2019 Project Abstract
For the Period Ending June 30, 2022

PROJECT TITLE: Forest and Bioeconomy Research - Subproject 3 MFRC to support advancement of biochar for forest health
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APPROPRIATION AMOUNT: $400,000
AMOUNT SPENT: $400,000
AMOUNT REMAINING: $0

Sound bite of Project Outcomes and Results
Biochar is a material that can be produced from residual biomass that can improve soil health and reforestation while storing carbon for the long term in soils. This project demonstrated production and deployment of insect-damaged balsam fir and black ash as biochar to improve seedling regrowth and retain nutrients in sandy forest soils.

Overall Project Outcome and Results
We demonstrated the concept of using Minnesota black ash and balsam fir as feedstocks for the generation of biochar for forest soil amendments to improve reforestation efforts. We produced biochars from both black ash and balsam fir wood chips at a variety of temperatures and characterized these by measuring different physical and chemical properties.

The fully-characterized biochar samples were evaluated in greenhouse plant growth studies. Biochars from black ash and balsam fir processed at 550°C were the most promising candidates for positive soil health improvements, as these products revealed a) the highest water holding capacities, b) minimization of potentially harmful mobile organics (extractives content), and c) greatest nitrogen and dissolved organic carbon retention. Field trials were then performed at the Cloquet Forestry Center to evaluate biochar impact on red pine and red oak seedling survival. Biochars were added to the soil surrounding newly-planted red pine and red oak seedlings using a randomized nested design with appropriate controls. Early results on photosynthesis and respiration rates from the field study are positive but conclusions on biochar's role on improving seedling survival will require long-term monitoring at the field site, extending beyond the end of this project.

We also produced two literature reviews. The first study examined net carbon sequestration potential of using biochar in forest regeneration projects and concluded that there is ample supply of black ash in Minnesota to support industrial-scale biochar production and that 20 years of biochar production in Minnesota, just from black ash, would sequester approximately 6.7 million tons of CO_2. The second study was a techno-economic analysis performed by Dovetail Partners. This report concluded that the ecological and economical benefits of biochar implementation are best suited for revegetation efforts for jack and red pine in areas with sandy soils. This report can be found online: Dovetail Partners report.

Project Results Use and Dissemination

1) Toczydlowski, Alan JZ; Robert A Slesak; Rodney T Venterea; Kurt A Spokas. Effect of Biochar Feedstock and Pyrolysis Temperature on Nutrient Cycling in Forest Soil. 2021 ASA, CSSA and SSSA International Annual Meetings, Salt Lake City, Utah. Oral presentation November 7-10, 2021.
2) Reuling, Laura F; Alan JZ Toczydlowski; Robert A Slesak; Marcella A Windmuller-Campione. Effects of biochar on drought tolerance of Pinus banksiana seedlings. USFS National Silviculture Workshop, Kellogg, ID. Oral presentation July 12-14, 2022.
3) McFarland, Ashley; Fernholz,Kathryn; Groot, Harry. Biochar Potential in Minnesota's Forests. Commissioned Report 2021.
4) Singsaas, Eric. Engineering functional biochar for specific applications. North American Biochar & Bioenergy Conference, Morgantown, West Virginia. Oral Presentation August 8-11, 2022.
5) Barry, Brian. A new approach for complete pore size distributions and regime-specific total pore volume determinations of biochars. North American Biochar & Bioenergy Conference, Morgantown, West Virginia. Oral Presentation August 8-11, 2022.
6) Singsaas E, Barry B, Kolomitsyna O, Kacharov O, Yemets S, Young M, Toczydlowski A, and Slezak R. 2022. Biochar from insect-damaged trees used as a forest soil amendment: production, characterization, and application. Natural Resources Research Institute, University of Minnesota Duluth, Technical Report NRRI/TR-2022/16.
7) Singsaas, E., Kolomitsyna, O., Kacharov, O., Young, M., and Barry, B. 2022. Biomass pretreatment to make clean syngas from Minnesota wood residuals. Natural Resources Research Institute, University of Minnesota Duluth, Technical Report NRRI/TR-2022/17
8) Wright, C. 2022. Biochar Production Scenarios in Minnesota Utilizing Ash (Fraxinus spp.) as a Feedstock. Natural Resources Research Institute, University of Minnesota Duluth, Technical Report NRRI/TR-2022/15