On-farm biomass pretreatment

A. What is this research project?

Our research investigates the ability of on-farm pretreatments with dilute acid or alkali to improve enzymatic degradability of cellulose and hemicelluloses in biomass at the biorefinery.

B. What problem does it address?

Recently, wet storage methods have been proposed for feedstock preservation and on-farm storage of perennial grass and corn stover biomass. The advantages over a dry storage system include:

- lower risk of fire
- reduced harvest costs
- improved feedstock susceptibility to enzymatic hydrolysis.

We believe that wet storage systems may also present a unique opportunity for farmers to add value to the feedstock through chemical or biological pretreatment at ambient temperature and pressure but prolonged reaction times; this may lower pretreatment costs and provide better return for farmers.

C. How is the project different from or how does it enhance other projects?

Very few studies are being conducted at the farm level for pretreatment of biomass.
This project is scalable and has been tested at pilot scale (> 500 kg).

D. What are the potential benefits of partnering with ARS on this research?

We have expertise at pretreating and assaying samples at farm scale.
We have on-hand pretreated material.
We have access to switchgrass, reed canarygrass, and corn stover.

E. Who are the potential customers?

Biorefineries, custom biomass harvesters, biomass producers.
Stage of Development
Published preliminary study – lab scale.
Optimizing pretreatment at lab scale via response surface: analyzing samples.
Tested at pilot scale: analyzing data.
Will test at full-scale this season.

Results: Acid & Lime Pretreatment

Substrates: Reed Canarygrass, Switchgrass
Chemical: Acid = H_2SO_4 (3% or 9% of DM); Alkali = $CaOH_2$ (5% or 15% of DM)

		Conversion Efficiency	
Crop	Treatment	Cellulose η*	Xylose η*
Reed Canarygrass	Control	33 %	6 %
	Acid Low	54 %	13 %
	Acid High	67 %	26 %
	Alkali Low	54 %	23 %
	Alkali High	79 %	67 %
Switchgrass	Control	15 %	9 %
	Acid Low	25 %	16 %
	Acid High	29 %	23 %
	Alkali Low	24 %	23 %
	Alkali High	42 %	77 %

* LSD = 4.1% and 2.5% at α = .05 for cellulose and xylose, respectively

Results: Ozonolysis

Substrates: Reed Canarygrass, Switchgrass
Ozone level: at 1, 2, and 5% of DM (5% wt/wt concentration)

		Conversion Efficiency	
Crop	Ozone Concentration	Cellulose η*	Xylose η*
Reed Canarygrass	Control	42 %	6 %
	1% of DM	67 %	13 %
	2% of DM	71 %	26 %
	5% of DM	59 %	23 %
Switchgrass	Control	16 %	9 %
	1% of DM	27 %	16 %
	2% of DM	32 %	23 %
	5% of DM	41 %	23 %

* LSD = 3.3% and 3.0% at α = .05 for cellulose and xylose, respectively

Moving Forward

We would like to partner with an entity with sufficient capacity to optimize fermentation of pre-treated material at pilot and/or full scale.

Researchers

PARTNERSHIP OPPORTUNITY

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