficiency</td>
<td>10-30 % increase</td>
<td>(Gaunt and Cowie, 2009)</td>
</tr>
<tr>
<td>Liming agent</td>
<td>1 point pH increase</td>
<td>(Lehman and Rondon, 2006)</td>
</tr>
<tr>
<td>Soil moisture retention</td>
<td>Up to 18 % increase</td>
<td>(Tryon, 1948)</td>
</tr>
<tr>
<td>Crop productivity</td>
<td>20-120% increase</td>
<td>(Lehman and Rondon, 2006)</td>
</tr>
<tr>
<td>Methane emission</td>
<td>100% decrease</td>
<td>(Rondon et al, 2005)</td>
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<tr>
<td>Nitrous oxide emissions</td>
<td>50 % decrease</td>
<td>(Yanai et al., 2007)</td>
</tr>
<tr>
<td>Bulk density</td>
<td>Soil dependent</td>
<td>(Laird, 2008)</td>
</tr>
<tr>
<td>Mycorrhizal fungi</td>
<td>40 % increase</td>
<td>(Warnock et al., 2007)</td>
</tr>
<tr>
<td>Biological nitrogen fixation</td>
<td>50-72% increase</td>
<td>(Lehman and Rondon, 2006)</td>
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Carbon cycle and biochar

The Carbon Cycle

Atmospheric CO₂

Photosynthesis

Biomass

Biomass Decomposes or Burns

59% of Carbon Released as CO₂

Almost all of the carbon returns to the air

Green plants remove CO₂ from the atmosphere via photosynthesis and convert it into biomass. Virtually all of that carbon is returned to the atmosphere when plants die and decay, or immediately if the biomass is burned as a renewable substitute for fossil fuels.

The Biochar Cycle

Atmospheric CO₂

Photosynthesis

Biomass

Pyrolysis

Biochar

50% of Carbon

Syn-Gas or Bio-Oil

Energy

Up to half of the carbon is sequestered

Green plants remove CO₂ from the atmosphere via photosynthesis and convert it into biomass. Up to half of that carbon is removed and sequestered as biochar, while the other half is converted to renewable energy co-products before being returned to the atmosphere.
Biochar is a valuable resource for industry

- for the production of bio-coal - a transportable product with high specific energy and the same calorific value as that of coal for small and medium-sized power plants and for personal use for stoves
- for wastewater treatment
- for the production of plastic and plastic dyes
- as a suitable filler for rubber products

**CONTENT OF SUBSTANCES IN BIOCHAR (on the dry residue)**

<table>
<thead>
<tr>
<th>Substance</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>86%</td>
</tr>
<tr>
<td>H₂</td>
<td>&gt;0,8%</td>
</tr>
<tr>
<td>N₂</td>
<td>&gt;1,1%</td>
</tr>
<tr>
<td>O₂</td>
<td>&gt;0,7%</td>
</tr>
</tbody>
</table>
The use of biochara
Waste that can be processed into biochar

• agricultural waste (waste from livestock farms, husks of sunflower grains, husks of rice, husks of coffee beans, coconut shells, crop residues, grain, feed, fruits, straw, shells, husks and grain dust, etc.);

• biodegradable street and garden waste (leaves, flowers, roots, pruning of trees, vineyards and shrubs, pruning from environmental measures, hay, grass);

• wood production waste (bark and wood chips, sawdust, shavings, wood wool, etc.);

• food waste (materials from washing, cleaning, cleaning, centrifuging and separation processes (pulp, cake or squeezing)).
New biochar markets
Technology of continuous low-temperature pyrolysis for converting wet and dry biomass into biochar

The pyrolysis plant works with prepared raw materials (biomass). For plant materials (oilcake, sawdust, wood chips, bark and other plant residues) allowable requirements:

1. maximum permissible humidity - natural wood moisture (up to 60%);
2. maximum allowable particle size of biomass - 30 mm;
3. stones and metal objects larger than 3 mm should not be allowed into pyrolysis plants
Plant for the production of biochar

Design documentation has been developed. Separate assembly units were manufactured.
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