Opportunities for biochar production to reduce forest wildfire hazard, sequester carbon, and increase agricultural productivity of dryland soils

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The specific aims of the study were to: (1) Optimize woody biomass biochar feedstock collection and transport, and biochar production and application in the Upper Klamath Basin, (2) Evaluate the physical properties of forest-origin biochar and its function as a soil amendment, (3) Optimize fire hazard reduction in the context of biochar production, and (4) Identify the long-term carbon consequences of an optimized forest-to-field biochar production chain.

A harvesting cost model or tethered and non-tethered cut-to-length harvesters and forwarders was developed based on a field study of forest restoration timber sale on the Fremont-Winema National Forest (Petitmermet 2018, Petitmermet et al. 2019a). Using this harvesting model and BioSum Assessment Model, estimates of biochar feedstock availability were developed for the Upper Klamath Basin (Petitmermet 2018, Petitmermet et al. 2019b) using a Composite Resistance Score to guide scheduled treatments over a 20 year period. Marginal cost curves for supply were developed to potential plant sites in the Upper Klamath study area.

Two biochar production technologies were evaluated, conventional thermal pyrolysis and microwave. Biochar production estimates were developed based on a brownfield site at Worden, OR and a site co-located with a sawmill at Yreka, CA. Four scenarios were evaluated in terms of complexity from simple biochar recovery through power and condensable liquid recovery. Working with our technology suppliers, the Karr Group and BSEI, and equipment suppliers, a detailed equipment list was developed from energy and mass balance analyses. Of the four scenarios evaluated, a conventional pyrolysis conversion process, with heat recovery, but without power recovery, resulted in the lowest per unit production costs. The capital cost of establishing a biochar plant at either a brownfield site or co-locating with an ongoing commercial facility was about the same cost as long as basic infrastructure was available. At a plant scale of 50,000 bone dry tons of feedstock input, biochar production costs were about one-third of reported production levels in the literature for smaller scale installations. This enables a much larger market that potentially includes commercial agriculture (Sessions et al. 2019).

Discussions were held with compost producers and fertilizer distributers in the Klamath area to examine methods of delivering biochar to farm fields. For organic farmers, mixing biochar with compost appears to be a logical method of distributing biochar to fields using the conventional compost delivery supply chain. However, demand for biochar in the Klamath Basin appears more limited than originally thought due to widespread leasing of lands that do not encourage long term investments by lessees. These findings have focused product distribution on super-sack output at the facility followed by either truck or rail to larger markets.

Carbon consequences of biochar production depend upon the comparison baseline. Where logging residue is left to decay on site after forest restoration treatments, the net carbon storage attributed to 20 years of biochar production is generally negative for the first several decades, balances its initial carbon debt after about a century, then remains positive for several centuries at levels approximately one-fourth the total feedstock carbon processed (Campbell et al. 2018).

A popular magazine outreach article summarizing the project is under development (Kauffman, 2019).

References Cited

Campbell, J., J. Sessions, D. Smith, and K. Trippe. 2018. Potential carbon storage in biochar made from logging residue: basic principles and southern Oregon case studies. Published Sep 13, 2018. PLoS ONE 13(9): e0203475.

Kauffman, M. (2019 in preparation). Opportunities for biochar production to reduce forest wildfire hazard, sequester carbon, and increase agricultural productivity of dryland soils

Petitmermet, J. 2018. Tethering and Biochar: Two Emergent Technologies with Implications for Fuels Treatments on Federal Forest Lands. MS thesis, Oregon State University, 221 pp.

Petitmermet, J., J. Sessions, J. Bailey, and R. Zamora-Cristales. 2019a. Cost and productivity of tethered cut-to-length systems in a dry forest fuel reduction treatment: A case study. In Press. Forest Science.

Petitmermet, J., J. Fried, and J. Sessions. 2019b. Regional analysis of feedstock availability from forest restoration to support biochar production in the Upper Klamath Basin, a case study. In final review. Journal of Forestry.

Sessions, J., D. Smith, K. Trippe, J. Fried, J. Bailey, J. Petitmermet, W. Hollamon, C. Phillips, and J. Campbell. 2019. Can Biochar Link Forest Restoration with Commercial Agriculture? Biomass and Bioenergy 123(2019):175-185.