Optimizing Sorghum Hybrids as Feedstocks for the Bioenergy and Biorenewables Industries

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Defining the feedstock challenge …..

“Though biofuels, biopower and bio-based products are rapidly emerging and maturing industries are providing significant contributions to growing energy needs around the globe, these industries will not reach the desired level of scale or sustainability without a set of feedstocks optimized for these end-uses”¹

¹Biofuels & Biochemicals Then and Now: Innovation Trends from Feedstocks to End Products. 2014. Leo Zhang, Research Analyst, Cleantech Group
NexSteppe Vision

Be a leading provider of scalable, reliable and sustainable feedstock solutions for the biofuels, biopower, biogas and biobased product industries
## Biobased Feedstocks for Fuels and Chemicals

<table>
<thead>
<tr>
<th>Examples</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oils</strong></td>
<td></td>
</tr>
<tr>
<td>Soy</td>
<td>Most expensive</td>
</tr>
<tr>
<td>Palm</td>
<td>Transportable (energy dense)</td>
</tr>
<tr>
<td>Jatropha</td>
<td>Easily refined</td>
</tr>
<tr>
<td><strong>Starches</strong></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>Moderately expensive</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>Transportable &amp; storable</td>
</tr>
<tr>
<td>Cassava</td>
<td>Easily converted to sugar</td>
</tr>
<tr>
<td><strong>Sugars</strong></td>
<td></td>
</tr>
<tr>
<td>Sweet sorghum</td>
<td>Less expensive</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Direct source of fermentable sugar</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>Must be processed immediately</td>
</tr>
<tr>
<td><strong>Biomass</strong></td>
<td></td>
</tr>
<tr>
<td>Biomass sorghum</td>
<td>Cheapest feedstock</td>
</tr>
<tr>
<td>Perennial grasses</td>
<td>Transport limited (low bulk density)</td>
</tr>
<tr>
<td>SRWCs*</td>
<td>Storable</td>
</tr>
<tr>
<td>Wastes &amp; residues</td>
<td>Most difficult to process</td>
</tr>
</tbody>
</table>

*SWRCs – Short rotation woody crops*
Advantages of purpose-bred sorghum

• Genetic diversity
• Established agronomic systems
• Inherently heat and drought tolerant
• Scalability – high yields in ~120 days
• Complementary to other biomass
• Lower nutrient inputs conventional crops
• Broad geographic range
Sorghum Is a Genetically Diverse Crop

**Grain Yield**
- Grain sorghum

**Bred for animal feed and food**

**Nutrition & Palatability**
- Forage sorghum

**Biomass Yield & Low Moisture**
- Biomass sorghum

**Bred for biopower, biofuels, biobased products**

**Juice & Sugars**
- Sweet sorghum
The NexSteppe Platforms
Molecular breeding = Designed with Purpose™

- **Biomass Sorghum**
  - Biomass
    - Biopower
    - Cellulosic Biofuels
    - Anaerobic Digestion

- **Sweet Sorghum**
  - Fermentable Sugars
    - Biobased Products
    - Advanced Biofuels
Palo Alto Biomass Sorghum

- Annual biomass crop
- Reaches maturity in ~120 days
- High yield
- Range of maturities
• High dry matter yield
• Low moisture at harvest

• Designed with Purpose™
• Compositionally optimized
Malibu Sweet Sorghum

- Annual sugar crop
- High sugars and juice
- Range of maturities
Cross platform attributes

• Good standability
• High yield
• Range of maturities
• Disease and insect resistance
Agronomy and Supply Chain

- Optimized agronomic practices
  - General and local land preparation best practices
  - Weed control programs
  - Sowing, population density, row spacing
  - Nutrient use efficiency
  - Irrigation timing and volume
  - Disease and Insect pest scouting
  - Harvest timing for maximum yield, composition and MC

- Harvest, collection and storage
  - Harvest options
    - Fresh, dry & bale, ensilement
  - Storage options
    - Bales, silage, pellets, syrup
Land prep and sowing

Forage chop for “JIT”

Inadequate land preparation

Windrow for drying
Commercial harvest
Commercial collection
Transportation
In Many Parts of the World, More Than One Crop Is Possible

*In more arid regions irrigation may be required*
Demand from Around the World
Commercial Seed Shipping to Customers
Thank you

nexsteppe

DEDICATED TO SUSTAINABILITY