



**Biochar**  
as a support for the  
multifunctionality  
of soils



# Biochar

## Its main uses

### Heat production

Pyrolyse produces more calories than what it intrinsically needs

### Carbon trap

One metric tonne of biochar corresponds to 3.48\* tonne of CO<sub>2</sub> trapped for centuries into soils (decomposition speed  $\simeq$  0.3% per year)

*\* Terra Fertilis biochar data*

### Restructuring soil amendment

⇒ We will concentrate on that point during this talk





# The origin of biochar

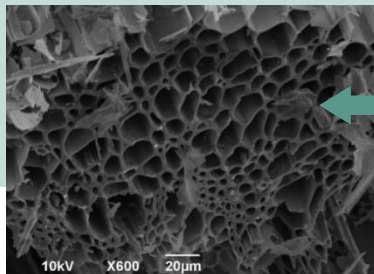
## A solution for the Future, inspired by ancient civilizations

### The discovery of *Terra Preta*...

Located in areas of a few hectares, Terra Preta\* is a man-made soil:

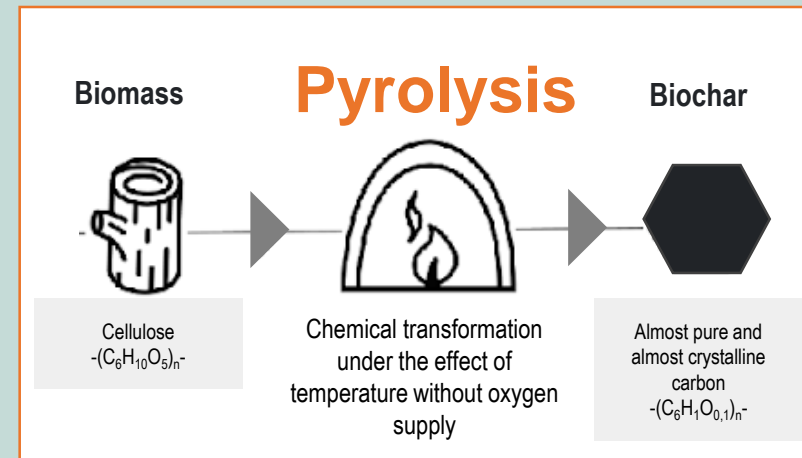
- › created by the burial of **organic waste, coal, pottery shards...** over thousands of years by **Amazonian peoples**
- › known for its **exceptional fertility**, preserved for centuries, in contrast to the usually poor Amazon lands

The secret behind *terra preta*:  
a high carbon content in the soil ( $\pm 10\%$ )



\*Terra Preta de Índio : Indian black earth

### ... and its industrial replication



# Biochar used as an amendment

## The conditions for success



Soil depletion

### Threats to soils

Loss of organic matter  
Waterproofing  
Contamination  
Settlement, Erosion  
Loss of biodiversity  
Salinisation, Acidification...



### Soil needs

Reduction of phyto products  
Reduction of mineral soil  
improvers in favour of organic  
soil improvers  
Better management of water  
Better aeration



Soil fertility

A depleted soil, that needs to be restructured

The intrinsic quality of the biochar, which depends on:

- the starting biomass quality
- the pyrolysis process

# Biomass

## About the importance of the type of raw material used

Theoretically, all biomass can be transformed into biochar by pyrolysis:

- *Organic waste*
- *Vegetable waste*
- *Paper*
- *Wood...*

However, in order to obtain a biochar of **agronomic quality**, it is necessary to use a raw material of a well defined nature.

**A defined type of wood**  
**+ An optimized and fixed**  
**pyrolysis process**

**A reproducible biochar**  
**with constant physicochemical**  
**characteristics**



Consistency  
(heartwood) and  
quality of the  
biomass used

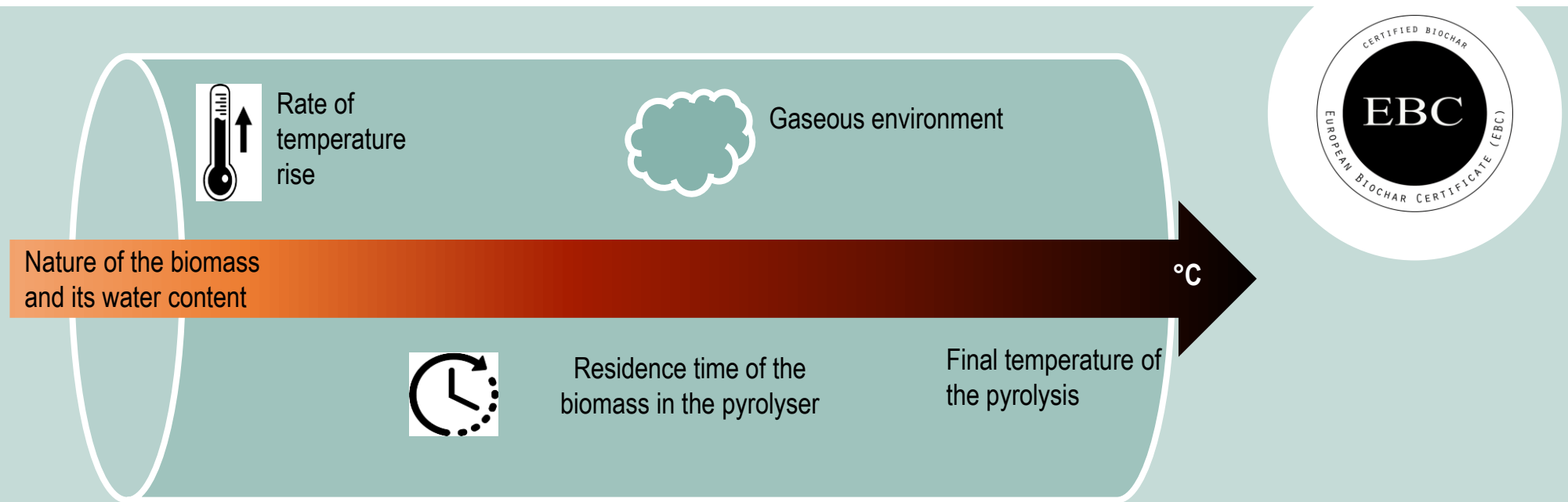
A certified  
premium  
biochar

MA  
n°6210215



# Pyrolysis

A process that is dependent on several parameters



# What is a good quality biochar ?

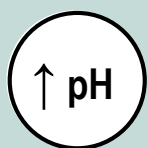
## Main characteristics

› **A stable carbon compound**  
with carbon content > **80-90%**

**Sufficient mechanical stability**  
**Absence of contaminants** (VOCs,  
polyaromatics, heavy metals...)



Soil regeneration



Alcalinisation



Long-lasting action



› **A porous material**

**High specific surface area** > 300 m<sup>2</sup>/g

**Nature of its surface condition**

**Wide distribution of pore diameters** (macropores, mesopores,  
micropores, nanopores)



Water and nutrient  
retention and cation  
exchange capacity

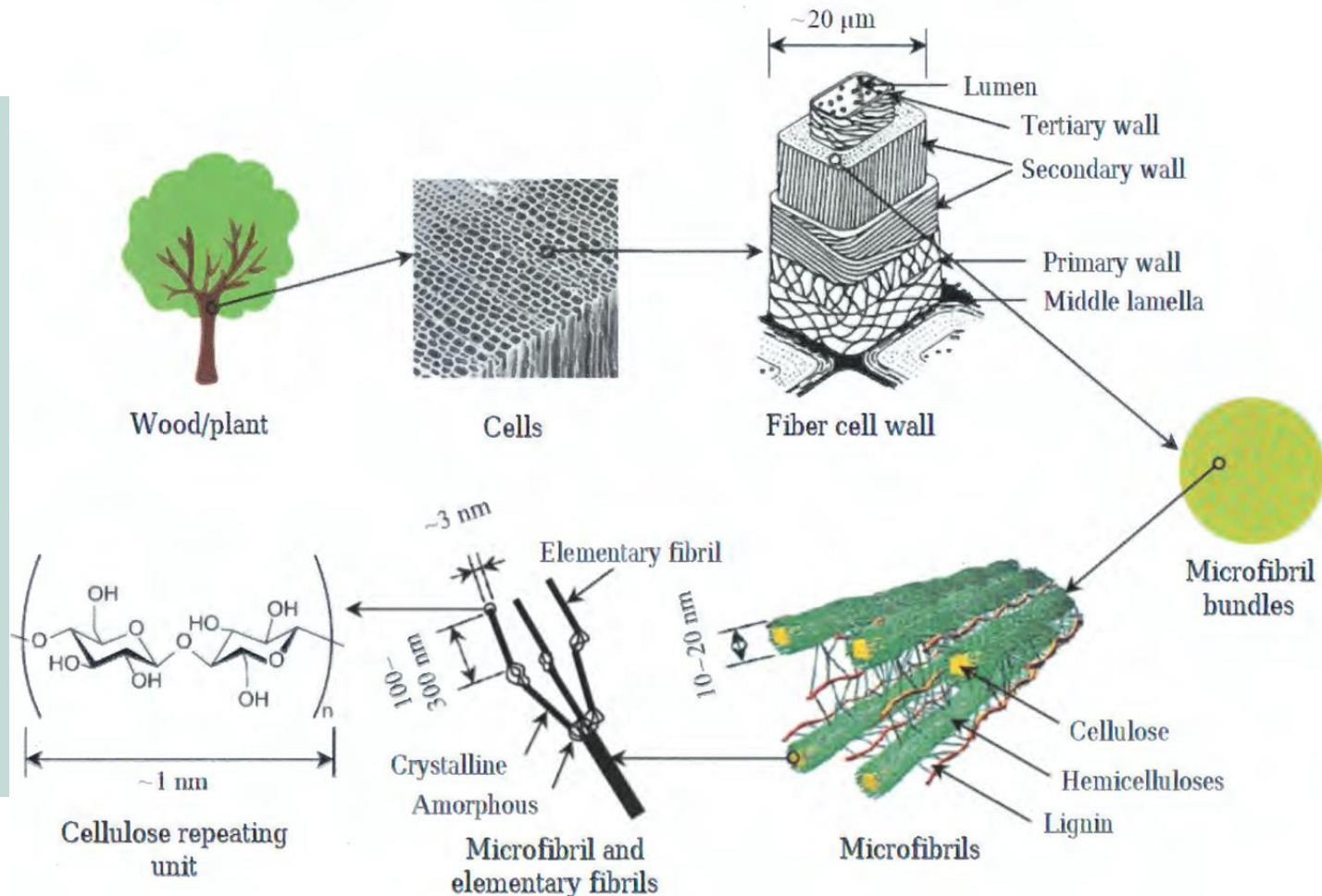


Habitat for  
microorganisms



# Main characteristics

## Structural composition of spruce wood (Ritter 2008)



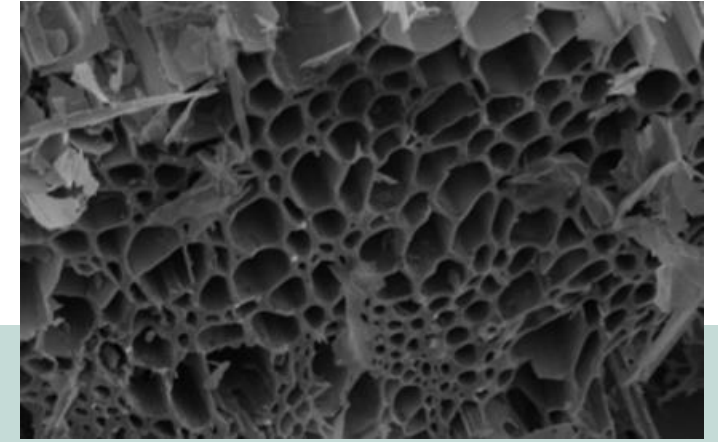


# Main characteristics

## Porosity and pore size distribution

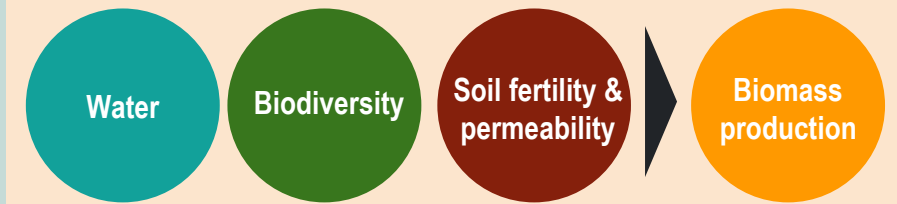
Biochar consists of a **wide distribution of pore diameters** resulting from the **original structure of the wood** and the escape routes of the gases produced in the organic matter during pyrolysis

- › **Pores smaller than 50 Å** constitute the major part of the surface where the adsorption phenomena of nutrients (and pollutants) take place.
- › **Macro, meso and micro pores** (the original structure of the wood) allow the circulation of water and air as well as the sustainable settlement of micro-organisms.



Soil aeration  
Water and Nutrients retention  
Stimulation of microbiological life

### Soil Multifunctionality

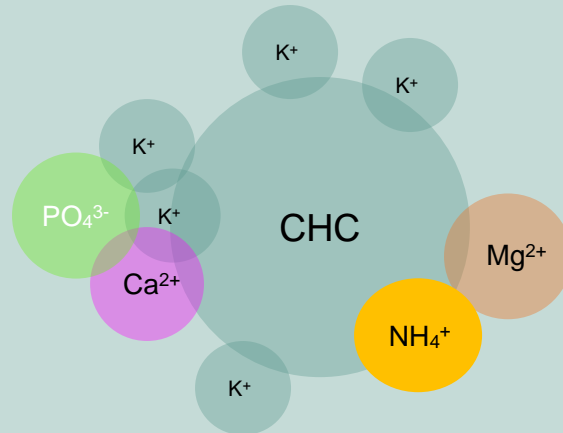


# Main characteristics

## Specific surface area and carbon content

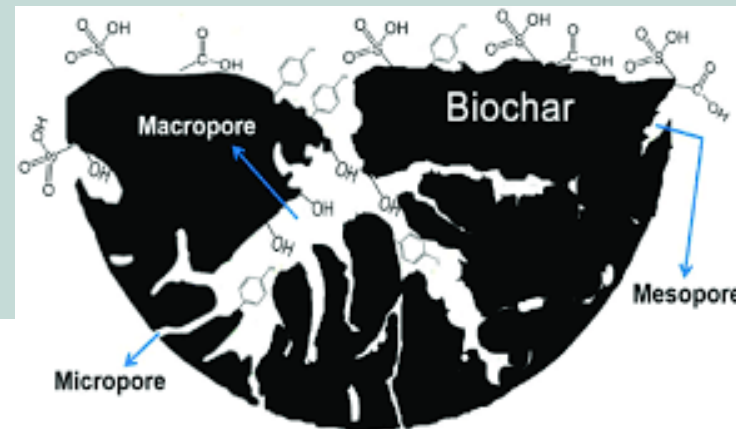
### Clay humic complex (CHC)

- › Negatively charged, thus retaining cations
- › Leaching of anions



### Biochar

- › Specific surface area :  $> 300 \text{ m}^2/\text{g}$   
mean pore diameter =  $30 \text{ \AA}$
- › Carbon content  $> 90 \%$   
near crystal structure  
 $\text{C}/\text{H} \approx 70$



Biochar provides soils with a complementary adsorption surface to the clay-humus complex (CHC).

### Soil Multifunctionality

Soil fertility

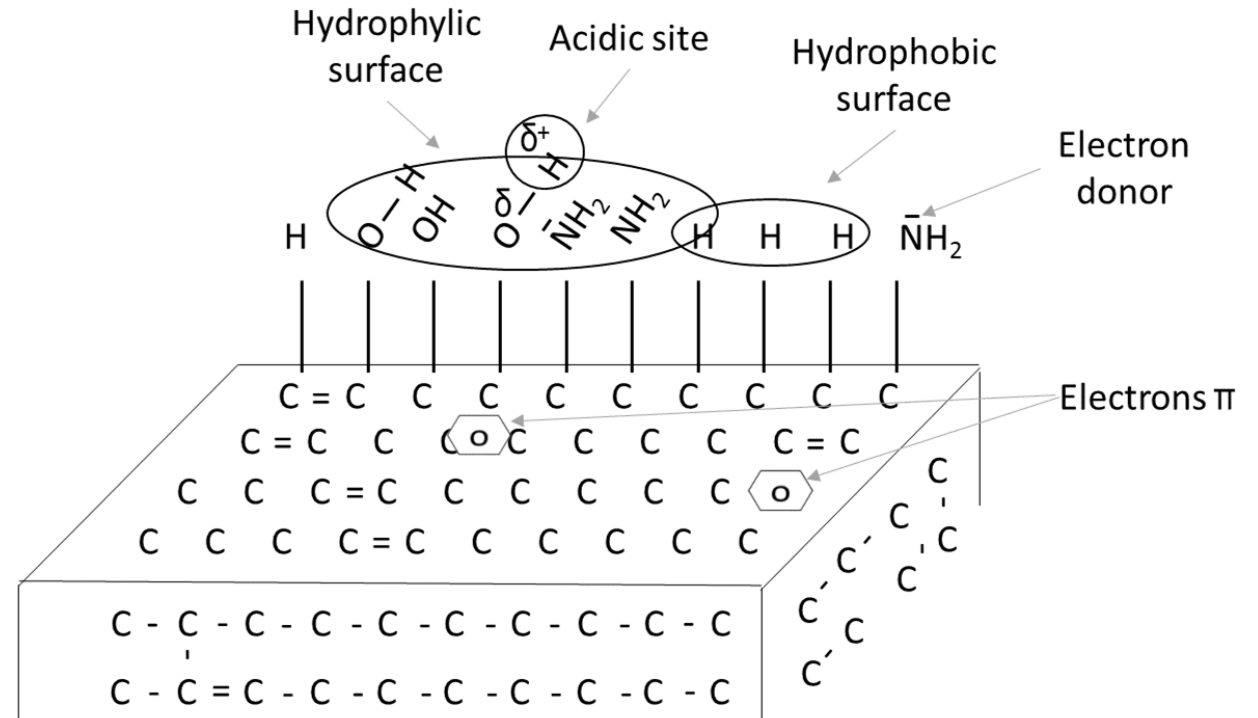
# Main characteristics

## Surface functionalization

Good quality biochar has a variety of acidic and basic sites (Bronsted and Lewis) on its surface that allow the **adsorption of cations and anions**.

This limits the leaching of anions and **allows the optimization of nitrogen inputs**.

These strong sites also irreversibly **adsorb polar organic molecules (contaminants)** until their catalytic degradation.



### Soil Multifunctionality

Soil  
fertility

Water

# Main characteristics

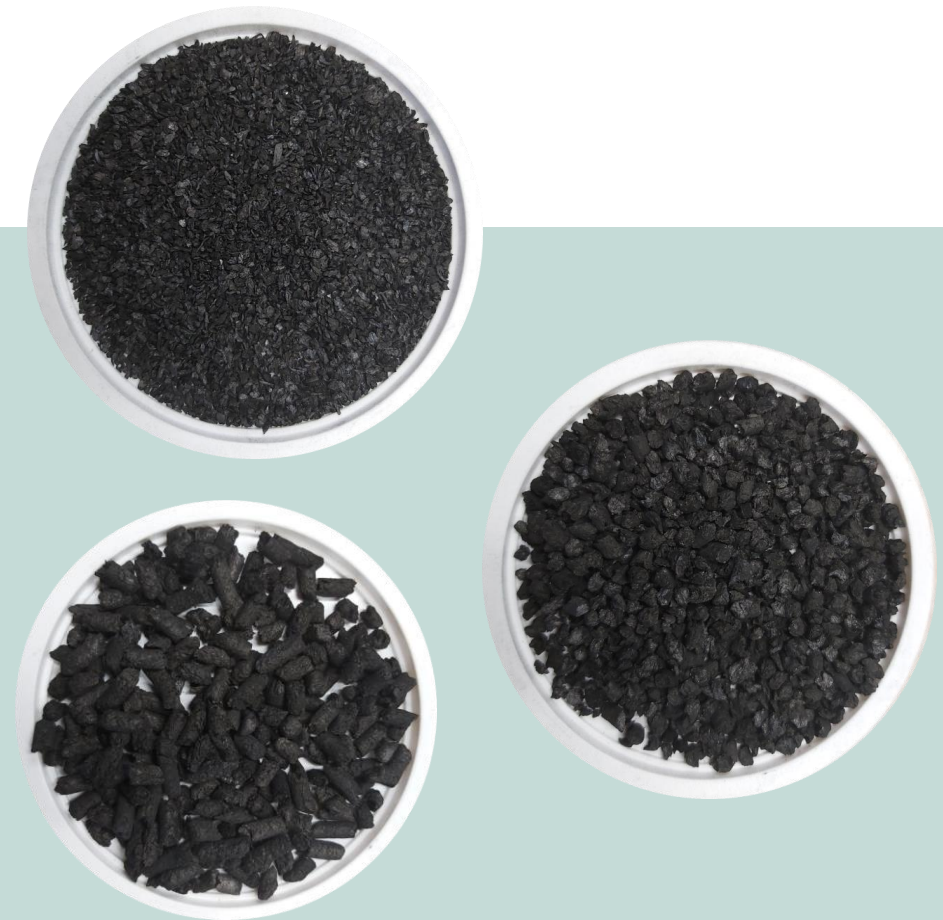
## Structure and mechanical stability

Biochar may be very friable (producing fine particles) and therefore difficult to handle without care.

**The raw material determines the macrostructure of the biochar and its mechanical strength.** For example, biochar produced from pellets is much more mechanically stable than biochar from raw wood.

The spreading means must be adapted according to the mechanical strength of the biochar (pellets, powder or large pieces).

It should be noted that the granulometry of the biochar has practically no influence on its agronomic qualities.





# Main characteristics

## Chemical purity

Biochar **must not contain** contaminating organic molecules (polyaromatics, dioxins, VOCs...) and heavy metals.

This criterion can be reached when the raw material is not contaminated and if the pyrolysis temperature is high enough.



**Soil  
Multifunctionality**

Soil  
fertility

# Buying biochar for soil amendment use

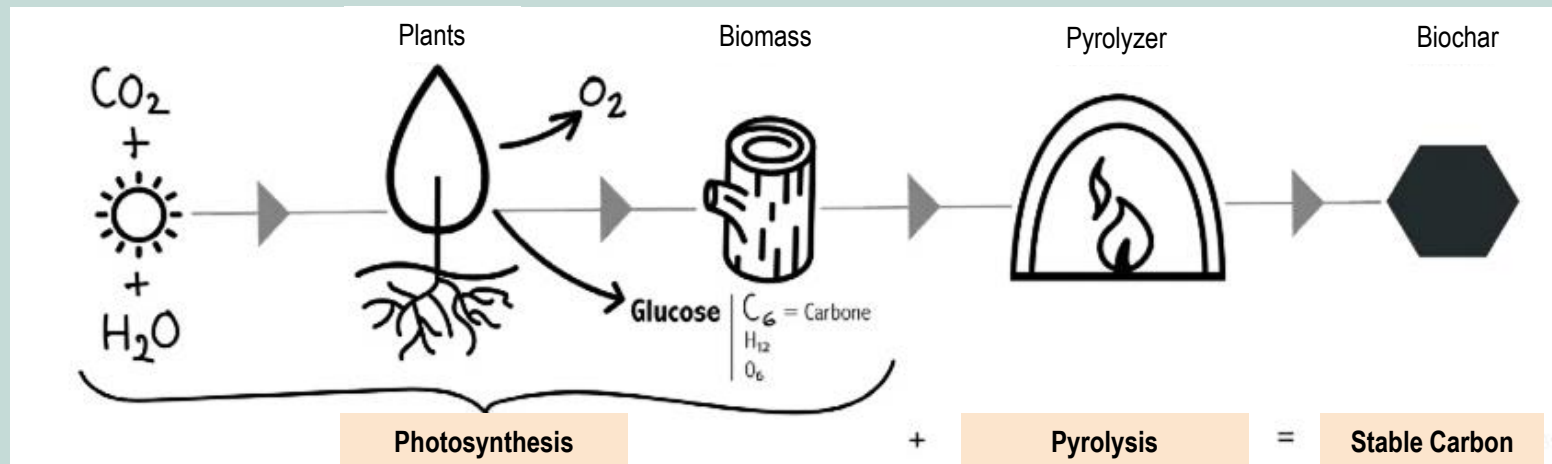
## Product certification and Marketing Authorization

- Use a certified biochar with a **Marketing Authorisation** from the ANSES
- Select a supplier that has **EBC-Certification** for the production process and the product  
EBC is a quality label for the manufacture of biochar. Level “AgroBio” will allow use in organic agriculture
- Ask for cultivation tests on the product from **independent test centres**
- Make sure that **external laboratories** validate the technical characteristics of the product



# Carbon Sequestration and its storage in the soil

Through photosynthesis, plants absorb CO<sub>2</sub> and transform the carbon it contains into biomass. By means of pyrolysis, a stable carbon compound is obtained: biochar. Instead of being released into the atmosphere, the CO<sub>2</sub> sequestered by the wood raw material is permanently fixed in the biochar. It will not undergo further decomposition by microorganisms. Mixed with earth, it is stored in the soil.



**Soil  
Multifunctionality**

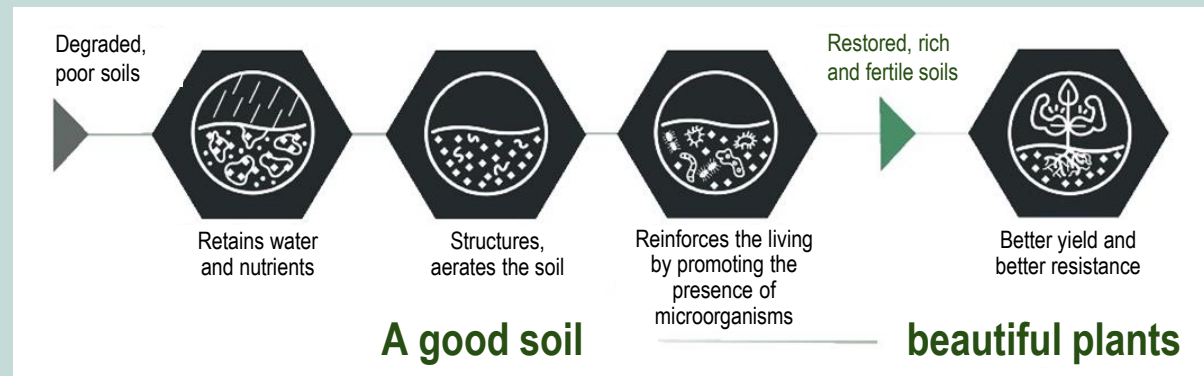
Climate

# Conclusion : Biochar as a support of the multifunctionality of soils

Soil regeneration, biomass production, carbon sequestration and an investment for the future

Adding biochar to soils can both store carbon and restructure them effectively if:

- the soil needs it
- the biochar is of good quality, certified by official bodies and has a MA.



The input is considered as **an investment**, not a burden.

There is no need to continue to add biochar year after year when enough has already been added.





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