Making Biochar with Specified Properties

Modeling for Designer Biochar

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Incentive:

"…agronomic utility of biochars is not an absolute value, as it needs to meet local soil constraints"

Enders et al/ Bioresource Technology 114 (2012)

Background

Langara College has dedicated facilities for making (1kg) and analyzing biochar

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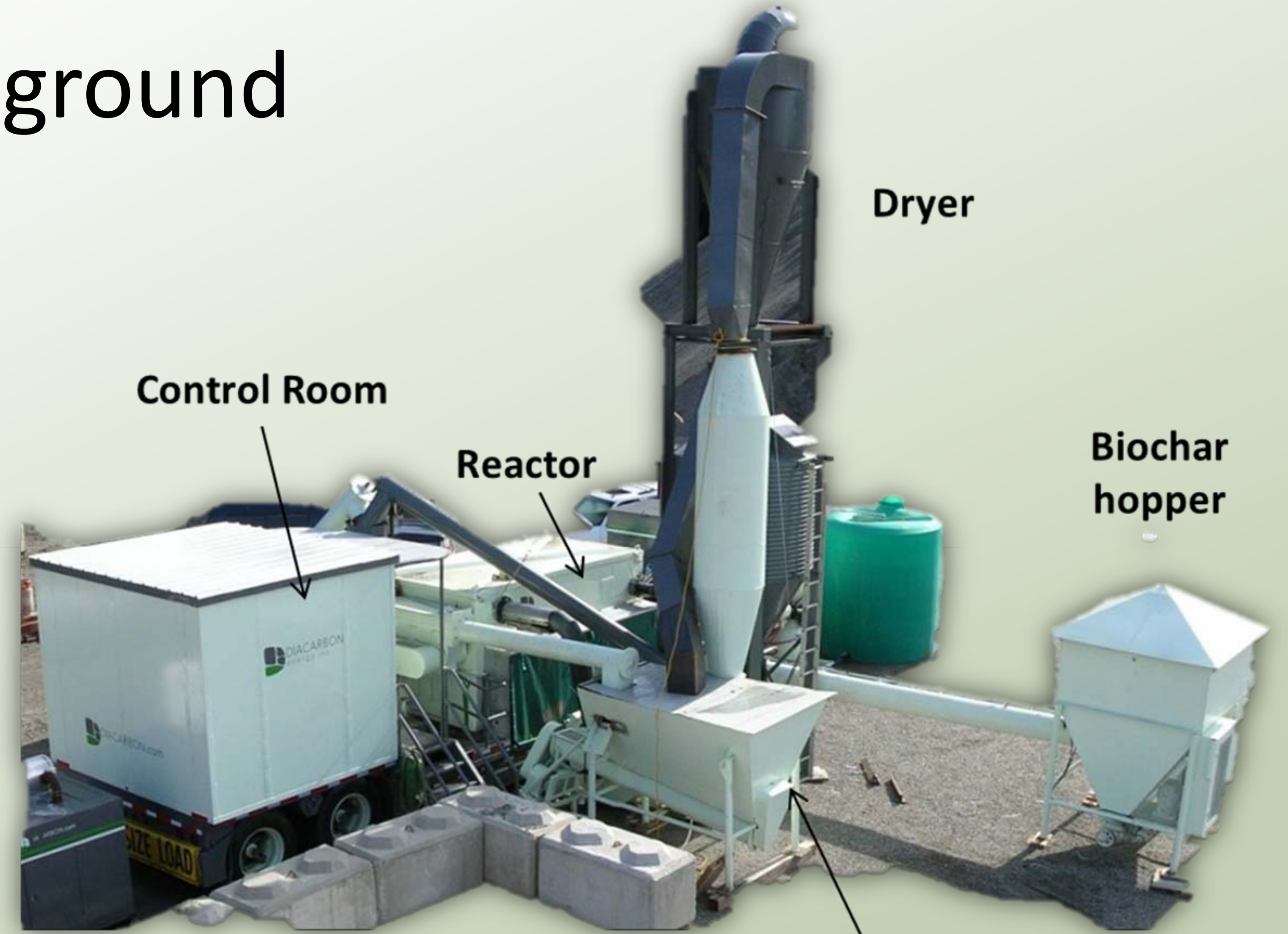


Diacarbon Energy operates the largest commercial biochar reactor in Western Canada (1 tonne/hour)

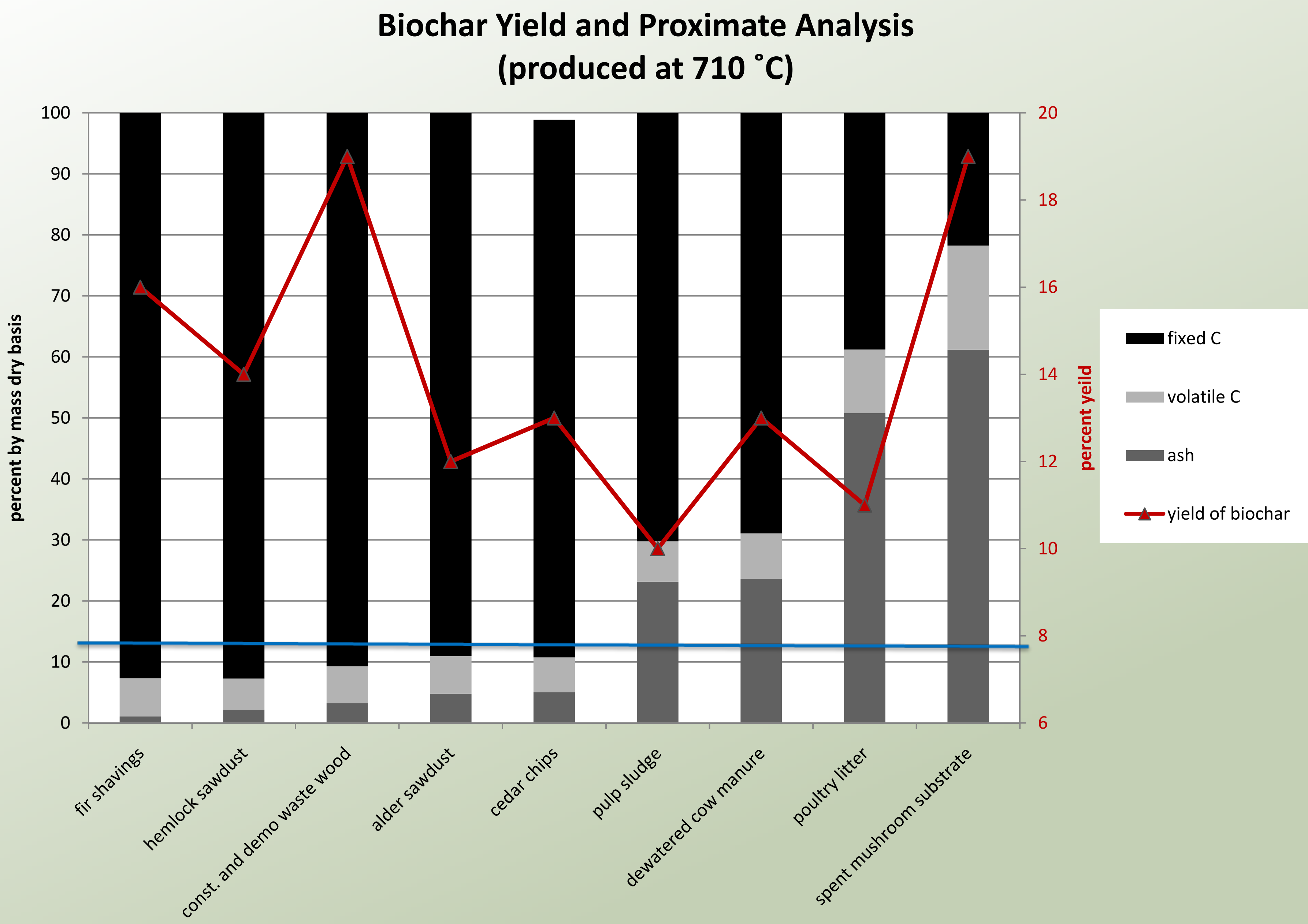
Background

Langara College and Diacarbon Energy are working to utilize low value agronomic byproducts for quality biochar production:

- spent mushroom substrate
- poultry litter
- anaerobic digestate

Current objective biochar characteristics for Diacarbon supply contract (biochar as an energy product)

- Maximum low value ag byproduct feedstock
- Maximum of 15% ash
- Minimum of 20 kJ per gram
- Other elemental considerations


Biochar Yield and Proximate Analysis
(produced at 710 ˚C)
percent by mass dry basis
100
90
80
70
60
50
40
30
20
10
0
percent yeild
20
18
16
14
12
10
8
6
fixed C
volatile C
ash
yield of biochar
fir shavings
hemlock sawdust
const. and demo waste wood
alder sawdust
cedar chips
pulp sludge
dewatered cow manure
poultry litter
spent mushroom substrate

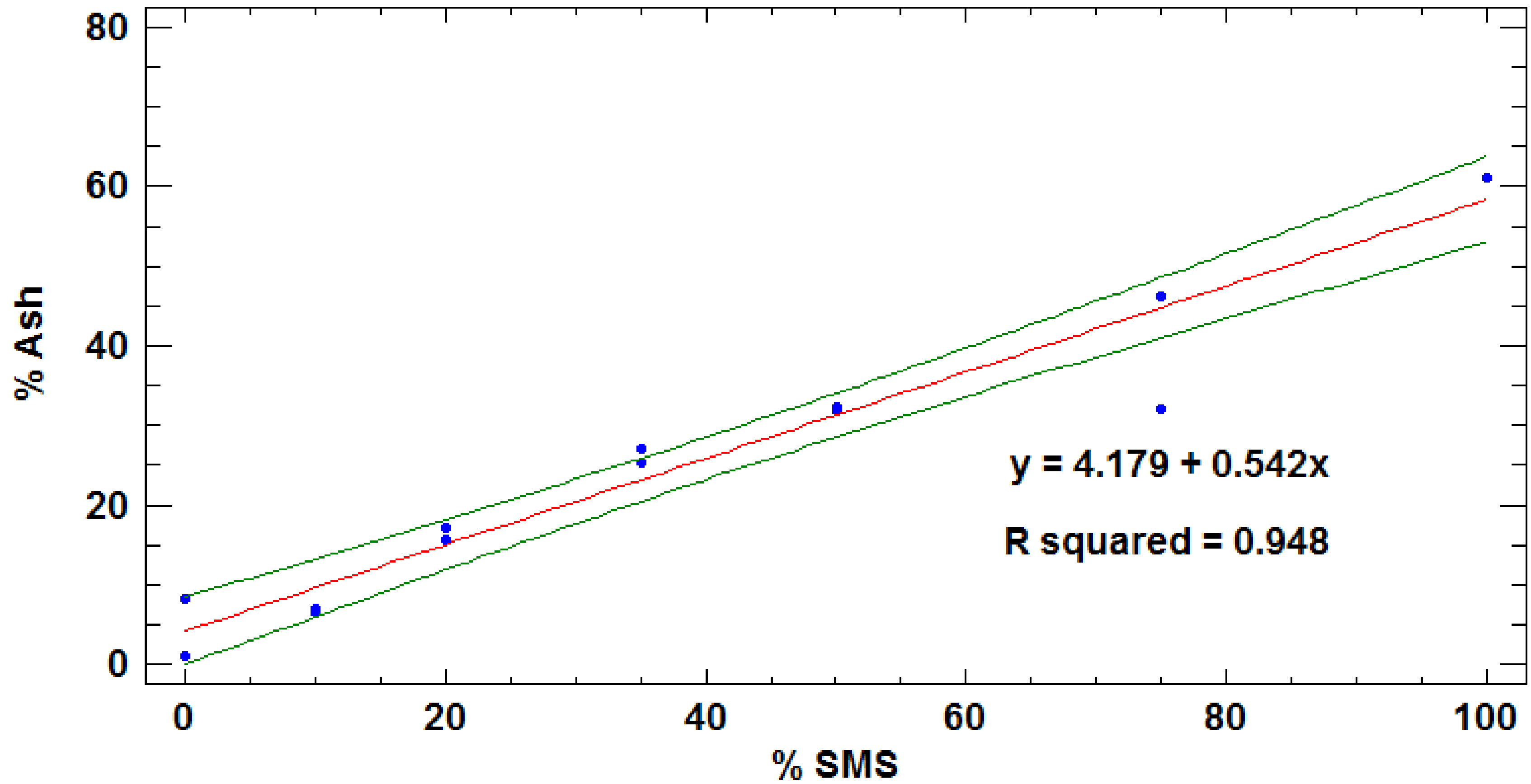
The Goals of this Study

- Be able to produce biochar with *specified* characteristics by blending feedstocks
- Develop a *predictive* model that relates biochar properties to feedstock blend proportions and process temperature
- Suggest blend formulations to Diacarbon Energy that satisfies their target biochar properties

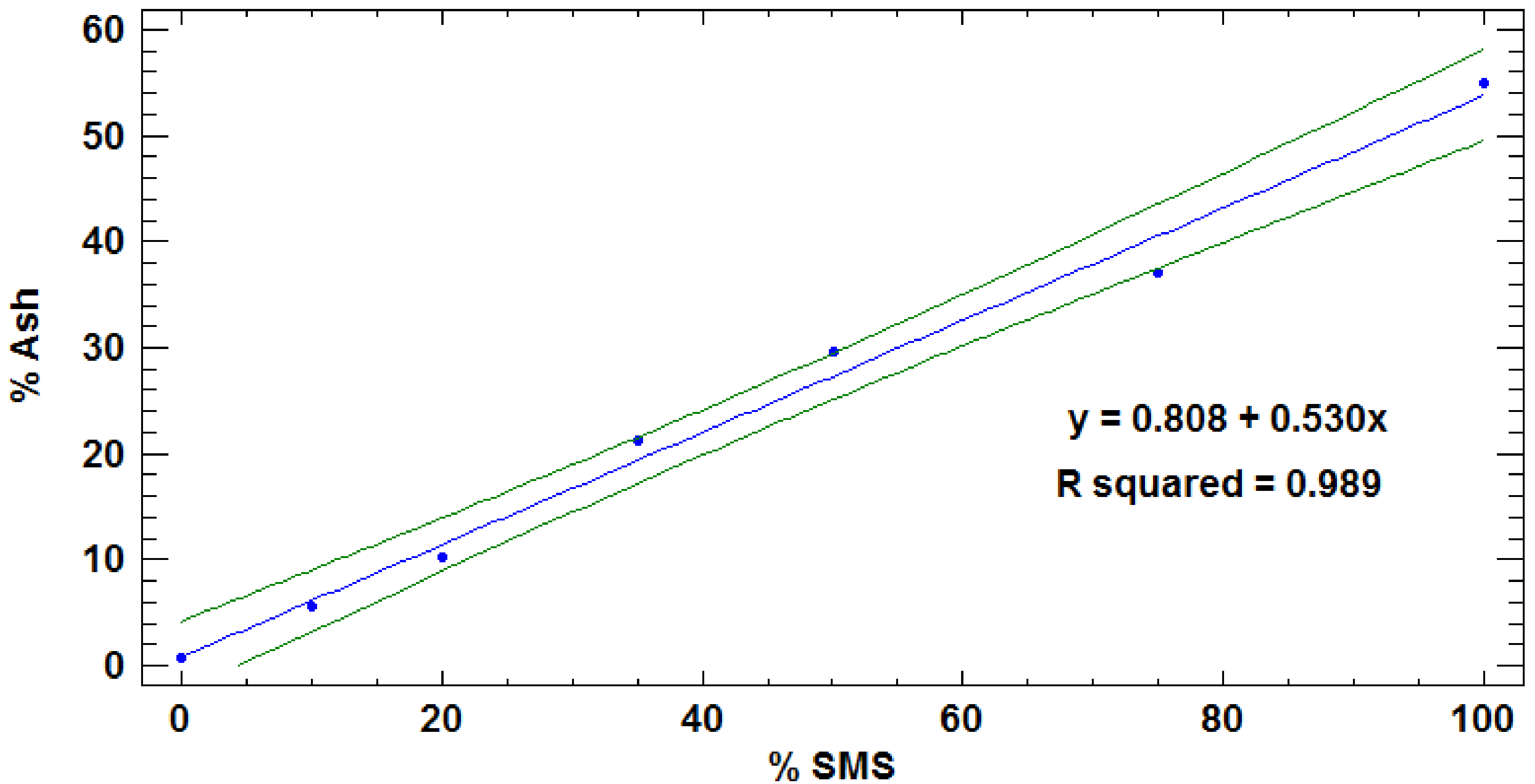
Experimental approach

- Produce batches of biochar using various blends of Fir and spent mushroom substrate (SMS) at different temperatures.
- Analyze the biochar for physical and chemical characteristics.
- Model the relationships
- Suggest optimal formulations and operating conditions

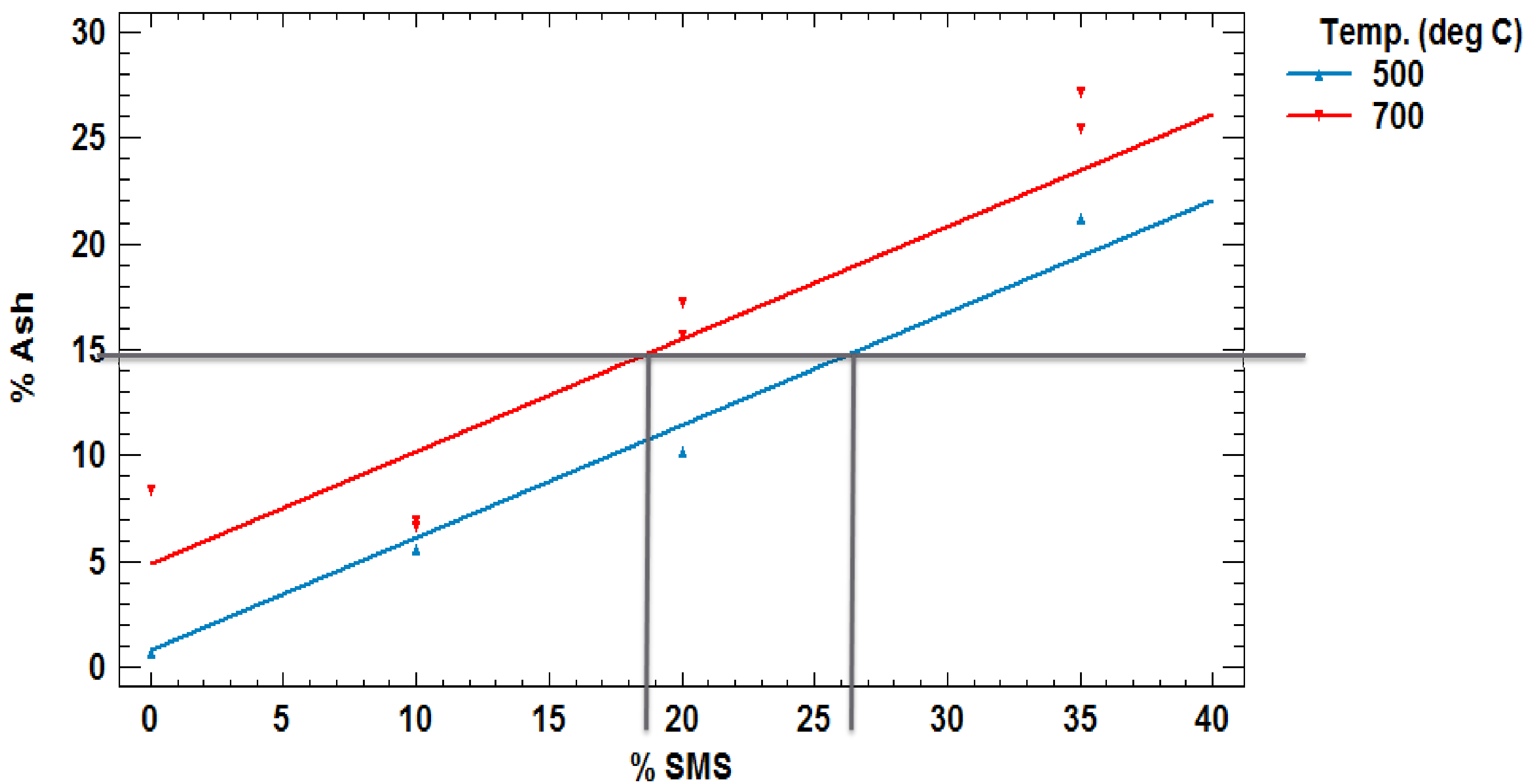
Plot relating biochar % ash to amount of spent mushroom substrate relative to Fir in the feed stock.
Treatment temperature 700 C.



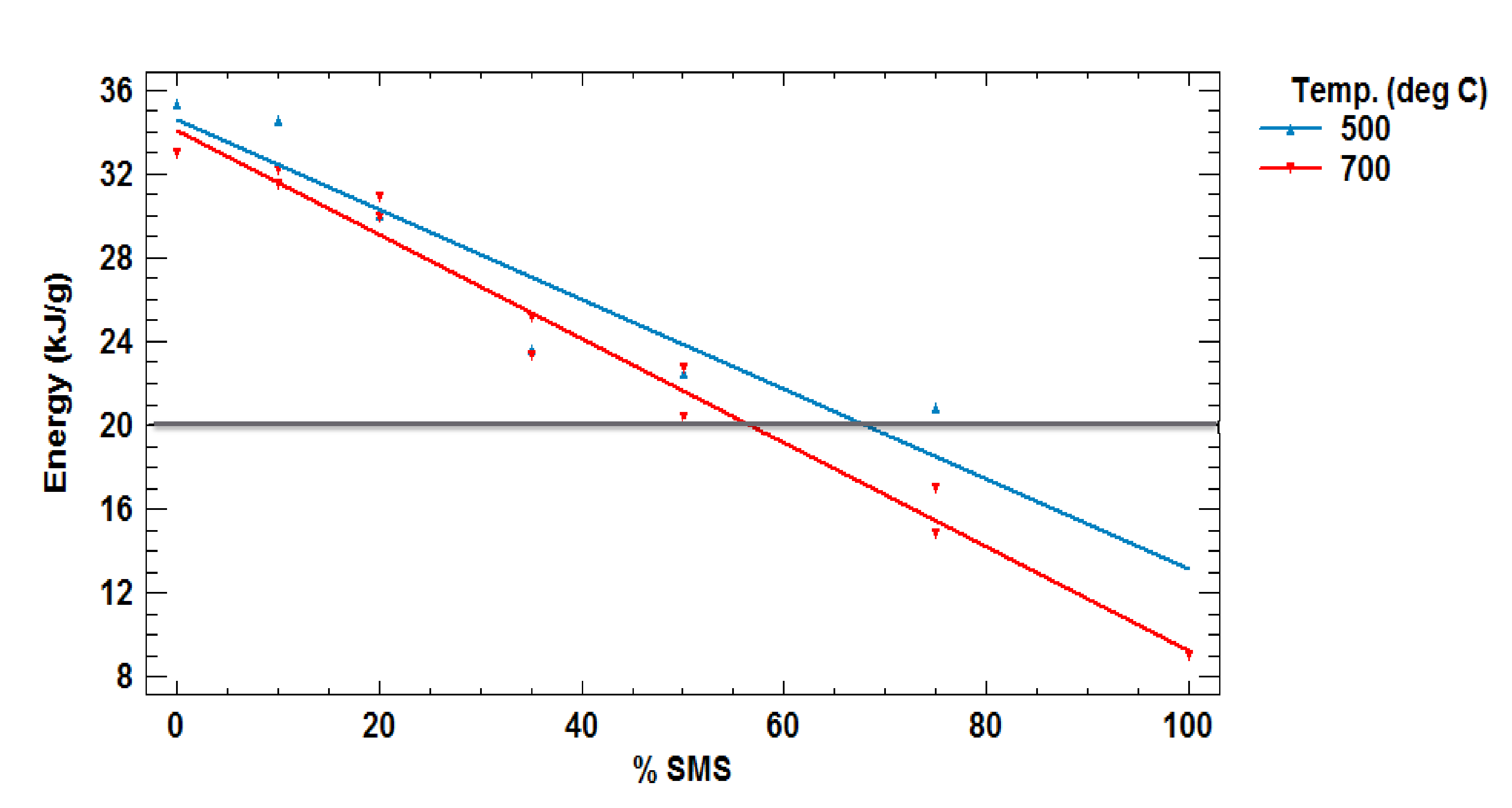
Plot relating biochar % ash to amount of spent mushroom substrate relative to Fir in the feed stock.
Treatment temperature 500 C.



Plot relating biochar % ash to treatment temperature, and amount of spent mushroom substrate relative to Fir in the feedstock



Plot relating biochar % ash to treatment temperature, and amount of spent mushroom substrate relative to Fir in the feedstock



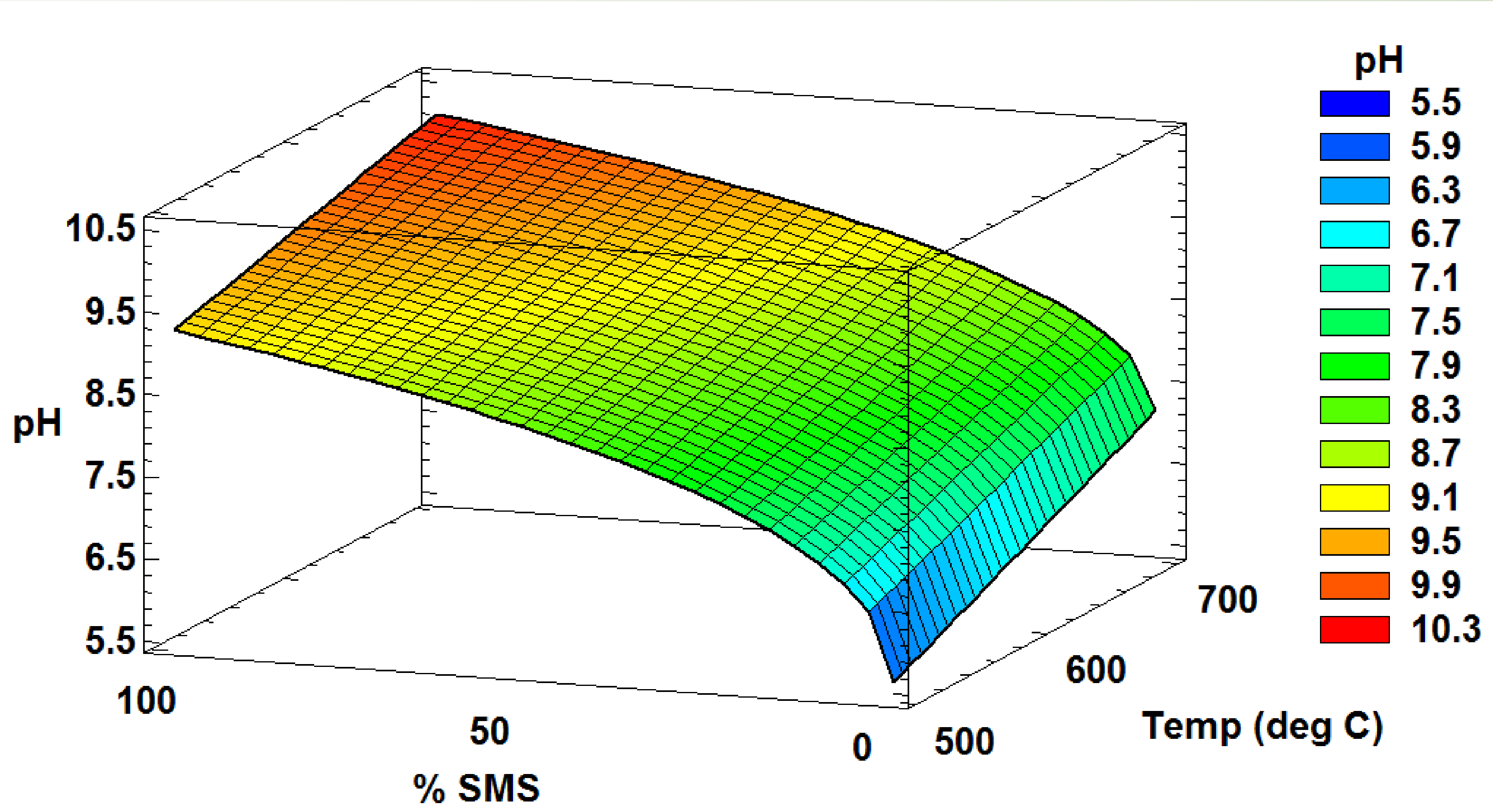
Recommendations for Diacarbon:

- Operating the reactor at temperatures near 500 C, a blend of 25% spent mushroom substrate and 75% Fir optimizes the economic return and produces biochar with the desired qualities.
- Similar exploration of local feedstocks will reveal other options allowing for fluid operation as economics and availability varies.

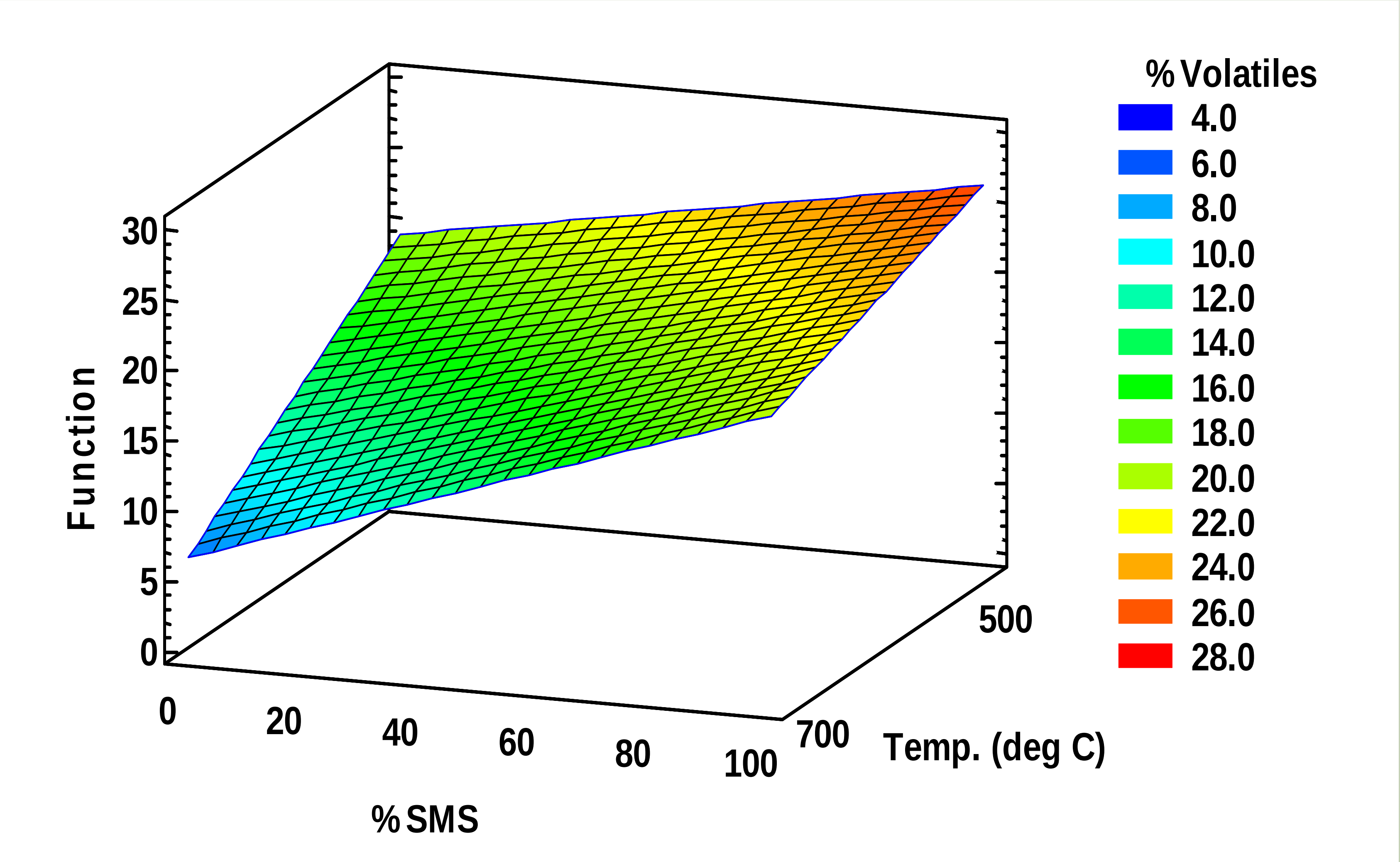
Can the methodology be used to tune biochar properties for other applications?

Yes!

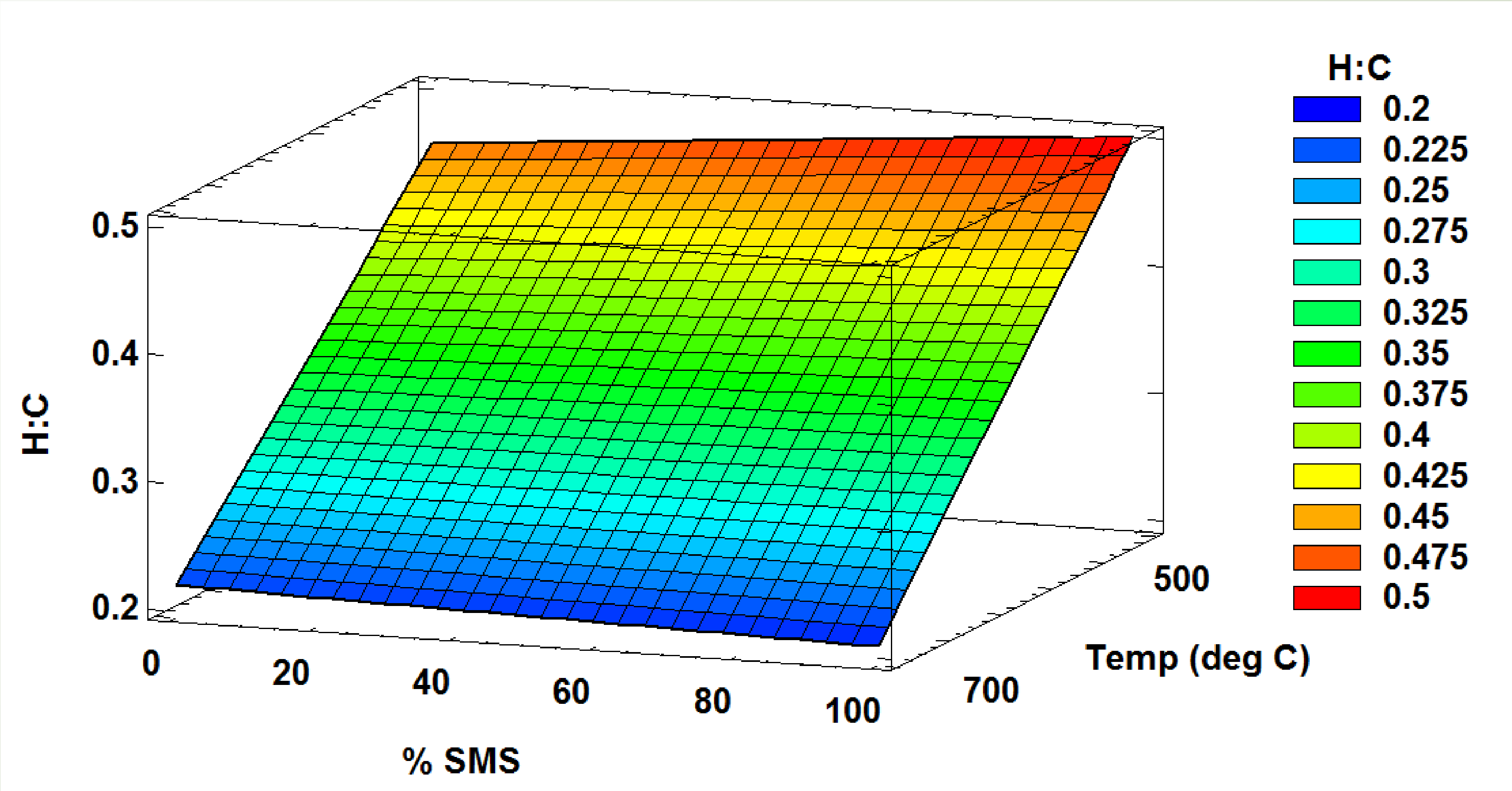
Surface plot relating pH to treatment temperature and amount of spent mushroom substrate relative to Fir in the feedstock

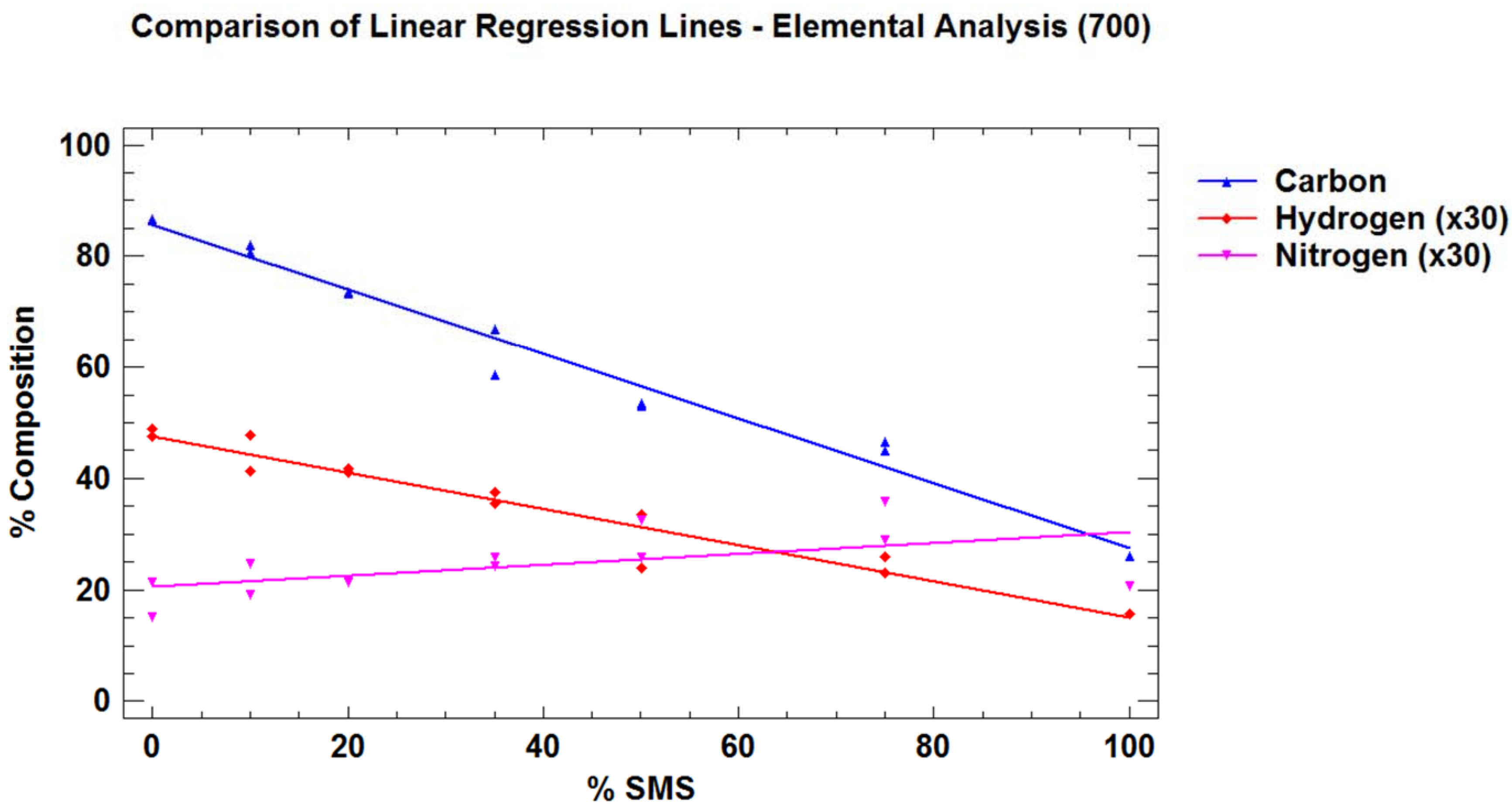


Surface plot relating biochar % volatiles to treatment temperature, and amount of spent mushroom substrate relative to Fir in the feed stock



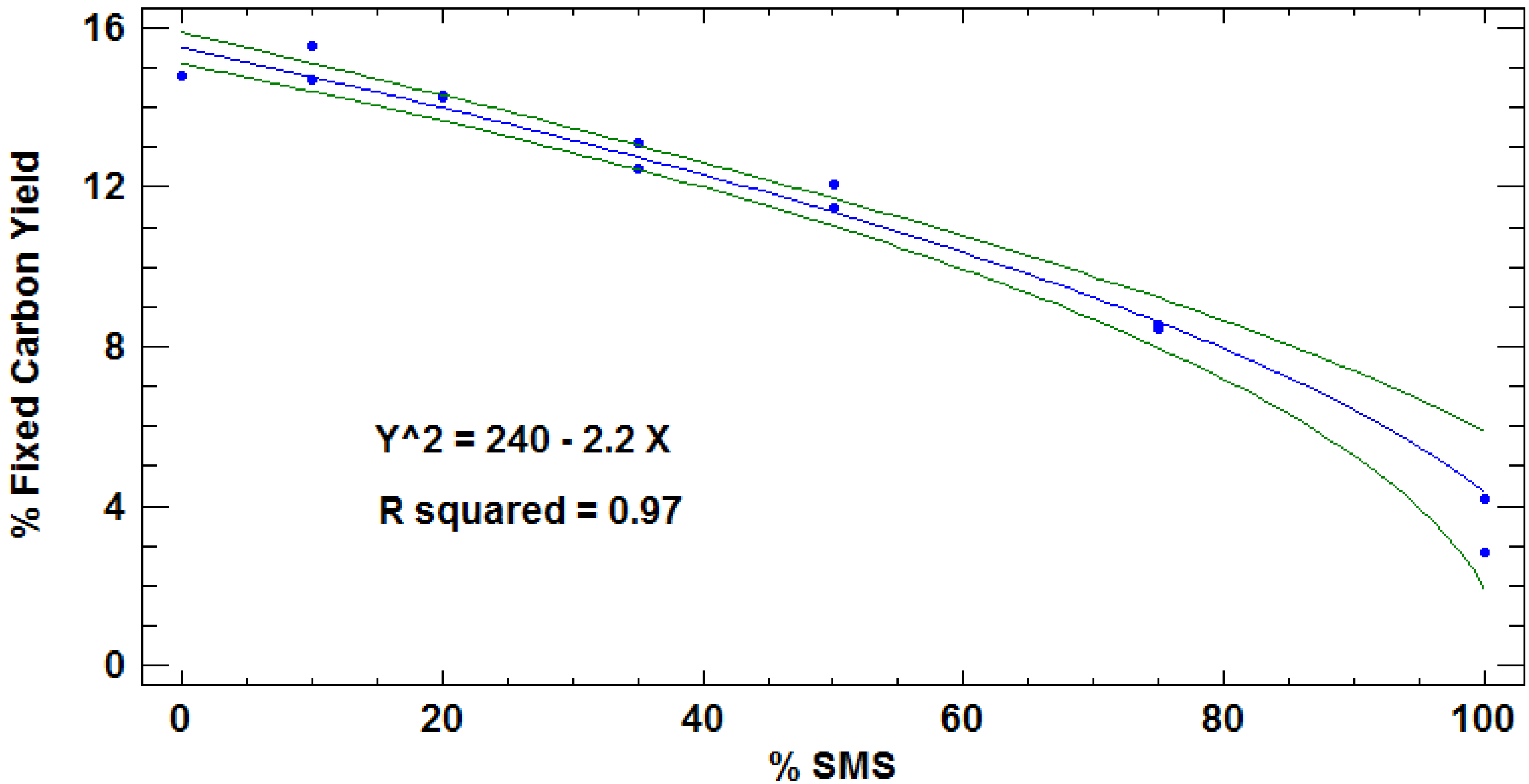
Surface plot relating H:C mol:mol to treatment temperature, and amount of spent mushroom substrate relative to Fir in the feed stock





Comparison of Linear Regression Lines - Elemental Analysis (700)
% Composition
% SMS
0
20
40
60
80
100
Carbon
Hydrogen (x30)
Nitrogen (x30)

Plot relating yield of fixed C to amount of spent mushroom substrate relative to Fir in the feedstock. Treatment temperature 700 C.



Short term vision

*Given **local** biochar ideal target properties AND **locally available** biomass samples, be able to provide feedstock formulations that will produce the desired biochar while minimizing cost.*

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Thank you

Students and technicians: Marcus Stein, Heidi Streick, Hiromi Seguma, Fraser Johnson