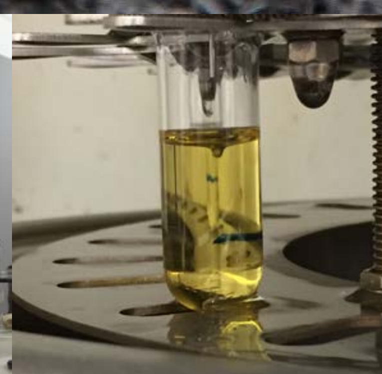
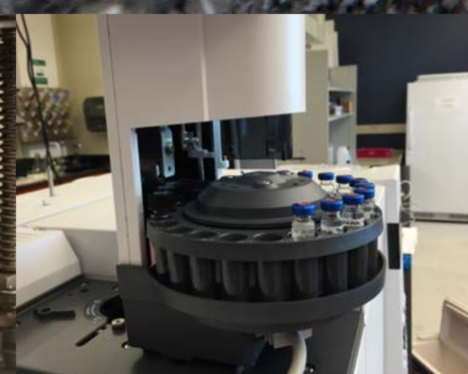
Quantification of Polycyclic Aromatic Hydrocarbons in Biochar

Sarah Richard, Dr. Yucheng Feng, Dr. Puneet Srivastava

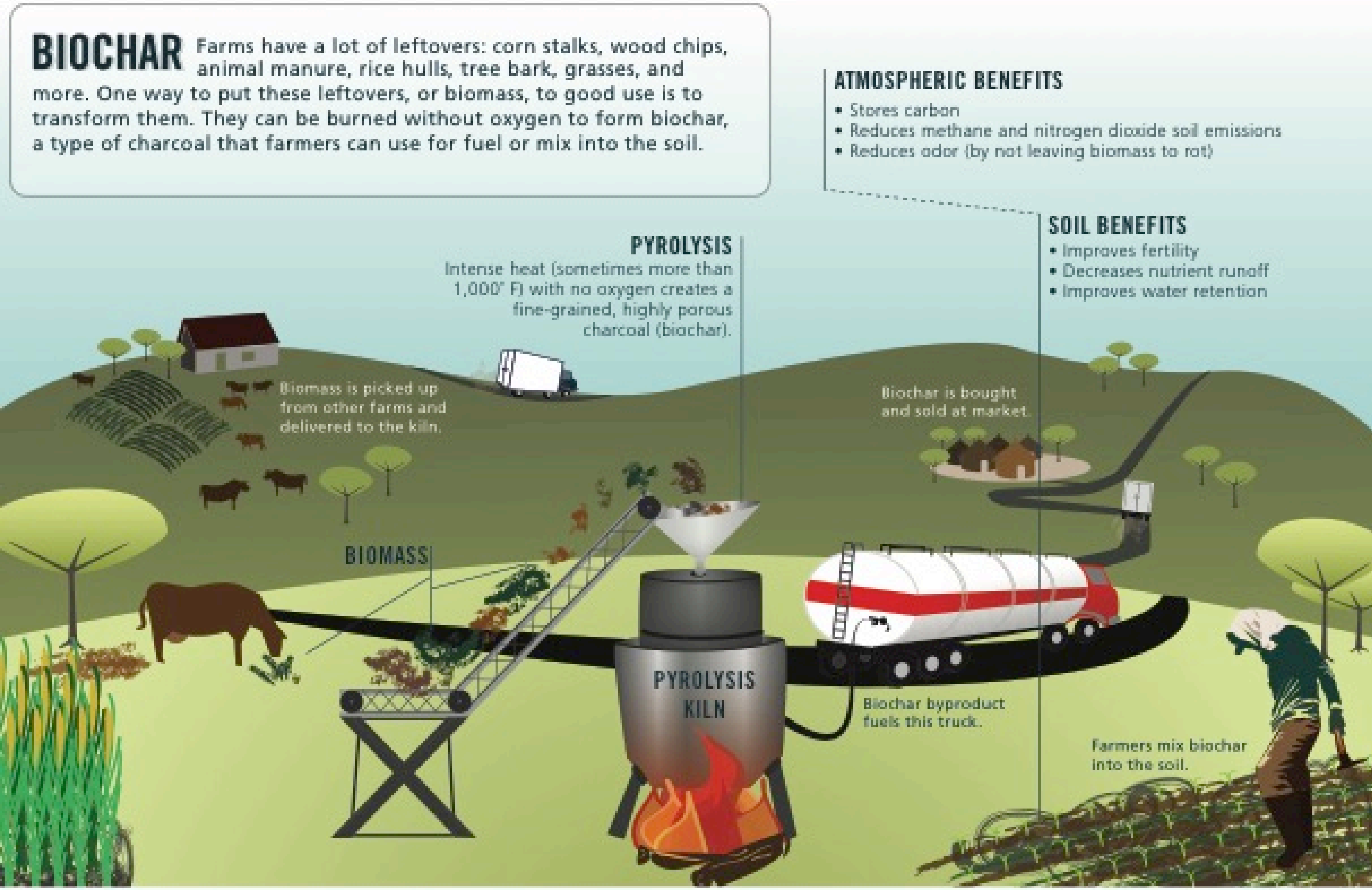
Auburn University





What is biochar?

- Biomass-derived "charcoal" intended specifically for application to soil
  - Sequester carbon
  - Improve soil function
- Byproduct of the biofuels process



http://insights.ifpri.info/files/2012/03/biochar_infographic.pdf

Potential Effects of Biochar Amendment

Positive

- Plant production increased
  - Effective soil conditioner
  - Benefits root growth, retention and acquisition of water/nutrients, and cation exchange capacity
  - Liming effect
- Higher carbon content and cannot be readily returned to the atmosphere as CO_2

Negative

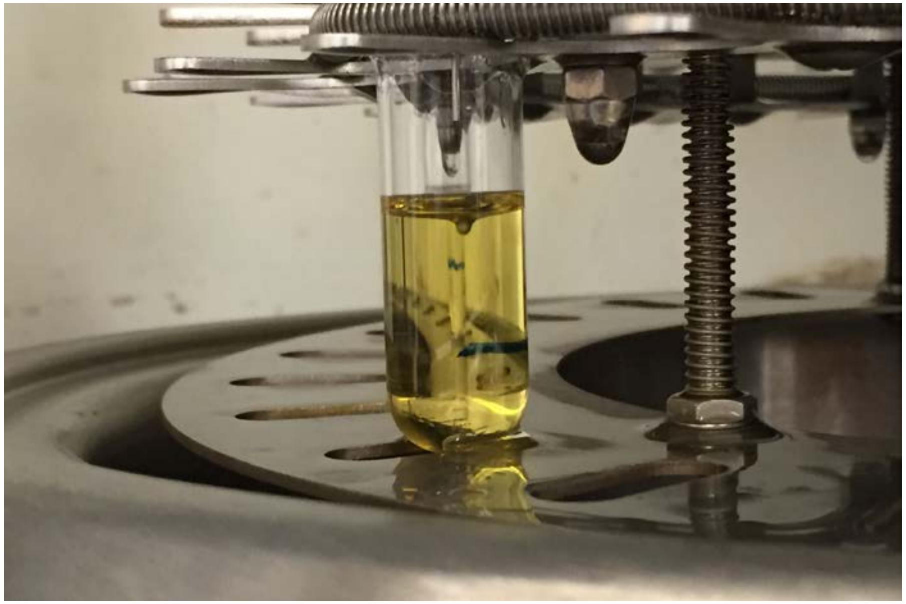
- Risk of contamination
  - Polycyclic aromatic hydrocarbons
- Crop residue removal
  - Soil loss by erosion
- Soil compaction during application
- Reduced efficacy of soil applied pesticides

Long Term Goals

- What are the optimal conditions in which to produce biochar?
  - Mitigate risks
  - Produce the most benefits for the soil environment
- What are the risks associated with applying biochar that is not produced under optimal conditions?

Objective

Quantify total PAHs in biochars produced from feedstocks at different temperatures



Biochars

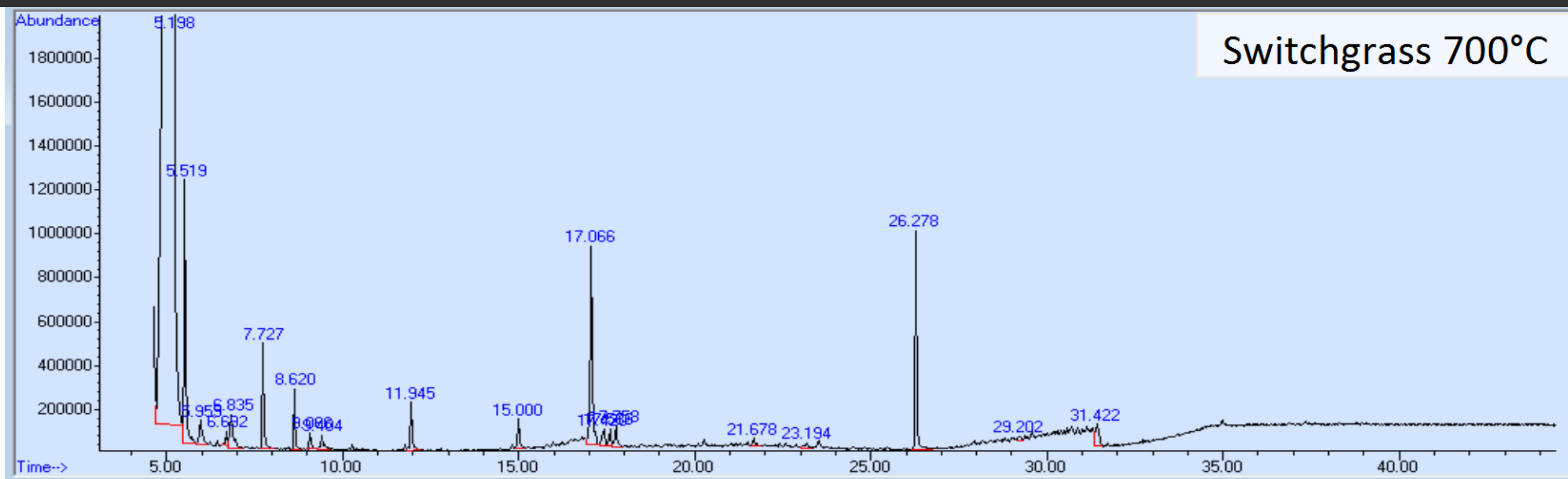
	Slow Pyrolysis			Gasification
	400°C	550°C	700°C	1100°C
Switchgrass	✔	✔	✔	✔
Loblolly Pine	✔	✔	✔	
Hardwood				✔

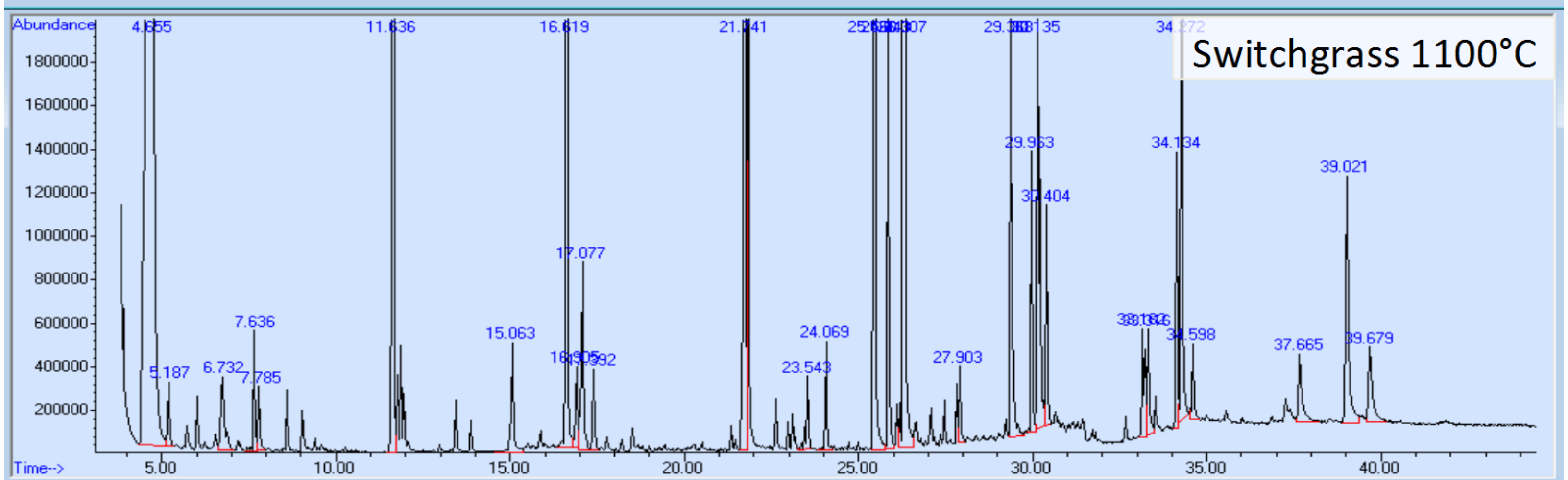
- Slow pyrolysis chars made in-house
  - Pyrolized for one hour at the target temperature
- Gasification biochars from industry sources

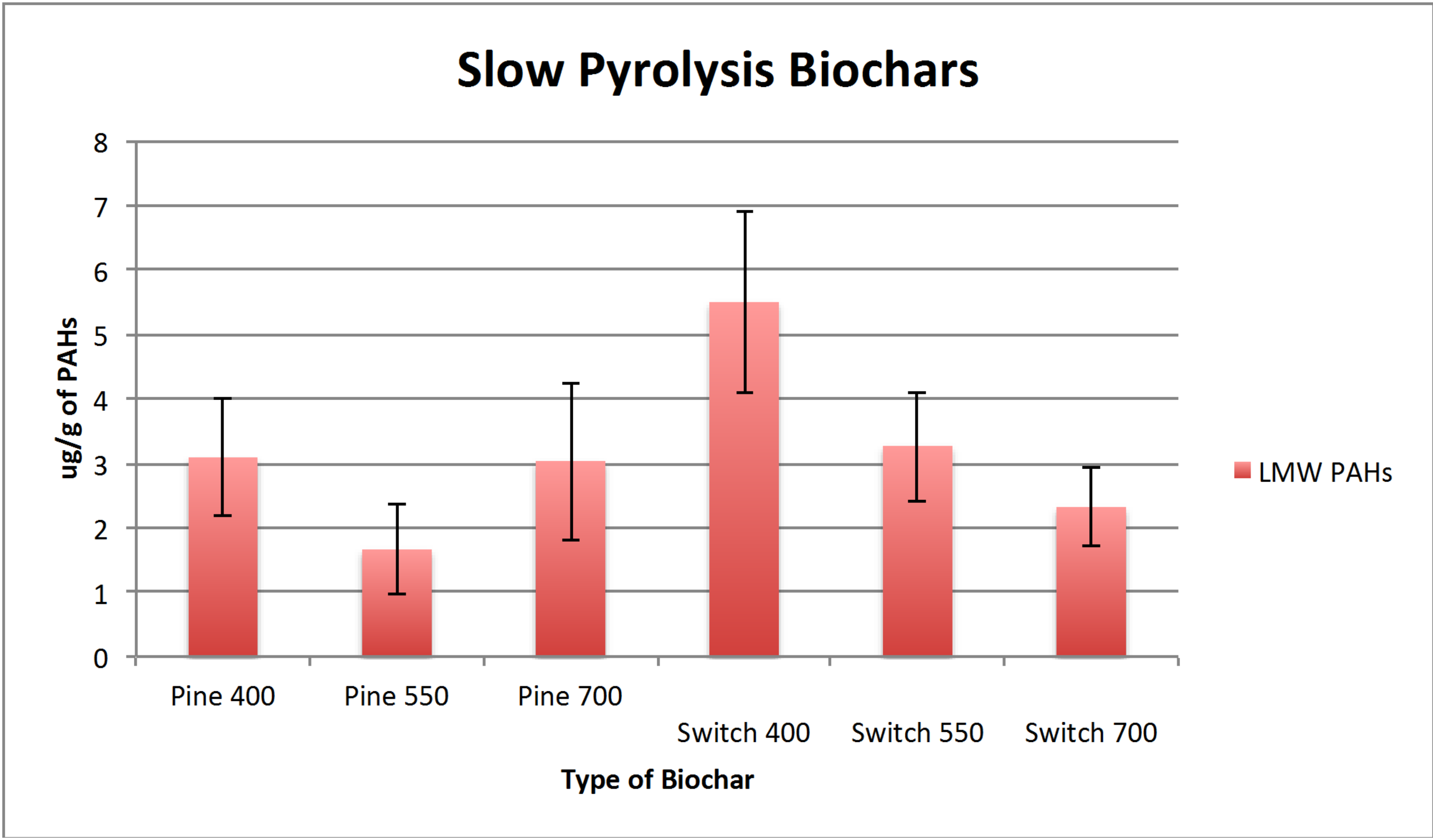
Methods

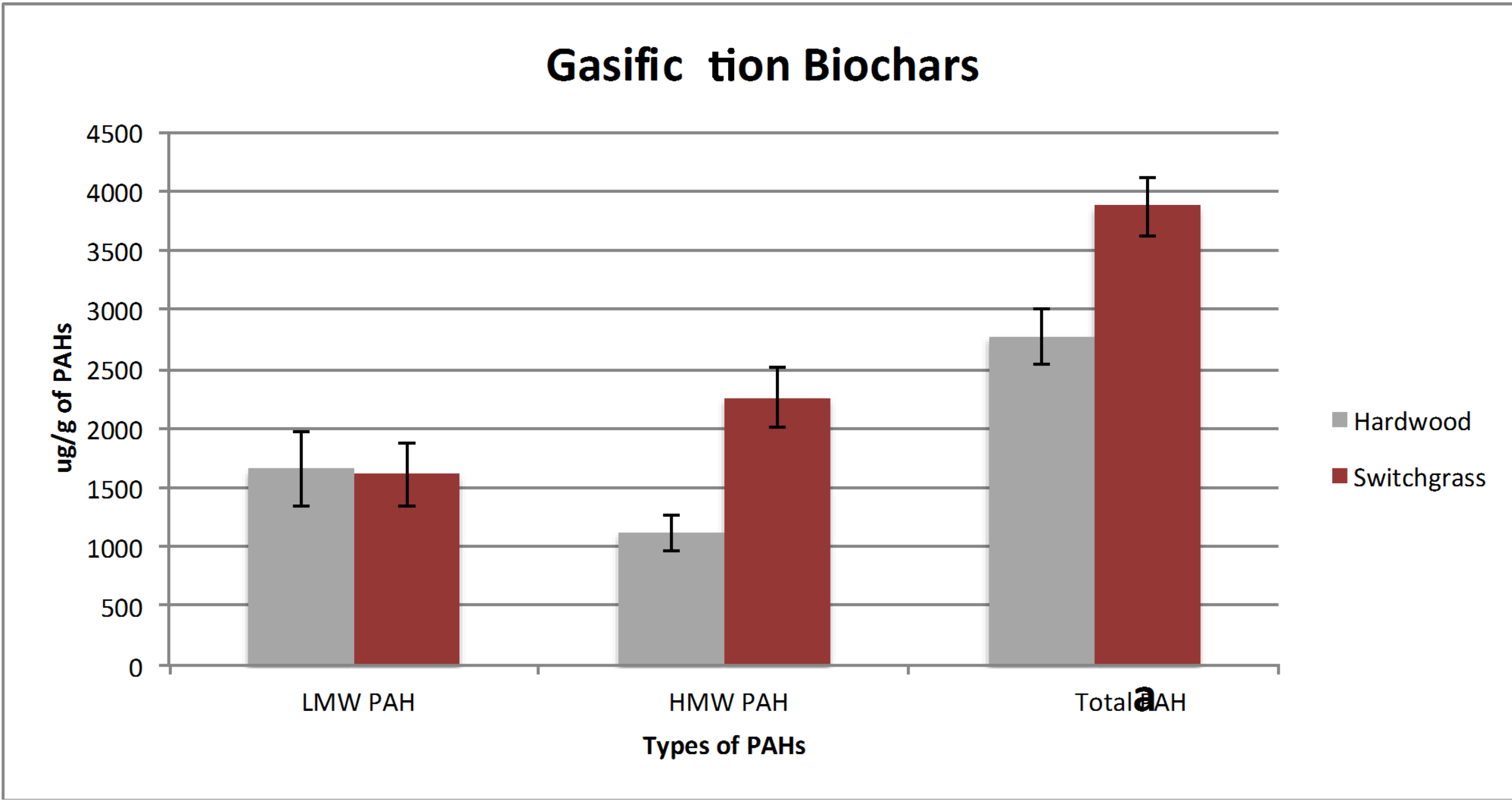
1. Soxhlet Extractions
2. Rotary Evaporation
3. Silica Gel Clean-Up
4. GC-MS Analysis

GC-MS Results






Slow Pyrolysis Biochars
ug/g of PAHs
0
1
2
3
4
5
6
7
8
Pine 400
Pine 550
Pine 700
Switch 400
Switch 550
Switch 700
Type of Biochar
LMW PAHs



Gasific tion Biochars
4500
4000
3500
3000
2500
2000
1500
1000
500
0
ug/g of PAHs
LMW PAH
HMW PAH
Total PAH
a
Types of PAHs
Hardwood
Switchgrass

Expected PAH Concentrations in Soil Amended with Gasification Biochars

PAH Classification	EPA Standard (µg/g soil)	Hard 10 ton/acre (µg/g soil)	Switch 10 ton/acre (µg/g soil)	Hard 40 ton/acre (µg/g soil)	Switch 40 ton/acre (µg/g soil)
Naphthalene	**29-100**	7.8	5.4	31.4	21.5
Acenaphthylene	**29-101**	2.3	3.1	9.4	12.3
Acenaphthene	**29-102**	0.2	0.1	0.6	0.5
Fluorene	**29-103**	0.2	0.1	0.9	0.3
Phenanthrene	**29-104**	5.1	6.2	20.4	24.8
Anthracene	**29-105**	0.9	1.3	3.5	5.0
Fluoranthene	**29-106**	3.5	5.0	14.0	20.1
Pyrene	**1.1-1.8**	4.1	8.2	16.4	32.8
Benzo(a)anthracene	**1.1-1.9**	1.3	0.7	5.2	2.8
Chrysene	**1.1-1.10**	0.5	0.6	1.9	2.3
Benzo[B]fluoranthene	**1.1-1.11**	0.4	1.6	1.5	6.4
Benzo[k]fluoranthene	**1.1-1.12**	0.3	0.4	1.0	1.8
Benzo(a)pyrene	**1.1-1.13**	1.1	2.3	4.5	9.2
Dibenzo(A,H)Anthracene	**1.1-1.14**	0.0	0.0	0.0	0.0
Benzo(G,H,I)Perylene	**1.1-1.15**	0.0	1.3	0.0	5.2
Indeno(1,2,3-CD)Pyrene	**1.1-1.16**	0.0	2.4	0.0	9.7

Concentrations of PAHs that would be present in the soil at an application rate of 10 ton/acre and 40 ton/acre

Summary

- Biochar source, production temperature, and pyrolysis time affect the concentrations of PAHs
- Biochars produced from gasification contained more types of PAHs and in higher quantities
- Biochars produced from gasification contained levels of PAHs above the EPA standards for soil
- Slow pyrolysis biochars contained lower concentrations of PAHs, fewer types of PAHs, and would be acceptable for soil amendment

Future Research

- Conduct bioavailability assays to determine the potential uptake of PAHs in plants and soil organisms
  - Evaluate uptake in polyoxymethylene passive sampler
  - Evaluate uptake in food crops

Questions?