Energy Sorghum in Subtropical/Temperate Climates

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Outline

• Bioenergy Sorghum Development
  – Sweet Sorghum
    • Development
    • Challenges
  – Energy Sorghums
    • Development
    • Challenges
Emphasis on Subtropical/Temperate Environments means.....the fall/winter season precludes year round production.

**Implication**: Year round production (just-in-time harvest) is not possible.
Sorghum Types and Use

- **Grain Sorghum**
  - Grain
  - Stover

- **Forage Sorghum**
  - Hay, Grazing
  - Silage

- **Sweet Sorghum**
  - Accumulate sugar in the stalk

- **Energy Sorghum**
  - Delayed flowering in temperate environments
Why Sweet Sorghum in U.S.?

• High Yield Potential
  – Sugars, Starch, and Lignocellulose

• Harvest Flexibility
  – Ratoon
  – Staggered Planting

• More Water-Use Efficient than other sugar production crops

• Sugar to Ethanol is proven technology....
Sweet Sorghum

• Component Yields
  – Sugars in Juice from Stalk
  – Starch in Grain
  – Structural Carbohydrates in bagasse

• Production System use combined infrastructure
  – Sorghum-based planting
  – Modified Sorghum Production model
  – Modified Cane-Based harvest system
  – Modified Cane-Based Processing System
Sweet Sorghum: Challenge No. 1

- Sweet Sorghum Cultivars
  - Low seed yield
  - Difficult to produce
  - Don’t capture heterosis

- Sweet Sorghum Hybrids
  - Subtropical/Temperate Adaptation
  - High Sugar Yield
  - High Sugar Content in Juice
  - High Juice Yields
Sweet Sorghum Hybrid Development in Texas AgriLife Research

- Seed Parent Development
  - High Brix
  - Short Height
  - Med to High Juice Volume
  - Good Seed Production
  - Daylength Insensitive

- Seed Parent Distribution
  - Available through Texas AgriLife/TAMU OTC

- Hybrid limitations will be solved quickly.
Sweet Sorghum: Challenge No. 2

• Short harvest season in temperate zones
  – Reduces Length of Mill Season

• Seasonal limitations in subtropical zones
  – Sugar yields / biomass yields vary across seasons
  – Cropping systems for sweet sorghum are important
Sweet Sorghum: Challenges

• Challenge No. 3
  – Hybrid sweet sorghum produces starch (primarily in grain);
    • Harvest/Processing Systems
    • Plant physiological processes must be modified through genetics and breeding

• Challenge No. 4
  – Need Agronomic and Pest Management Practices for Sweet Sorghum
Energy Sorghum
Why Energy Sorghum in U.S.?

• **Photoperiod Sensitive** - Reproductive growth is initiated in response to increasing night length/diminishing daylengths
  • genotype defines trigger
  • ranges from 13’30” to as low as 11’30” (daylength)

• **Why is this Beneficial?**
  – Long Canopy Duration
  – Enhanced Drought Tolerance
    • Vegetative Growth
    • Quiescent Periods
  – Higher Biomass Yields and less sensitive to timing of moisture
Energy Sorghum

• Component Yields
  – Ligno-cellulosic biomass
  – minimal, if any, sugar or starch

• Hybrids
  – Dual Purpose (multicut)
  – Bioenergy (single cut)

• Production is roughly modeled on Forage Production Systems.
Development of Energy Sorghum

- Germplasm Development
  - High Yield
  - No Lodging
  - Dry Matter
  - Composition

- Breeding
  - Hybrid Development and Testing

- Existing Hybrids are good....

- Future Hybrids will be better....
Ceres-Texas AgriLife Sorghum Commercialization

- Products from collaboration will be sold under Ceres’ Blade brand
  - High biomass and sweet types
- Late-stage trials & seed scale-up
- Royalties support future research
Energy Sorghum: Challenges

• Challenge No. 1
  – Efficient and economic biofuel conversion system for lignin, cellulose and hemicellulose

• Challenge No. 2
  – Modification of NSC composition to match conversion system
  – Genetic manipulation of PS systems to match production regions
Energy Sorghum: Challenges

• Challenge No. 3
  – Efficient agronomic production practices

• Challenge No. 4
  – Efficient harvest, storage and pre-processing practices
“Sorghum is drought tolerant and performs well on marginal soils.”

- Crop specialists interpretation:
  Compared to other crops, sorghum will yield under stress.

- Non crop specialist’s interpretation:
  Sorghum is a crop that will produce high yields with very little water and little, if any, fertilizer.

- Reality:
  Sorghum will produce proportionally to inputs
Summary

• Sorghum is the logical choice for use as an annual dedicated bioenergy crop
• Sweet sorghum have potential in specific production regions
• Energy sorghums have wider adaptation and greater potential in temperate regions.
• There are challenges to be solved; it will require research.
Questions?