# Biochar Supplementation in Growing and Finishing Cattle Diets

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# Biochar and Cattle

- Potential Benefits
  - Greenhouse gas ($CH_4$, N) emissions
  - Efficiency (digestibility)
  - Animal health
- Environmental concern
  - $CH_4$ 28x warming potential of $CO_2$
- Energetic loss
  - 2-12% of Gross Energy intake is lost as methane (Johnson & Johnson, 1995)
  - ↓ $CH_4$ = ↑energy retention = ↑efficiency
- Efficiency measured relative to production output (lbs of beef)

# Leng et al., 2012 Animal Performance

- Biochar from rice husks
- 0.6% of DM
- Forage based diets

healthline.com

- Small animals (184 lbs)
- Low weight gain (0.26 lb/d)
- Intake (5 lb/d; 2.7% of BW)

healthyt1ps.com

# Leng et al., 2012 Animal Performance

- Biochar from rice husks
- 0.6% of DM

| | Biochar | No Biochar | *P*-Value |
|---|---|---|---|
| ADG, lb/d | 0.28 | 0.23 | 0.056 |
| DMI, lb/d | 4.95 | 5.07 | 0.90 |
| Feed:Gain | 19.1 | 23.2 | 0.03 |
| $CO_2$, ppm | 2234 | 1938 | < 0.01 |
| $CH_4$, ppm | 64.0 | 84.5 | 0.07 |

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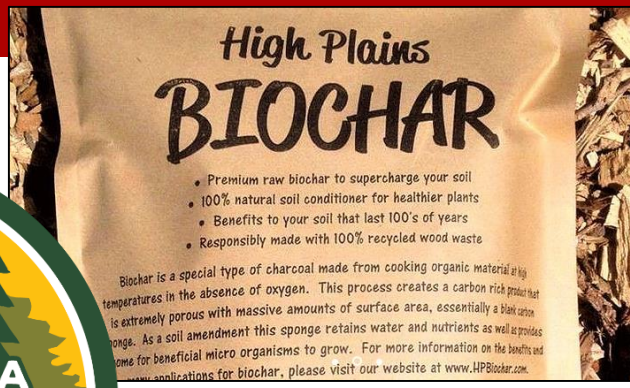
17.7% improvement in efficiency
24% reduction in $CH_4$ production

# UNL metabolism study




- 6 animals
- Digestibility
- $CH_4$ and $CO_2$ production

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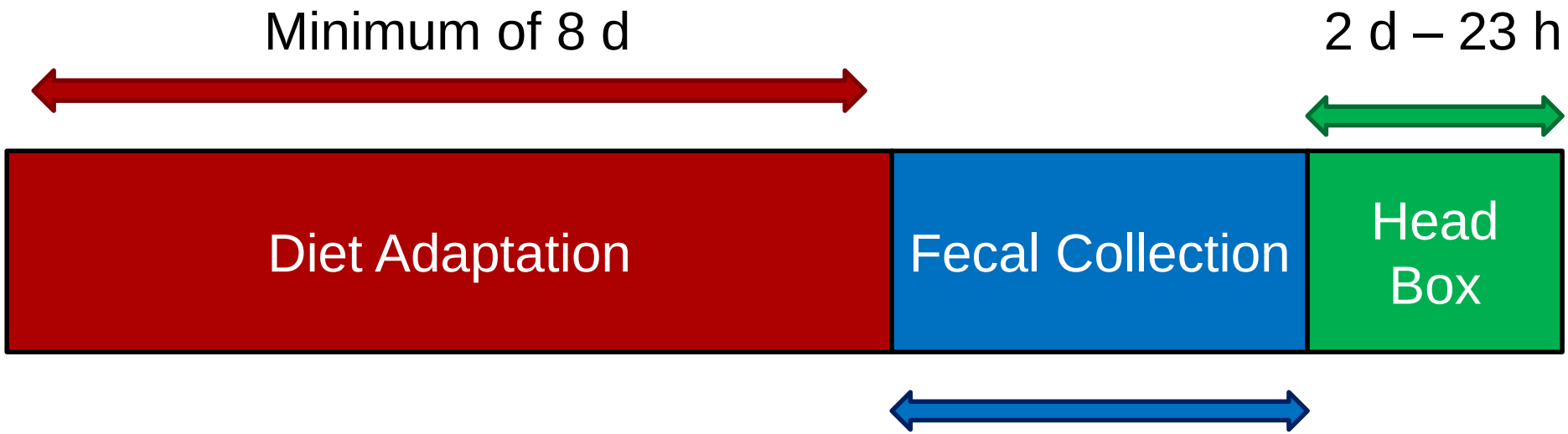
## Growing Trial

- 6 periods
- 3 treatments
- 1164 lb BW

## Finishing Trial

- 3 periods
- 3 treatments
- 1284 lb BW

# Experimental Design




Marker for digestibility calculations
- Growing study: acid insoluble ash
- Finishing study: titanium dioxide

**0, 0.8, and 3%** biochar in diet

# Experimental Design

- Statistics
- MIXED procedure of SAS
- Steer = random
- Trt & Period = fixed
- PROC IML for contrast coefficients
- $P < 0.10$

- Growing
  - Digestion = 6x6 replicated Latin rectangle
  - Gas = 5x6 unbalanced replicated Latin rectangle
- Finishing
  - 6x3 balanced Latin rectangle


COW #

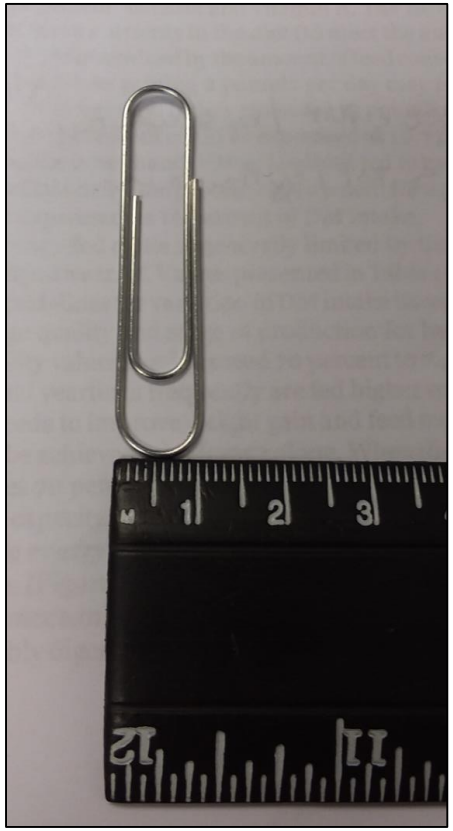
# Biochar

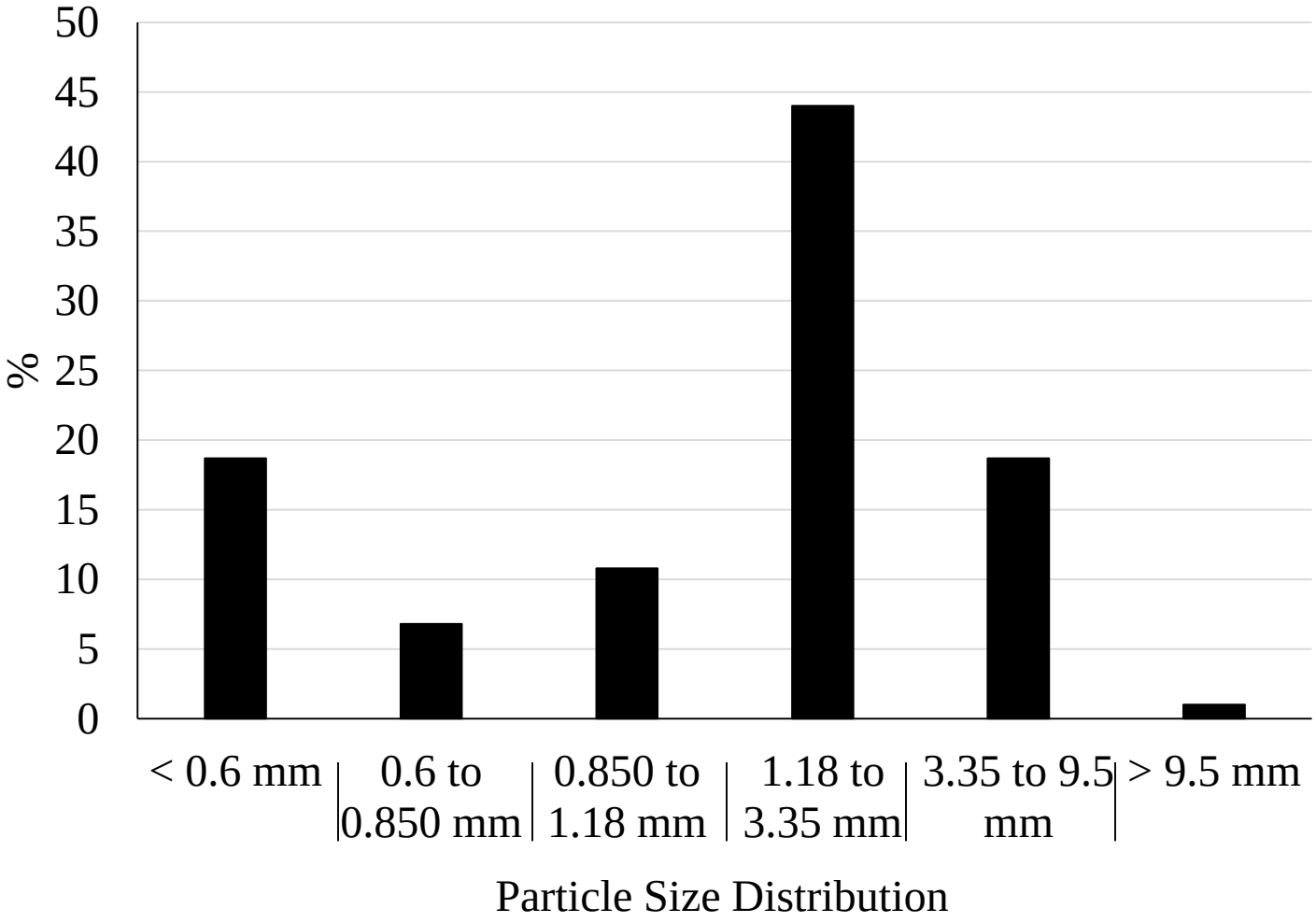
- Dioxins (PCDDs) and Furans (PCDFs)
  - Non detectable (<10.0 ng/kg)
- Cadmium, lead, arsenic, mercury
  - Non detectable (<0.98 mg/kg)

- 85% C, 0.7% N, 94% OM
- pH 8.0

# Biochar

- Particle size 44% 1.18 to 3.35 mm





# Growing Trial – Diet

| Ingredient, % (DM basis) | Treatments | | |
|---|---|---|---|
| **Brome hay** | ← | 21 | → |
| **Wheat straw** | ← | 20 | → |
| **Corn silage** | ← | 30 | → |
| **Wet distillers grains** | ← | 22 | → |
| **Supplement** | 7 | 6.2 | 4 |
| **Biochar** | 0 | 0.8 | 3 |

Supplement contained limestone, tallow, urea, salt, trace minerals, vitamins A-D-E, Rumensin, and biochar replacing fine ground corn

# Growing Trial

| | Biochar inclusion, % DM | | | | *P*-value | |
|---|---|---|---|---|---|---|
| | 0 | 0.8 | 3 | SEM | Lin | Quad |
| **OMI, lb/d** | 16.0 | 15.8 | 15.7 | 0.42 | 0.52 | 0.74 |
| **OMD, %** | 58.6 | 60.6 | 57.7 | 1.16 | 0.31 | **0.10** |
| **NDFi, lb/d** | 9.33 | 9.22 | 9.42 | 0.24 | 0.62 | 0.57 |
| **NDFd, %** | 50.5 | 52.6 | 48.2 | 1.55 | 0.08 | **0.10** |

# Growing Trial

| | Biochar inclusion, % DM | | | | *P*-value | |
|---|---|---|---|---|---|---|
| | 0 | 0.8 | 3 | SEM | Lin | Quad |
| **$CH_4$, g/d** | 109 | 97.2 | 100 | 5.1 | 0.42 | 0.14 |
| **$CO_2$, g/d** | 5549 | 5051 | 5163 | 172 | 0.19 | **0.05** |
| **$CH_4$, g/lb DMI** | 6.23 | 5.64 | 5.77 | 0.27 | 0.43 | 0.18 |
| **$CO_2$, g/lb DMI** | 319 | 293 | 300 | 8.2 | 0.27 | **0.06** |
| **$CH_4$:$CO_2$** | 0.02 | 0.019 | 0.019 | 0.001 | 0.67 | 0.70 |

# Growing Trial

| | Biochar inclusion | | |
|---|---|---|---|
| | No | Yes | *P*-value |
| **$CH_4$, g/d** | 109 | 98.6 | 0.11 |
| **$CO_2$, g/d** | 5549 | 5107 | 0.02 |
| **$CH_4$, g/lb DMI** | 6.23 | 5.70 | 0.13 |
| **$CO_2$, g/lb DMI** | 319 | 296 | 0.03 |

8% reduction

# Finishing Trial – Diet

| Ingredient, % (DM basis) | Treatments | | |
|---|---|---|---|
| **Dry rolled corn** | ← | 53 | → |
| **Corn silage** | ← | 15 | → |
| **Wet distillers grains** | ← | 25 | → |
| **Supplement** | 7 | 6.2 | 4 |
| **Biochar** | 0 | 0.8 | 3 |

Supplement contained limestone, tallow, urea, salt, trace minerals, vitamins A-D-E, Rumensin, and biochar replacing fine ground corn

# Finishing Trial

| | Biochar inclusion, % DM | | | | *P*-value | |
|---|---|---|---|---|---|---|
| | 0 | 0.8 | 3 | SEM | Lin | Quad |
| **OMI, lb/d** | 22.4 | 24.4 | 22.9 | 0.95 | 0.81 | **0.06** |
| **OMD, %** | 72.8 | 70.4 | 68.7 | 1.65 | 0.13 | 0.52 |
| **NDFi, lb/d** | 6.64 | 7.37 | 7.44 | 0.31 | **0.05** | 0.09 |
| **NDFd, %** | 56.6 | 54.2 | 53.4 | 3.37 | 0.39 | 0.59 |

# Finishing Trial

| | Biochar inclusion, % DM | | | | *P*-value | |
|---|---|---|---|---|---|---|
| | 0 | 0.8 | 3 | SEM | Lin | Quad |
| **$CH_4$, g/d** | 141 | 128 | 122 | 13.9 | 0.39 | 0.62 |
| **$CO_2$, g/d** | 8204 | 8402 | 7755 | 558 | 0.50 | 0.66 |
| **$CH_4$, g/lb DMI** | 5.68 | 4.64 | 4.82 | 0.66 | 0.51 | 0.32 |
| **$CO_2$, g/lb DMI** | 335 | 302 | 301 | 27.9 | 0.52 | 0.51 |
| **$CH_4$:$CO_2$** | 0.017 | 0.016 | 0.016 | 0.002 | 0.56 | 0.56 |

# Finishing Trial

| | Biochar inclusion | | |
|---|---|---|---|
| | No | Yes | *P*-value |
| **$CH_4$, g/d** | 141 | 125 | 0.32 |
| **$CO_2$, g/d** | 8204 | 8079 | 0.86 |
| **$CH_4$, g/lb DMI** | 5.68 | 4.73 | 0.22 |
| **$CO_2$, g/lb DM** | 335 | 302 | 0.34 |

16.7% reduction

# Mechanisms?

- Porous biochar
  - Surface area: weight
  - Absorb gases
- Microbial population shift / Improved microbial habitat
  - Microbial growth efficiency
  - H transfer/sink

# Costs

- Cost of feed
- Implementation

- Drawbacks?
  - Meat quality / safety
  - Digestibility/performance
  - Adsorption key nutrients

# Benefits

- $CH_4$ reduction
  - Energy efficiency
  - Environmental
- Recycling of ‘nutrients’

# Future

- US Forest Service

- 2 treatments
- Growing and Finishing
- ~100 steers fed in 10 pens
- Performance: weight gain, feed intake, efficiency, carcass data
- Gas emissions: $CO_2$ and $CH_4$
- FDA waiver (FUA)

# Future

- Nebraska Environmental Trust

- Manure application
- 3x2 factorial
  - 0, 5, 10% biochar
  - 30 vs 60 days
- Nutrient losses
  - Organic matter, N (total, organic, ammonium, nitrate)
  - $CH_4$ production
  - Manure from cattle fed biochar

The Nebraska Environmental Trust

preserving NATURAL NEBRASKA™ for future generations

# Biochar in Cattle Diets

- Growing calves 8% reduction in $CH_4$
- Finishing cattle 16% reduction in $CH_4$


- Opportunity?
- Gain, intake, and feed efficiency?
- Animal health?
- N capture in manure
- FDA approval needed

# Thank You!!

- High Plains Biochar
  - Rowdy Yeatts
- Nebraska Forest Service
  - Adam Smith
  - Heather Nobert

HIGH PLAINS BIOCHAR

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