NOVEL BIOCHAR INJECTION FIELD TRIAL

COLORADO STATE UNIVERSITY (CSU)

WESTERN COLORADO RESEARCH CENTER – GRAND VALLEY (WCRC-GV)

AGRICULTURAL EXPERIMENT STATION (AES)

FRUITA, CO

2023

PARTNERS & RESOURCES

Scope of Trial

The purpose of this field trial is to test the viability of a novel method of incorporating biochar into soil. An existing machine that is currently used in the sports turf industry to apply a variety of medias, will be used in an agricultural hay production field, using biochar as the media. The biochar will be injected (the machine uses high pressure water injectors) vertically down into the soil profile to a depth of about 8-10 inches, in a uniform grid pattern. We are trying to determine if a porous media (biochar) installed into the soil in this manner, into an active production crop, can produce equal or more forage, and/or higher quality forage using 50% less irrigation water (by frequency or duration). Initial estimates are that this method will amend the soil to hold an additional 3,000 - 6,000 gallons of water per acre. Soil and forage mass & quality samples will be collected before during and after the trial and a report will be produced and submitted to partners by December 2023.

Biochar Used

1. This trial is using a product called 'Persist' biochar manufactured by VGrid Energy Systems in Camarillo, CA. This biochar feedstock is derived from Pistachio shells that are fed into VGrid's Bioserver which uses a gasification process at temperatures of up to 1,300°C. The high-temperature gasification system provides biochar with higher carbon content and great porosity than lower-temp pyrolysis technology. As a result, it holds more water and nutrients, and sequesters more CO2 from the atmosphere (for longer durations).

2. VGrid's Bioserver consists of two trailer-based units: the gasifier and the gen set. The gasifier can process 200 lbs. of biomass per hour, yielding 40 lbs. of biochar, and the accompanying gen set produces 100 KWh of electricity. Energy is the primary product here and biochar is the byproduct. The Bioserver meets even the most aggressive air quality standards, represented by their air quality permits in the Central Valley of California.
   Bioserver - V-Grid Energy Systems (vgridenergy.com)

Trial Design (Figure 1.)

1) 4 Strip Fields – Field N1 & N2 (apx. 2 acres)
   a) Strip 1 – **Biochar Injection – Water reduced to 50%**
   b) Strip 2 – **No Amendment – Water reduced to 50%**
   c) Strip 3 – **Biochar Injection – Water at 100%**
   d) Strip 4 – **No Amendment – Water at 100%**

Sensors - Continuous Data Monitoring

1) Soil Sensors
   a) All-in-one sensor placed in the middle of each field.
      i) **Temperature**
      ii) **Soil Moisture**
      iii) **Electrical Conductivity (E.C.)**

Potential Applications

1) Agriculture
2) Mine Reclamation
3) Forestry
4) Soil Remediation
5) Urban Landscapes
6) NRCS Soil Carbon Amendment Codes 336 & 808
7) Any land area that needs increased rates of infiltration and water retention.

Potential Outcomes

1) **YIELD** - Equal or better yield or lower yield
2) **HAY QUALITY** - Higher quality forage or lower quality forage
3) **MOISTURE (WHC)** - Soil retained moisture for longer or shorter periods of time.
4) **TEMPERATURE** – Increase, decrease, or no change.
5) **ELECTRICAL CONDUCTIVITY (E.C.)** – Salts increased, decreased, or stayed the same.
6) **NUTRIENTS** - Soil nutrients were retained for longer periods or diminished quicker.
7) **BIOLOGY** - Soil biology & CO2 respiration increased/decreased.

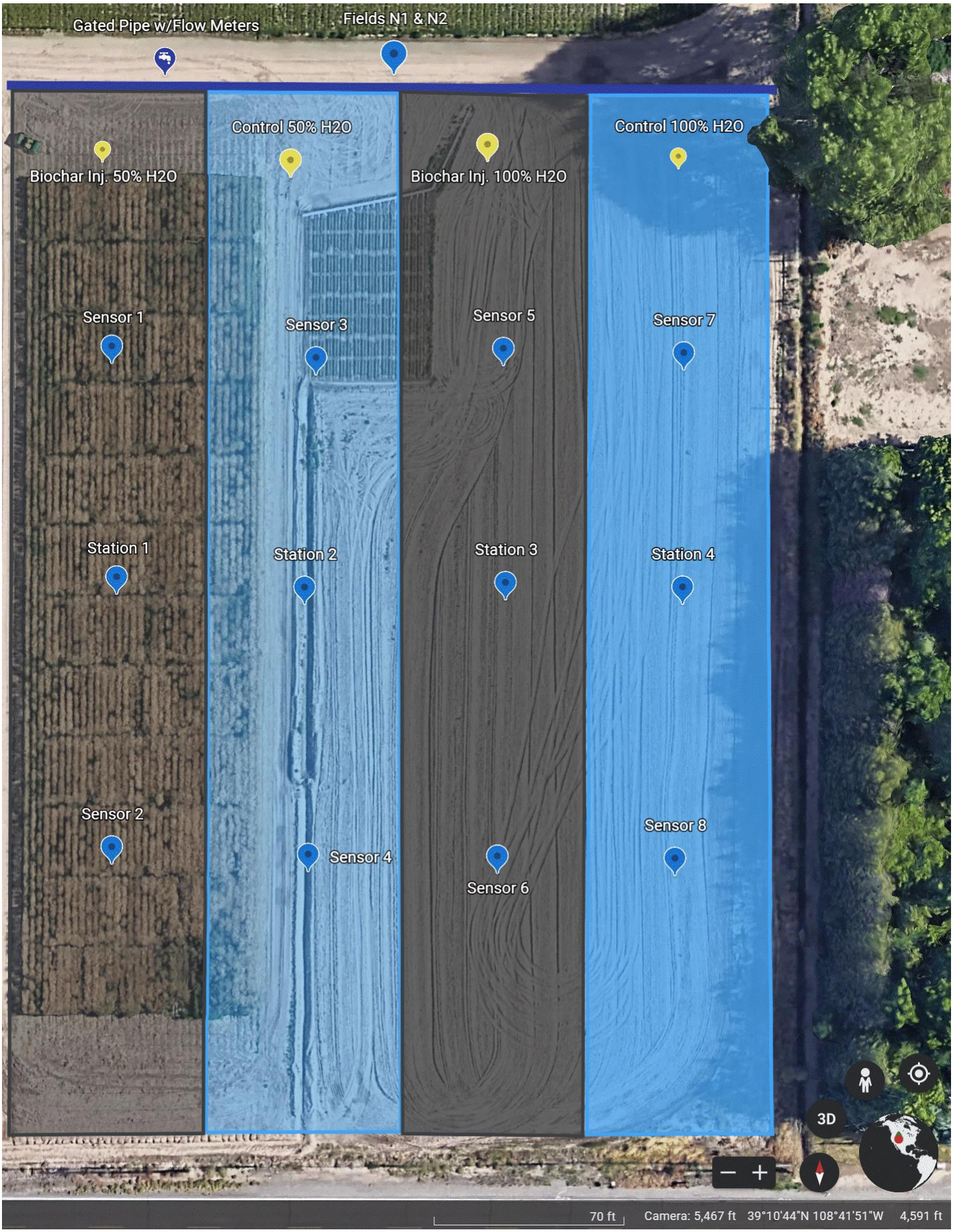

Figure 1. Field Map (top is North)

Feedback Received

Hans-Peter Schmidt – Renowned Biochar & Soil Scientist, Ayent, Switzerland Ithaka Institute - Publications (ithaka-institut.org)

"Thanks for sharing your presentation. I am absolutely convinced that this is the way to go for biochar application. I do advocate it for years and we tested different injection technologies for trees but not for fields and pastures. I see a huge market for such a machine, and I hope you will bring it to success...it will quickly become a microbial and nutrient hotspot. It will also be the only place where soil biota will find water during draught...This will become a game changer in biochar application, Best Wishes Michael...Let me know about your further steps and we could present it also in the Biochar Journal."

Deborah S. Page-Dumroese, PhD, Senior Scientist & Research Soil Scientist, U.S. Forest Service, Rocky Mountain Research Station, Moscow, ID www.fs.usda.gov/rmrs/people/ddumroese

"Thanks for this, Michael. I think another opportunity is restoration of rangeland soils (with or without wildfire). Many rangeland sites have invasive species, and in some cases, biochar may limit the spread of invasives by tying up N and allowing natives that are better able to tolerate low N environments, occupy a site. Thanks again – keep me posted on your progress!"

Patrick Freeze, PhD, Soil/Soil Health Customer Support and Technical Specialist, Kerney, NB www.wardlab.com/about-us/

"Thanks for sharing this. This looks like a great study. Biochar has a laundry list of benefits, from improving soil tilth to reducing plant uptake of heavy metal(loid)s. And it repurposes biomass that would otherwise be landfilled. The benefits it provides can be seen multiple years due to its high stability. I'm not sure if people consider this but one of the main components that allows it to hold so much water is, after charring the pistachio shells and breaking down the material, the product is enriched with not only salts but "water-loving" amorphous silica. Plants acquire silica for structure, and pistachio shells appear to be high in this. Both salts and silica have also been shown to help overcome the hydrophobic nature of "unactivated" chars, which is critical for environmental application. Plus, silica has a long shelf-life in the soil since it can be stabilized by several soil components. Along with the high affinity for water, biochar can "normalize" a soil environment that can experience periods of wetting, both through improved infiltration and from its ability to shuttle electrons like a conductor, which typically occurs in waterlogged systems. The main benefit from this is you don't experience the nitrogen volatilization and losses, iron dissolving, or microbial impacts you would normally see in a reducing environment. I did some biochar work abroad for about year in southern Asia. There, they were using rice husk biochar, which is about 30% silica by weight, so that component did influence much of the soil properties. I think the application of this material in crop production in alkali areas would be extremely useful. Several people have pointed out the issue of elevating the pH with organic amendments, but I have a theory that the high carbon will ultimately buffer the impacts from salts or pH since those soils tend to have much lower organic matter in

general. I think this study you're doing now will tell you everything you need in terms of how it affects the soil chemical environment. You might also look at biochar enriched with iron for the vineyard, which may help with chlorosis issues. I know some of my viticulture peers at Washington State were looking at this with compost. I hope the results prove useful! Hopefully, they have all the data on silica, carbon, and salt content; could be worth assessing. The water-extractable carbon and nitrogen on the SHA will be useful too since you're applying quite a bit of carbon. That can ramp up microbial activity which normally mineralizes nitrogen, but the char is supposed to also bind mineral nitrogen (ammonium); it'll be interesting to see the results. And, I love the soil core picture at the end!"