Can Biochar Link Forest Restoration with Commercial Agriculture?

Economic Evaluation of a Forest-to-Farm Biochar Paradigm

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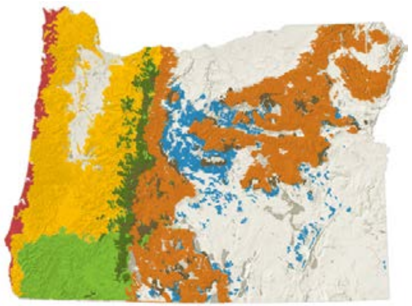
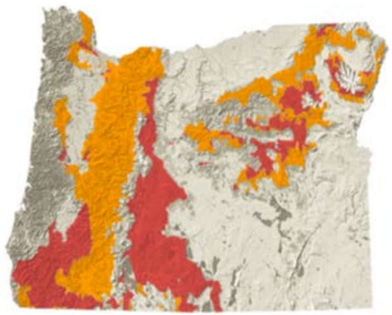
Agricultural Research Service

Oregon State University
College of Forestry

Sessions et al., Journal of Biomass and Bioenergy (in review)

Catastrophic fire threatens Oregon's forests

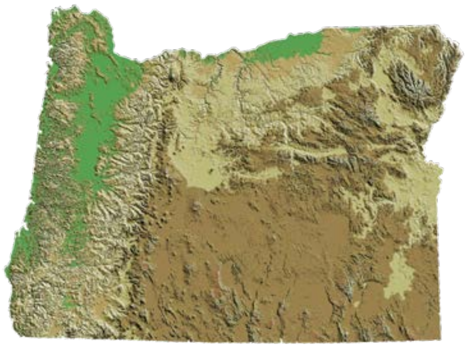


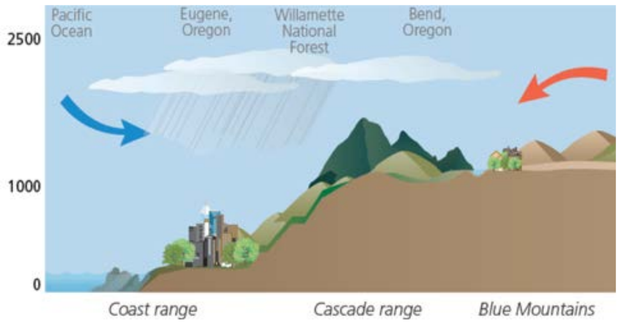


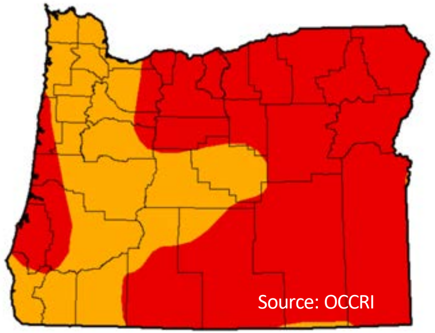
Source: US Drought Monitor

- 4 million ha. are at high risk of wildfire in Oregon
- Most of the risk is due to decades of fire suppression and a lack of funds to support fuel reduction treatments
- Limited demand for forest harvest residues restricts the ability of foresters to fund restoration projects.

Drought threatens Oregon's crops

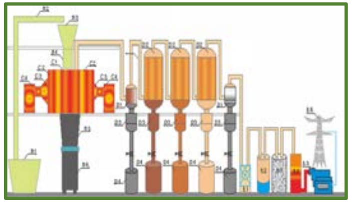


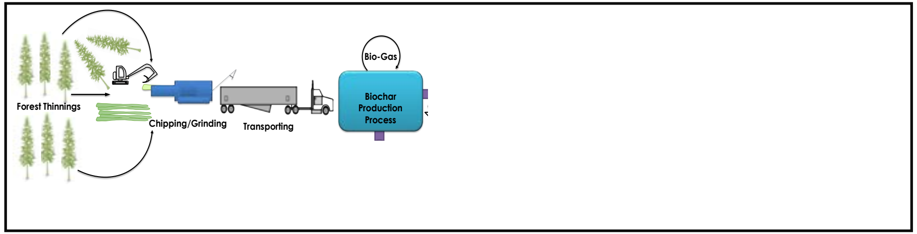




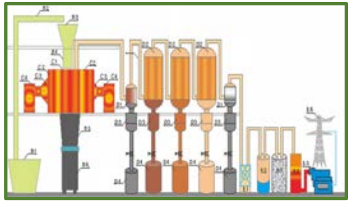
- In 2015 drought caused over >$1.2 billion in crop losses
- Biochar has the potential to improve water availability in agricultural soils, but limited supplies means costs are high.
- **Does a forest-origin biochar strategy pair these reciprocal needs of forest restoration and agricultural productivity?**

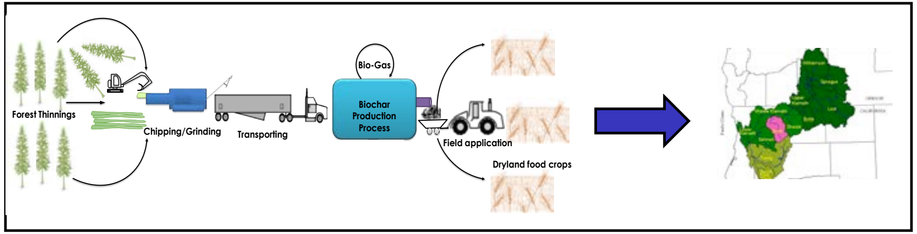
Does a forest-to-farm biochar paradigm pair the needs of forest restoration and agriculture?



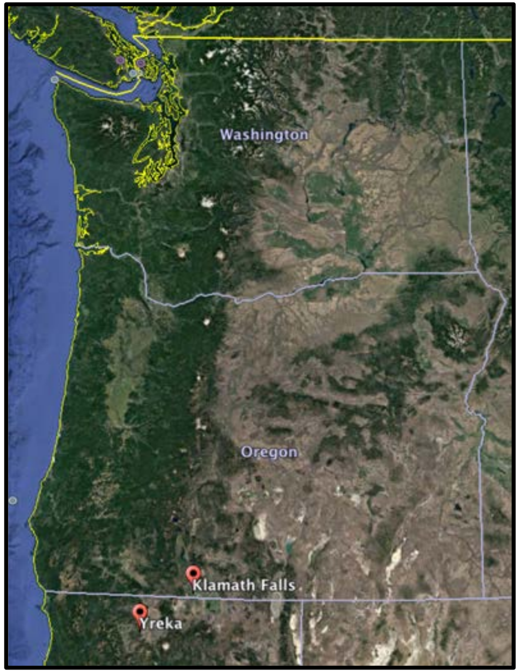


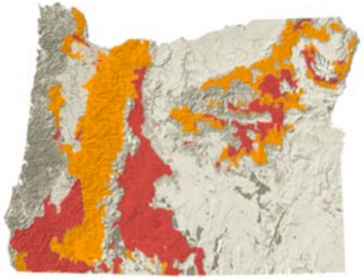
Does a forest-to-farm biochar paradigm pair the needs of forest restoration and agriculture?

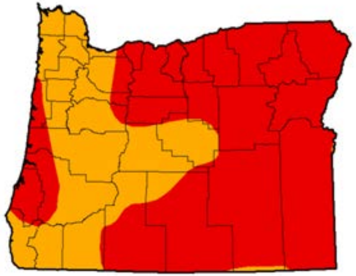


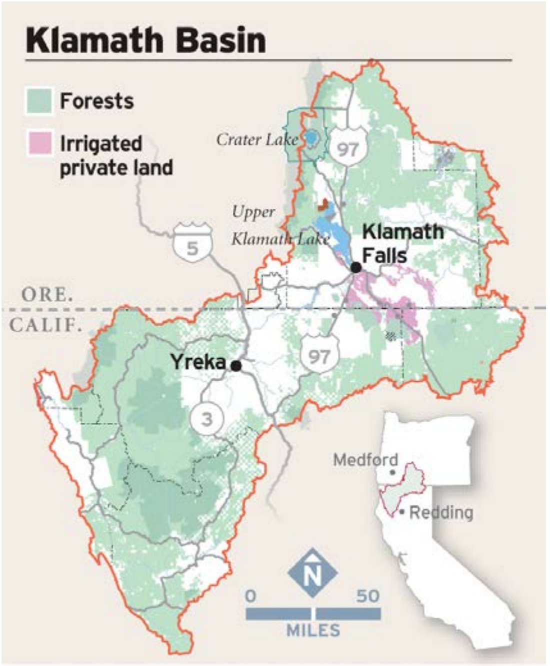


Study Area: Klamath Basin of Oregon









DAN AGUAYO/THE OREGONIAN

Is it economical to reduce fuel loads on steep slopes?

A shift level productivity study using steep slope harvesting technology was used to develop a model of tethered harvest.

Is it economical to reduce fuel loads on steep slopes?

- The cost of tethered machines on tethered operations (TT) and untethered operations (TU), and the cost of untethered machines on untethered operations (UT) were estimated.

- Model calculated average harvest and transport cost to each plant

	No Firewatch			With Firewatch		
Cost per	TT	TU	UT	TT	TU	TT
green ton	$26.84	$23.63	$21.38	$27.04	$23.80	$21.55

	Wardon, OR	Yreka, CA
Harvest and Transport (Per BDT)	$50	$60

Josh Petitmermet et al., (in preparation)

BIOCHAR PRODUCTION PROCESS

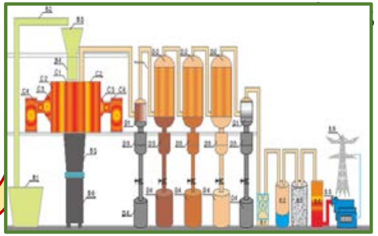
50,000 BDT of forest restoration logs / year

Chipping

Drying

Milling

Microwave Pyrolysis



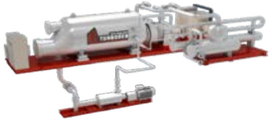
Thermal Pyrolysis

Scenario 1
Biochar
Production

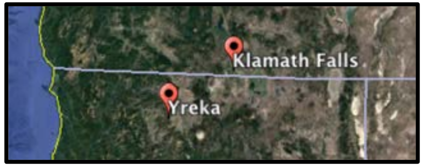
18,000
tons/year

Scenario 2
Heat Recovery

Scenario 3
Electricity
generation



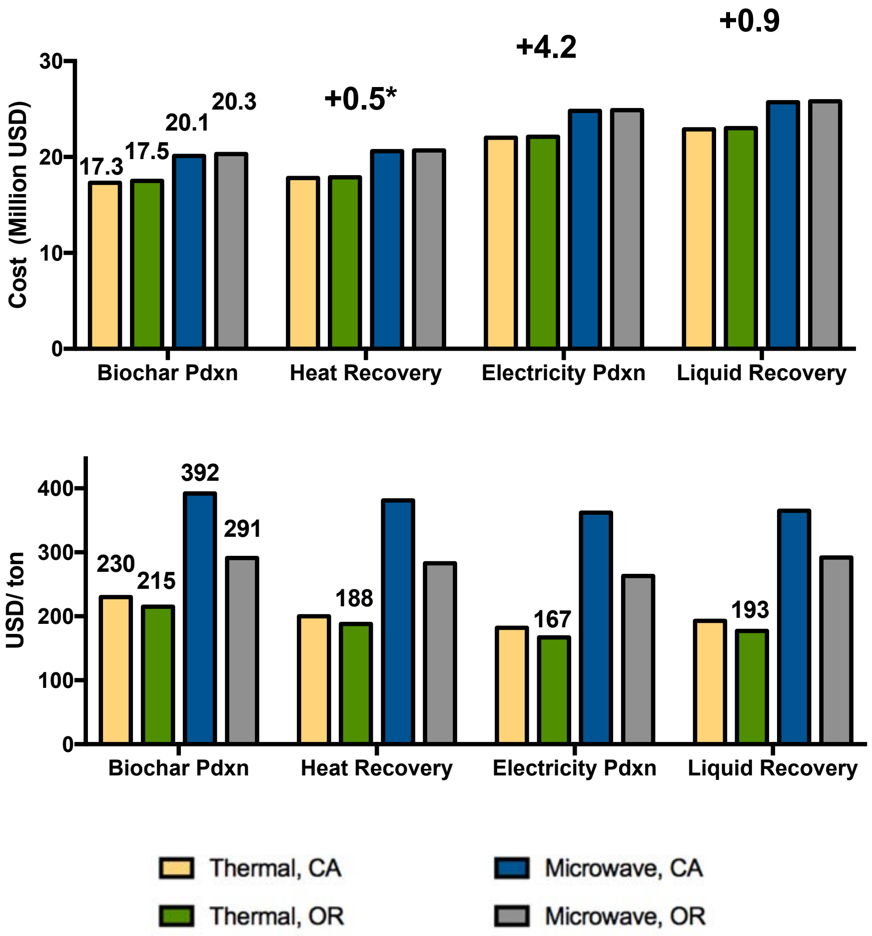
Scenario 4
Liquid
Recovery



Complexity of plant does not increase price

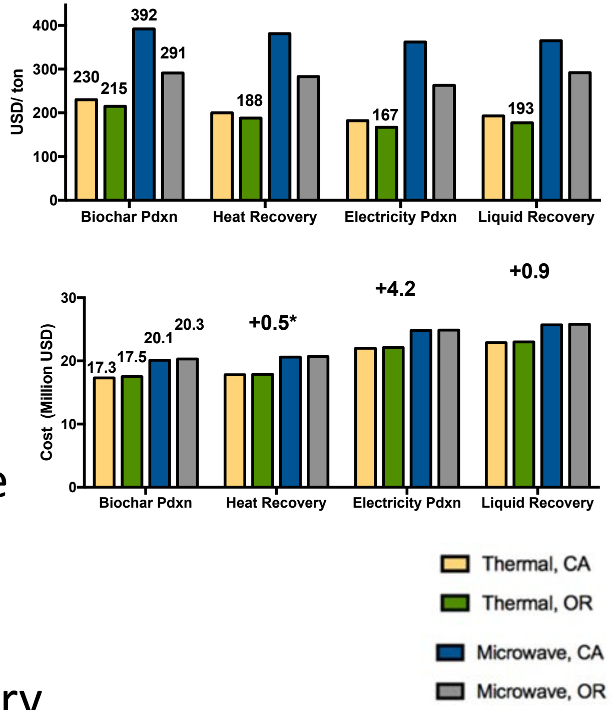
Capital Costs

Biochar Production Cost



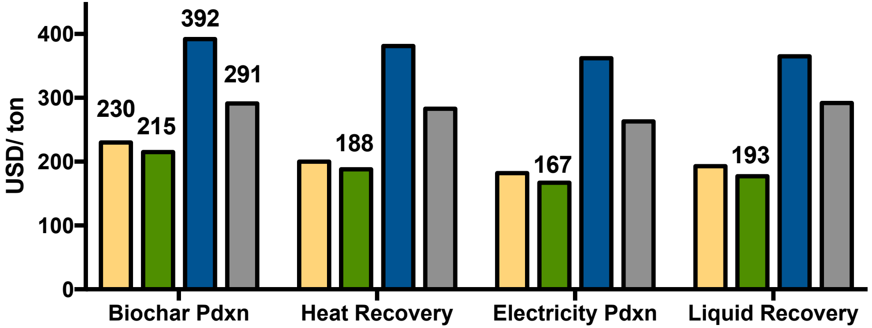
Critical Economic Factors

- Plant location
  - Influences delivered log costs
- Electricity rates
  - Higher in California and for microwave production
- Plant Complexity
  - Recovery of energy and condensable liquids adds capital and operating costs but in the end, offsets the production cost
- Seasonality
  - Influences raw material and finished product inventory
  - Log deliveries limited to summer months
  - Product sales limited to spring and fall months
  - Plant operates year round to maximize asset utilization

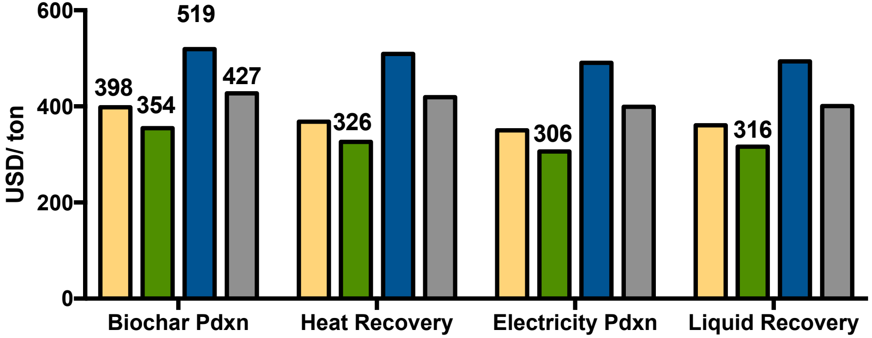


Harvest and Transport Impact Biochar Production Costs

Biochar Production Cost without Harvest and Transport



Biochar Production Cost with Harvest and Transport



Can Farmers Afford Forest-Origin Biochar?

Crop	Area Harvested (ha)	Total Production (Mg)	Value ($ Mg^{-1})	Value ($ ha^{-1})
Oats	823	3,167	$207	$795
Potatoes	3,359	129,138	$160	$6,168
Barley	6,635	33,086	$124	$618
Hay (excluding alfalfa and barley)	6,798	34,347	$190	$960
Wheat	7,274	32,790	$136	$615
Alfalfa	20,236	189,750	$184	$1,722

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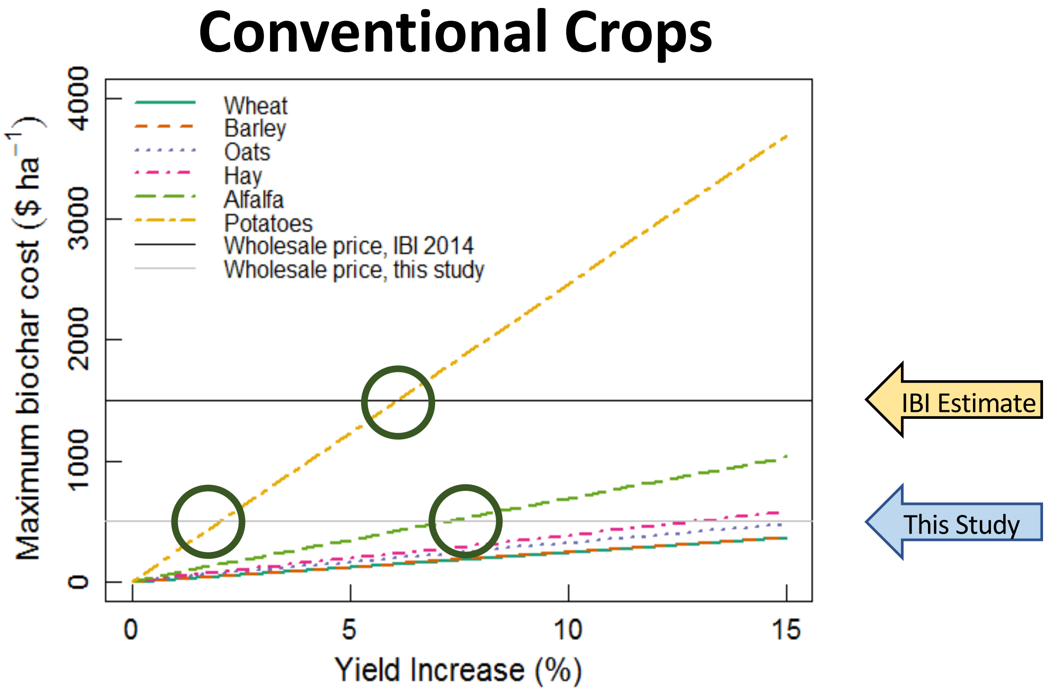

Claire Phillips: PNW Biochar Atlas Session 1C Wed 9:45

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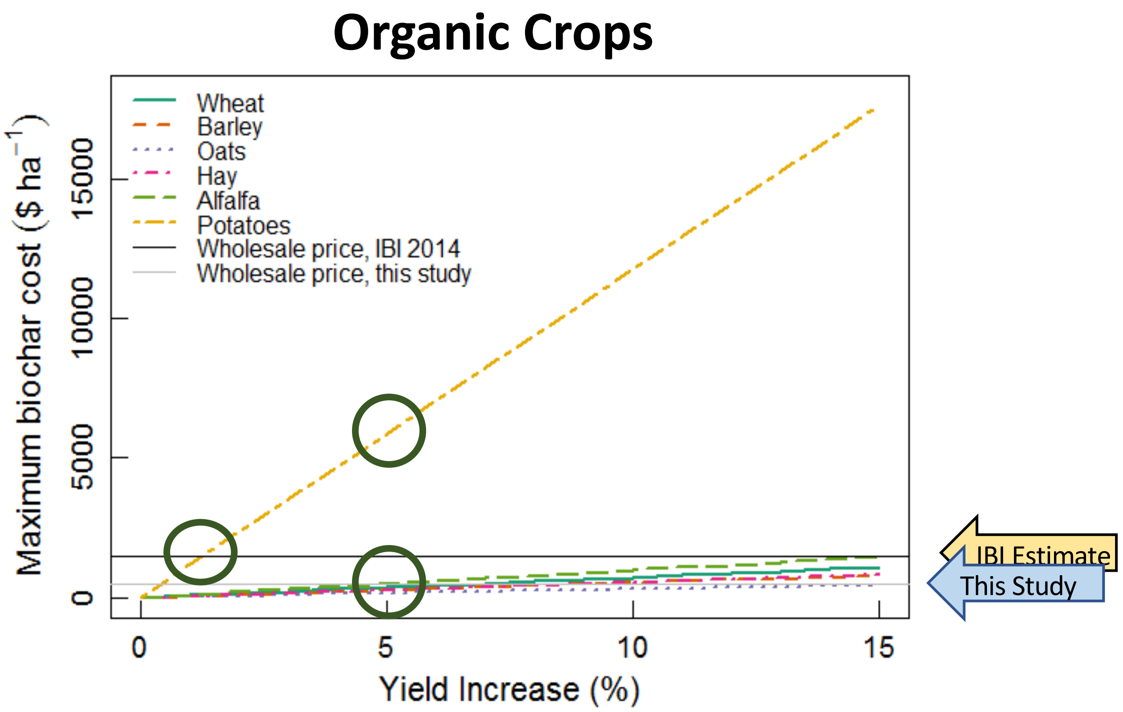

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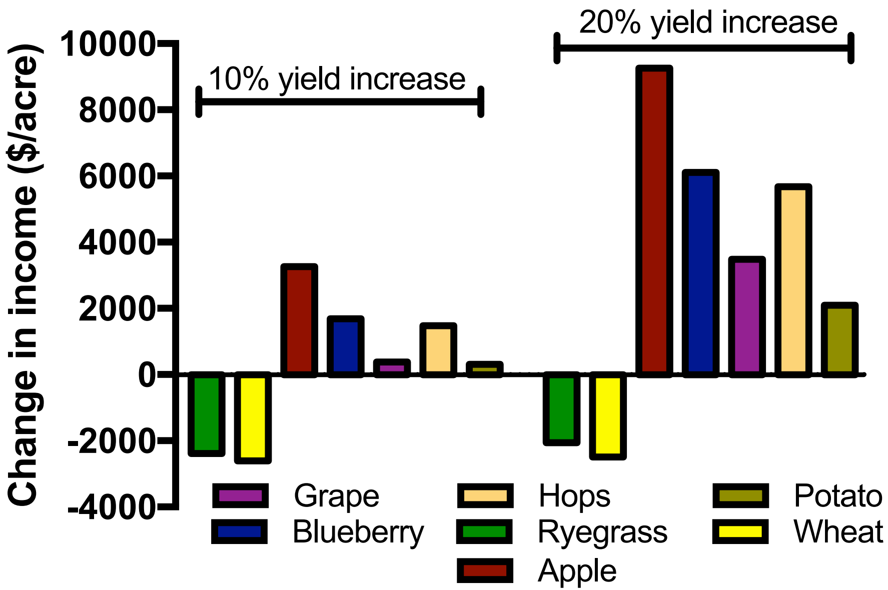

*Assume 2-ton acre amendment rate

Summary

- **The production of biochar from forest residues has the potential to**
  - **Reduce fire risk**
  - **Store forest-origin carbon in agricultural soils**
  - **Lower the price point for biochar products**
- **Our economic analysis determined that:**
  - **Microwave pyrolysis is more costly than thermal pyrolysis**
  - **Electrical generation from this process adds a significant capital cost but lowers overall price point**
  - **Local commodity markets are not enough to support a biochar industry**

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Collaborators: Karr Group; BSEI Inc.; Green Diamond; Miller Timber

USDA United States Department of Agriculture Agricultural Research Service

Oregon State University College of Forestry

Char Properties

	Proximate			Ultimate				
	Volatile	Fixed C	Ash	C	H	N	O	S
	%	%	%	%	%	%	%	%
Microwave	13	82	5	88	2	0.5	5	0.089
Thermal	14	73	12	83	2	0.5	5	<0.005

	VOCs									Semi-volatiles		
	Acetone	2-Butanone	Benzene	Toluene	Ethylbenzene	m,p-Xylenes	o-Xylene	4-Isopropyltoluene	Naphthalene	Naphthalene	2-Methylnapthalene	Phenanthrene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Microwave	62	21	8.8	11	2	4.4	2.6	5.7	BMDL	2.6	BMDL	BMDL
Thermal	38	BMDL	2.6	1.8	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL