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Genomic Tools for Cane Wide Hybrids as Energy Feedstocks

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Outline

- Introduction: Sugarcane
- Complex Genome
- Prolific: Wide hybrids
- Genomic Tools
- Future Directions

Introduction

- The International Energy Agency's Biofuels Technology Roadmap ➔US$13 trillion in biofuels by 2050. That's 50 Chevrons!
- 20 million new acres of cultivation needed by 2020
- Hardwood is ≈ 8,400 BTUs and cane is ≈ 8,000 but 12-month tree
- **The chase for low-cost sugars will need a series of accelerators, and game changers**

Brazilian Sugar Ethanol

- In 2003 → cars that run on ethanol, gasoline, or **both**: FLEX-FUEL vehicles.
- **Sugarcane, not engine technology, is the real key to Brasil's ethanol boom.**
- Brazilian ethanol, **subsidy-free**, is competitive with gasoline prices as long as world oil remains above **$35**/barrel
- Sugar mill → self-sufficient. Electricity from bagasse: 2 X cheaper than the US corn ethanol.

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Sugarcane

- Most efficient photosynthesis system;
- Among the most efficient crops in converting solar energy into biomass;
- High sucrose accumulation;
- Ease of propagation (clonal); multiple harvests;
- ERoEI = 9:1 (corn = 1.3)

ABILITY TO CROSS WITH DIFFERENT SPECIES OF DIFFERENT GENERA

Sugarcane, Not a Model Crop…

- Modern varieties:
  - Highly complex polyploid;
  - Inter-specific hybrids:
    - 80% S. officinarum;
    - 10% S. spontaneum;
    - 10% recombinants
  - 10 -12 copies of the genome;
  - 2n ~ 115 chromosomes
  - Narrow genetic base

Germplasm Collection Weslaco Saccharum Complex

Species	Accessions
Erianthus spp.	24
Miscanthus spp.	15
Saccharum barberi	10
Saccharum officinarum	10
Saccharum robustum	10
Saccharum sinense	10
Saccharum spontaneum	11
Total	90
Sorghum	

- Cell wall composition
- Molecular markers

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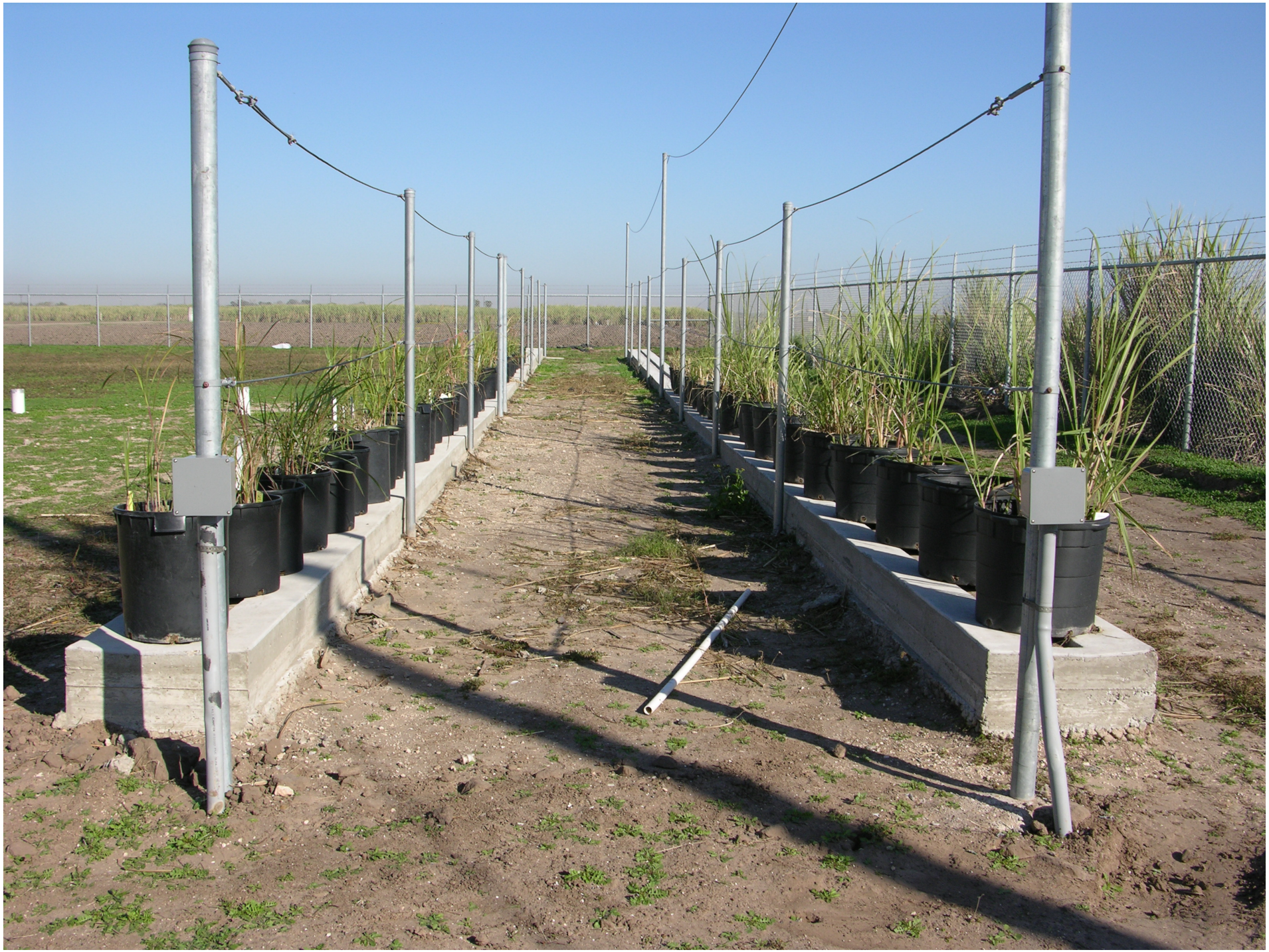
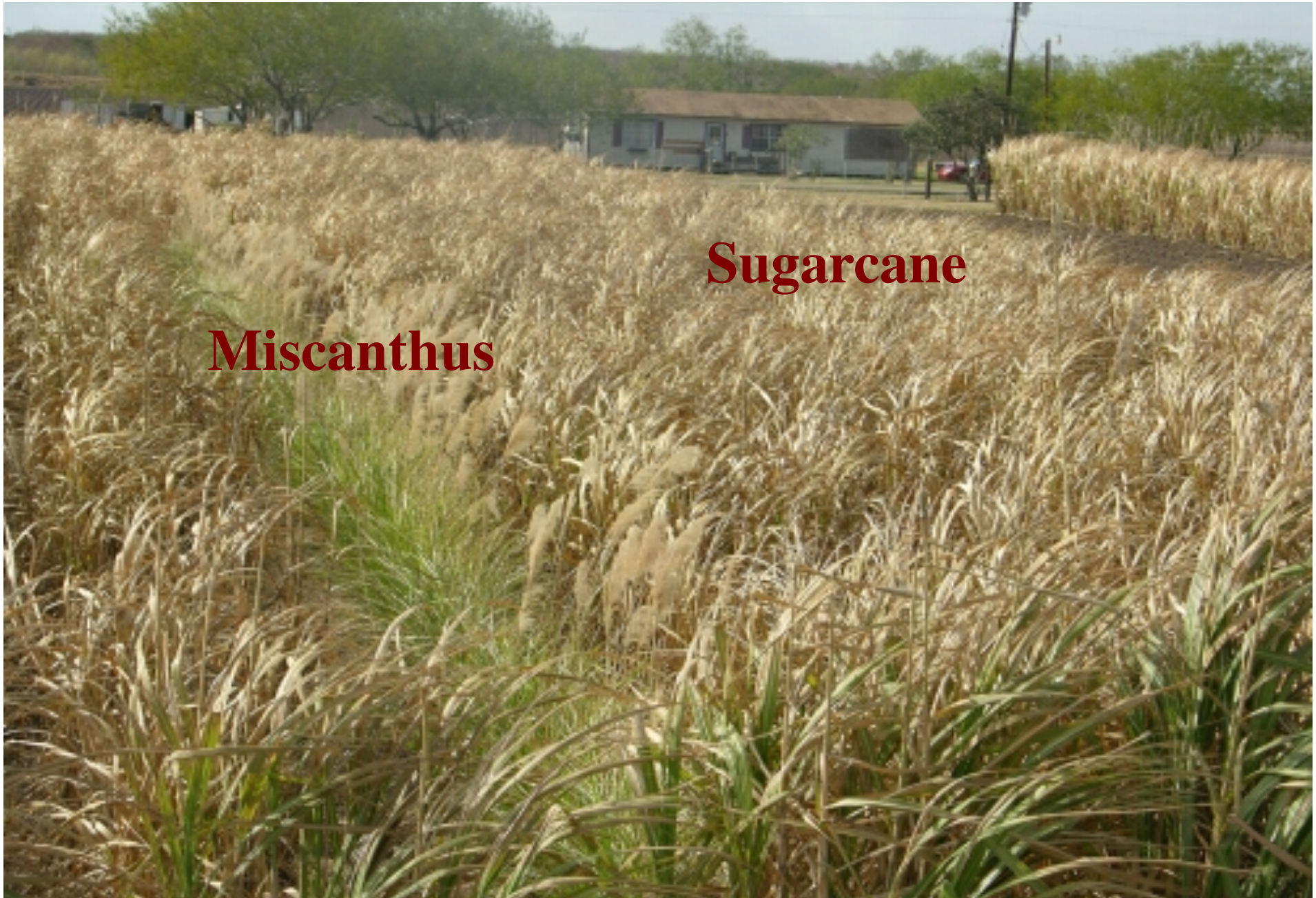
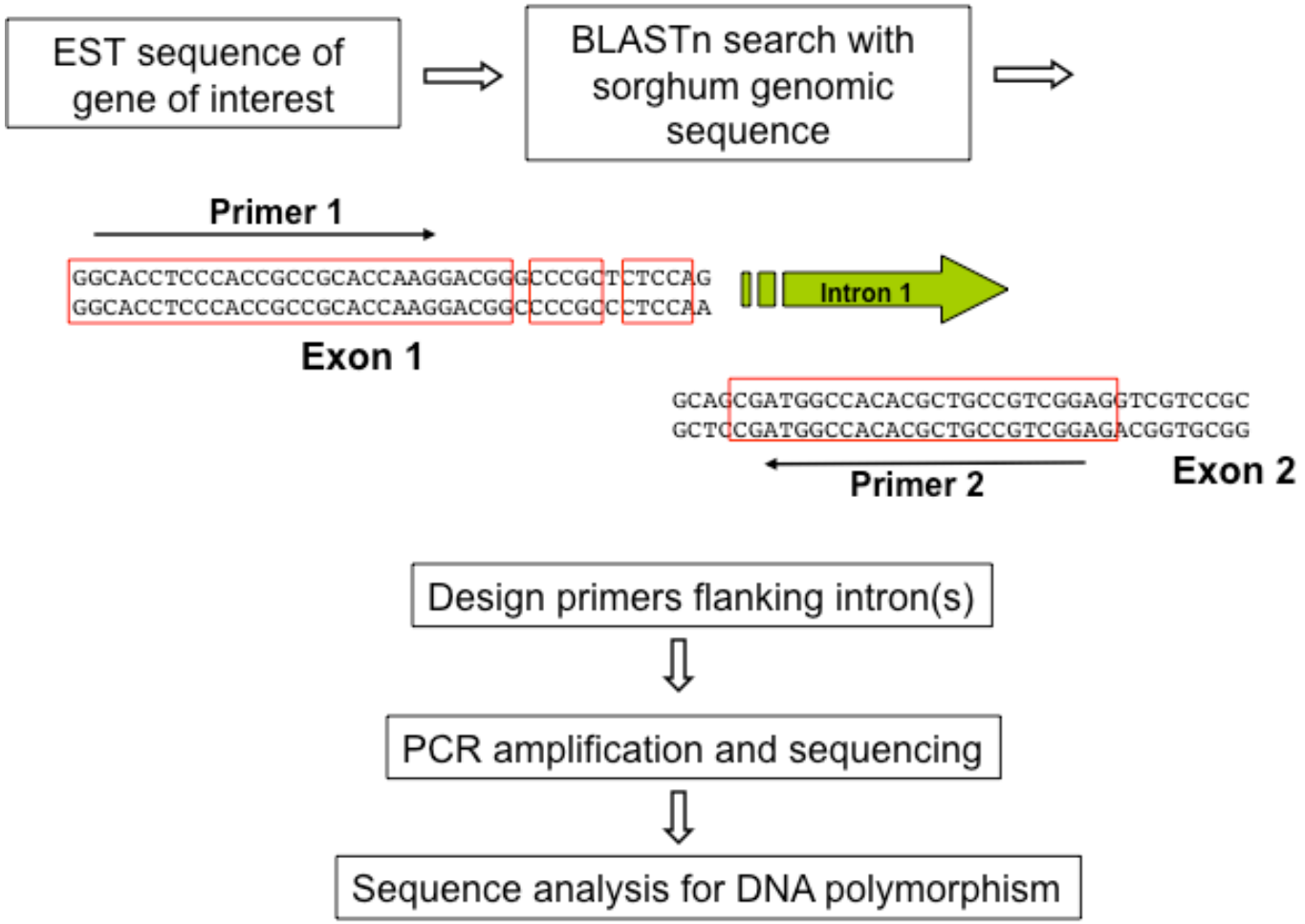


Miscanthus: Cold Resistance



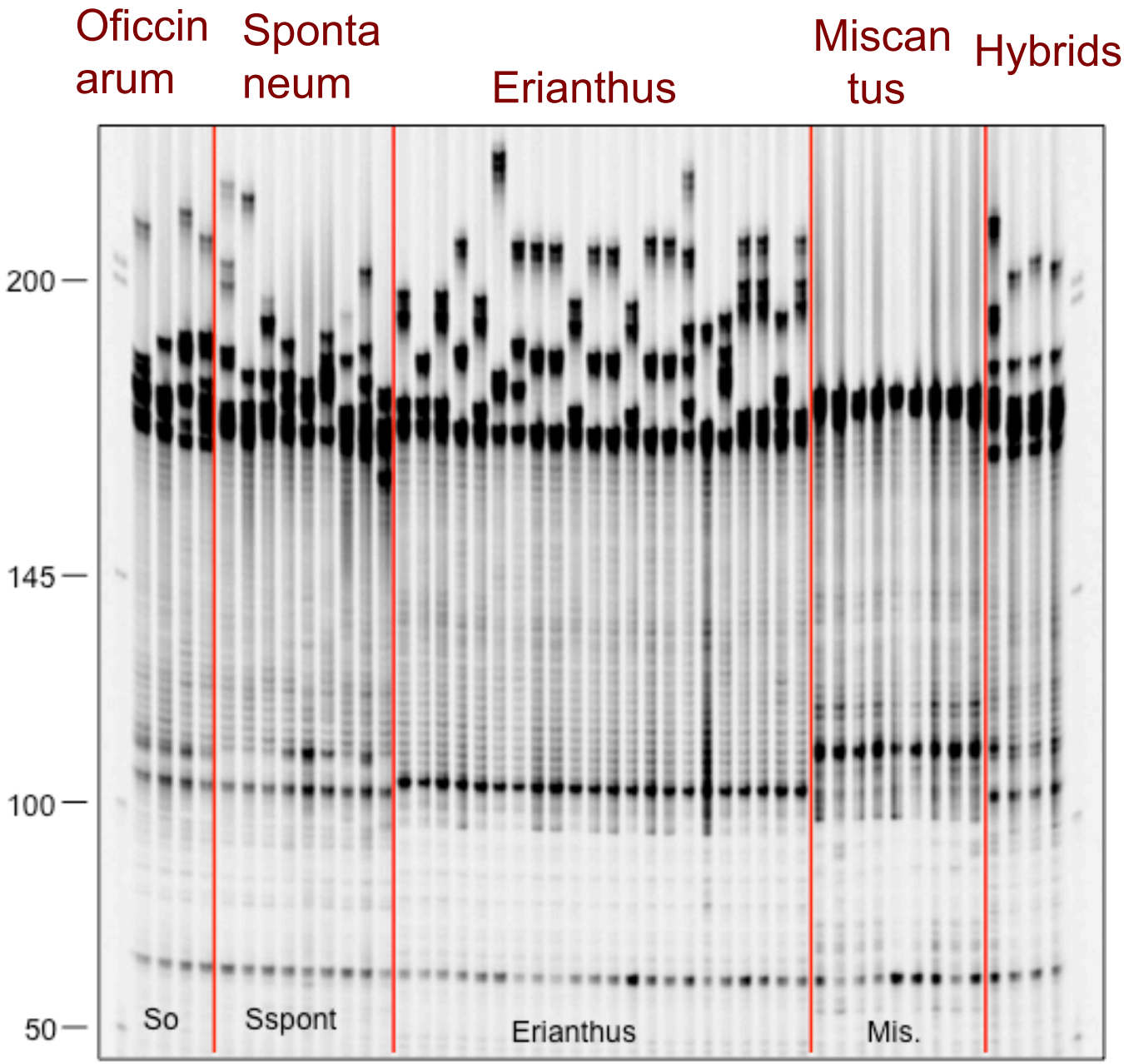
Genomic Tools

CISP - Conserved Intron Scanning Polymorphism



Feltus et. Al (06) 140:1183-1191

SSR Identified by CISP in CCoAOMT



Park et al., 2011
Mol. Breeding

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Sequence Analysis for Polymorphism

DNA Polymorphism based on PAL, 4-CL and CCoAOMT

Genus Pair	SNPs	INDEL	Total
Saccharum spp* x Erianthus	71	25	96
Saccharum spp x Miscanthus	39	14	53
Erianthus x Miscanthus	29	16	45

*Saccharum spp.: S. officinarum; S. spontaneum; S. robustum, S. sinense; S. barberi

Sequence Information

Sugarcane vs. *S. spontaneum* before & after cold:

PARAMETER	NUMBER
Reference count	171,290
GC contents in %	42.22
Total read count	14,616,938
Mean read length	95.76

Quantitative real-time PCR:

- 7 contigs after 5 °C for 20 hrs
- One contig w/ 6 X higher expression in Spont: ~ to Hordeum ptn., involved in **cold response**.

Bioenergy/Sugarcane Program @ Texas AgriLife - Weslaco

- Genetic Breeding Program for:
  - Sugar
  - Energy production
- Crossing/Photoperiod Facilities with 10 independent chambers
- Acquiring High-Throughput Molecular Marker platform
- Applying Deep-Sequencing ➔ generation of SNPs, for Marker-Assisted Selection

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Future Direction

- Next generation sequencing:

  RAD Sequencing Sugarcane Wide Hybrids for Molecular Breeding

- Tissue culture: large scale propagation; Yield trials
- New wide crosses: Miscanthus, Erianthus, Sorghum, *S. robustum*

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