**Scott River Watershed Council's**
**North Coast Resource Partnership**
**Regional Forest and Fire Capacity Program**

Siskiyou County Fuel Reduction, Greenhouse Gas Reduction and Soil Health Amendment Demonstration Project

**Economic Viability Report**

**12/22/21**

**Siskiyou County Fuel Reduction, Greenhouse Gas Reduction and Soil Health Amendment Demonstration Project - Economic Viability Report**

The primary goal of this project was to determine the economic feasibility of using carbonator technology to convert excessive forest fuels into biochar. This economic analysis provides information about the conversion of feedstock to biochar, the cost of running the Tigercat 6050 Carbonator, and the laboratory analysis of the biochar. It also discusses the potential for carbon sequestration through the long-term storage of carbon as biochar, and the use of biochar as a soil amendment.

**Conversion of Feedstock to Biochar:**

The project area was located on private land in Patterson Creek drainage outside of Etna, within the Scott River watershed, a subbasin of the Klamath River basin. The feedstock was predominantly Ponderosa Pine (*Pinus ponderosa*) at a low elevation site of 2827 feet. The biochar operation ran for 80 hours and utilized feedstock harvested from 19 acres. The trees ranged from 12-18 DBH and were calculated to be 19.6 bone dry tons/ acre. Trees were felled in the spring of 2020 and left in doodle piles (large log piles) to cure over the summer. The project utilized work that was being completed as part of a fuel reduction and shaded fuel break funded by the California Climate Investments (CCI) grant. The cost of preparing the feedstock was used as match funding for $74,307, this included rocking the road to provide access during the wet season as well as cutting and preparing the feedstock. For this analysis the road rocking is not included as that had additional benefits to the larger project. The cutting of the feedstock is estimated at $414 per acre.

The feedstock was then piled at the landing and fed into the machine with an excavator. Additional wood was skidded to the landing as needed. In the 80 hours of run time the biochar operation reduced 373 bone dry tons of feedstock to 46.67 tons of biochar. The biochar was 13% of the bone-dry tonnage. The conversion rate also increased as the operators became more efficient. There were issues with equipment freezing and breakdowns in the first couple of days of the project. The project increased from 1.6 yards/ hour to 5.15 yards per hour on the last day (Table 1).

*Table 1: Carbonator production*

| Run hours | Volume (yds) | Yard/ hour |
|---|---|---|
| 3 | 2 | 0.62 |
| 10 | 16 | 1.60 |
| 20 | 38 | 1.90 |
| 6 | 17 | 2.83 |
| 15 | 31 | 2.07 |
| 13 | 45 | 3.46 |
| 13 | 67 | 5.15 |
| Total yards | 216 | |

**Cost to operate Carbonator:**

There are additional costs associated with this project including pre-project planning, equipment mobilization and set up, along with housing and amenities for employees. For this analysis equipment rates were provided by Falk Forestry Inc. if the project would have continued for an additional 80-hour period. The rates include fuel costs for operation of the machinery. This rate is more realistic of the Carbonator operated using local labor. The cost to operate the Carbonator is ~$666/ hour. The total cost for preparing the feedstock and creating the biochar is estimated to be $847/ hour (Table 2).

*Table 2: Economic Cost Analysis*

| **Siskiyou County Fuel Reduction, Greenhouse Gas Reduction and Soil Health Amendment Demonstration Project** | | | | | | |
|---|---|---|---|---|---|---|
| 12/6/20 thru 12/12/2020 | | | | | | 80 hours |
| **Budget Item** | **Rate/ acre** | **Units (acres)** | **Total Cost** | **Hours** | **Cost /hr** | **Acres/ hr** |
| **Preparing Feedstock** | | | | | | |
| Cutting with Feller Buncher | $357 | 35 | $12,500 | 80 | $156 | 0.4375 |
| Firewater/Swamper | $56 | 35 | $1,974 | 80 | $25 | 0.4375 |
| **Feedstock preparation Totals** | **$414** | | **$14,474** | | **$181** | |
| **Equipment** | | | | | | |
| Excavator | 632 | 19 | $12,000 | 80 | $150 | 0.2375 |
| Dump Truck | 421 | 19 | $8,000 | 80 | $100 | 0.2375 |
| Water Tender | 421 | 19 | $8,000 | 80 | $100 | 0.2375 |
| Carbonator | 842 | 19 | $16,000 | 80 | $200 | 0.2375 |
| **Subtotal** | **$2,316** | | **$44,000** | | **$550** | |
| **Labor Costs** | | | | | | |
| 4 heavy equipment operators | $116.00 | 19 | $9,280.00 | 80 | $116.00 | 0.2375 |
| **Carbonator costs** | **$2,432** | **19** | **$53,280** | **$80** | **$666** | |
| **Total costs** | **$2,845** | **19** | **$67,754** | **$80** | **$847** | |

**Biochar Analysis:**

The biochar was sent for analysis to Control Labs in Watsonville, California. The initial analysis of the biochar results showed a very low carbon content of 37.6%. Because of this low reading, additional samples were sent, and the biochar was retested. The second analysis showed a carbon content of 50.8% (Table 3). Additional analysis of the biochar might be of interest to better understand the overall carbon content and the heterogeneity of the biochar. These results showed that the biochar did meet the standards International Biochar Initiative (IBI) Laboratory Tests for Certification Program and had acceptable levels of concentrations of heavy metals. Based on these results the biochar generated had a bulk density of 16 lbs./ cu ft. and 50.8% of it was organic carbon. In total, there was 23.70125 tons (47402.50 lbs.) of organic carbon stored as a biochar product. In general, 1 lb. of carbon is equal to 3.67 lbs. of carbon dioxide ($CO_2$). Our analysis shows that 173,967.17 pounds $CO_2$ or 87 tons $CO_2$ is contained in the biochar generated throughout the duration of this project (US Energy Information Administration, 2021). This analysis does not account for recalcitrance in the soil. Typically, biochar has one to two orders of magnitude longer persistence than the biomass it is made from (University of California, Agriculture and Natural Resource, 2016). The Climate Action Reserve estimates recalcitrance at an assumed annual decay of 0.3% for biochar with similar Hydrogen to Carbon ratios for a 100-year permanence period. It is expected that 70% of the carbon (121,777 lbs.) will remain in the soil for 100 years. The Climate Action Reserve is also in the process of developing a Biochar Protocol that will provide guidance on how to quantify, monitor, report, and verify climate benefits from the production and use of biochar (Climate Action Reserve, 2021).

*Table 3: Biochar Analysis Summary*

| **Biochar Analysis** | |
|---|---|
| Moisture (time of analysis) | 46.2 % wet wt. |
| Bulk Density | 16.0 lb/cu ft |
| Organic Carbon | 50.8 % |
| Hydrogen/Carbon (H:C) | 0.44 |
| Total Ash | 44.6 % |
| Total Nitrogen | 0.40 % |
| pH value | 8.45 |

**Soil Application of Biochar:**

The efforts from this project have been built upon to continue to enhance our understanding of biochar in the region. The biochar from the project was distributed to five local agricultural producers in the Scott Valley. The objective of introducing biochar amendments as an agricultural practice is the potential to reduce inputs of water and fertilizer, increase the profitability to agricultural producers and at the same time, conserve water for environmental needs and provide resilience to climate change.

To further analyze the potential benefits of this type of application, SRWC secured grant funds from the Conservation Innovation Grant (CIG) through the USDA Natural Resources Conservation Service. SRWC and the producers have set up a field trial to study the effects of biochar and water holding capacity. The study will have three treatments and a control: Biochar Only (BO), Compost only (CO), Composted Biochar (CB) and a Control (C). The composts are made on site with manure readily available to the producers. Each trial will be replicated four times using a randomized block design for a total of 16 plots per site. These field trials will provide data to the agricultural and forest health professionals to enhance the understanding of the benefits and costs of using biochar, compost, and composted biochar as a soil amendment.

**Summary Statement & Lessons Learned:**

The Tigercat 6050 Carbonator is a scaled-up tool for making biochar in the field and can operate on a forestry level scale of fuel reduction. However, it is important to consider that the operation of the carbonator can only occur outside of the declared fire season. This significantly reduces the amount of time the carbonator can operate throughout the year in our region. The carbonator is mobile and can go out to timber harvest or fuel reduction sites and operate in the field. This reduces the hauling costs of moving chips or logs and reduces the risks associated with open pile burning. Transportation costs of hauling water for quenching and distribution of the biochar product will need to be considered for more remote locations. The quenched biochar could also be left in the forest and have the same carbon sequestration effects. The operation of the Carbonator would be more cost effective if it were to stay in a region and work collaboratively with various landowners and projects. There is a broad interest in biochar from around the region however the cost of operating the Carbonator is more expensive and less efficient than pile burning or other types of field reduction. Financial incentives such as the developing carbon credit program or newly created conservation practices through NRCS may encourage landowners to adopt these practices in a forestry and agricultural setting.

**References:**


Climate Action Reserve: https://www.climateactionreserve.org/wp-content/uploads/2021/08/Biochar-Protocol-Kickoff-Webinar-081221.pdf

UCANR Biochar and Carbon Sequestration:
https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=22224

US Energy Information Administration: https://www.eia.gov/tools/faqs/faq.php?id=82&t=11