



***CHN Analyzer Labs in General  
Chemistry and Environmental Science***

**Scott Donnelly      Tim Whittier**  
**Arizona Western College**

*Colorado River*



Las Vegas

Glen Canyon Dam

San Juan River

Flagstaff

Little Colorado River

Colorado River

Phoenix

ARIZONA

NEW MEXICO

AWC

MEXICO

Tucson

# *Presentation Topics*

- **CHN Elemental Analyzer**
- **Lab Activities:**
  - **Post-harvest Ethanol from Wheat**
  - **Chemical Composition of Coal**

# *CHN Elemental Analyzer*

60 Sample  
Carousel



$O_2(g)$  not shown

↑  
↓  
Combustion

↑  
↓  
Reduction

$He(g)$

$N_2(g)$

**Perkin Elmer 2400 Series II**

Mass  
(mg)

1.5mg < sample mass < 3mg

2.95

1.5

0.21

4.75

1.2

0.14

blank

blank

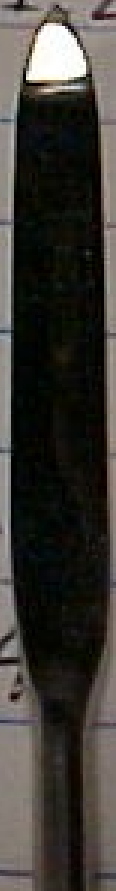
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1.4

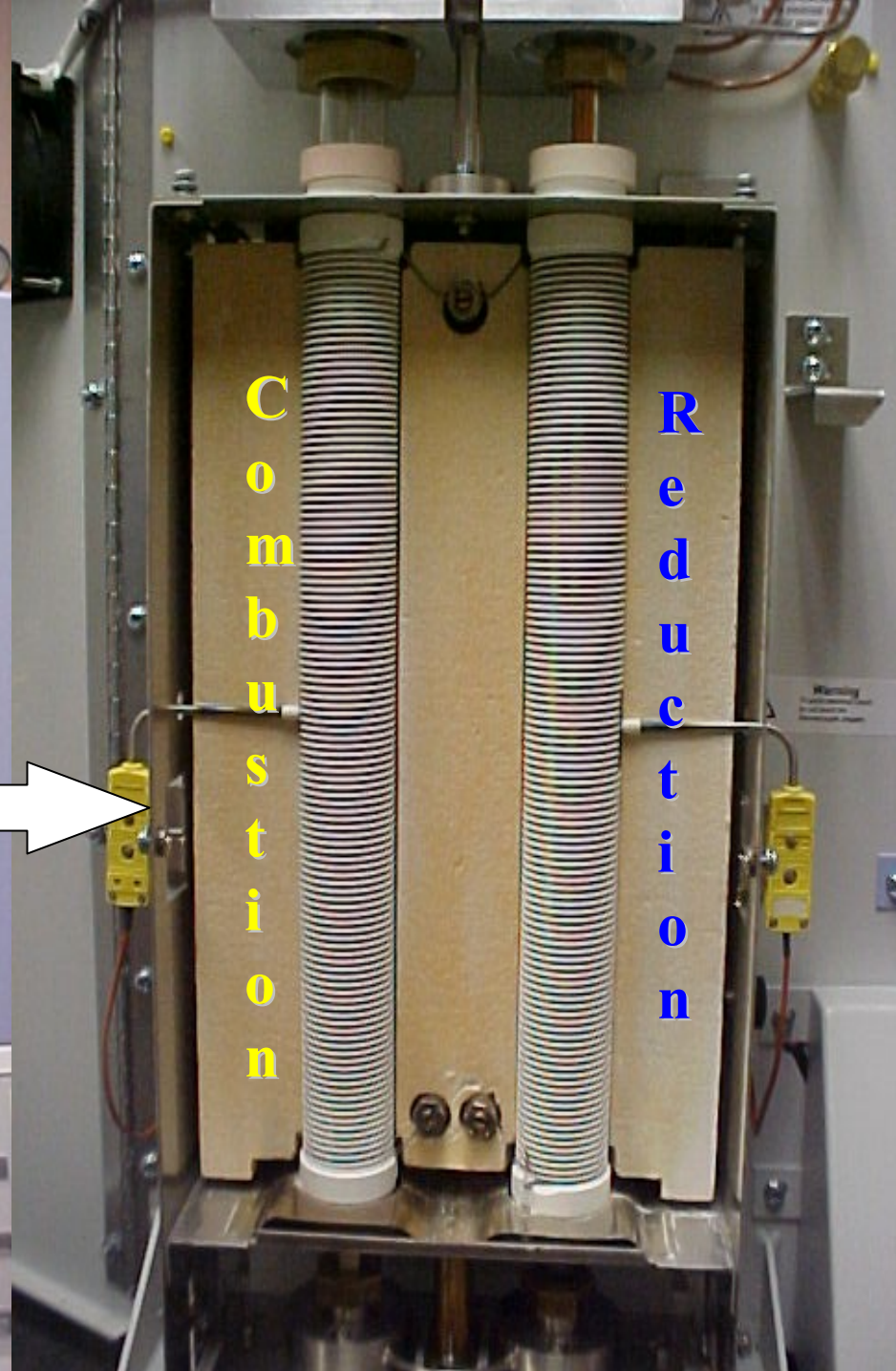
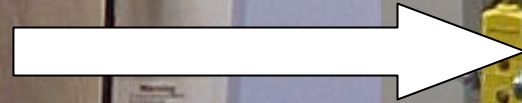
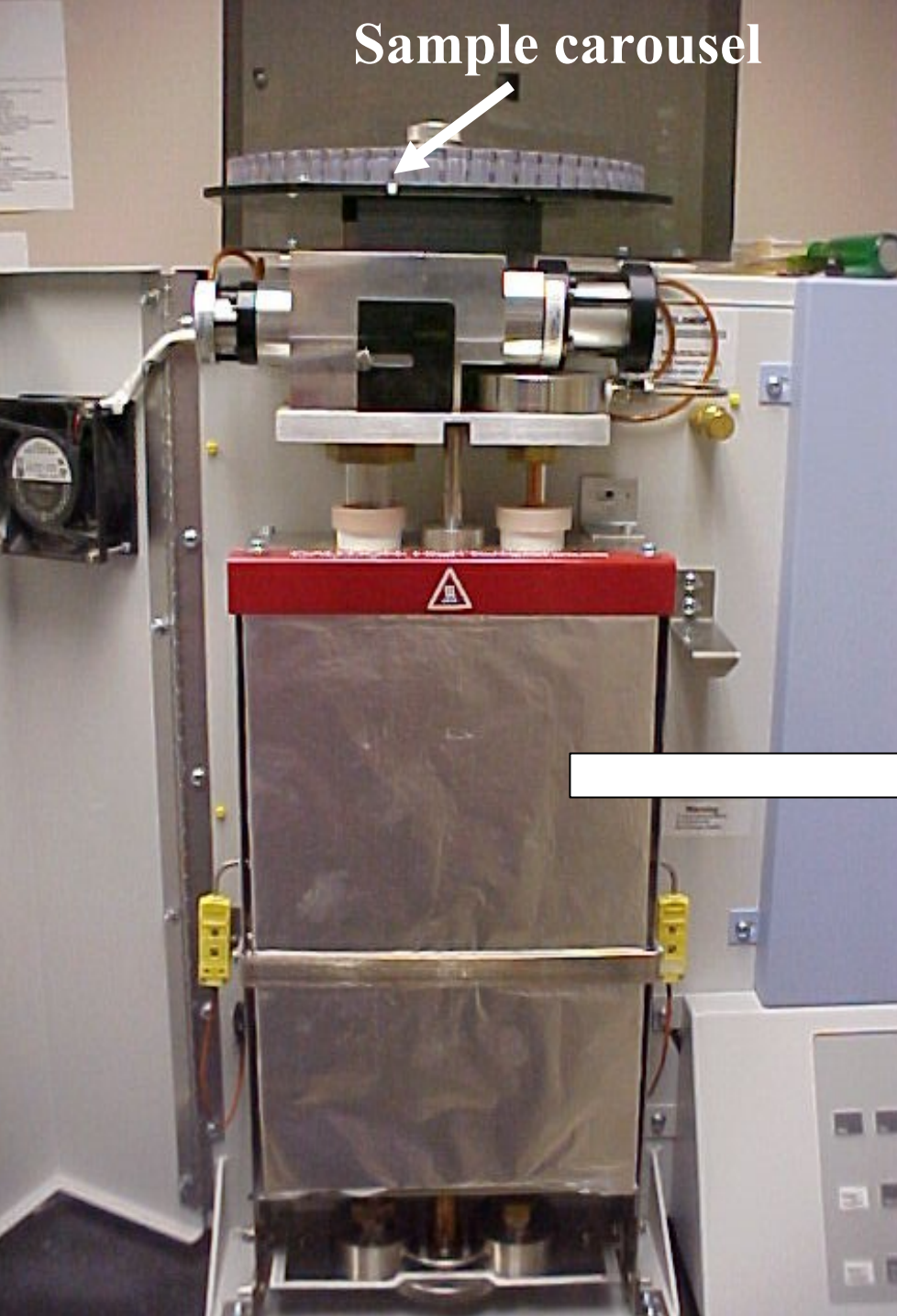
0.18



Tin cup



Sample carousel





*Cellulosic Ethanol Post-Harvest  
Wheat Activity*

**Why do it?**

**Durham wheat**



HOW YOU'LL LIVE FOREVER (ALMOST) Page 60

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# E85

## 85% Ethanol

# *Educational Benefits*

- **Relevant national and global concern as related to energy and conservation of finite resources issues**

- **Opportunity to conduct lab outside chemistry building**



# *Questions Asked:*

**How big is an acre?**

**How much energy is needed to grow an acre of wheat?**

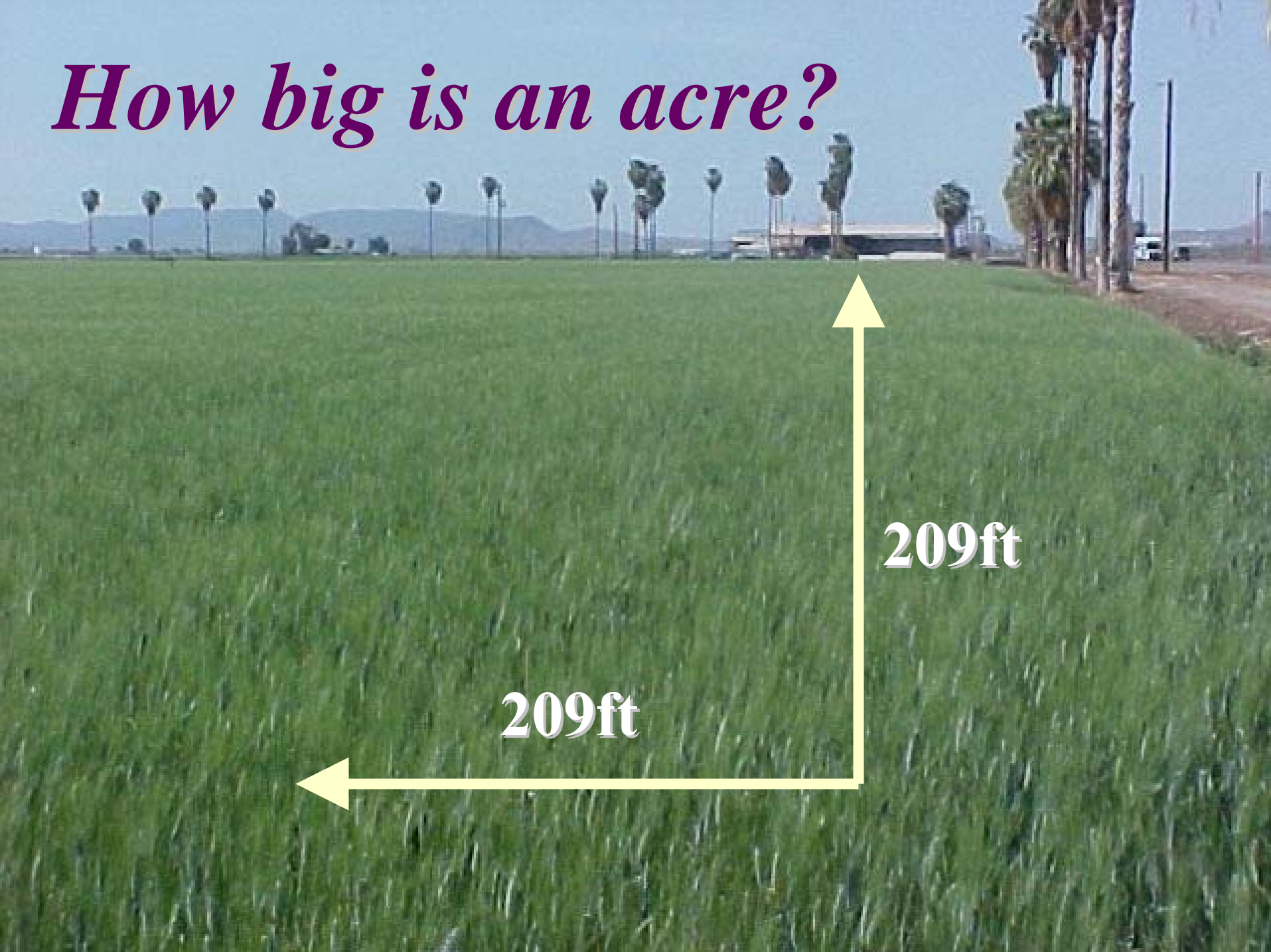
**How much does an acre of wheat (dry) weigh?**

**How much ethanol could be produced from the post-harvest biomass?**

# *Equipment Needed for Fieldwork:*

- **300' tape measures**
- **One meter length rulers**
- **Portable quantum meters**

# *How big is an acre?*



209ft

209ft

# *Photosynthetically Active Radiation (PAR)*

April 2006 ~3pm



**Units:  $\mu\text{mol photons/m}^2 \bullet \text{s}$**

# *Daily Energy Incident on Acre*

$$E = h\nu \text{ where } \lambda = 525\text{nm}$$

$$c = \lambda \cdot \nu$$

$$E = \sim 7 \times 10^{10} \text{J} =$$

**2.5 tons bituminous coal =**

**$\sim 490$  gallons crude oil =**

**$\sim 550$  gallons gasoline**

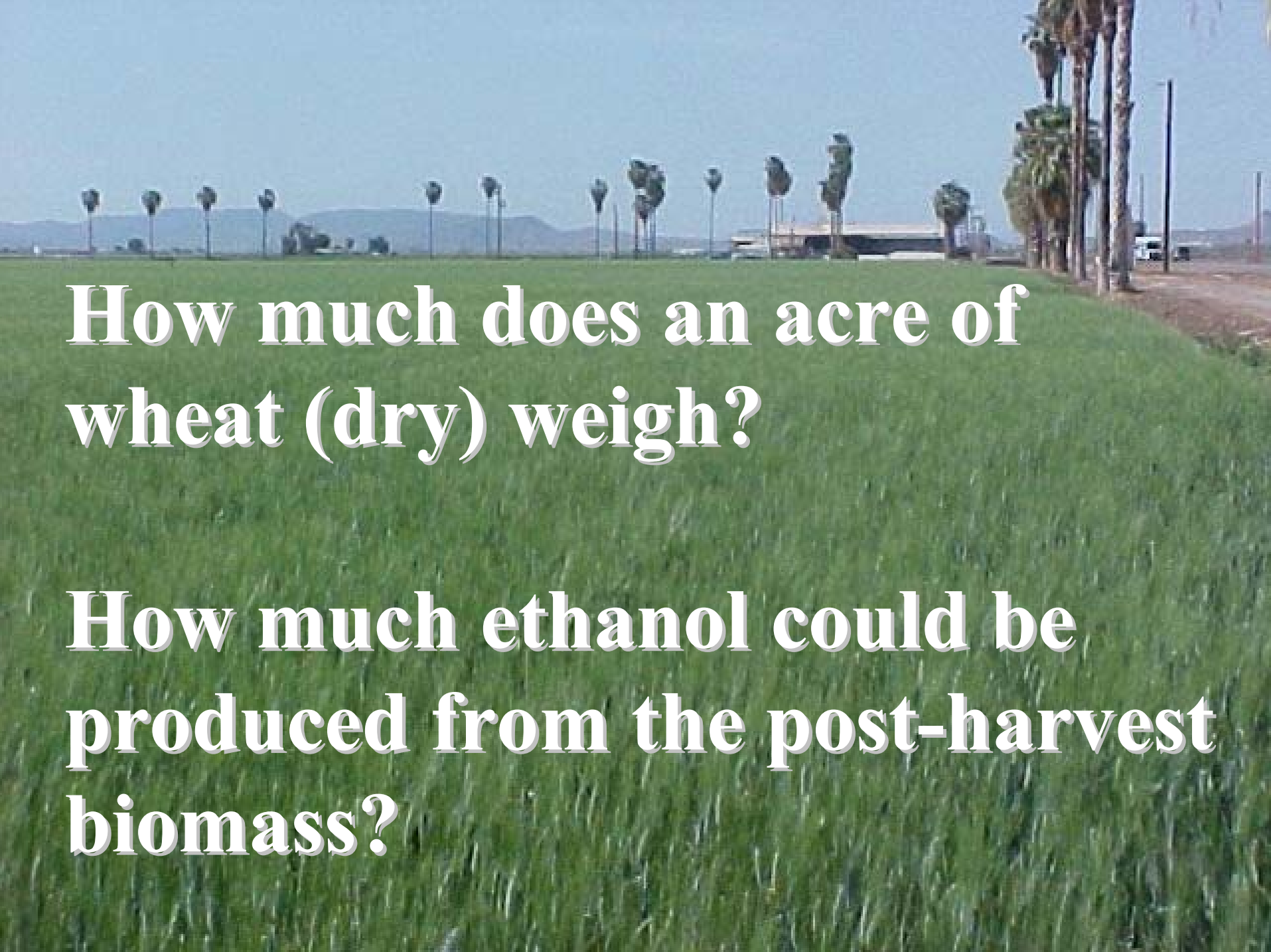
*80-100 wheat stalks/ft<sup>2</sup>*

*13.2g/five stalks (dry)*

*CHN data: 45.7%C*



**One acre = 43,560 ft<sup>2</sup>**



**How much does an acre of  
wheat (dry) weigh?**

**How much ethanol could be  
produced from the post-harvest  
biomass?**

# *Student Calculations:*

**Cellulosic biomass (dry): ~20,000lbs**

**Available carbon\*: ~9,150 lbs**

**Mass Ethanol: ~17,520 lbs\*\***

**Volume Ethanol: ~2,650 gallons\*\***

**\*: CHN analysis for cellulosic biomass = 45.7%C**

**\*\* : Assuming 100% efficiency for simplicity**



Image: [e85fuel.com/index.php](http://e85fuel.com/index.php)

**~2,650gal Ethanol =  
~1,770gal Octane 87 gasoline\***

**\*: Based on enthalpic density (Btu/gal) comparison**

***Anthracite or Bituminous Coal:  
Which Is Better to Burn?***



# *Navajo Generating Station (NGS)*



## **Coal consumption:**

**A maximum of 25,000 tons per day if all three 750-MW units are running at full load.**

**<http://www.srpnet.com/about/stations/navajo.aspx>**



**Anthracite**

**Mass %C: >90%**

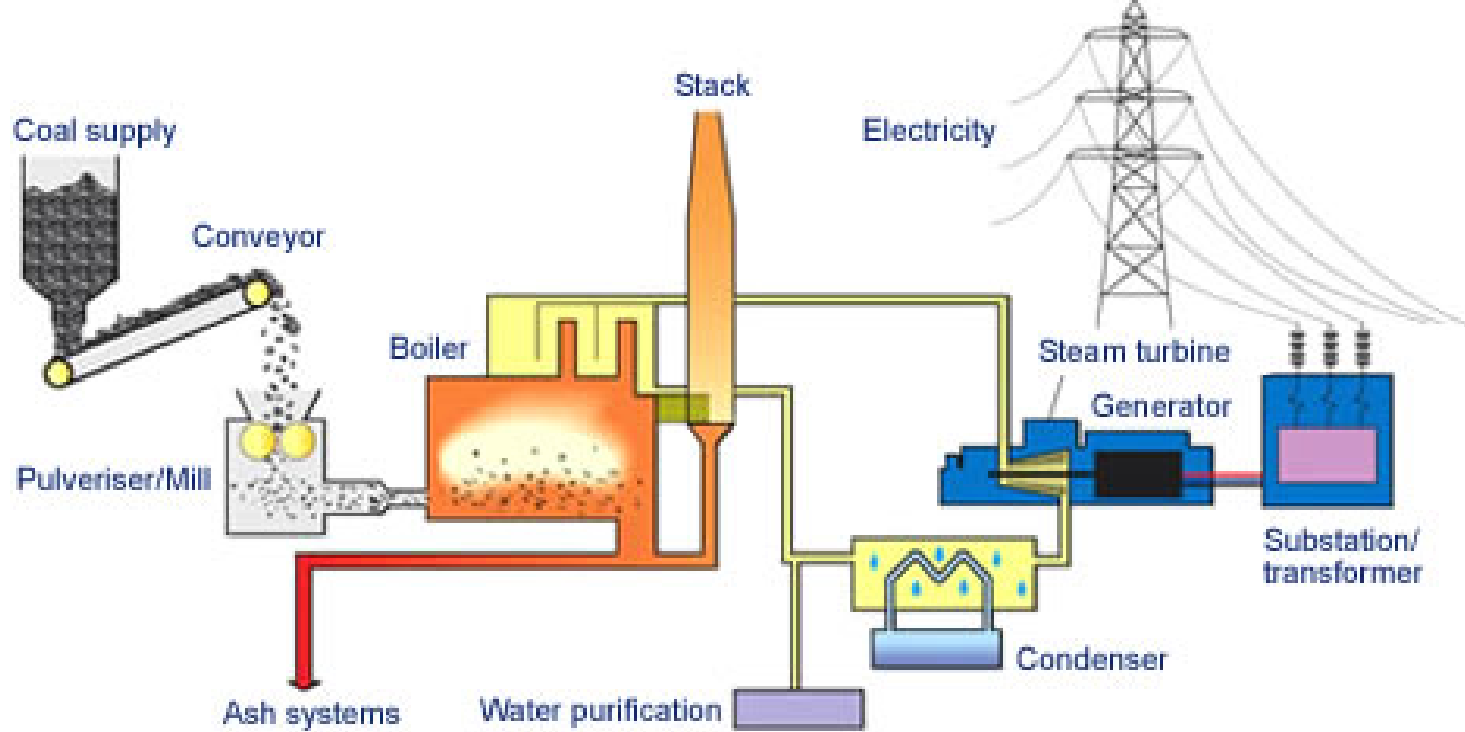
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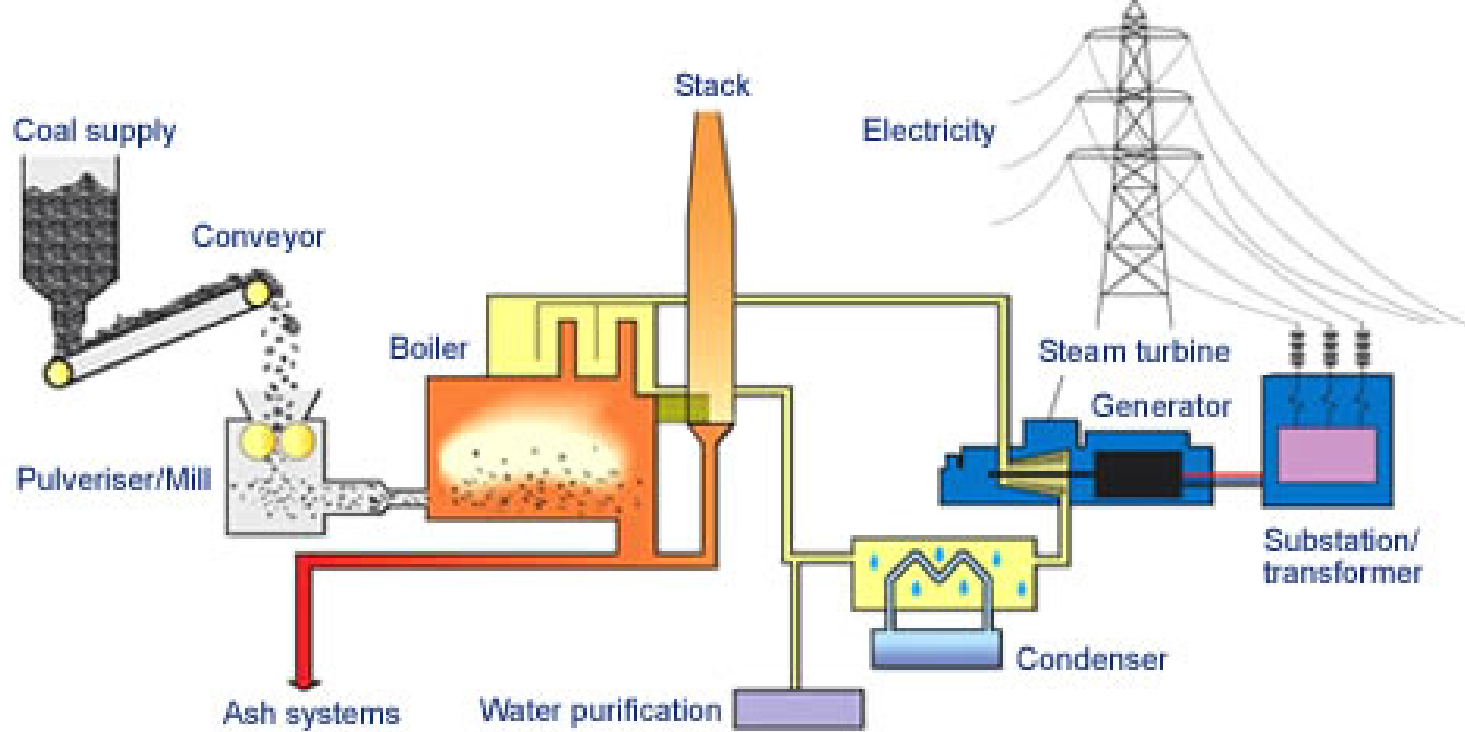
**Bituminous**

**Mass %C: 70-80%**

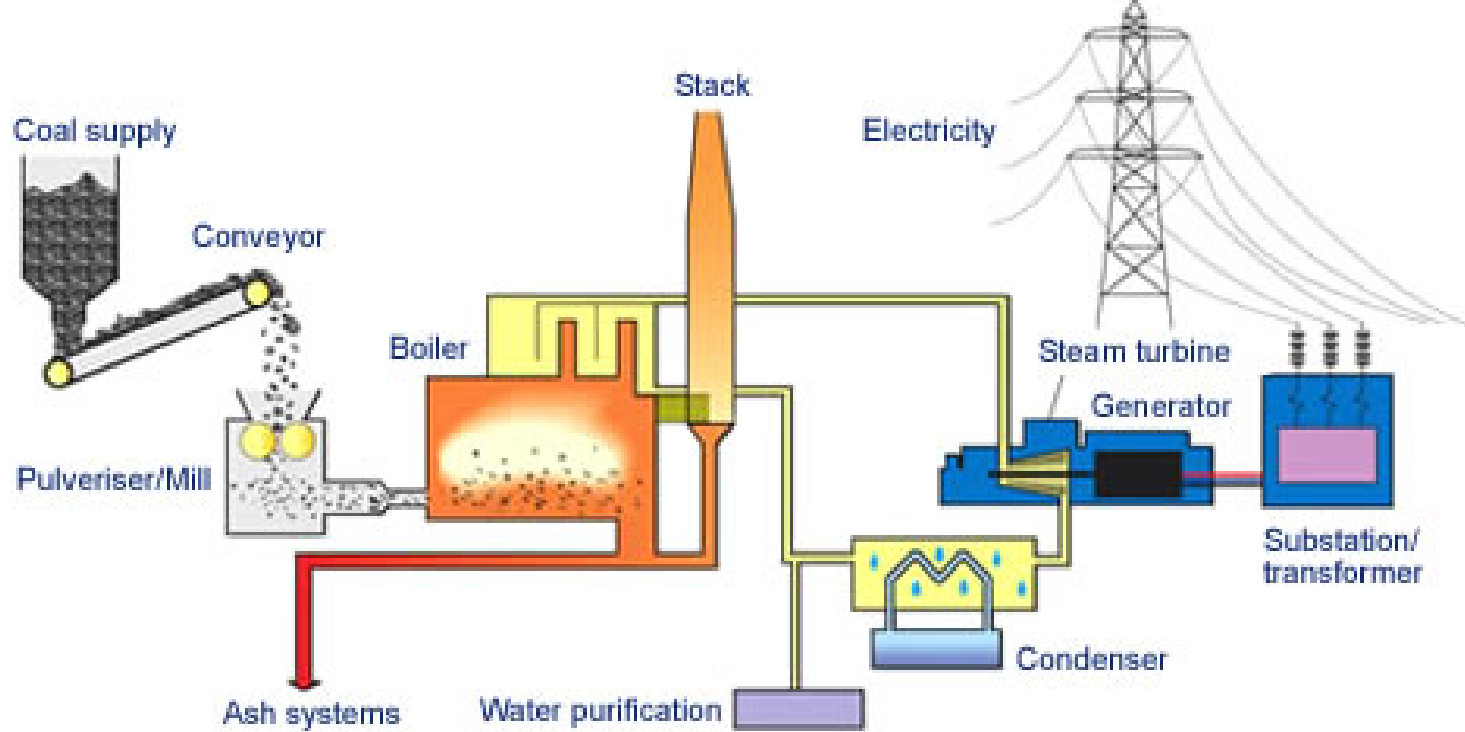
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**Based on the CHN analysis which coal type- anthracite or bituminous- has the larger specific enthalpy (Btu/ton)? *Offer an explanation.***



**Which coal type releases more CO<sub>2</sub> per ton burned? *Offer an explanation.***



**If anthracite produces more  $\text{CO}_2$  per weight burned than bituminous, then why use anthracite? *Offer an explanation.***

# *Acknowledgements*



National Science Foundation  
WHERE DISCOVERIES BEGIN

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- **Organizers of this regional meeting**
- **My lovely wife and our two children**