

Biomass to Biochar for Landscape Health in Carlton County, MN

Final Project Report July 2022

Background:

Many conservation projects completed by landowners generate biomass.

- woody invasive plant removal
- wildfire fuels reduction
- forest stand management (thinning, disease tree removal, ect...)
- wildlife habitat brush management (Sharptailed Grouse)
- brush management for silvopasture acres

Often this biomass is piled and either burned or left to slowly rot away back into the landscape. Sometimes, dealing with this biomass can be a deterrent to a landowner completing BMPs for their property.

Burning this biomass from conservation projects in a biochar kiln is favorable to open pile burning because the flame cap kilns burn much of the emissions generated from the burning process. Another benefit to using a kiln is that the burning process is more controlled and stopped at the right time to produce biochar that has several proven beneficial uses:

- nutrient and water holding capacity (especially when mixed with animal manure or compost)
- sequesters some of the carbon for centuries
- odor control as a livestock bedding additive
- animal health in small dietary supplements
- biofiltering of water contaminants

There are no kilns currently available to northern MN landowners to use to achieve this cleaner burn of biomass from their property projects. So the vision of this project was to build some and demonstrate their use.

Grant Tasks:

1. Build small biochar kilns to be used to turn low value/high volume biomass from landowners conservation projects into biochar.
2. Use kiln fabrication as a real world project for High School Shop class.
3. Demonstrate use in 3 scenarios.
4. Develop best practices for kiln use to minimize emissions, maximize biochar production, address safety issues, and outline usages.

1. Design - Build

First the SWCD led assembling of a kiln design team on a video call. Team members included: Harry Groot, Dovetail Partners, biochar producer and utilization expert
Darren McAvoy, U of Utah professor and biochar researcher,
Russ Kurhjetz, Carlton SWCD Board Chair and small acreage landowner

Brad Matlack, Carlton SWCD Manager
Jeff Jackson, Extension educator and NRRI biochar researcher
Sam Horner, Carlton SWCD Conservation Technician

Several options for kilns were discussed. It was decided to focus this project on building 2 Oregon kilns. This 5' x 5' top dimension kiln would be a doable size for a high school shop class to build, more easily managed by landowners on site, and easily stored and transported by the Carlton SWCD. Free plans were readily available from several internet sources. The kilns built in this project used 14 ga steel sourced from an ordinary steel supply company in Proctor MN.

Another Video call meeting was held to discuss kiln adaptations to make the Oregon kilns mobile to landowners sites and around the sites to access biomass to burn. One kiln would be left un-accessorized for mobility but could be loaded onto a small trailer. The second kiln had axels welded on to the bottom of the kiln to accept pneumatic tires which could be easily removed during kiln burning. This kiln also had a bracket added to attach a handle/hitch for pulling by hand or with light equipment, and channels on the bottom for use with equipment forks.

A build meeting video call was held with HS shop instructors from 2 different Carlton County schools, and some members of the design team. Build plans were reviewed and mobility modifications were discussed.



Selecting a design for the cleanest burning kiln was not a goal of this project. Many kiln designs are being used throughout the U.S. and research is ongoing to look at the cleanest burning options.

This project also envisioned a big box kiln in the range of a 10 foot x 5 foot size more accepting of typical length of brush. The Oregon kilns do require more cutting of the feed stock to fit the 5' x 5' kiln size then desired. But this too was a compromise for mobility and manageability.

Components of the SWCDs biochar creating enterprise

As the kilns were being built by the HS shop class, SWCD staff was assembling the rest of the equipment needed to be self-contained for delivery to landowners to use on their projects. This equipment included:



A 65 gallon water tank our experts indicated would be adequate for quenching the kiln contents to stop the pyrolysis process before reaching the ash stage. The tank was fitted with a valve to accept a standard garden hose and would use gravity flow with the tank elevated above the kiln to produce water flow.

A “weed burner” type torch for lighting the kiln stock. This proved to be a very effective and efficient way to get the kiln to a good uniform flame cap.



For Kiln #1 - a heavy duty lawn cart to carry a kiln pulled by light equipment



For kiln #2 - a handle/hitch for pulling the kiln with welded axels and removeable wheels.



Trailer for transporting kilns to landowners and tiedown straps. This project borrowed a trailer from the Carlton County Parks department. 6x12 with ramp

Some miscellaneous equipment purchased for documenting aspects of the stock, burn process, and other side impacts.



Infrared thermometer to record kiln temps and various items nearby.



Moisture Meter to check dryness of feed Stock



2. Use kiln fabrication as a real world project for High School Shop class.

Although materials were offered to 2 high schools for each to build a kiln, only one school ended up engaging in the actual build of the kilns for this project. SWCD staff worked with the Cromwell HS shop instructor to take delivery of the sheet steel and associated materials. The SWCD took delivery of the first kiln in January and the second in March. This stage of the project was hampered by multiple pandemic related issues including availability of parts and welding supplies, and student labor availability due to class load, holiday time, and sickness.



(from left) Cromwell HS shop teacher Pete Johnson, and the lead student builders. The SWCD organized a small pizza party for these students as an appreciation for their work.

3. Demonstrate use in 3 scenarios.

| Scenario | Timeline | Objective |
|------------------------------|---------------|--|
| Initial Kiln Testing | February 2022 | Gain Experience for SWCD staff |
| Cromwell HS Student Demo | February 2022 | Educate on Biochar Production |
| Cloquet Forestry Center Demo | March 2022 | Demonstrate Flame Cap Kiln Use |
| Buckthorn Cutting Disposal | June 2022 | Conservation Project Application of Kiln Use |

Samples of the resulting biochar from these burns was collected for analysis. A spread sheet was started to record burn details and the resulting biochar characteristics. This information is important to determining quality of biochar for use as a soil amendment.

Demonstration scenario details with pictures is documented in a separate report (RSDP Grant Results Report).

4. Best Practices Guidance for Landowner Biochar Production using the Oregon Kiln

All along the way in this project, much was learned about production and utilization of biochar. This information is detailed in a separate project report (RSDP Grant Results Report) and will eventually be formatted and edited to create a “Landowners Guide to Biochar in MN”. Additionally, video footage of the demonstration of these kilns was collected and will be edited into a couple videos on producing biochar in an Oregon Kiln.

All materials will be available on the SWCD’s Website at CarltonSWCD.org

Project Challenges:

Having students build the kilns presented several challenges.

1. While we were hoping to get the kilns built and tested in the fall before cold weather and deep snow restricted feed stock acquisition, organizing shop teachers, then fitting the project into the welding class curriculum, and finally Covid 19 infection rates in November – February presented delays to the fall demo plan.
2. The build part of this project was also affected by supply chain issues including getting welding gasses and getting parts for the plasma cutter which cut the sheet metal for fabrication.

The education value of having student build real world applicable projects, along with engaging several science classes at the same school in a kiln demo to make biochar was worth the delays. But fabrication could have been completed much quicker using an established fabrication shop.

Staff changes:

When envisioned in March, this grant was supposed to be implemented primarily by SWCD forest specialist staff. Due to hiring complications, grant tasks were carried out by a new technician with limited grant experience. This required significantly more SWCD Manager time on the match side.

The first 4 months of the grant saw 2 key partners leave their positions. One was a grant funded partner and the other was a match contributing partner. In November of 2021, a budget adjustment was done to account for the changes on both the grant and match side of the budget resulting from these changes.

Grant funds

Grant fund savings were realized in the Carlton FD line due to all but the June demo was conducted during the winter eliminating the need for fire control stand by assistance.

This savings was put into additional equipment and supplies and SWCD staff time.

Match funds

Significantly more time was spent by the SWCD manager to complete this project. This included time to research production and utilization information for the landowner best practices guide, reporting, and project management.

Final Expenditures

| Description of expense (Start with personnel costs, then travel and supplies, and any other costs.) | Funding source | Original Budget | | Actual Expenditures | |
|---|--|-----------------|-----------------|---------------------|-----------------|
| | | Grant | Match | Grant | Match |
| PERSONNEL | | | | | |
| Personnel: Carlton SWCD, Forestry Specialist (x6 days @ | RSDP | \$2,880 | | \$5,020 | |
| Personnel: Dovetail Partners, McFarland (x2 days @ \$600/day) | RSDP | \$1,200 | | \$600 | |
| Personnel: Carlton SWCD, District Manager, Matlack (x4 days @ \$664/day) | Carlton SWCD | | \$2,656 | | \$22,806 |
| Personnel: Carlton SWCD, Forestry Specialist Extra time | | | | | \$14,765 |
| Personnel: Carlton SWCD, Ag Staff, landowner outreach (20 hrs. @ \$60/hr) | Carlton SWCD | | \$1,200 | | |
| Personnel: Dovetail Partners, McFarland (x2 days @ \$600/day) | Dovetail Partners | | \$1,200 | | \$1,650 |
| Personnel: tools and labor for kiln fabrication at school | Local school district | | \$1,000 | | \$1,000 |
| Russ Kurhajetz - liaison with school district and support demonstrations (40 hours @ \$35/hour) | Personal, Carlton County SWCD Board Member | | \$1,400 | | |
| MATERIALS & SUPPLIES | | | | | |
| Materials & Supplies: kiln fabrication by students | RSDP | \$2,500 | | \$3,003 | |
| Materials & Supplies: expenses related to demos and outreach events | RSDP | \$500 | | \$75 | |
| CONTRACTS | | | | | |
| Contract: Carlton VFD - time and equipment during demonstrations (x3) | RSDP | \$1,680 | | \$280 | |
| Contract: biochar characterization/analysis | independent lab | \$500 | | \$282 | |
| EQUIPMENT | | | | | |
| Equipment: truck to pull trailer for demos | Carlton SWCD | | \$500 | | \$500 |
| Equipment: equipment to load biomass and move biochar during demos | Local landowner contribution | | \$1,080 | | \$0 |
| Equipment: trailer to haul kilns for demonstration work | Carlton County | | \$4,000 | | \$4,000 |
| | | | | | |
| | | \$9,260 | \$13,036 | \$9,260 | \$44,721 |