ON-FARM PRODUCTION AND USE OF BIOCHAR FOR COMPOSTING WITH MANURE

- UBET - Umpqua Biochar Education Team
- Project of SURCP – South Umpqua Rural Community Partnership
- 2015 Conservation Innovation Grant - NRCS

SURCP.ORG

Project objectives & goals

- Farmers in Oregon often have forest land and forestry residue that they burn for disposal
- Farmers with livestock have manure that can be a problem to handle
- Combine two waste steams to create value
  - Help farmers make biochar
  - Test different methods of composting manure and biochar
  - Determine economic costs and benefits to farmers
  - Share what we learn

Project Deliverables

- Design and build **kilns** at Umpqua Community College
- Onsite demonstration **workshops** for biochar production and use in compost and manure management
- **Pot trials and field trials** testing different biochar composts
- **Guide sheets** for public distribution on biochar production, biochar use, and monitoring.
- Input into **CSP 384 biochar enhancement**

UBET -- Umpqua Biochar Education Team

Jim Long and UBET

Jim Long – founder of UBET

In Memoriam, 1935-2016

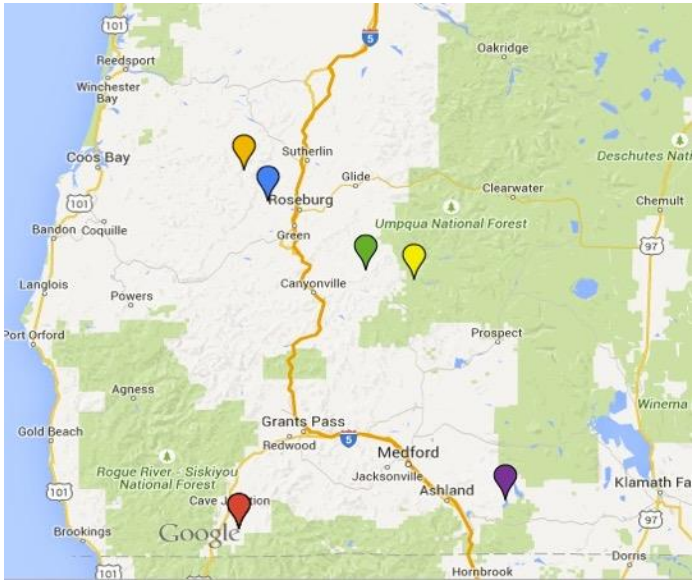
"He surveyed the area, saw where he could contribute, and did so."

Jim Long was a Professor of Adult and Continuing Education at Washington State University, Pullman, for 27 years.

He was involved in more than two dozen community groups in Douglas County.

He was to serve as co-director and evaluator of the UBET CIG project.

Participating Farmers



Farm Livestock and Acreage						
cows	pigs	sheep & goats	fowl	horses	pasture acres	woodlot acres
250					200	
600		325			1150	120
	12	37	100		35	3
		47			35	43
	60	60	200		30	250
			18		1	
		17	73		6	6
		3	36	17		
850	72	489	427	17	1457	422

Farms with most participation:

- Michaels Ranch
- Morrison-Fontaine Farm
- Daisy Hill Farm
- Siskiyou Alpaca
- Willow Witt Ranch
- Tierra Buena Worm Farm

Other participating farms:

- Frog Farm
- East Fork Ranch
- Page Creek Ranch

Big Project – Many Moving Parts!

- People
  - Volunteers
  - Farmers
  - Students
  - OSU Researchers
- Farms
  - Animals
  - Compost
  - Woody waste
- Technology
  - Kiln design
  - Kiln logistics
- Science
  - Pot trials
  - Compost experiments
  - Field trials – four farms
- Economics
  - Labor & machinery inputs
  - Quantifying benefits
- Extension
  - Workshops
  - Guidance Documents

KILNS

- UCC Welding Department
- Oregon Kiln
- Ring of Fire Kiln
- Quenching
- Crushing

UCC Welding Department

Umpqua Community College is making our kilns. We hope this could be the start of a new industry in Oregon making biochar from forestry waste.

Design Parameters - the Oregon Kiln

- Sized for feedstock
  - Logs 4 to 5 feet long
  - Up to 6” diameter
- Portable but Durable
  - Less than 200 lbs
  - 14 gauge steel
- Ergonomic for loading
  - Only 2 feet high
- Capacity
  - Makes > 1 cubic yard of biochar in about 4 hours
- Economical
  - Pyramid shape cheaper to fabricate than cone
  - $650 for Kiln – 5’ top base, 4’ bottom base, 2’ high sides

Oregon Kiln in the Woods

Tractor Kiln version with fork pockets

- Farmers were using tractors to move kilns with mixed results
- UCC Welding students made 4 new tractor-movable kilns

Double-walled Ring of Fire

- Inner ring dimensions:
  - 6 ft diameter
  - 42”high
  - 3.7 cy capacity
- Outer rings serves as an effective heat shield:
  - Improves conversion efficiency
  - Protects operator
- Modular, light weight, easy to transport
- Cost – similar to Oregon Kiln

Daisy Hill Farm – Grape Prunings

Morrison-Fontaine Farm







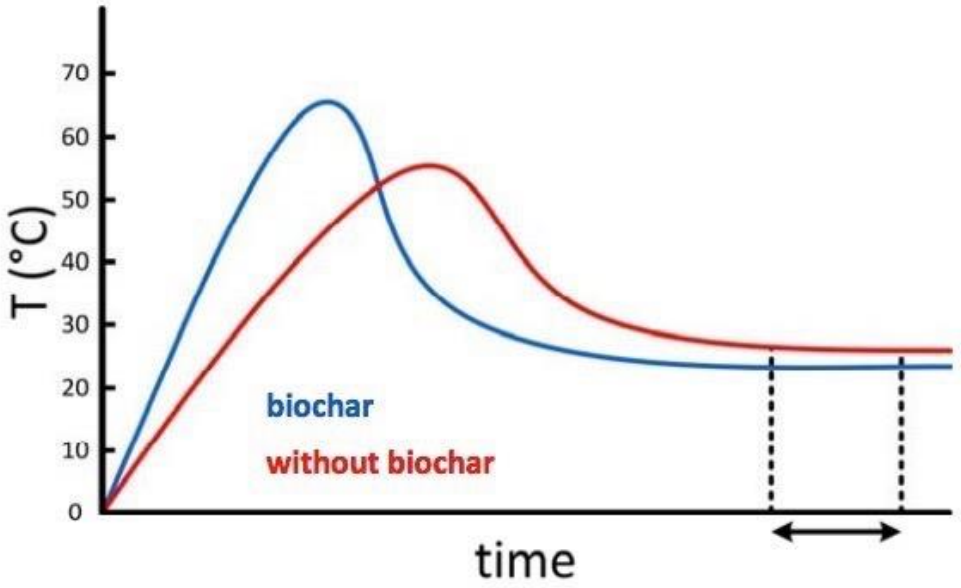


Quenching and Crushing Char

COMPOST and BARNS

- Compost experiments
- Use of biochar in barns
- EM-1 to acidify and inoculate biochar

Possible Benefit of Biochar to Compost



Biochar increases the temperature in a compost process, accelerating the time needed for material decomposition[4, 6, 7]

- Only occurs if you have C:N right
- Also depends on C:N impact of biochar

What is the C:N of biochar?

- Typically, only about 10-30% of the total C in biochar is mobile and available*
- C:N of biochar itself could be about 100:1 or greater – it depends on the biochar
- IMPORTANT: Biochar influences C:N by absorbing N
- Not all sorbed N is available
- Biochar content for good compost ranges from 5%-50% depending on N content of manure

*http://www.terra-char.com/uploads/2/3/7/9/23790961/composting_with_biochar.pdf

Morrison-Fontaine: A Successful Pile

2 parts biochar; 2 parts fresh, hot, smelly dairy manure; 3 parts goat barn waste. Pile was hot for weeks. Never turned. Lots of worms at the end.

Siskiyou Alpaca

Observations of Pacapoo Compost:

Pacapoo **without biochar**
- Got several degrees **hotter**
- Had more worms at the end
- Appeared less mature - no grass on top, slimy manure texture

Pacapoo **with biochar**
- Several degrees **cooler**
- Fewer worms
- More mature – grass and weeds growing, crumbly, soil-like texture

WHY???

Compost experiments to test ingredients

Compost microcosms in fiber bags get hot enough to show differences between recipes

Michaels Ranch Compost 2016

Observations from 2016 compost:

- Biochar added after barn cleaning
- Biochar poorly mixed
- Clumpy texture difficult to spread on field
- Never got hotter than 90 degrees
- Plain manure pile did not heat either

Michaels Ranch Compost 2017

Observations of 2017 Compost:

- Biochar added early so cows could mix it
- Pile got hot – at least 130 degrees
- Fine, friable texture– hopefully easier to spread on field

EM-1 for manure composting

- In Germany, sauerkraut juice is sprayed in cattle barns to control ammonia odor and kill pathogens
- EM-1 includes lactic acid bacteria, yeasts, photosynthetic bacteria with >30 species
- EM-1 bacteria thrive and outcompete pathogens
- Acidity prevents ammonia volatilization

Tierra Buena Worm Farm

- Poorly composted rabbit manure poses a risk of fecal coliform and salmonella contamination of worm castings.
- Adding biochar and EM-1 to address odors and pathogens

Willow Witt Ranch

Workers reported less ammonia smell when biochar was scattered across bedding

WORKSHOPS - OUTREACH

- Annual Biochar Expo in Roseburg, 2015, 2016, 2017
- Biochar production sessions with invited neighbors and friends:
  - Two in 2015
  - Five in 2016 – should have been more, but very wet winter!
  - Six in 2017
- Two composting workshops in 2016
- Kiln demonstration for Firewise Expo, Medford, 2017
- Presentation to Douglas County Forage Group meeting at Michaels Ranch, October 5, 2017

Composting Workshop – Tierra Buena

Firewise Expo – May 12-13, 2017

- UBET spoke to 800 middle school students in Medford

POT TRIALS AND FIELD TRIALS

- Pot Trials and Field Trials
  - **Siskiyou Alpaca bok choy bed** – Pot trial and field trial compared alpaca manure compost with and without biochar.
  - **Michaels Ranch pasture** – Pot trial compared cow manure compost with and without high carbon boiler ash. Field trial also included boiler ash alone. Second application will be made this fall.
  - **Daisy Hill Farm pasture establishment** – no pot trial. Field trial compared biochar compost against control. Second application was made in October 2017.
  - **Morrison-Fontaine Farm hay field** – Pot Trial compared two kinds of boiler ash, one biochar, with and without lime and fertilizer. Field trial compared biochar compost and combinations of plain biochar, lime, fertilizer.

Pot Trial with OSU help

- Compared high carbon boiler ash from sawmills already in use on Douglas County pastures as a liming agent, with homemade biochar
- Poster presented at US Biochar Symposium, 2016

Pot Trial Protocol

- Simple 2-week test in grow tent
- Cucumber seeds
- Germination percent
- Count growth nodes
- Dry and weigh above ground biomass

Siskiyou Alpaca Bok Choy Bed

Pot trial results

Treatment	Germination (%)	Secondary Leaves (count)	Biomass (grams)
B	96	78	2.16
NB	100	54	2.12
C	98	56	1.70

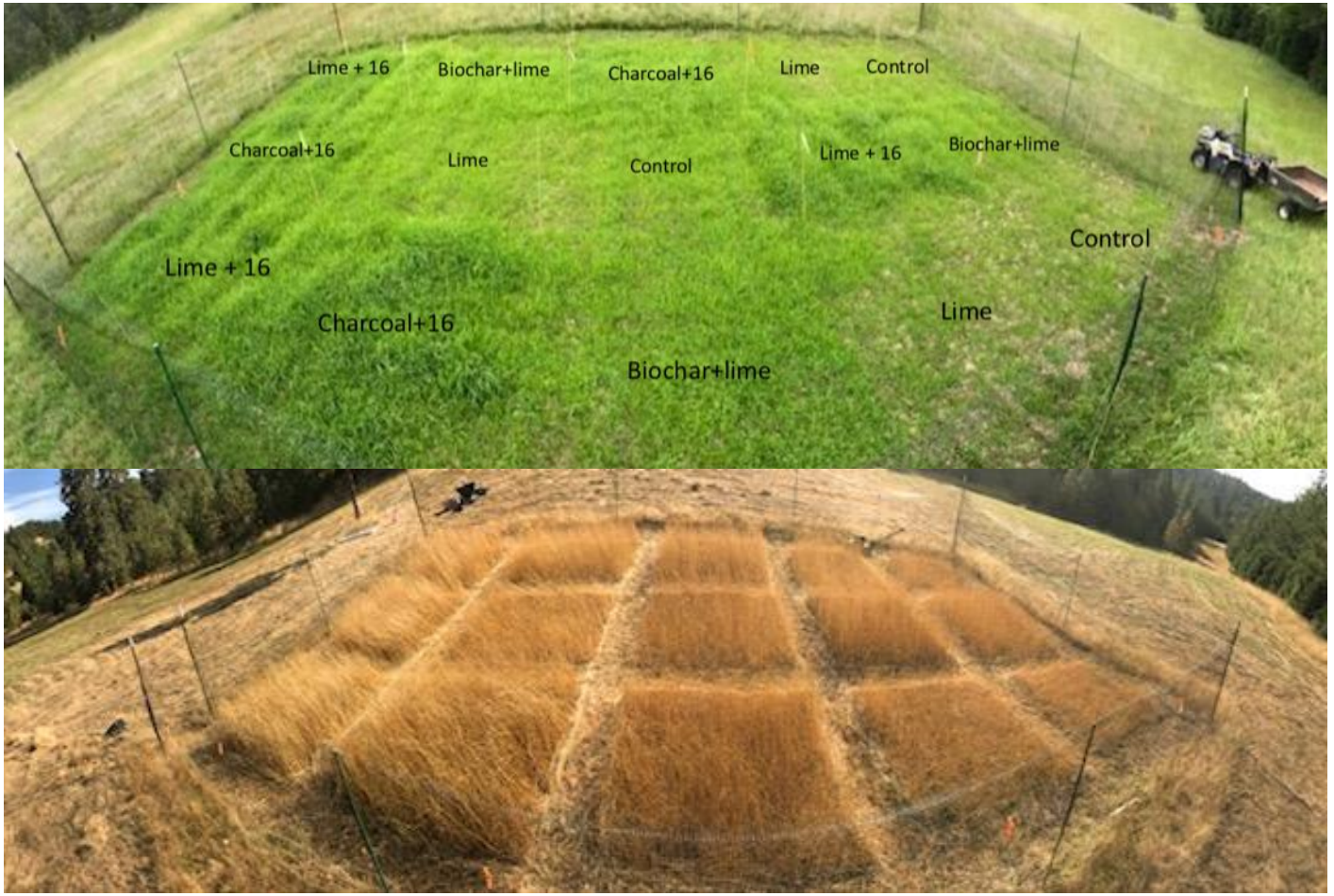
Bok Choy Harvest, pounds					
Block	2-Jun	7-Jun	14-Jun	10-Jul	Total
W1 - NB	5.75	5	7	16.6	34.35
W2 - B	1	4.9	6.75	19.6	32.25
W3 - B	1.25	5.25	5	18.1	29.6
W4 - NB	2.25	3.75	4	17.5	27.5
				Field Total	123.7

No significant difference in yields (B=Biochar; NB=No Biochar)

Daisy Hill Pasture Establishment (.5 ac)

- **Noticeably more clover in biochar plots at end of season**
- **Second biochar application in October 2017**

Morrison-Fontaine Farm Hay Field



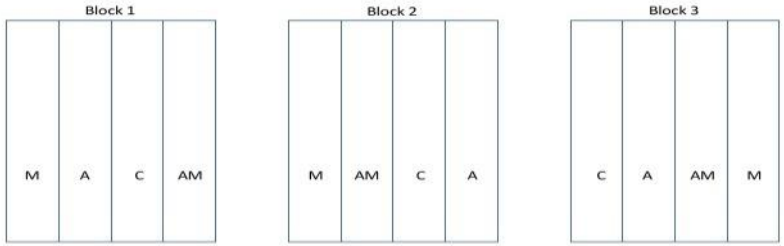
- **OSU will help with data analysis**
- **Second application planned for Spring 2018**

Michaels Ranch Pasture

Pot trial results:

Treatment	Germination (%)	Secondary Leaves (count)	Biomass (grams)
AM	96	41	1.96
M	100	43	2.07
C	98	38	1.58

Replicated block design



M-manure
A-boiler ash (40% carbon)
AM-manure with boiler ash
C-control

Field trial results:

Forage Harvest, grams				
Treatment	Block 1	Block 2	Block 3	Average
Manure	352	335	284	323.7
Ash	364	410	302	358.7
Manure + Ash	339	289	362	330.0
Control	307	327	387	340.3

Application Rates
Manure (M) – 2.39 t/ac
Boiler Ash (A) – 4.2 t/ac
Ash-Manure mix (AM) – 3.17 t/ac

- **No statistically significant difference in yields**
- **Inconsistent application rates complicate results**

Oregon Biochar Atlas - OSU

- http://www.pnwbiochar.org/
- Has case studies for Michaels Ranch & Morrison Fontaine Farm

Soil and Compost Tests

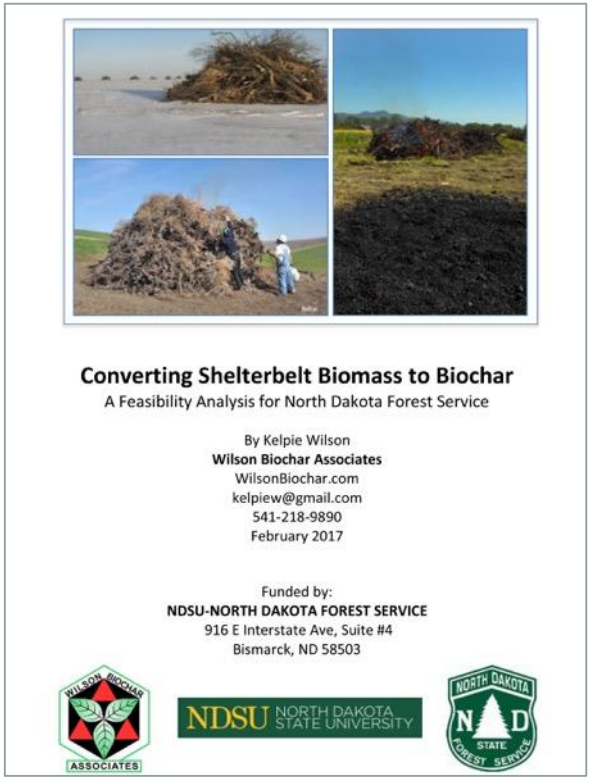
- As farmers, we have many questions about appropriate tests
- What are the best tests to tell us something about soil life?
  - Enzyme analysis
  - CO2 respiration
  - Active carbon
- What are best tests to evaluate long term impact on soil?
  - pH
  - CEC
  - Total carbon – how much biochar to raise soil C by 1%?
- Need to find simplest, cheapest way to evaluate soil impacts of biochar and biochar composts

CHALLENGES & ECONOMICS

- Costs
  - Labor not available
  - Mechanization needed
- Benefits
  - Field trials need more time to determine if biochar compost benefits crops/pasture
  - Effects of biochar use in barns are immediately obvious (odor reduction), but hard to monetize.

Michaels Ranch – orchard removal job too big for small kilns

Report by Wilson Biochar Associates for N. Dakota Forest Service addresses this need:



Converting Shelterbelt Biomass to Biochar

A Feasibility Analysis for North Dakota Forest Service

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February 2017

Funded by:
NDSU-NORTH DAKOTA FOREST SERVICE
916 E Interstate Ave, Suite #4
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GUIDANCE DOCUMENTS

- TO BE PRODUCED:
  - How to make and operate the Oregon Kiln and Ring of Fire Kiln
  - How to crush, process and prepare biochar
  - How to use biochar in animal barns and compost
  - How to conduct a biochar pot trial
  - How to use biochar compost in crop production
  - How to assess the economics of on-farm biochar production

Next Steps

- Oregon Biochar Atlas
  - Two of our farms are featured as case studies
  - http://www.pnwbiochar.org/case-studies/
  - Possibilities for long term field study monitoring?
- NRCS Programs
  - Implementing CSP 384 biochar enhancement?
  - Potential for including biochar in EQIP and other programs?
- Kiln Technology Transfer
  - Need to complete drawings
  - Already happening

Technology Transfer – Kilns purchased from Wilson Biochar Associates

- OSU Extension/Master Gardeners - Roseburg
- Utah State University
- Nebraska State University
- Oregon State University
- Josephine County Community Food Bank

Wilson Biochar Associates workshop for Utah State University in Draper, UT May, 2017

THANK YOU!

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