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Characterization of Water Stargrass from the Lower Yakima River as a Biofuel Feedstock

Lower Yakima Water Quality and Habitat Coordination Meeting

October 22, 2020

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U.S. DEPARTMENT OF ENERGY BATTELLE

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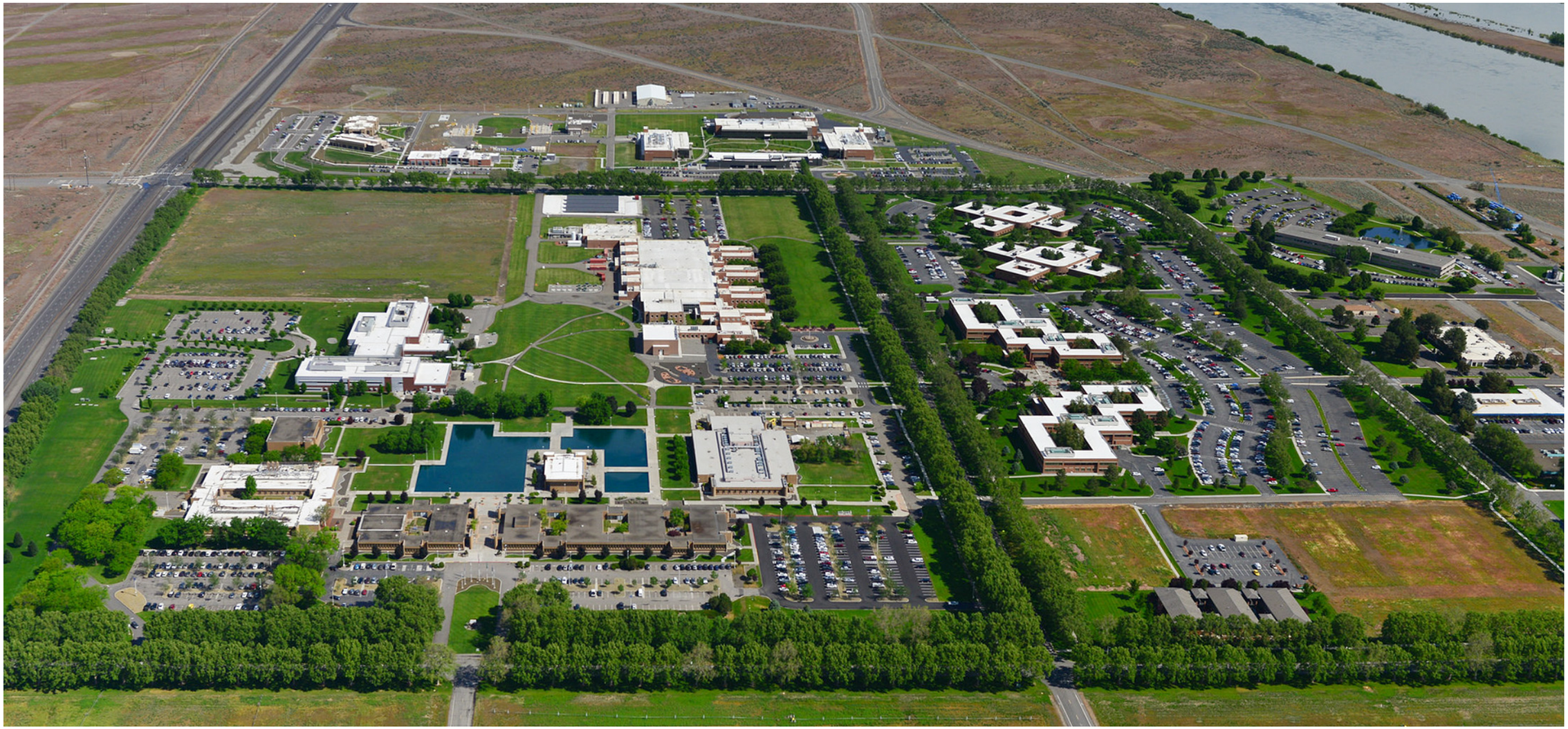
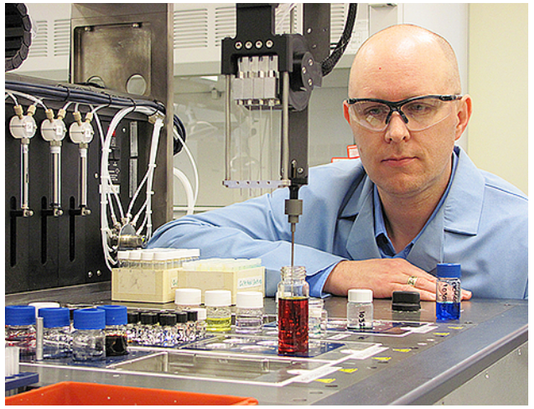


Bioproducts, Sciences & Engineering Laboratory (BSEL)



A research partnership with WSU

- Science and engineering of converting biomass—agricultural and forest residues, industrial waste streams—into novel energy sources including jet fuel
- Developing technologies to transform low-value biomass into value-added chemicals for products from plastics to pharmaceuticals
- Built in partnership with Washington State University on nearby WSU Tri-Cities campus to allow collaborative research
- High bay permits scale-up of biomass conversion processes

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The Challenge

- Water stargrass is an aquatic nuisance that is impacts salmon spawning in the Lower Yakima River
- Once harvested, can the stargrass be processed to recover energy or nutrients?

PNNL scientist Sam Fox with stargrass from the Yakima River

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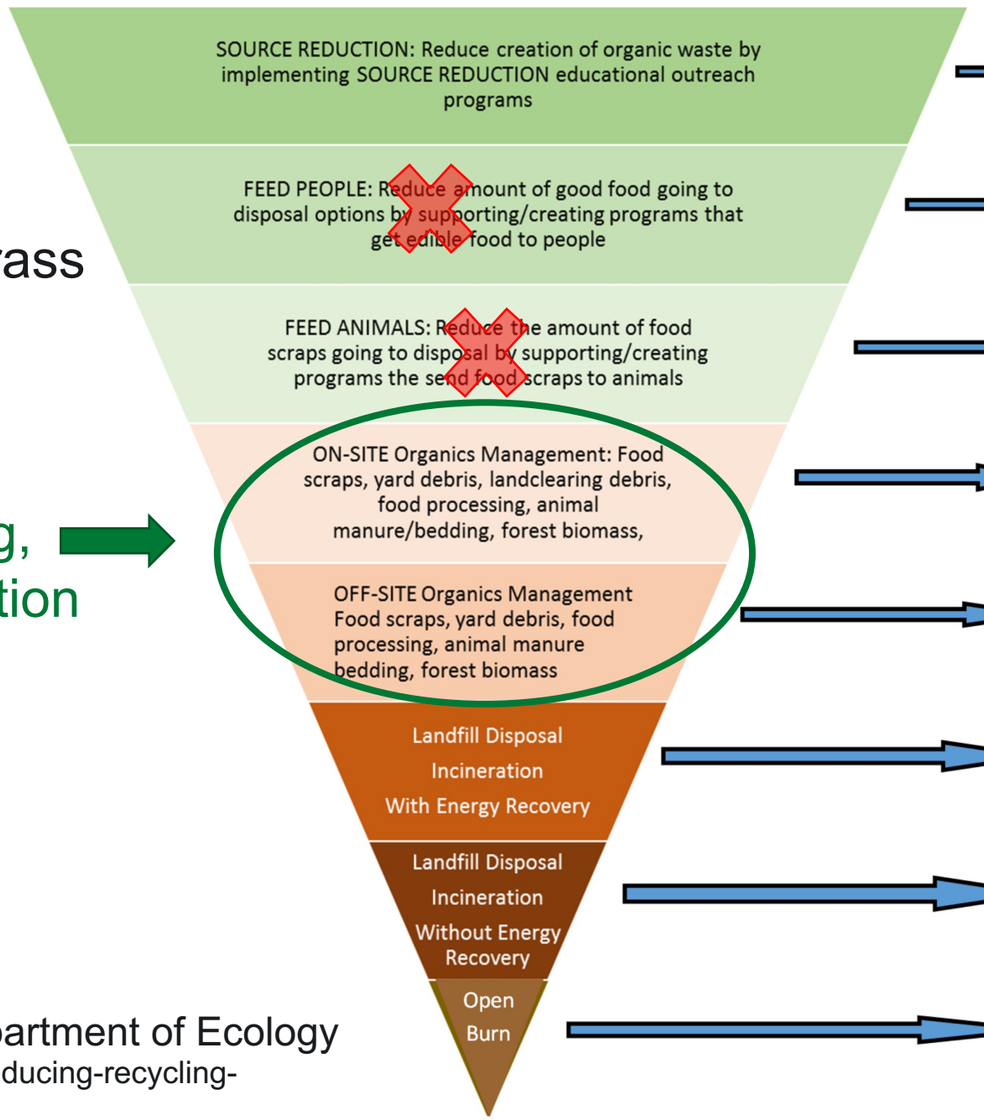
Waste management options for water stargrass favor on-site or off-site organics management

HTL, Composting, Anaerobic Digestion

WASHINGTON STATE PREFERRED ORGANICS MANAGEMENT HIERARCHY



WHAT	HOW	WHY
SOURCE REDUCTION: Reduce creation of organic waste by implementing SOURCE REDUCTION educational outreach programs	Create or support smart shopping and smart storage strategies or educational outreach campaigns like EPA's FOOD TOO GOOD TO WASTE and the FOOD RECOVERY CHALLENGE campaigns.	Less waste to manage. Shows that government is proactive.
FEED PEOPLE: Reduce amount of good food going to disposal options by supporting/creating programs that get edible food to people	Create or strengthen partnerships with and between food producers and food collection organizations.	Less good food sent for disposal so less landfill methane created. More food for hungry people. Promotes good public relations .
FEED ANIMALS: Reduce the amount of food scraps going to disposal by supporting/creating programs the send food scraps to animals	Contact local health department to get guidance. Facilitate connections between generators and farmers.	Less food sent to landfills so less landfill methane created.
ON-SITE Organics Management: Food scraps, yard debris, landclearing debris, food processing, animal manure/bedding, forest biomass,	Contact Ecology, local government or a consultant to learn about implementing onsite composting, vermicomposting, and/or anaerobic digestion programs.	No hauling required so no hauling charges. Create soil amendment, liquid fertilizer, energy from food residuals.
OFF-SITE Organics Management Food scraps, yard debris, food processing, animal manure bedding, forest biomass	Contact hauler, or self-haul material to company that processes material into beneficial products.	Food residuals converted into beneficial products. Less methane produced. Possibly lower garbage bill.
Landfill Disposal Incineration With Energy Recovery	If possible, contract to have wasted material sent to a landfill or incinerator with methane or energy recovery.	A portion of the embodied energy is captured.
Landfill Disposal Incineration Without Energy Recovery	Use public or private haulers to collect and deliver waste to the landfill or incinerator.	Inefficient use of resources. If this is the only current option, keep landfill destination in mind during future contract negotiations.
Open Burn	Reduce the occurrence of open burning by promoting alternative management methods like composting, anaerobic digestion, biochar production.	Outdoor burning is illegal in all urban growth areas in WA. Outdoor burning creates air pollution and wastes resources

Source: Washington State Department of Ecology
https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Organic-materials

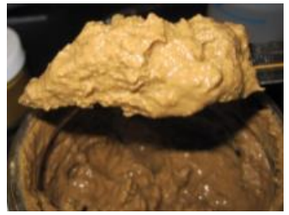
October 2016

HTL Process Overview

Hydrothermal Liquefaction (HTL)

Conversion of a biomass slurry (e.g., wood, algae, other) to biocrude and aqueous product

- 300–350°C
- 2800–3000 psig



Slurry Feedstock

HTL

Biocrude Product

+

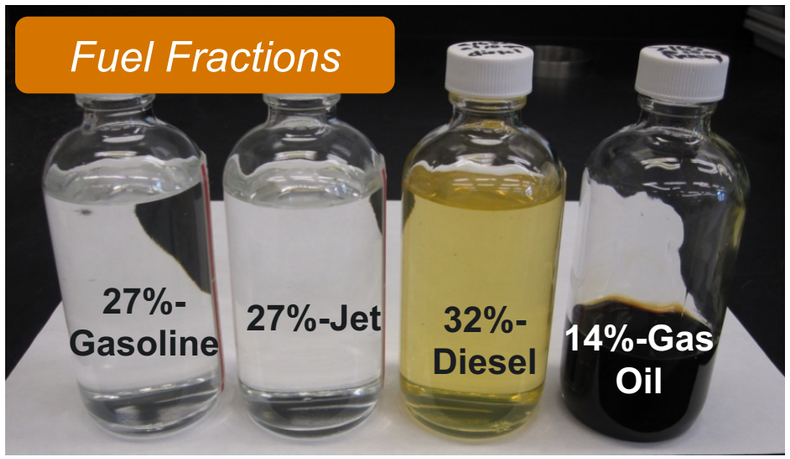
Aqueous Product (contains organics)

Catalytic Hydrotreatment

Hydrotreated Bio oil

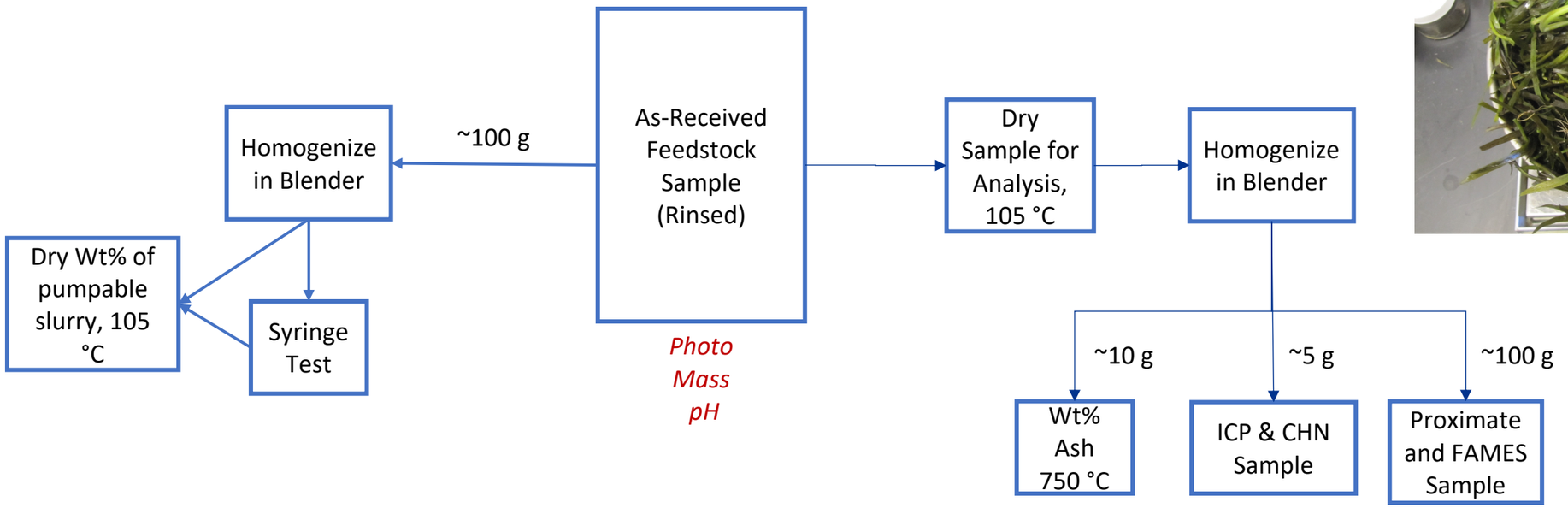
Bio oil product is refined via **Catalytic Hydrotreatment** and fractionated by **Distillation** to gasoline, diesel, jet fuel, and bottoms

Distillation



- Can be applied to wide range of feedstocks, especially suited to wet feedstocks
- Conceptually simple: a heated, pressurized pipe
- HTL biocrude is thermally stable and can be readily upgraded to hydrocarbon fuel blendstocks

A standard characterization plan helps screen for potential HTL feedstocks



ASSESS THE FOLLOWING:

- Wt% solids and ash content (target is >15 wt% solids with <15 wt% ash)
- Slurry pumpability
- Ash composition (metals by ICP-OES)
- Ultimate and proximate analysis (CHNS, ash, moisture, carbs, lipids, protein)

Photos from feedstock characterization

- Harvested from Lower Yakima River by Rich Sheibley (USGS) in June 2020, sample collected and transported to PNNL by Andy Schmidt

Dried stargrass


Powderized for analysis


Wet stargrass for formatting

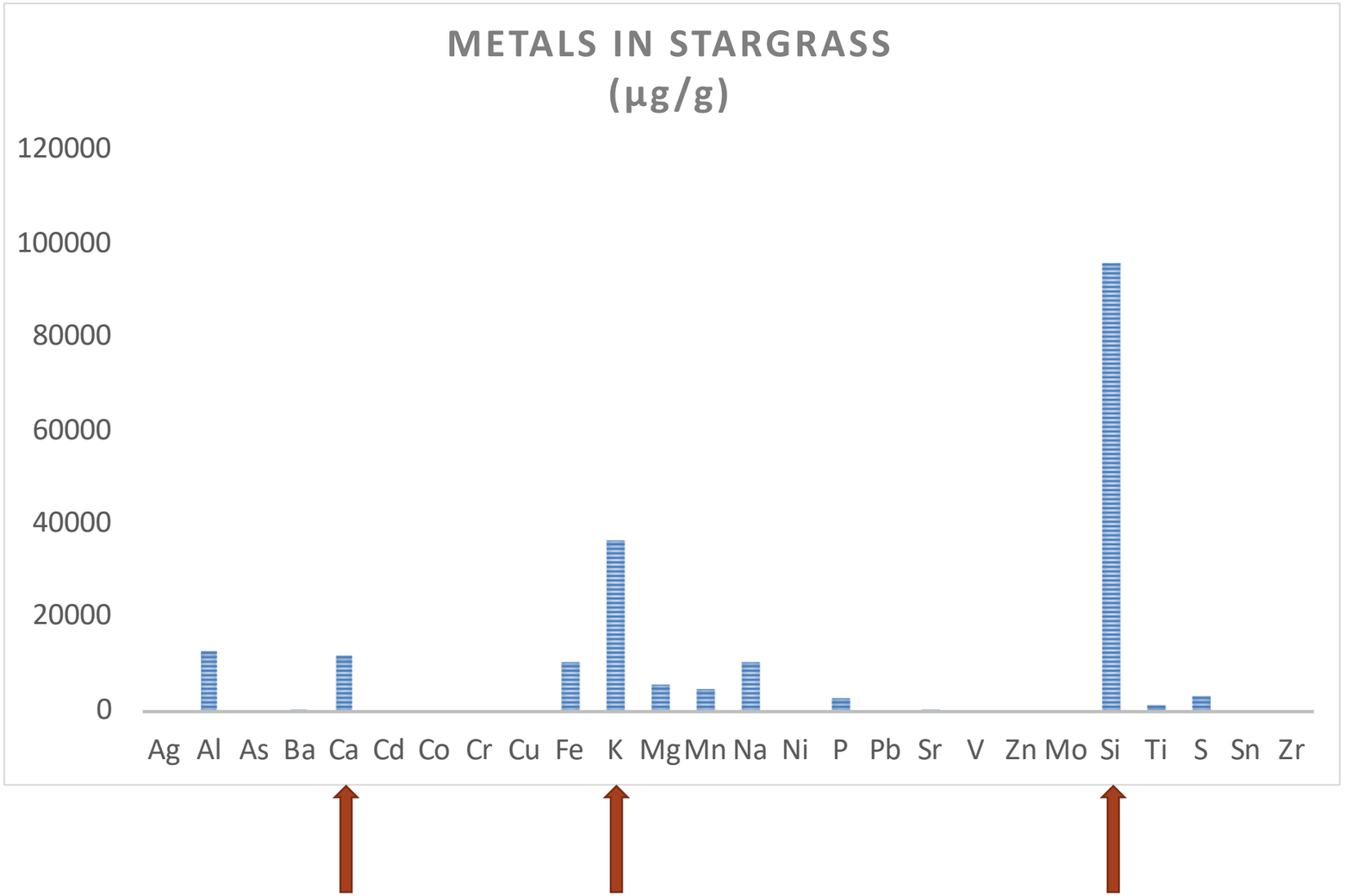

After 120 min of formatting

Results: Proximate and Ultimate Analyses

	Units	Result
Dry solids content	wt%	7.43
Ash content	wt%	37.0
Lipids	wt%	1.53
Protein	wt%	16.2
Carbohydrate	wt%	41.1
FAME	mg/g	30.2
Carbon	wt%	29.2
Hydrogen	wt%	3.83
Nitrogen	wt%	2.66
Sulfur	wt%	0.76

- Ash is high (>15%), dry solids content is low (<15%). Carbohydrate content is high. This is challenging for direct HTL.
- Water stargrass may be a good candidate for sequential HTL
  - Converts the carbohydrates into fermentable sugars at a lower temperature in the first stage; the residual solids are concentrated for HTL in a second stage.
- Hydrothermal processing has advantages over AD, but composting may be preferred depending on scale, project duration, and seasonal harvesting

Results: Metal Concentrations by ICP-OES



- Silica and alkali salts pre-dominate, as expected.
- The potassium (K) content in the plant matter may warrant investigation for nutrient recycling in the HTL process, coupled with the nitrogen and phosphorus content.

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Thank you

For questions and follow-up, please contact:
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