



**UNIVERSITY OF CALIFORNIA**  
Agriculture and Natural Resources

■ UC Master Gardener Program

# Everything you wanted to know about biochar but were afraid to ask

Erika Valek, Soil  
Conservationist, NRCS

Rainer Hoenicke, UC  
Master Gardeners



# Natural Resources Conservation Service (NRCS)

Through voluntary conservation programs, NRCS helps producers, soil and water conservation districts, and other partners protect and conserve natural resources on private lands throughout the United States.

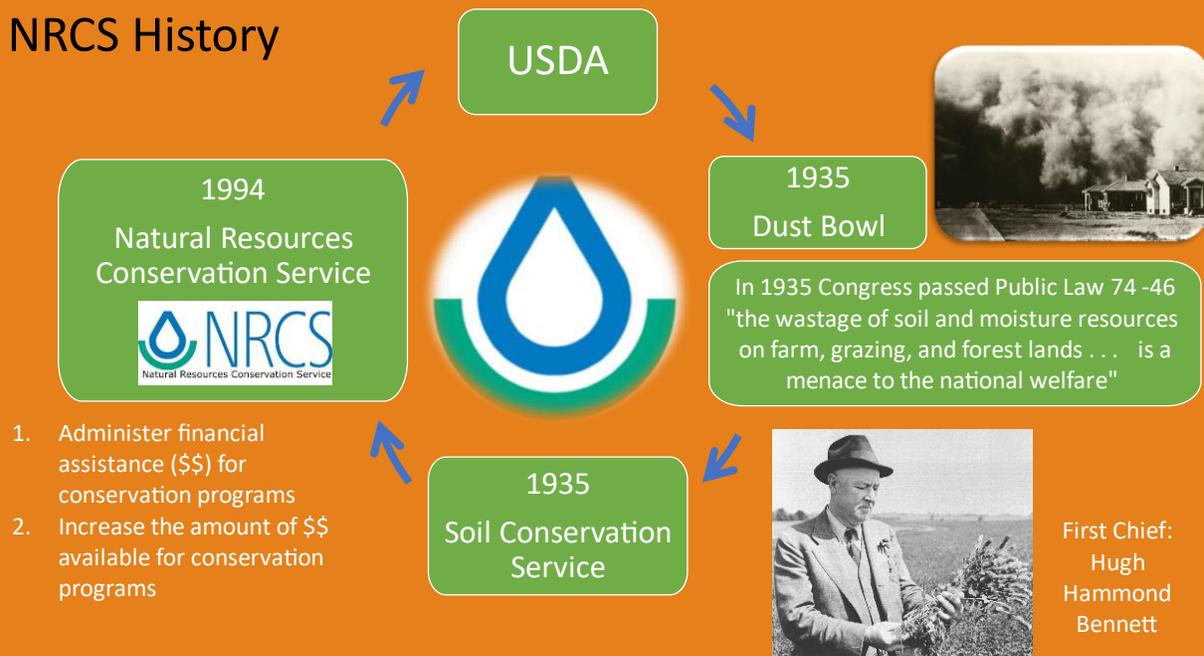


## Some Local Partners

- Napa Resource Conservation Districts
- University of California Cooperative Extension
- Napa County Firewise Foundation
- Napa County Flood Control and Water Conservation District
- Land Trust of Napa County
- Napa Green



## NRCS History



**The Dust Bowl led to the passage of Public Law 74-46. This established the Soil Conservation Service.**

**Hugh Hammond Bennett was a soil surveyor for the USDA. Through his travels around the country, he realized that soil erosion was a significant problem. He spent the rest of his career teaching Congress and farmers about soil erosion and conservation practices to reduce it. In 1994, the Soil Conservation Service was renamed the Natural Resources Conservation Service.**



## NRCS Conservation Programs in Napa

### Common resource concerns include:

- Plant Structure and Composition
- Plant Productivity and Health
- Plant Pest Pressure
- Wildfire Hazard from Biomass Accumulation
- Organic Matter Depletion
- Inefficient Irrigation Water Use
- Terrestrial Habitat for Wildlife and Invertebrates

### Common practices include:

- Forest Stand Improvement
- Woody Residue Treatment
- Brush Management
- Structures for Wildlife
- Cover Crop
- Conservation
- Soil Carbon Amendment
- Irrigation Water Management

NRCS is increasing their involvement in urban agriculture to assist community gardens, rooftop farms, and small vegetable operations.



**NRCS is opening Ag offices in Compton and Oakland and is training more staff to help with urban agriculture.**



## When it comes to biochar, there are lots of questions!

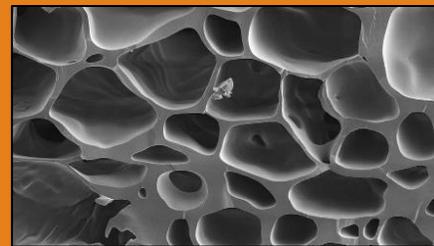


### What is Biochar?

“A specialized form of charcoal that is produced by heating biomass using **high heat** in **low-oxygen environments**”

-Sonoma Biochar Initiative, Sonoma Ecology Center

- Unlike ash, biochar is not completely combusted
- Stable solid, dense carbon structure with a high surface area
- Has a low nutritional content but is a great adsorber with a high surface area, creating ion exchange sites
  - Soil nutrient and water molecules bind onto biochar and are held in the soil
- Holds nutrient and water in the soil over thousands of years
- Different feedstocks (wood, straw, manure, nut shells, corn stalks etc.) and different temps will produce biochars with varying properties

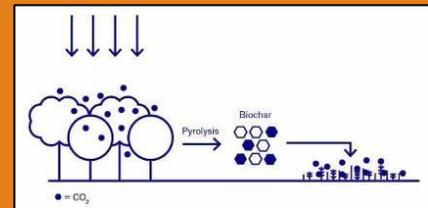


**Biochar is created using temperatures between 400-800C. It is similar to charcoal but differs in that biochar has greater porosity and surface area.**



## Benefits of Biochar

- Indigenous people in the Amazon (> 2,500 years ago) would burn organic matter and bury it, known as Terra Preta
  - These agriculture areas are still highly fertile today
- **Biochar is known to:**
  - Increased surface area to bind water molecules and soil nutrients
  - Enhance soil structure, decrease bulk density and improve porosity
  - Increase water holding capacity
  - Decrease acidity
  - Regulate nitrogen leaching and soil pollutants
  - Improve microbial properties
- Making biochar is considered carbon negative
  - The unstable carbon in the decomposing biomass is converted to stable carbon in biochar
  - This stable carbon is then stored in biochar in the soil



**Decomposing organic matter emits CO<sub>2</sub>. Biochar locks carbon into its structure; applying this to the soil allows for sequestration of the carbon in the soil.**

## Biochar in Forest, Cropland, and Horticulture

- **Forests:**
  - Historically wildfires had intervals about every 5 to 15 years in oak woodlands.
  - The exclusion of fire has greatly altered soil properties and forest composition.
  - Biochar can be compared to the charcoal found after a wildfire in these fire prone ecosystem and can mimic soil properties after a wildfire.
    - Mechanical thinning and biochar application may have similar effects as a low intensity wildfire
- **Cropland:**
  - Important to activate the biochar by mixing it with compost before applying it to cropland or garden beds
    - The water and nutrients of the compost will bind to the biochar and be available in the soil for plants
  - Raw biochar will adsorb the water and nutrients in the soil, competing with the crops for several months until both are stabilized

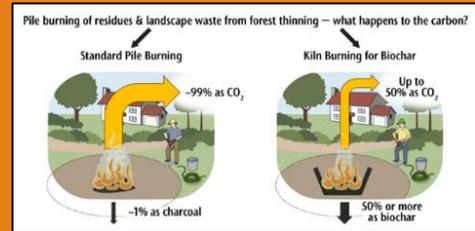




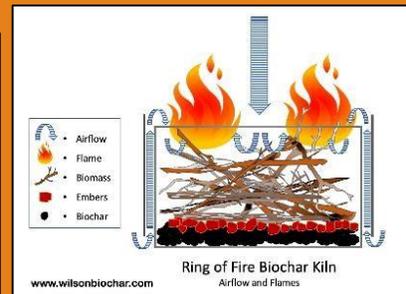
## How is Biochar Made?

- **Pyrolysis** – the process of burning biomass in the absence of oxygen
- **Conservation burning** – standard pile burn
  - Lighting from the top down, small diameter material
  - Using a water source to extinguish the fire before all the biomass turns to ash
- **Flame Cap Kilns** – metal, open top
  - Placed directly on the ground
  - Two rings allows for oxygen to flow through the outer ring and into the top of the inner ring
  - Oxygen is not reaching the bottom of the inner ring

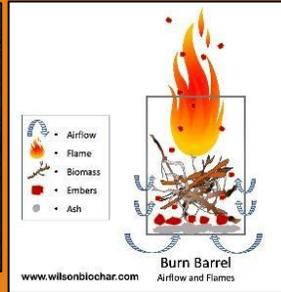
It's important to break the biochar into smaller pieces after it's cooled by driving over it or crushing it with heavy equipment



Sonoma Ecology Center in 2021 found that burning forest slash in a Ring of Fire Biochar Kiln led to biochar with a 70% stable carbon content.



**Note: We do not recommend making biochar at home due to the risk of injury.**



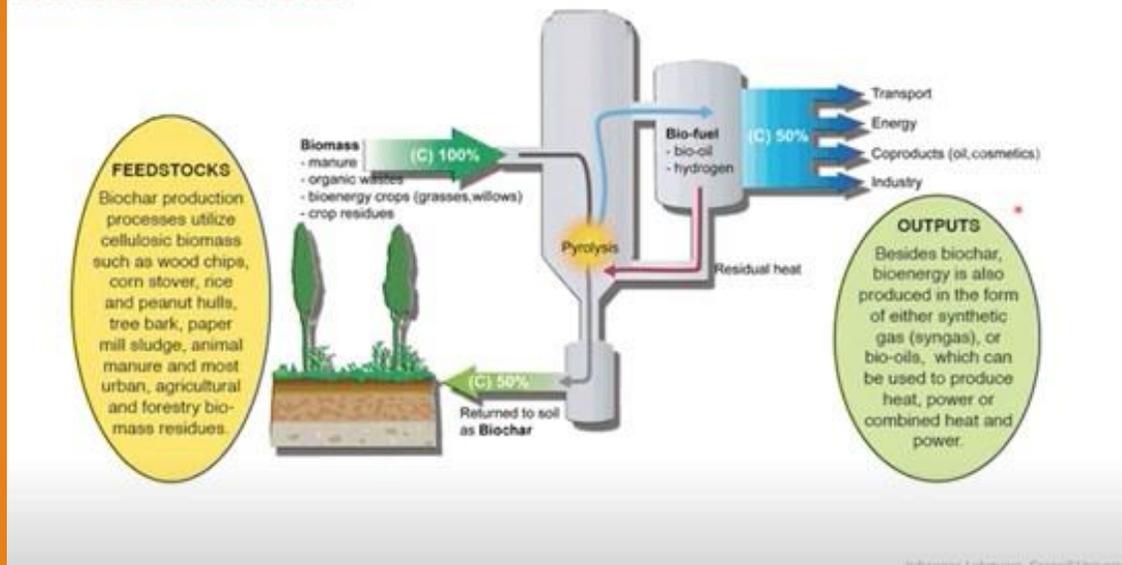
## Types of Kilns

Napa RCD  
Conservation  
Burn  
Workshop,  
2021

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## How is Biochar Made?



From - North Coast Soil Hub Workshop, "Clear as Mud"

Johannes Lehmann, Cornell University

(Some of the concepts portrayed on this slide are still theoretical and/or controversial.)



Local Use of Biochar:

# Four Winds Winery

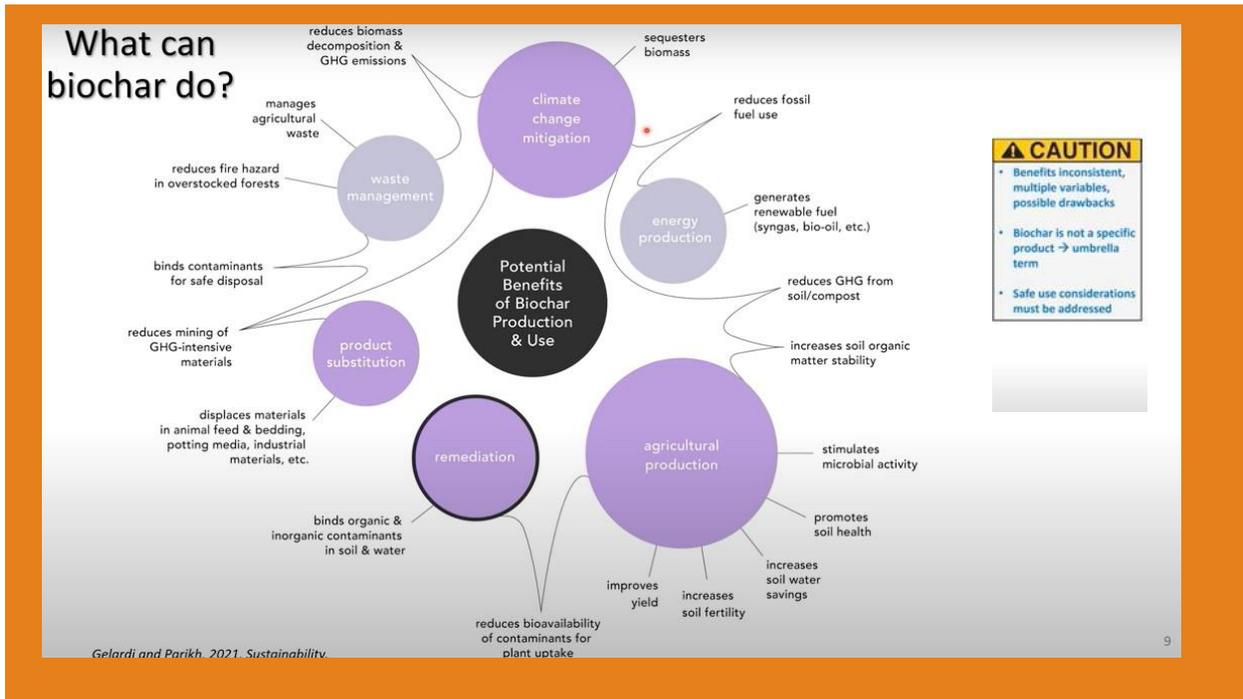
- Vineyard: 4 ac
- Rangeland: 76 ac
- Forest land: 26.8 ac
- Soils: 176: Rock outcrop-Hambright complex  
50 to 75% slopes
- Burned in the 2017 Atlas Wildfire
  - Soil burn severity: low to moderate
- Oak woodland
  - Trees: coast live oaks, CA buckeye
  - Shrubs: poison oak, manzanita, sticky monkey flower, chamise in drier open areas



Measurement	Existing Conditions	Desired Conditions
Dominant Tree Species	Coast Live Oak	Coast Live Oak
Approx. Number of Trees per Acre	180 trees/ac	100 trees/ac
Average Distance between Trees	12 feet	15-20 feet
Average Tree Diameter	7" DB	10" + DBH
Tree Diameter Range	1-26"	10-20"
Basal Area	180 - 210 ft <sup>2</sup> /acre	90 ft <sup>2</sup> /acre



Post-fire brush and tree removal products are used to produce biochar, which is then incorporated as an amendment to vineyard soil.



**Biochar has the potential to provide benefits for climate change mitigation, agricultural production, pollution remediation in soil, water and waste management and in energy production.**



## Biochar for the home garden...

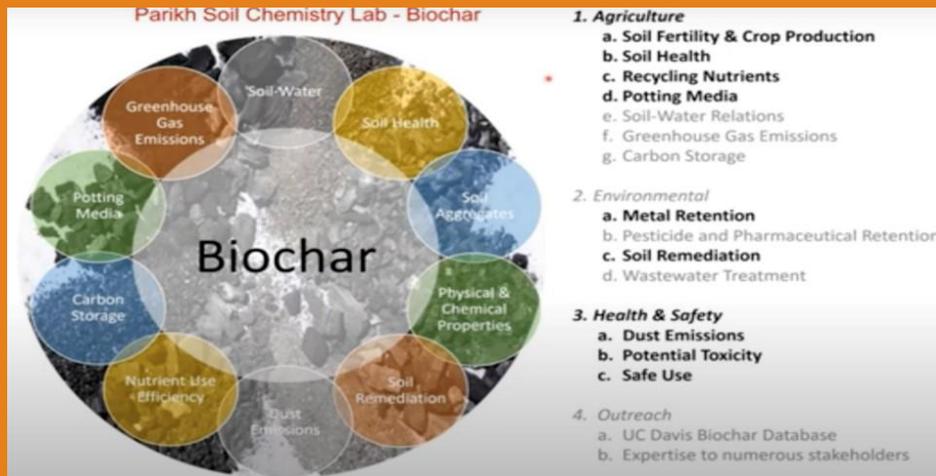


Be caution and read the labels when buying commercial biochar products. There is ongoing research to try to determine which biochar substrates are most useful for which purposes. It is not a one-size-fits-all product!

## Biochar is highly variable based on:

- ❖ Feedstock (e.g. chicken manure, wood chips, crop residues, construction wood waste)
- ❖ Pyrolysis temperature
- ❖ Pyrolysis process

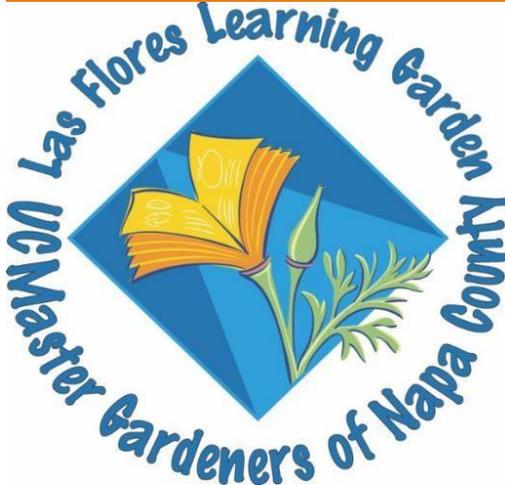
Prof. Sanjai Parikh, UC Davis Dept. of Land, Air, and Water Resources



The Environmental Soil Chemistry Group is led by [Sanjai J. Parikh](#) and housed in the [Department of Land, Air and Water Resources](#) at the [University of California, Davis](#). The primary objective of the group is to examine biogeochemical processes that influence soil and water resources that have bearing on environmental remediation, food safety and security, and soil health.

In horticulture, biochar is very good as peat moss or coco fiber replacement, and for increasing drainage of heavy soils.

## Educational Booth at Fall Fair



Napa County Master Gardeners are likely to have an educational booth about biochar at the Master Gardener Fall Faire on the last Saturday in September, (Sept. 28, 2024,) at Las Flores Learning Garden.

## Resources

- [Napa RCD Conservation Burn Workshop, 2021](#)
- [Biomass to Biochar: Maximizing the Carbon Value, 2021](#)
  - Washington State University, US Forest Service
- [Use of Portable Field Kilns to Process Biomass into Biochar](#)
  - Sonoma Ecology Center
- US Forest Service Biochar Webinar Series in 2022
  - [Hedging Your Biochar Bet: Pairing Biochar Properties with Soil Deficiencies to Improve Agronomic Outcomes](#)
- [Opportunities and Uses of Biochar on Forest Sites in North America, 2021](#)
  - US Forest Service

We hope this presentation has piqued your curiosity about the evolving subject of biochar. Much more research is being done to fine tune what we know and to learn more about biochar and its uses. Thank you for reading!

