BioChar: *How an Ancient Practice Works with Modern Technology*

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Outline

- What is biochar?
- Biochar Production Technologies
- Current research at UGA
- Application of Biochar
- Environmental benefits
- Conclusions

What is charcoal?

- Charcoal is a solid residue remaining after biomass (wood) is carbonized or pyrolyzed under oxygen deprived condition.
- Primary purpose is to **produce heat**
- Used in iron works, cooking and filtration applications
- Rich in fixed carbon (70-95%)
- Heating value= 26-32 MJ/kg

What is Biochar?

- Biochar is a carbon rich charcoal produced as a co-product during pyrolysis of biomass (wood, grasses, organic residues).
- Primary purpose is to **apply on the soils to improve soil health and soil carbon sequestration.**
- **“Charcoal for application to Soils”**

EU report (2010)

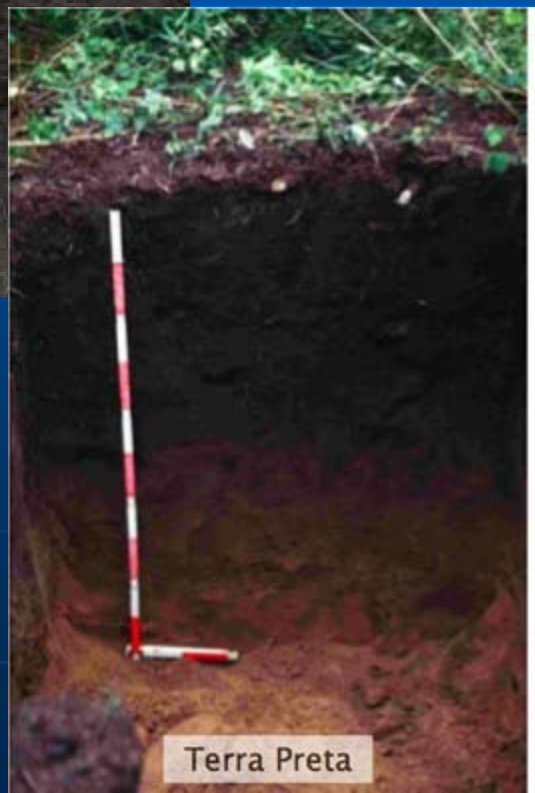
Historic Development - Biochar

- Charcoal is considered as a first synthetic material produced by human 38,000 yrs ago (Brad, 2001)
- Late 1800s– Black earth in Amazon
- 1950s – Biochar for seedling growth medium
- 1950s – 1970s – Charcoal production for energy
- 1980s – Japan biochar research for soil application
- 1990s – Biochar as potting mix
- 2000s – Intensive Biochar R & D; Rediscovery of Amazonian Black soil (*Terra Preta de Indio*) – 2500 yrs ago. Soil contains 150g of C/kg of soil compared to 20-30 g of C/kg of soil.

Amazonian Dark Earths

Photo by Wim Sombroek

Source: Glaser et al., (2001)

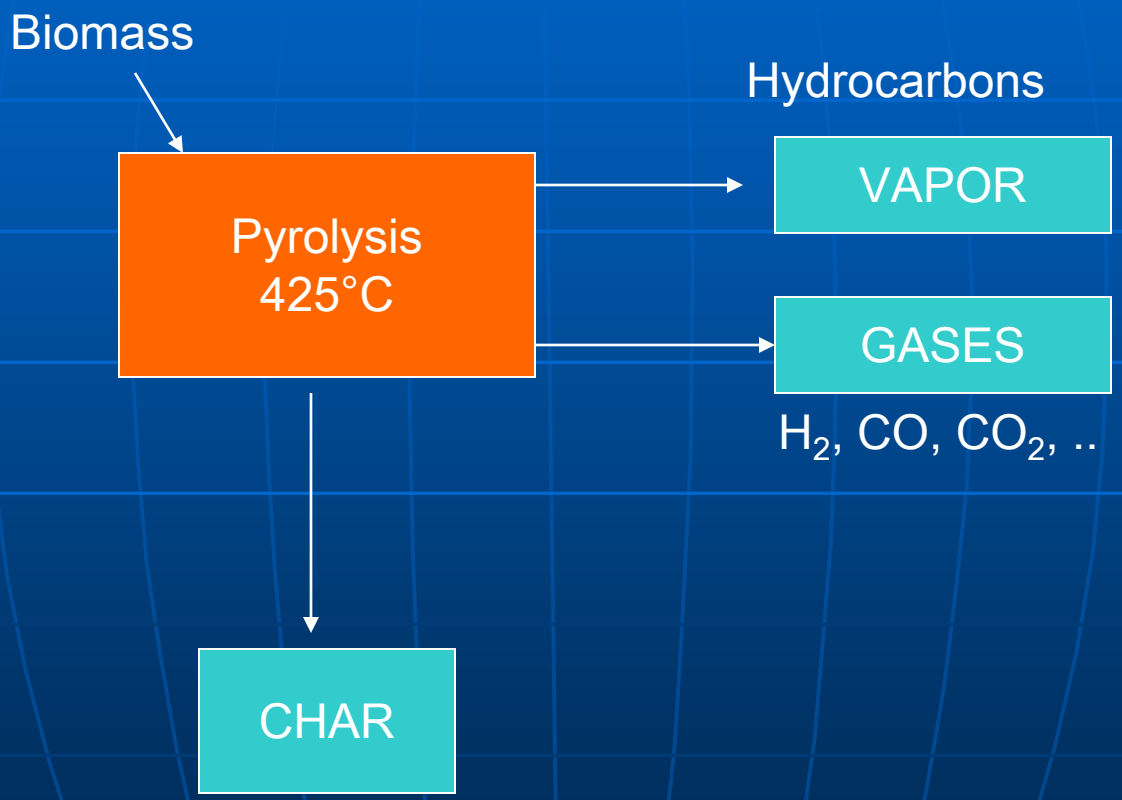


Charcoal (Biochar) Production

- World Production – 41 million t
- South Africa - 50% of the production
- Char yield
  - Traditional kilns = 10-20%
  - Missouri kiln = 20-30%
  - Linann Kiln = ~ 30% (China, Brazil)
  - High pressure kilns = ~45% (U of Hawaii)
- Char making is an art and require critical amount of energy and generates air pollutions

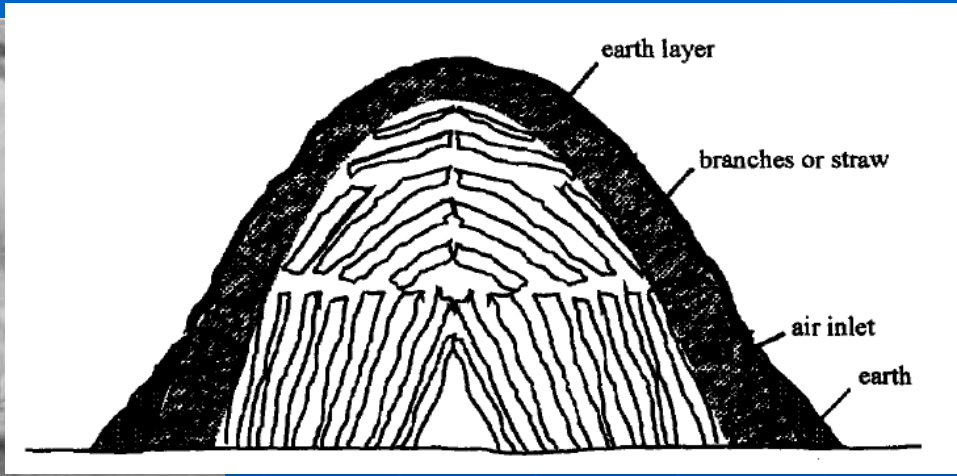
Source: Hillring (2006); Hollingdale (1999)

Pyrolysis Process



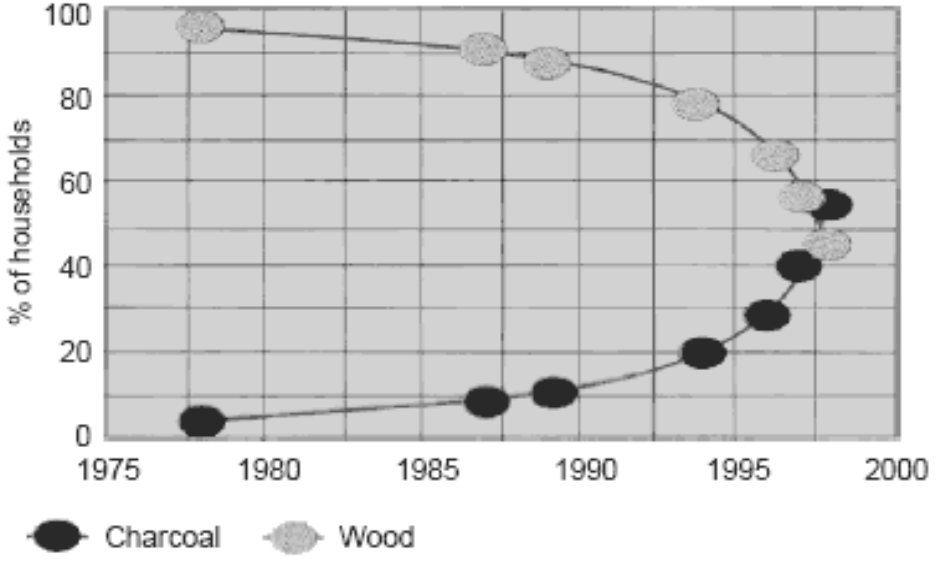
Pyrolysis Products

Ancient charcoal Production



Source: FPL, 1961

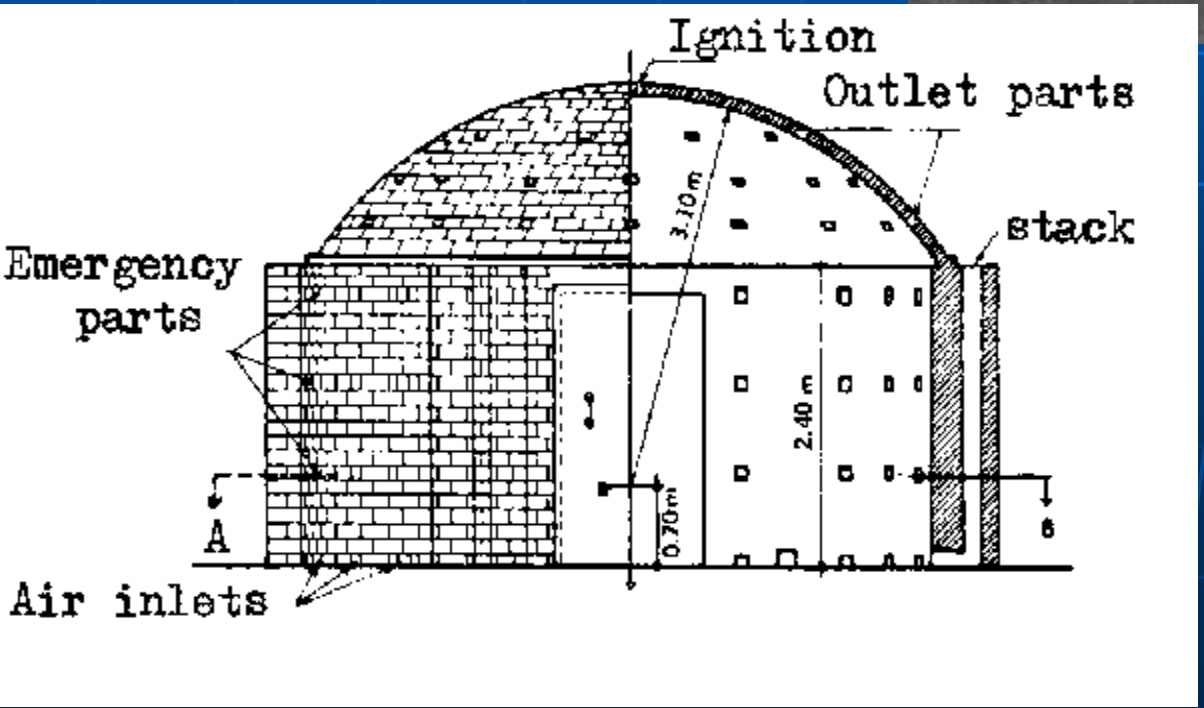
Charcoal Production in Africa



Source: World Bank, 2000.

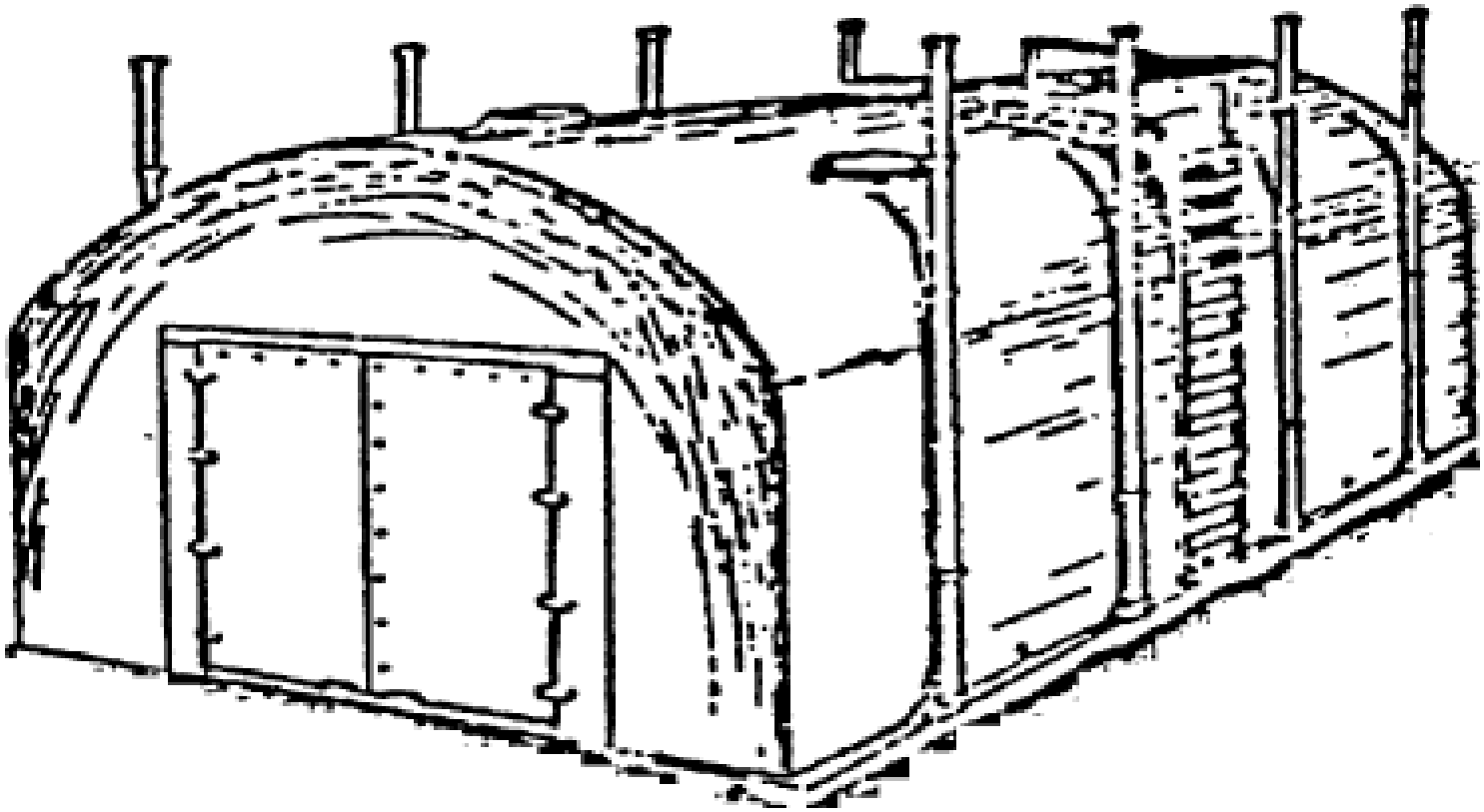
Source: Wood Energy, FAO report (2004)

Charcoal Making



Beehive Brick Kilns

Missouri Kiln (direct heating)



Indirect heating – Linann Reactor

Source: Rob Flanagan, SAFFE

Linann Reactor - Products

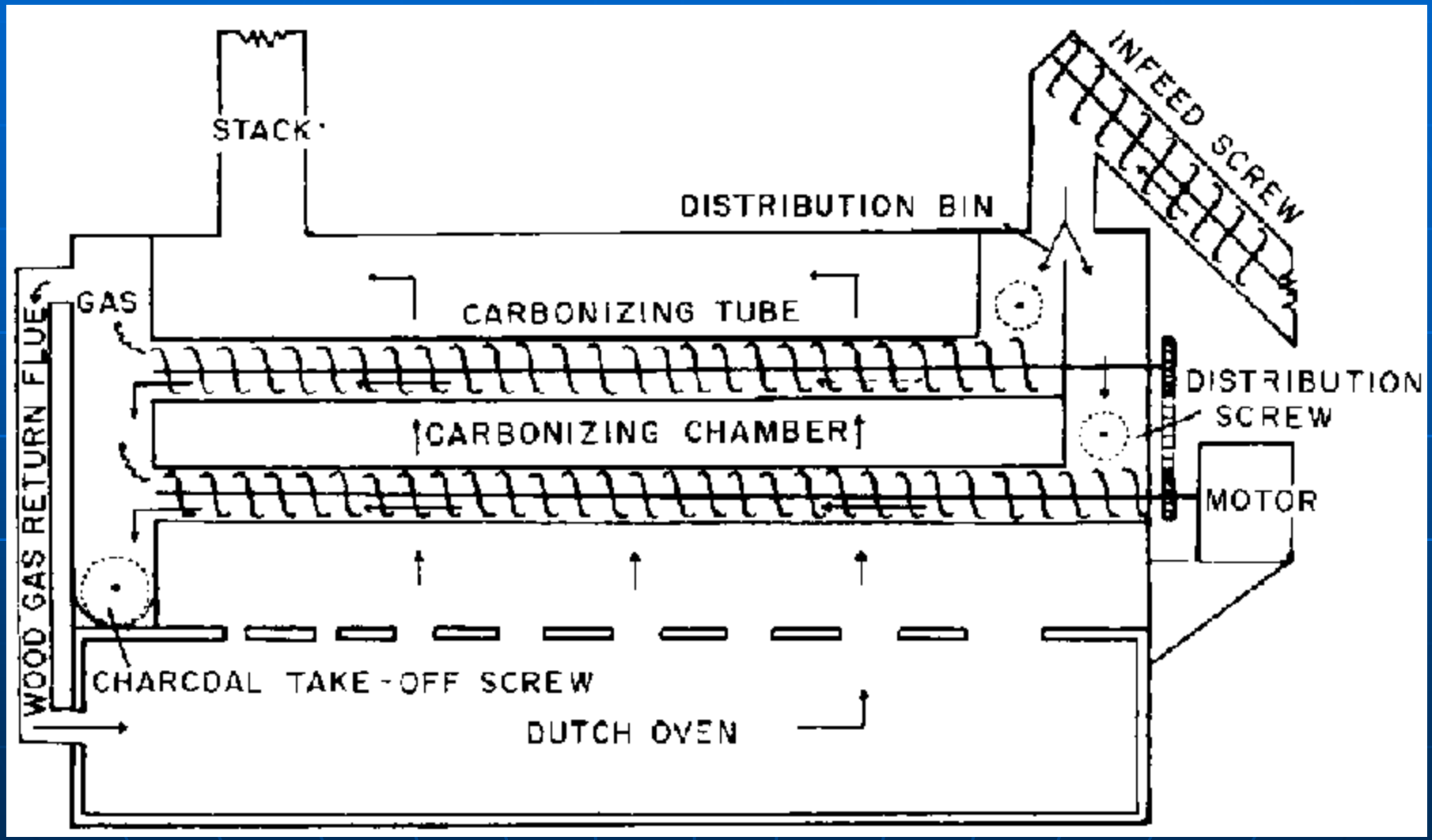
Wood Vinegar

Vinegar / liquid smoke

Charcoal

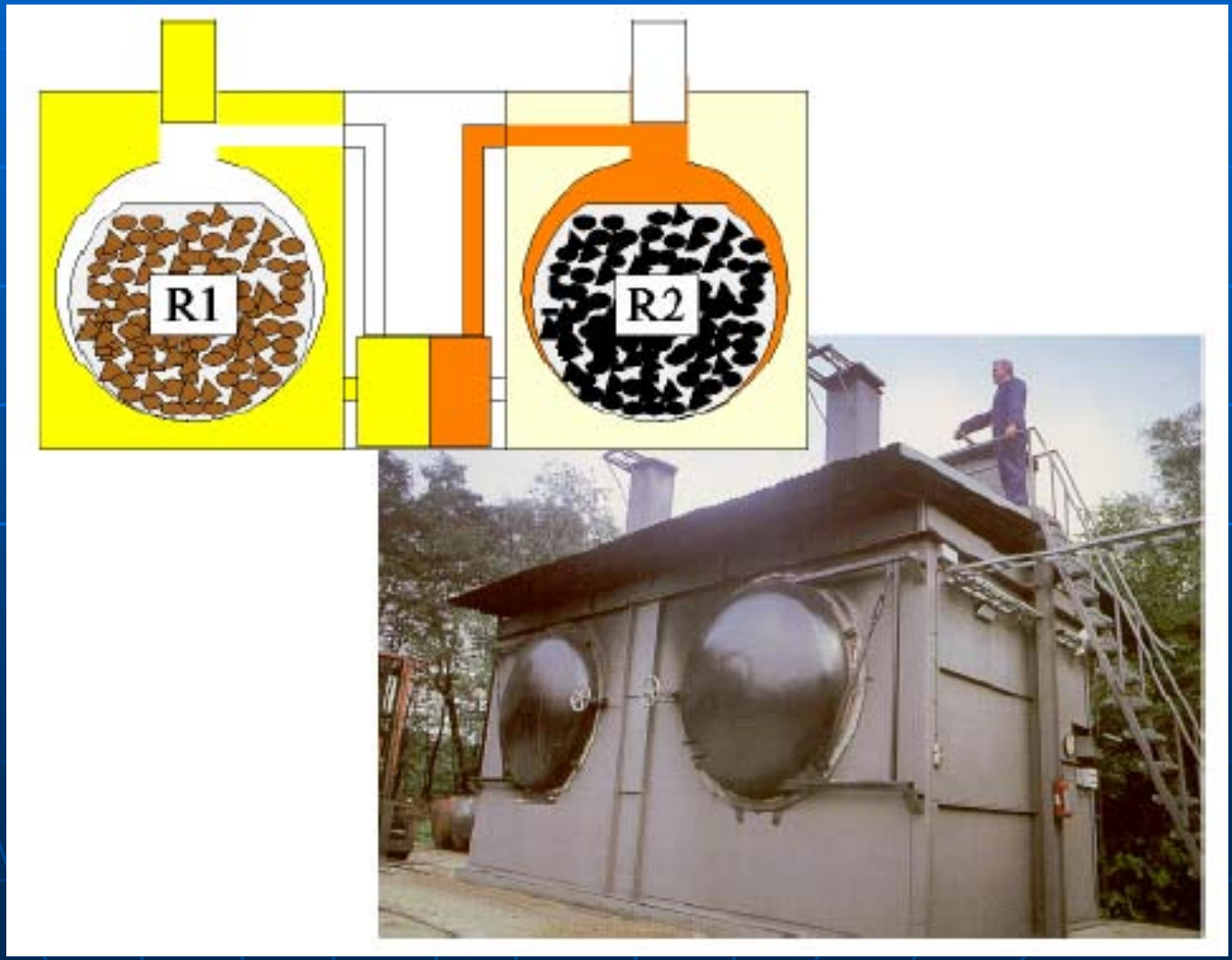
Source: Rob

Continuous Carbonizer



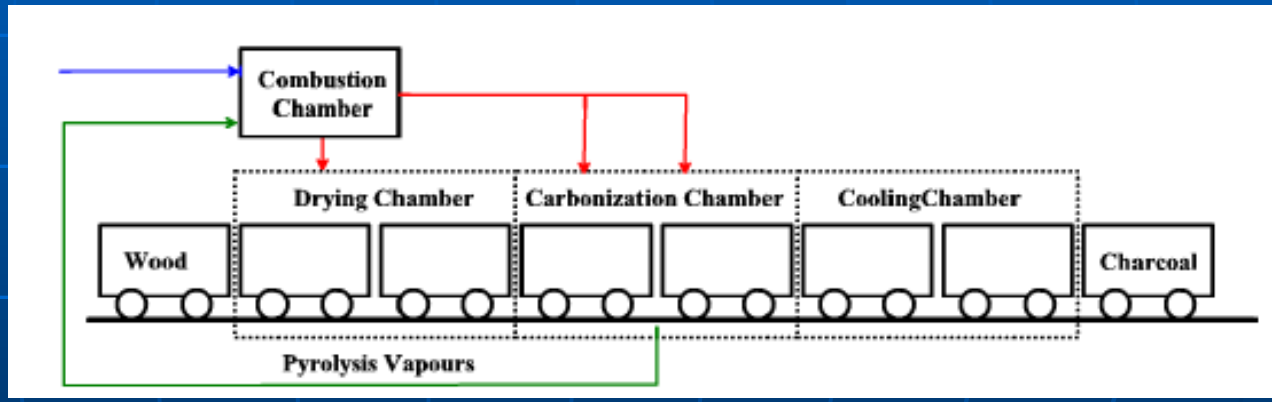
Source: Dargan & Smith (1958)

charcoal Production – VMR Oven Retort

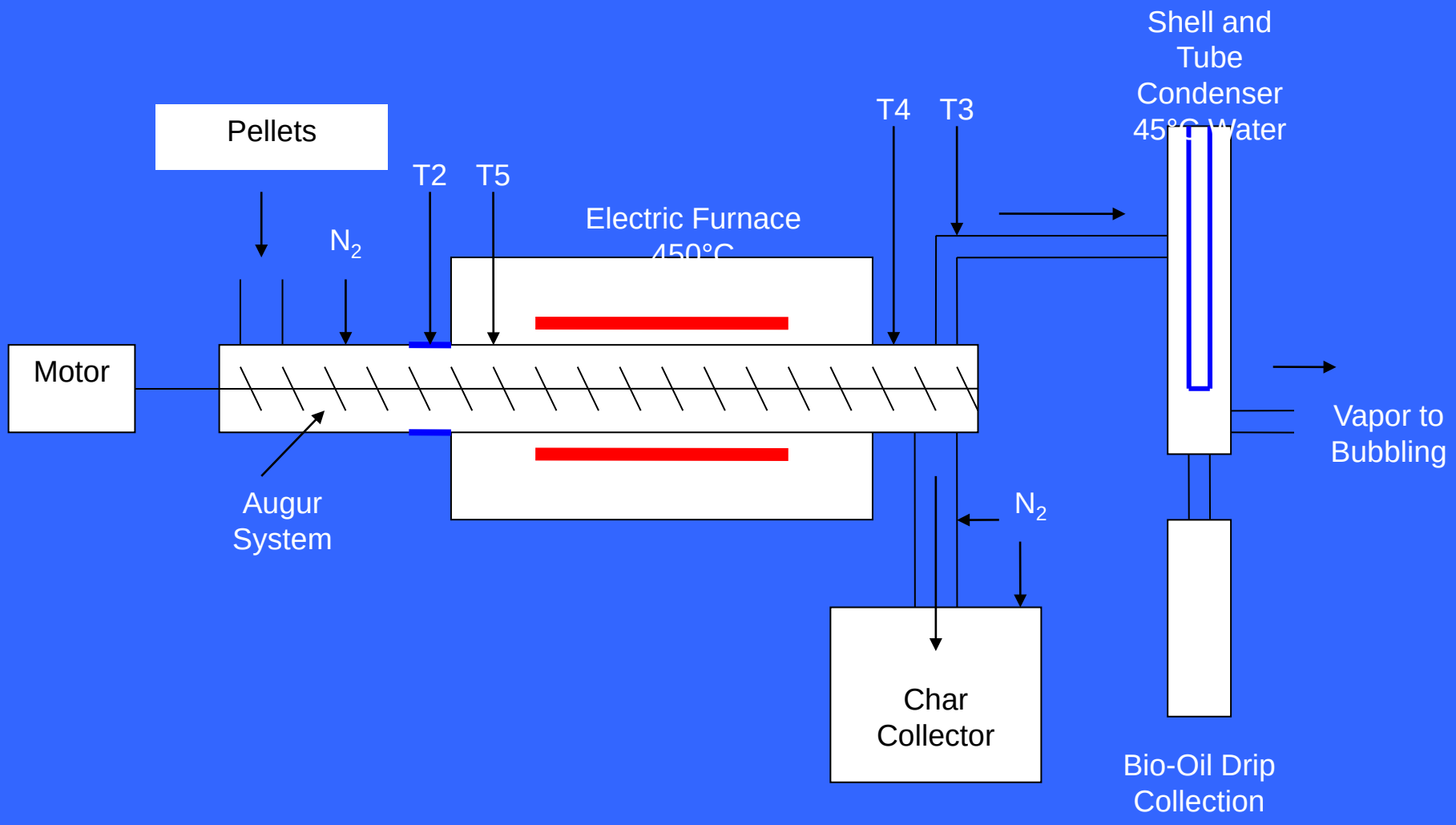


Source: FPL, 1961

Charcoal Production – Lurgi's Plant



UGA's Continuous Pyrolysis Unit



Pyrolysis Reactor

- Wood pellet feed

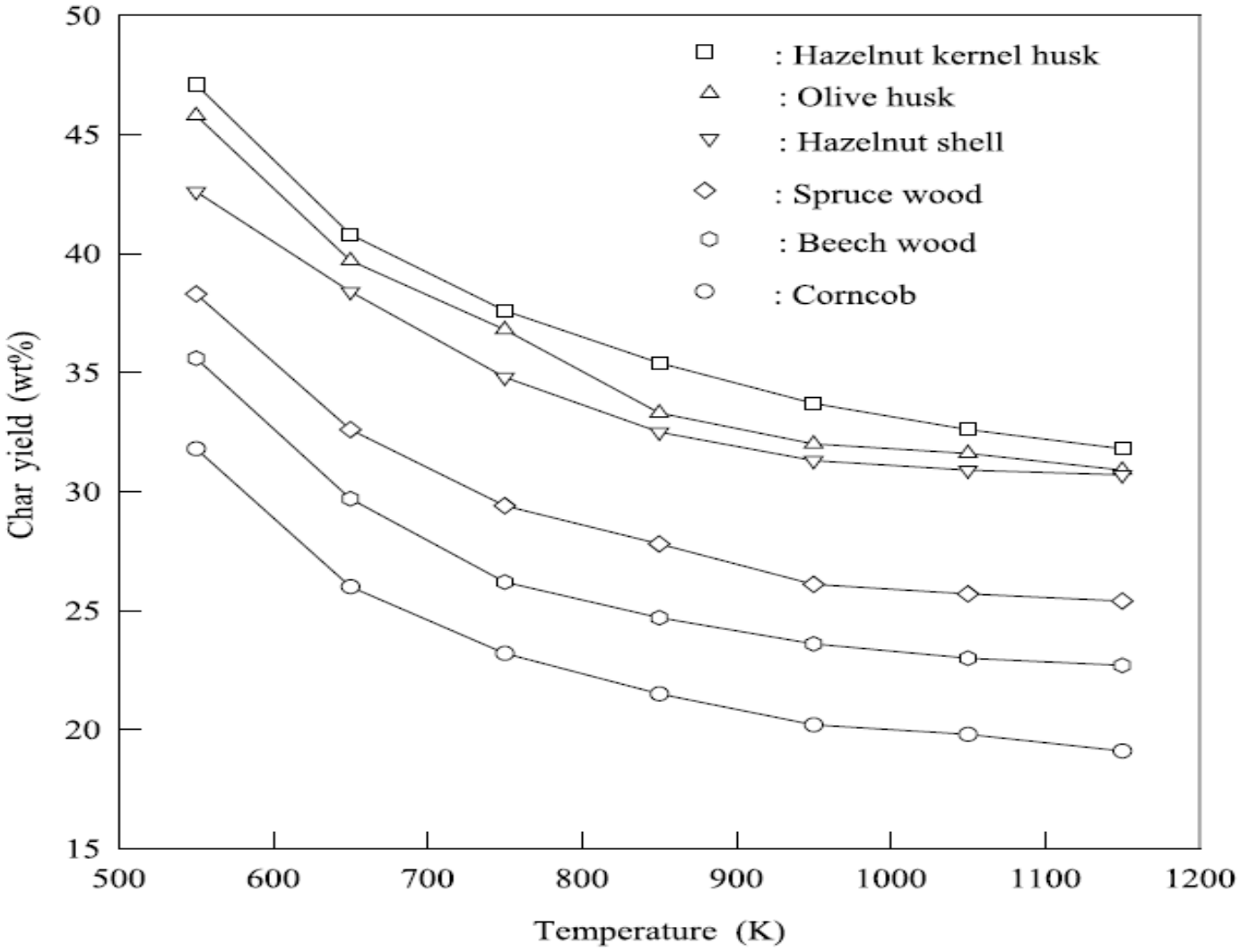
Charcoal (Biochar)

Bio-oil

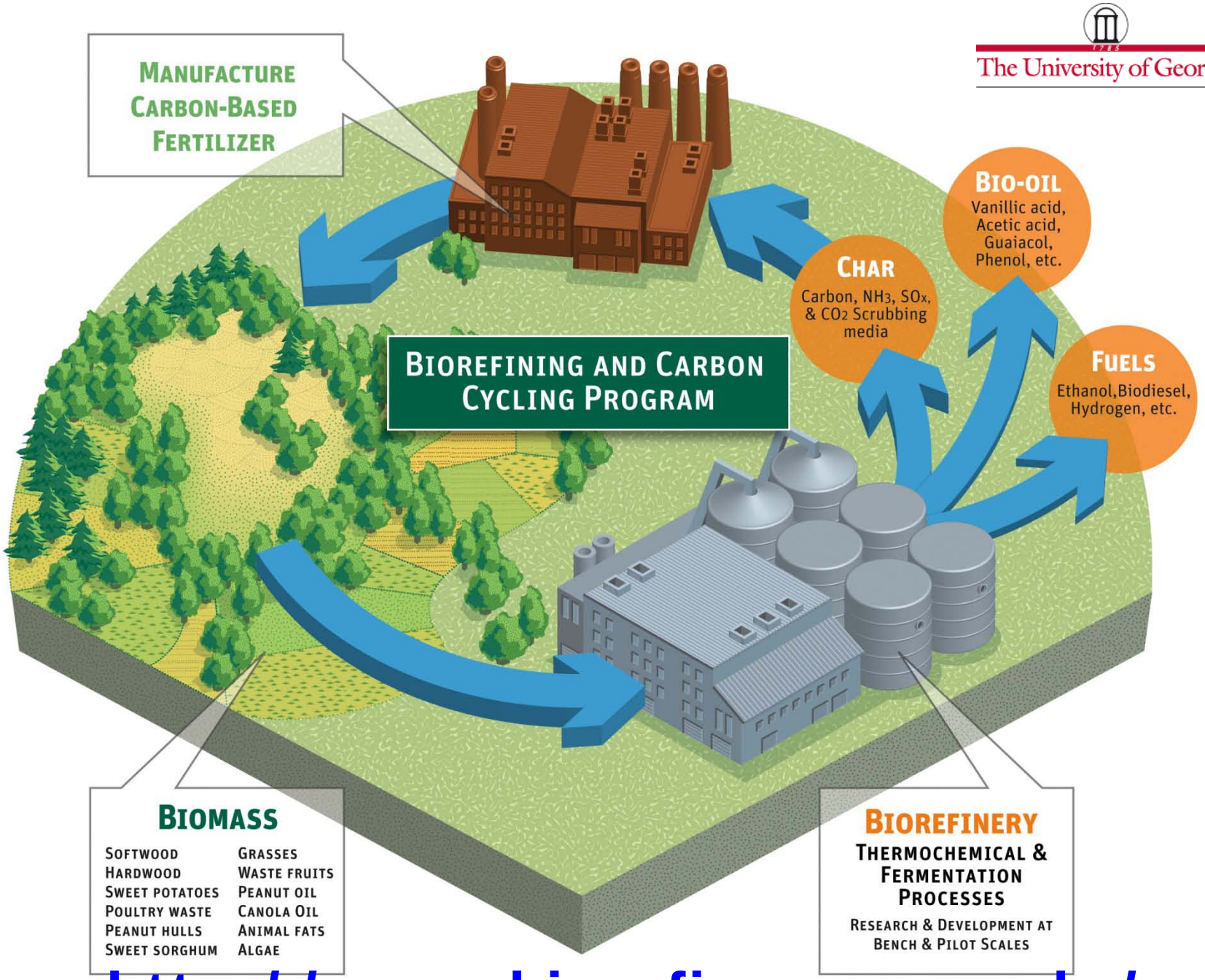
Rotary drum reactor – UGA

(indirect heating)

Biochar yield from various organic materials

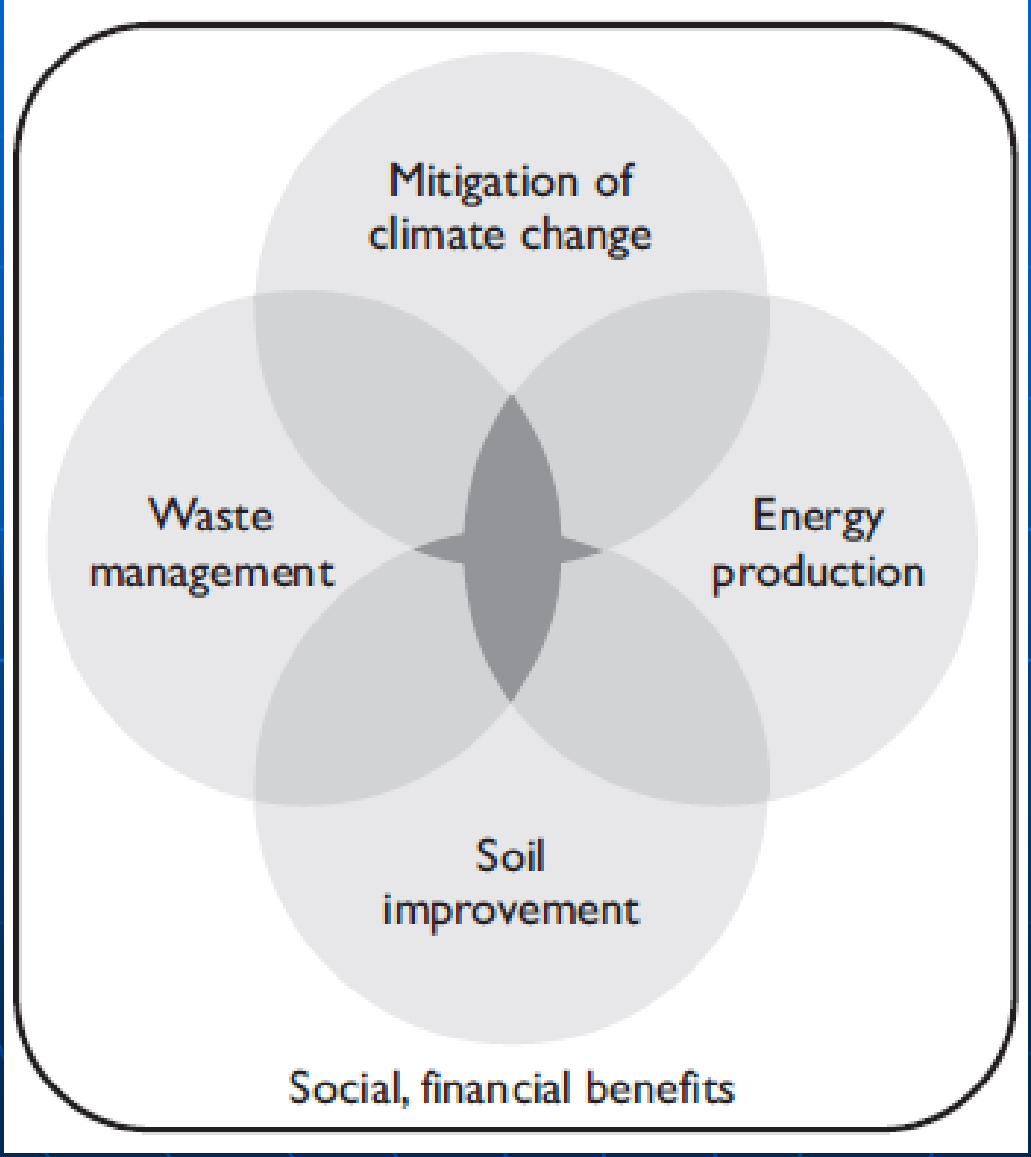


Demirbas, (2001)



http://www.biorefinery.uga.edu/

Applications of Biochar



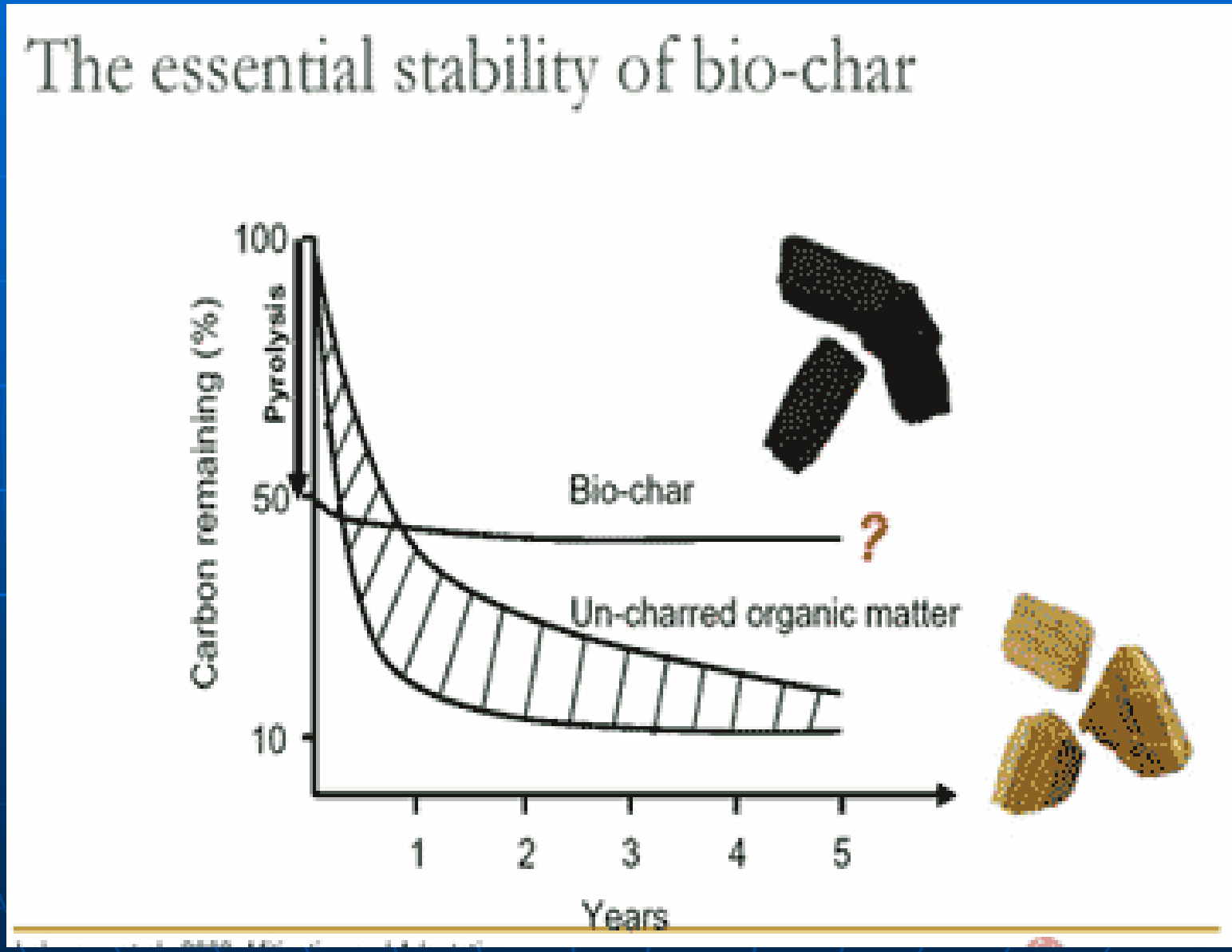
Source: Lehmann (2009)

Benefits of Biochar on Soil

- Improves soil properties – pH, water retention, nutrient leaching etc.
- As a soil amendment agent for crop growth
- Minimizes the nitrous oxide emissions
- High affinity to nutrients & high persistence (stability)
- Improved population of earthworms and microbial colonies

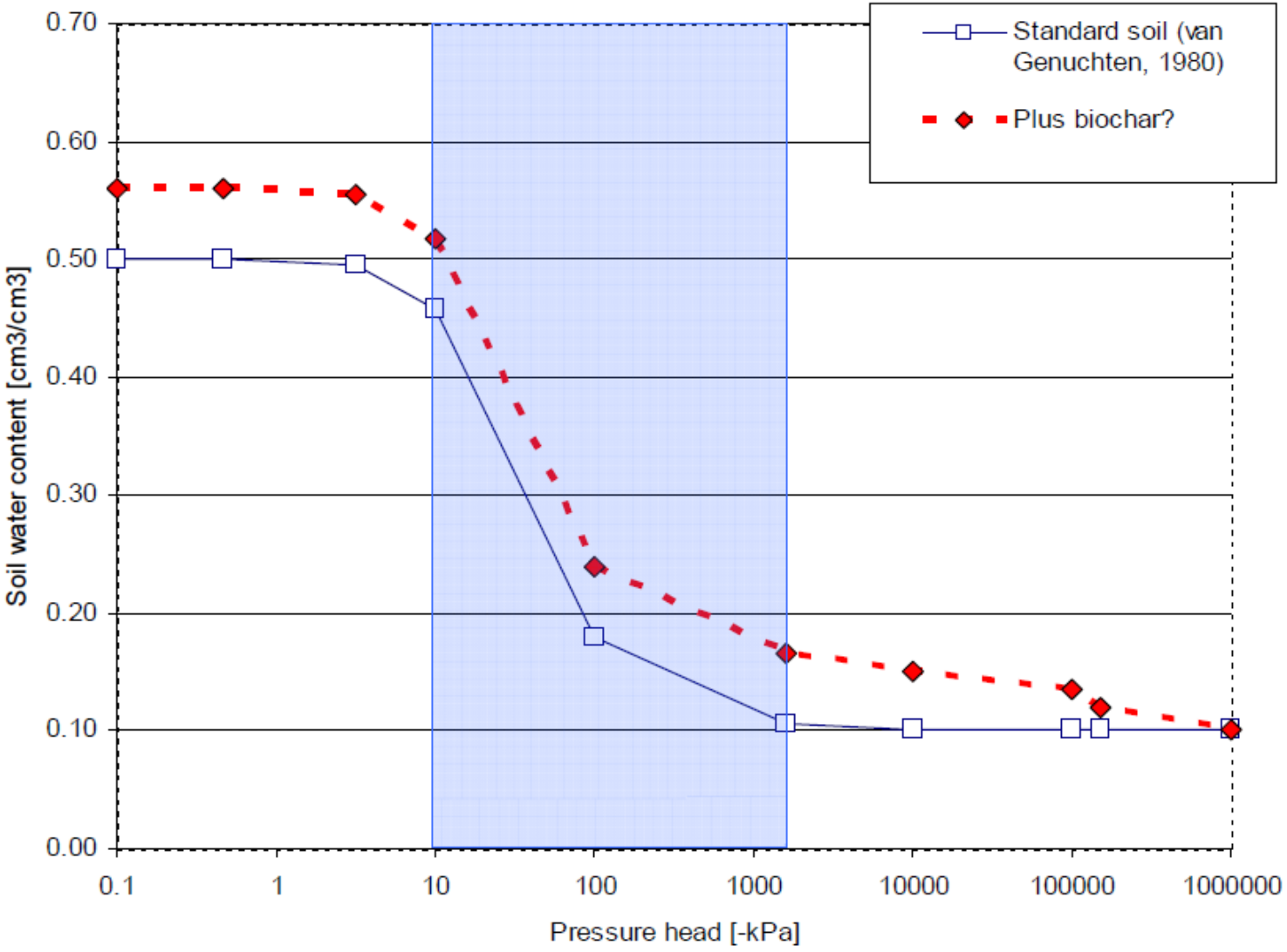
Source: Lehmann, 2007; www. Biochar.info

Benefits of Biochar

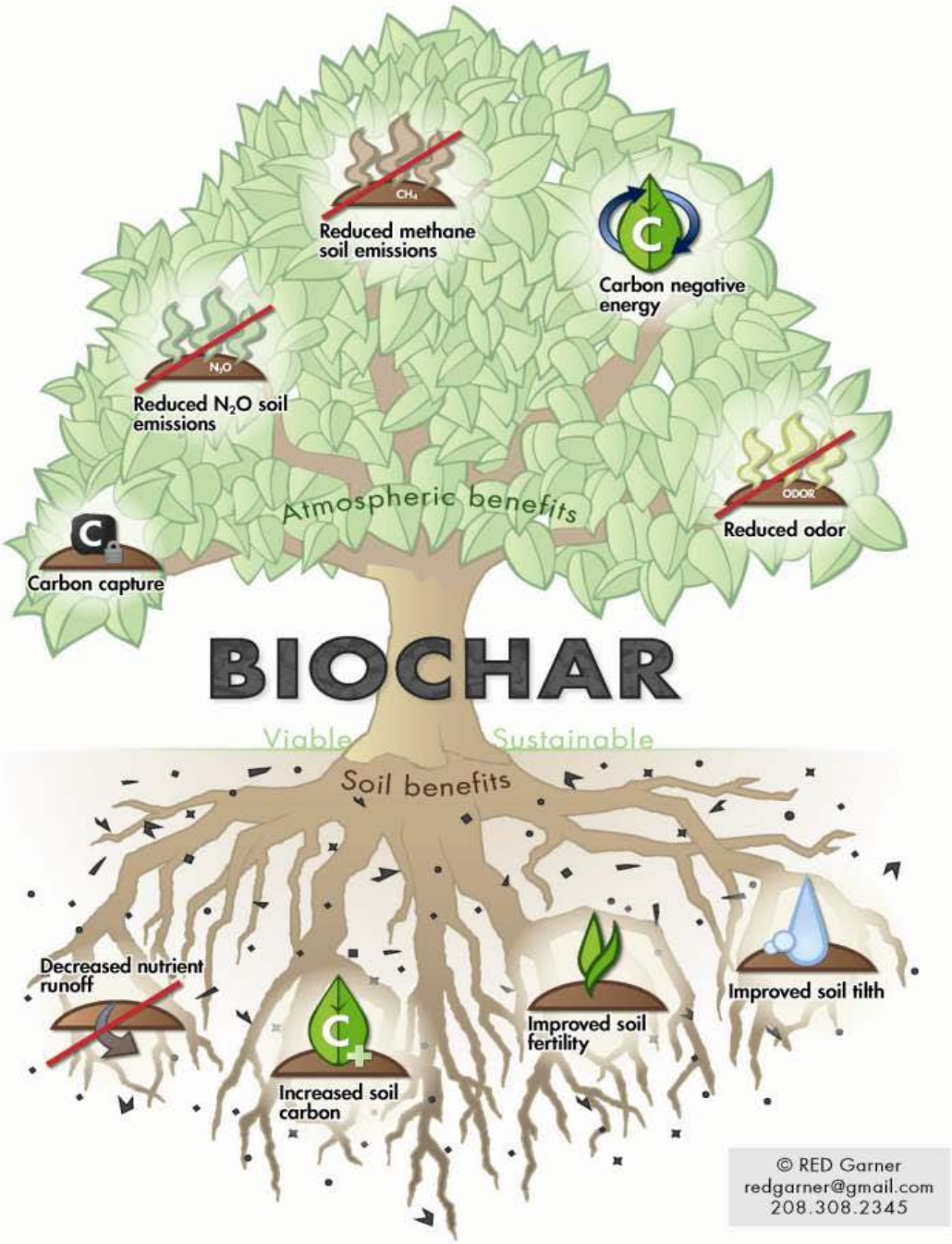


Source: Lehmann et al, (2006

Improvement in soil water retention capacity



Source: EU report, (2010)



International Biochar Initiative

Source: http://www.biochar-international.org/biochar

Useful Links

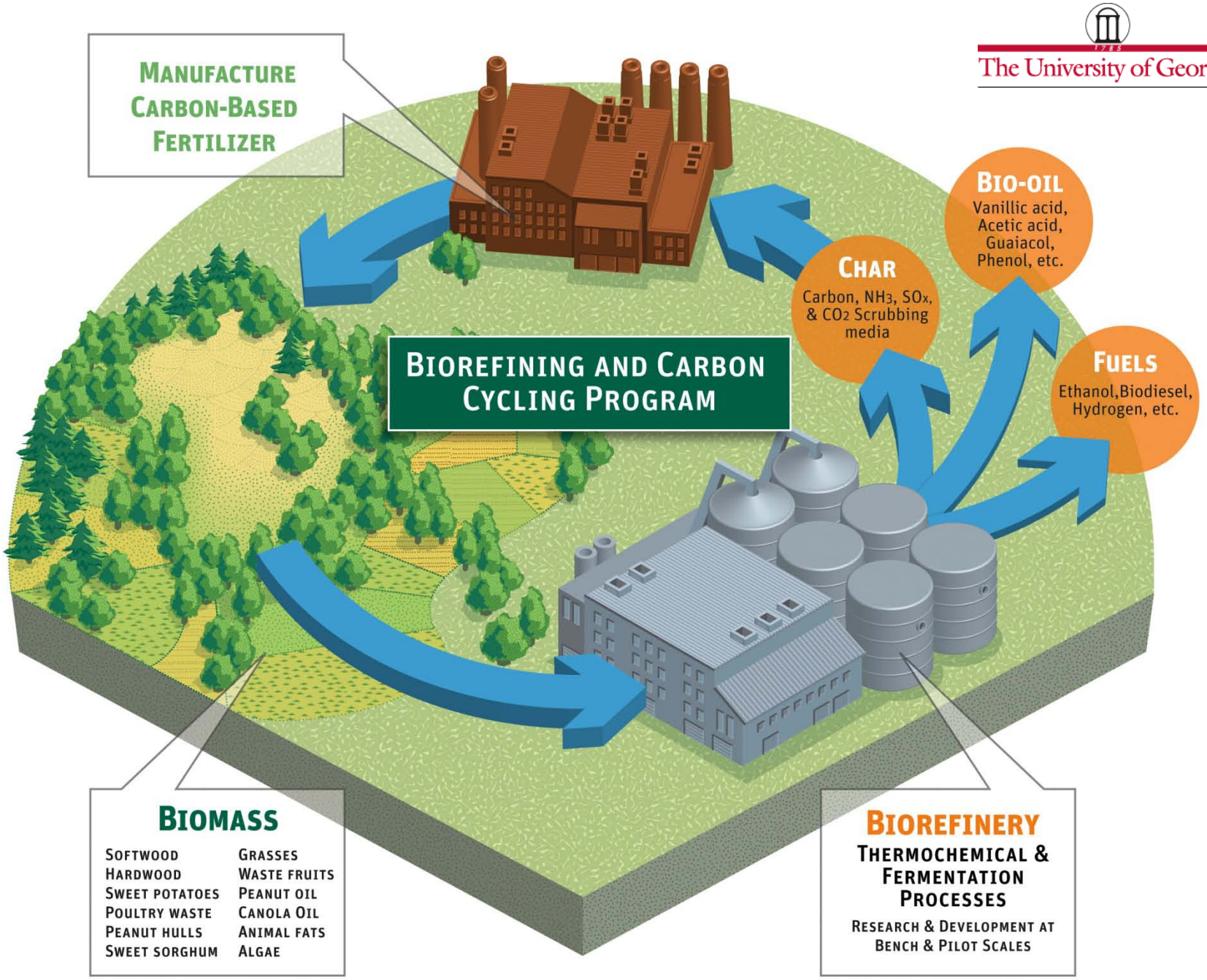
- www.biorefinery.uga.edu – Biochar &Carbon recycling research
- www.biochar-international.org – Biochar on soil application
- www.biochar.org
- Biochar application to soil – A critical review by EU. (2010) Report # 24099. www.jrc.ec.europa.eu

Summary

- Biochar is a carbon-rich organic material used to improve the soil health and carbon sequestration.
- Compared to ancient technologies, modern technologies may produce high biochar yield both efficiently and economically for soil applications
- While short term benefits of biochar on soil have been highlighted, the knowledge of long term benefits are still under R & D to fully understand the spectrum of biochar benefits

Thank You – Q/A

Biochar


The University of Georgia
MANUFACTURE CARBON-BASED FERTILIZER
BIO-OIL
Vanillic acid, Acetic acid, Guaiacol, Phenol, etc.
CHAR
Carbon, NH3, SOx, & CO2 Scrubbing media
FUELS
Ethanol,Biodiesel, Hydrogen, etc.
BIOREFINING AND CARBON CYCLING PROGRAM
BIOMASS
SOFTWOOD
HARDWOOD
SWEET POTATOES
POULTRY WASTE
PEANUT HULLS
SWEET SORGHUM
GRASSES
WASTE FRUITS
PEANUT OIL
CANOLA OIL
ANIMAL FATS
ALGAE
BIOREFINERY
THERMOCHEMICAL & FERMENTATION PROCESSES
RESEARCH & DEVELOPMENT AT BENCH & PILOT SCALES