Variation in switchgrass yield and composition impacts economics and sustainability

Background

- There is a wide range of variation in the composition and yield of perennial feedstocks.
- Few analyses of the value of feedstock composition have been conducted in the context of an overall supply chain and biorefinery.
- CBI has created and phenotyped common gardens of 300^{+} switchgrass (*Panicum virgatum*) natural variants for ongoing genome-wide associations studies (GWAS).

Approach

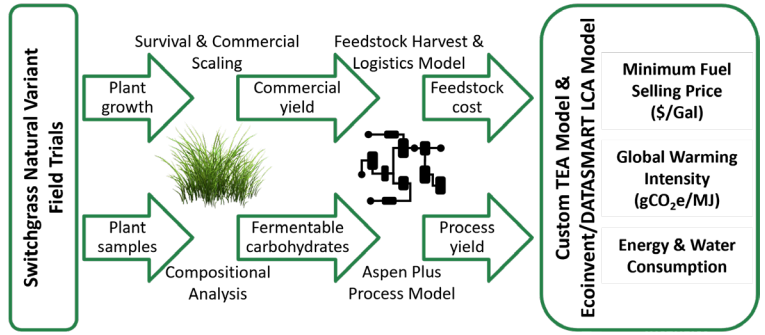
- 84 of 331 switchgrass genotypes had >7.5 Mg/ha at 3-years in the SE U.S. fields. We analyzed the variation of cell wall composition for these genotypes via high-throughput ^{1}H-NMR and py-MBMS.
- Yield and composition from identical genotypes were used in a series of techno-economic analyses (TEA) and life-cycle analysis (LCA) using models for feedstock supply and conversion (i.e., ASPEN, GREET) under a standard cellulosic ethanol process model.

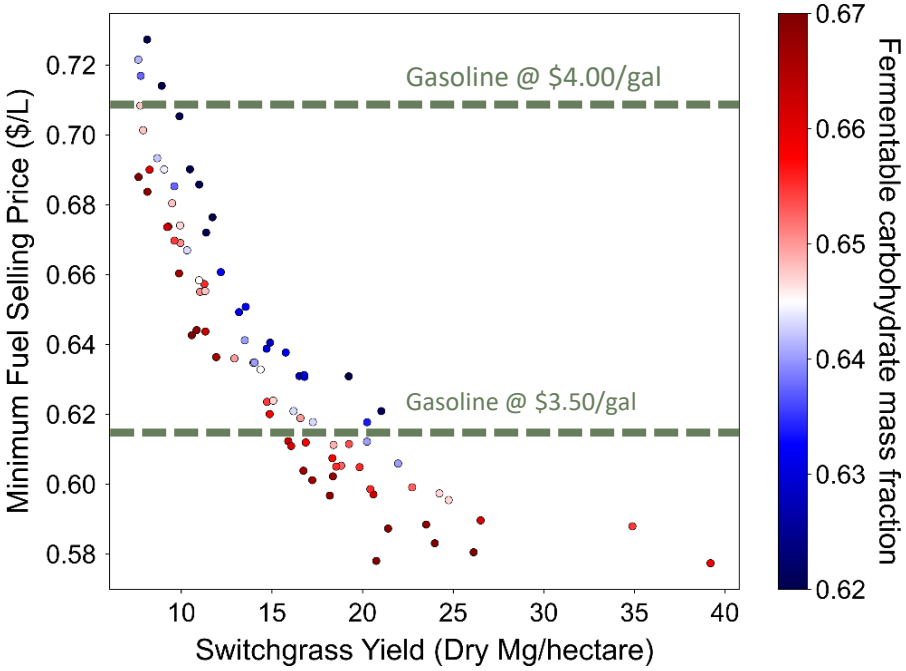
Results

- Variation in yield and composition from switchgrass is greater than previously reported.
- Switchgrass yield per area is the largest economic driver of minimum fuel selling price (MSFP), ethanol yield per hectare, global warming potential (GWP) and cumulative energy demand (CED).
- At any given yield, an incremental increase in fermentable carbohydrate content is significant but of secondary importance; the composition is more important at the highest yields.

Significance

- Our analyses highlight the primary importance of plant yield and then the incremental importance of carbohydrate content when selecting a feedstock that is economical and sustainable.
- Understanding the range of key feedstock phenotypic characteristics and how variation in growth and compositional phenotypes impact overall economic and sustainability metrics is important when selecting economically advantageous genotypes for domestication in an optimized supply chain from farm to biorefinery.





TEA analysis for ethanol MFSP of 3-y-old switchgrass varying in yield and composition. The dashed lines for two gasoline costs are estimates provided for an approximate comparison. The LCA plots of GWP, CED, and available water remaining are similar.

Happs RM *et al*. *ACS Sust Chem Eng* (2023). Doi:10.1021/acssuschemeng.3c05770