

1. USU Grants Program 2017

2. Reducing Hazardous Fuels Using Low Cost Biochar Kilns in Four Utah Counties

3. Discipline: Natural Resources

4. Project Leader: Darren McAvoy A00017655

Collaborators:

Andree Walker, Urban Director, Salt Lake County, A00016030

Dennis Worwood, Director, Emery County, A00015655

Troy Cooper, Director, Duchesne County, A00015037

Sterling Banks, Director, Summit County, A00015655

5. Project Duration: April 1, 2017-December 31, 2018

6. Total Amount Requested: \$30,000.

7. Abstract: This project will develop low cost biochar kiln operations in Utah. Simple biochar kilns will be purchased, a workshop and a subsequent demonstration will be conducted. The kilns will operate in in four counties in Utah on private land. Target audience includes wildland firefighters, arborists, fruit growers, and Master Gardeners.

1. Reducing Hazardous Fuels Using Low Cost Biochar Kilns in Four Utah Counties

Hazardous fuels are a problem across Utah. Invasive species such as Russian-olive have been removed and piled in many counties including Emery, Uinta, and Salt Lake. Beetle kill lodgepole pine is a problem in Summit County. Disposing of Douglas-fir thinning is a problem in Duchesne County. Juniper is being removed and disposed of on a grand scale across Utah. Simply burning these piles, as we have always done, is increasingly difficult with air quality and fire hazard restrictions in place. Pile burning is not only difficult, the excessive heat generated has been shown to cause long term productivity losses to the soil beneath the piles. The waste material in these piles is carbon that can be sequestered for decades or centuries by converting it into biochar, a durable soil amendment. The work of converting the excess carbon in our forests into carbon that can be utilized in our agricultural lands will create jobs and spur rural economies. This project has the potential to make improvements in diverse portions of our economy. These are a few of the problems this project will address.

The objective of this project is to develop low cost biochar kiln operations in Utah. The first step is purchasing four kilns and hiring a consultant (Kelpie Wilson, see appendix) to conduct a workshop at the Lone Peak Conservation Center in Draper. After the initial workshop in Salt Lake City the kilns will be moved to Duchesne County where they will be put to work for several weeks on private land, then used to conduct a demonstration. This is a 'teach them how to fish' approach to biochar production that arborists, loggers, fuels treatment companies, orchard growers, master gardeners and private landowners will adopt and apply.

We will use these methods to treat a wide variety of fuels including Russian-olive, Douglas-fir, lodgepole pine, aspen, and more. Some fraction of the biochar can be collected and distributed to local producers for agricultural application, while the remaining biochar can be spread on the forest sites. Each kiln is essentially a metal box, five feet square and two feet tall, weighing approximately 200 pounds; they are intended to be very portable and will be moved from project to project through the life of the grant.

When the Duchesne County project is complete the kilns will be moved and used in Emery and Summit Counties on privately owned lands. Additional outreach activities will include submission of manuscripts to scholarly publications that describe the program as well as biochar production and fuels reduction strategies.

This grant will catalyze the work between other grants held by the Darren McAvoy and the Utah Biomass Resources Group. Several existing grants will be leveraged in the completion of this work including biomass utilization grants and fuels reduction grants. This venture is intended to be a step toward the scaling-up of biochar production towards a completely mechanized operation so producers can use standard machinery to process larger volumes of material.

2. Literature Review

Although slash pile burning is a commonly accepted and inexpensive means of fuel reduction (Busse et al. 2013). Studies have revealed lasting negative impacts on the health and productivity of the soils (Rhoades and Fornwalt 2015) where the piles were burned. The massive amount of heat generated from these piles literally cooks the life out of the earth beneath where the pile was burned.

Soil Scientists with the Rocky Mountain Research Station report that slash piles burned in the 1980's on the Flathead National Forest caused the soil beneath the piles to be cooked so severely that they are still unproductive today, more than 30 years later (personal communication, Debbie Page-Dumroese, 2016). There is a good chance that I personally burned some of those same piles as a firefighter on the Flathead Hotshot Crew at that time. This project is a step toward preventing a repetition of those mistakes.

Fuels treatment in Utah and other western states is a complex problem. The BLM is treating more than 40,000 acres of Pinyon-Juniper woodlands in Utah annually (personal communication, Doug Page, 2015), most of which is masticated; chewed up by machines called Bull-Hogs that pulverize the trees and spread their shredded material on the ground to rot or burn. This work is being done to rehabilitate rangelands, reduce hazardous fuels, and improve wildlife habitat. There are invasive species removal projects ongoing in and around Utah that target woody species such as Russian-olive and tamarisk, and dealing with the material is a significant disposal issue in some Utah counties (personal communication, Dennis Worwood, 2017). Currently, when a fruit producer removes or prunes an orchard, the common practice is to burn the piles of old orchard wood that are pushed together with machines. Similarly, when a forest is harvested, only a third of the material is utilized; the rest is typically piled and burned.

Often, it is difficult to burn these piles when they are in close proximity to Wildland Urban Interface areas and risks are considered too high when in proximity to highly valued watershed areas. (Hessburg et al. 2007) Increasing air quality measures also make it increasingly difficult to conduct pile burning operations.

In presentations provided at the Biochar 2016 conference held in Corvallis, Oregon and the 2016 Statewide Wood Energy Team meeting in Missoula, Montana, we learned that simple biochar kilns were being produced and being used in efficient fuel reduction systems in several western states including Oregon, California, and Nevada, for example <http://www.reviewjournal.com/news/nevada/nevada-experiments-biochar-improve-health-forests>. As the chair of the Utah Biomass Resources group, I am unaware of these kilns being utilized in Utah.

The Utah Biomass Resources Group worked with Amaron Energy of Salt Lake City to develop and scale-up a mobile pyrolysis machine. This machine won a competition among similar machines in Washington State in 2014, (Utah Forest News, 2014) but this machine costs close to one million dollars to purchase. This rotary kiln design produces biochar, syngas, and bio-oil. While there is much value in this approach, it is cost-prohibitive for most Utahans. The simple kilns I'm proposing we purchase with this project cost about \$1,000 each, in comparison, and are much simpler to operate. My Nevada Division of Forestry colleague Eric Roussel, referred to in the news story linked above, calls this approach 'caveman' biochar production. Furthermore, using the higher cost kilns requires chipping the material to a half-inch minus size category; in one case in Nevada the chipping of the material cost more than the pyrolysis itself (personal communication, Ralph Coates, 2015). Chipping costs can be avoided with these simple kilns that can be fed with logs cut to a five foot length and six inches diameter.

Amending soils with biochar is like adding thousands of tiny sponges to the soil; it soaks up water and makes it available to plants. Charcoal added to soil has been shown to increase the water holding capacity of sand, slightly increase the capacity of loam, and reduce the water holding capacity of clay soil (Tyron, 1948). Incorporating 10-tons of biochar into the top six inches of soil over an acre of agricultural land has been shown to increase water holding capacity by tens of thousands of gallons on that acre (personal communication, Debbie Page-Dumroese, 2016). Biochar helps convert ammonium to nitrates

that are available to plants in forest soils (DeLuca et al. 2006). Finally, mycorrhizal fungi species distribution and abundance has been shown to be changed by the addition of biochar to soils (Lehmann et al., 2011).

With high oil prices the importance of forest biomass as an energy source increases as well. Amaron Energy and AEG CoalSwitch, two Utah companies, are currently working with PacifiCorp to replace 15% of the coal burned at two Utah power plants with a torrefied wood product, this is similar to biochar but cooked at a lower temperature; it is browned instead of blackened (Utah Forest News, 2016). If successful, this will mean the productivity of the surrounding forests is important to energy production. Biochar has been shown to increase the woody biomass output of young forests by as much as 41% (Thomas & Gale, 2015).

Charcoal production is an important ecological component of wildfire. With the aggressive suppression of wildfire over the past 100 years, natural charcoal production has been altered. More frequent fire has been shown to increase the accumulation of charcoal in forest soils (DeLuca & Aplet, 2008). Although the application of prescribed fire can be modified to maximize the production of charcoal, (Brewer et al. 2015), the public appears to have a limited appetite for prescribed fire. It is therefore sensible to seek solutions to these problems by putting that prescribed fire in a box, or a biochar kiln in this case.

3. Objectives:

- Introduce biochar kilns to the Utah wildland fire community, arborists, loggers and landowners as a means of hazardous fuels reduction
- Reduce hazardous fuels
- Sequester carbon
- Make value from trash (biochar from waste wood)
- Distribute biochar to Utah producers for soil amendment
- Introduce USU County Extension Agents to these methods of biochar production and subsequent biochar application on agricultural soils

4. Evaluation Plan

Participants in the workshop and demonstrations will be surveyed using paper and digital Qualtrics tools to determine and document the impact of the events. Feedback from participants will be recorded and reported. Spin-off projects involving biochar kilns being used in Utah and nearby will be closely monitored and documented.

5. Outputs and Outcomes

Utah residents and business owners will have an increased awareness of biochar production methods. Utahans will adopt these technologies and apply them to reduce hazardous fuels, produce biochar, amend soils, and sequester carbon. Outputs will include a Biochar Kiln Workshop with an estimated 45 participants, a Biochar Kiln Demonstration with 50 participants estimated, a Utah Forest News article, a Utah Forest Facts factsheet, and a Learn at Lunch Webinar.

6. Plans to Sustain/Leverage/Secure Funding

This grant will be leveraged by several other existing and yet-to-be-proposed grant projects.

Darren McAvoy is the Principal Investigator of a grant titled *Bureau of Land Management-Utah Biomass Resources Group Partnership*, for \$50,000 annually until 2021. The bulk of that grant is already committed to using biochar for rehabilitating failed reclamation sites associated with gas drilling in the Uinta Basin. Approximately \$5000. Of this grant can be applied to this biochar kiln project.

The UBRG also has a one-time \$20,000 grant from the USDA Forest Service for advancing biomass utilization in Utah. Although this money is mostly committed to other projects, there is the flexibility to put perhaps \$2000. of those the funds into a biochar kiln project as proposed here.

Darren McAvoy is a co-investigator of a grant that is administered by Southeast Area Forester Natalie Conlin, (Utah Division of Forestry, Fire and State Lands, (DFFSL). This \$240,000 grant, *Forest Restoration through Biomass Utilization in Southeastern Utah*, originates from the USDA Forest Service. Conlin has agreed to earmark \$10,000. for the considerable expense of paying crews to do the work of reducing fuel loading and producing biochar using these kilns.

Northeast Area Forester, PJ Abraham (DFFSL) is applying for a grant through his agency to conduct a thinning operation of Douglas-fir on private land in Duchesne County. These funds can be applied toward doing the often expensive field work of thinning and burning the removed material, but with the assistance of this Extension Grant, the piles can be burned in kilns instead of on the ground with the added benefits of reducing soil damage and air pollution while sequestering carbon.

There is a lack of science available on the emissions produced from the kilns we are proposing. Baseline work exists on the emissions of open pile burning therefore this might be the impetus of a worthwhile comparison study. In conducting the ground-work to prepare this proposal, I had meetings with Dr. Bill Doucette and Dr. Randy Martin of the Utah Water Research Laboratory, and others on conducting emissions testing as part of this proposal. It was ultimately decided that the scope of this Request for Proposals was too limited to allow both biochar production and emissions testing, so other sources of funding will be sought out for that purpose.

Finally, there is considerable interest to conduct a similar project in Montana where these types of kilns are yet to be introduced to the forest industry. Forestry Extension colleague, Martin Twer, and USDA Forest Service Biomass Coordinator Julie Kies, and myself have had considerable discussions on how to apply this simple technology in our respective states. We will continue this conversation as we pursue more funding.

7 Plans to Disseminate Results and Findings

The UBRG and USU Forestry Extension are well positioned to disseminate these results and findings with many tens of thousands of visitors to our websites each year. We will publish at least one story on this project in the [Utah Forest News](#). We will produce a [Utah Forest Facts factsheet](#), and conduct a Webinar as part of our [Learn at Lunch series](#), which has had as many as 500 participants in a single session. We

will work with local press to further spread the word. Finally, we will submit proposals to give presentations and/or professional posters at conferences such as the Association for Natural Resource Extension Professionals, the Society of American Foresters, and the National Extension Sustainability Conference, as well as other opportunities that arise. Funds from other operating budgets can be used in collaboration with this outreach effort.

8 Collaborators Roles

Darren McAvoy, Extension Assistant Professor, Wildland Resources Department, will lead the program.

Andree Walker Bravo, Urban Director, Salt Lake County Extension, will assist with the workshop at the Lone Peak Conservation Center; assist with logistics, help bring an audience, specifically the urban audience that might include Master Gardener members, orchard growers and arborists, collaborate with evaluation, help find gardeners and producers interested in utilizing the biochar, and edit documents derived from the program.

Troy Cooper, Duchesne County Director, will assist with logistics of a demonstration event to be held on private land on the Emma Park Road, assist with developing an audience for the workshop, help find local producers interested in utilizing the biochar as a soil amendment or otherwise, collaborate on evaluations, and edit documents derived from the program.

Dennis Worwood, Emery County Director, will assist with the logistics of utilizing the biochar kilns in Emery County, help find available feedstocks, consider conducting another demonstration for local audiences, identify producers interested in utilizing the biochar for agricultural production, collaborate on evaluations, and edit documents.

Sterling Banks, Summit County Director, will assist with the logistics of utilizing the biochar kilns in Summit County, help find available feedstocks, consider conducting another demonstration for local audiences, find producers interested in utilizing the biochar for agricultural production, collaborate on evaluations, and edit documents.

Area Foresters Natalie Conlin and PJ Abraham with the Division of Forestry, Fire, and State Lands will assist with finding interested private forest landowners host these activities, help coordinate crews, edit documents, and plan logistics. One of the requirements for the Utah Forest Landowner Education Program, which is the larger umbrella under which Darren McAvoy operates, is for USU Forestry Extension to cooperate with the Utah Division of Forestry, Fire, and State Lands in projects such as this.

9 Budget Narrative

The requested \$30,000. will be split into approximate thirds; one third to pay for the kilns and workshop consultant Kelpie Wilson, one third to pay for the crews to conduct the burns, and the final third for logistics and program support.

\$9,100: Wilson Biochar Consultant Kelpie Wilson will build and deliver four flame carbonizer biochar kilns from Oregon to Utah and conduct a workshop at the Lone Peak Conservation Center in Draper, Utah.

\$10,900: Lone Peak Hotshot Crew will load kilns and conduct the burns. The rate is \$26 per hour per person, in 4-6 person crews. This rate includes a fire engine, which will be important for safety and for quenching the char after production. These folks are also chainsaw trained and qualified. Since they are used to doing this kind of work, they are a good fit for the project. At these rates we estimate we'll be able to procure 'X' days (or whatever you calculate) of work with 4-6 person crews.

\$10,000: Logistical Support:

Trailer, \$2,500: A new or used trailer will be purchased to transport the kilns (\$). This trailer can be stored at the Green Canyon Environmental Research Area.

Darren McAvoy, Travel: \$2,500: These funds will pay for travel to transport the kilns, set up workshop and demonstrations, oversee and document the kiln usage, and to present at in-state professional meetings.

Megan Dettenmaier Salary, \$3,500: These funds will pay for three weeks of salary for Forestry Extension Educator, Megan Dettenmaier, to help with logistics of the project, write and publish the document outputs and conduct the webinar.

Kasy Kliewer, Salary, \$1,500: These funds will pay the salary of Forestry Extension Intern Kasy Kliewer, to help with logistics of moving the kilns around, and writing and publishing associated documents.

10 Budget Appendix

USU Extension Grants Program									
APPENDIX A - BUDGET TEMPLATE									
							11.4.16		
*Fill in blue cells where applicable - budget will be calculated automatically									
Salaries									
	Graduate student support							\$0.00	
	Fringe benefits (0.8%)							\$0.00	
	Graduate student insurance*							\$0.00	
	Undergraduate student and payroll support: Intern Kasy Kliewer							\$1,389.00	
	Fringe benefits (8.0%)							\$111.12	
	Technical or personnel (contract salary) support: Megan Dettenmaier							\$2,380.00	
	Fringe benefits (45.5%)							\$1,082.90	
	Crews (Lone Peak Hotshots) for loading kilns							\$10,900.00	
	Subtotal for Salaries and Benefits							\$4,963.02	

In-state Travel						\$2,500.00	
Materials/Supplies	Consultant workshop including kilns					\$9,100.00	
Equipment							
Other							
Subtotal						\$11,600.00	
TOTAL BUDGET						\$30,000.00	

11. Appendix



Kelpie Wilson

Wilson Biochar Associates

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January 10, 2017

Wilson Biochar Associates Biochar Demonstration Workshop

Wilson Biochar Associates works with farmers and foresters through various programs including a current Conservation Innovation Grant from the NRCS in Oregon. We help farmers, ranchers and foresters make biochar from biomass residues and we advise them on uses of biochar for manure management and application to soils.

Kelpie Wilson of Wilson Biochar Associates is prepared to conduct a workshop for foresters, tree care professionals and others in Utah in late May 2017. The workshop will consist of two parts:

1. A hands-on demonstration of the Oregon Kiln, a flame cap kiln designed by Wilson Biochar Associates to process logging slash, forestry waste and some forms of crop waste into high quality biochar.
2. Several hours of classroom instruction on "Biochar Production, Quality Control and Application to Agriculture, Landscaping and Forestry."

The two parts of the workshop may be conducted on the same day or divided into two consecutive days.

Workshop Description – Kiln Demonstration

Wilson Biochar Associates will provide the Oregon Kiln, a specific model of flame cap kiln, to the sponsors of the workshop. The Oregon Kiln is a steel pan, five feet across and two feet high, with a four-foot square base. The kiln is made of mild steel and weighs about 200 pounds. It comes with a set of windscreens to control air flow and a drain to allow for flood quenching of the hot char. Kelpie Wilson will demonstrate and discuss all aspects of biochar production using the kiln, including feedstock preparation, lighting, loading, air flow control, quenching and biochar post-processing. The Oregon Kiln model can produce one cubic yard of biochar per batch. Once end users become familiar with the mode of operation, they will have the knowledge to design their own versions of the flame cap kiln, scaled appropriately for the type and amount of biomass residues they wish to process.

Workshop Description – Classroom Instruction

Classroom instruction will include a review of kiln design principles and will discuss methods for scaling up the flame cap method of biochar production. Participants will learn simple methods of assessing biochar quality and suitability for the intended applications. We will discuss results from the biochar research literature that have implications for biochar use in specific soils and cropping systems, including both short term and long term effects. We will also look at methods for applying biochar to forests, fields, pastures and rangeland. We will utilize Power Point presentations and provide useful handouts to participants.

Workshop Schedule and Budget

The proposed workshop will require transportation for 4 kilns and ourselves from southwest Oregon to Salt Lake City, Utah, a distance of about 800 miles. This will require a total two-way travel time of four days. We allowed two days for preparation and conducting the workshop. The budget below outlines the fees and total amounts.

Fees	
Kiln Demonstration Workshop	\$600
Biochar Theory and Practice	\$600
Demonstration Kiln	\$1,000

Travel Costs	
Mileage rate for kiln delivery and personal transportation	\$1.50/mile
Overnight costs and per diem	\$250/day

Budget	
Four kilns	\$4,000
One complete workshop	\$1,200
Travel mileage (1600 miles)	\$2,400
Overnight and per diem (6 days)	\$1,500
TOTAL	\$9,100

Kelpie Wilson Qualifications

Kelpie Wilson is an engineer and analyst with 30 years of experience in renewable energy, sustainable forestry and resource conservation. Since 2008 she has focused on biochar. From 2008-2012 she was employed by the International Biochar Initiative and was responsible for managing a multi-stakeholder process to draft the first international standards and testing guidelines for biochar materials. She has consulted with private industry and government agencies through her company Wilson Biochar Associates. Her contracts have included work for Cool Planet Energy Systems, Gates Foundation, World Bank, Washington Department of Ecology, North Dakota Forest Service, and many others. She is on the board of the US Biochar Initiative and is a founder of and contributing editor to The Biochar Journal. Currently she is directing a Conservation Innovation Grant through the NRCS and South Umpqua Rural Community Partnership working with farmers to make biochar from waste biomass and use it in manure management. She works with several local groups in Oregon promoting sustainable forestry and agriculture, and presents many classes and workshops on small scale biochar production and use every year. She received her BS in mechanical engineering from California State University, Chico, where she graduated with honors. A list of her publications is available at WilsonBiochar.com.