Canadian Biomass Supply Chain Improvements to Increase Investment Opportunities

Innovations in Warm Season Grass Biomass Crops

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Montreal
• Canada’s leading agency in developing perennial herbaceous biomass crops since 1991

• International Agricultural Research & Development Programs since 1997

• International reputation for innovation in breeding, agronomy and market development of switchgrass
Big Bluestem Advantages:
Good biomass quality from high stem content, drought tolerance, low maintenance once established

Switchgrass Advantages:
Large de-hulled seed, quicker to establish and to peak production, easier to harvest
CURRENT STATUS

• In Eastern Canada ~1500ha in Ont and QC
• Nearly all is an unimproved switchgrass collection found near Cave-in-Rock Illinois in 1958
• Yields of 10 t/ha on better land and 7-8t/ha on average land
Lessons Learned

• Establishment has been challenging
• Easy to manage & harvest stands
• Switchgrass head smut has emerged as an important disease in older (8yr plus) monoculture stands of switchgrass
• Slow to develop bioenergy markets have been the main problem, need more effort on developing biomaterial and agri-food markets
Biomass Supply Chain Network
Priority Needs

Short-Term: Market Opportunities for Purpose Grown Biomass of Switchgrass and Miscanthus- Characterize most promising markets, key challenges and opportunities, prioritization

Longer Term: Developing Biomass Crops for Marginal Lands - especially low opportunity cost lands with surplus seasonal moisture
Switchgrass (SG) vs. Wheat Straw

- SG fiber length and strength is greater
- SG has greater ability to resist compressive forces
- Overwintered SG is ~.3% N, wheat straw is 0.7-1.0% N
- Widely tested for biocomposites and pulping applications
- Historically used for housing as it is resistant to decomposition
Switchgrass is a Premium Livestock Bedding

**BENEFITS**
- Ammonia Absorption
- Slow Decomposing
- Low Microbial Activity
- Animal Comfort
- Non-slippery
- Readily Dedusted
- High Quality Manure
Switchgrass is a Premium Horticultural Mulch

BENEFITS
Weed Control
Plant Response
Slow Decomposing
Soil Building
Moisture Conserving
Winterhardiness
Emerging Feedstock Development Successes

• Improved agronomy and breeding is enabling the crops to be easy to establish for 6-8 year crop rotations.

• Big bluestem-switchgrass mixtures appear promising for optimizing yields and improving biomass quality.

• Breeding progress is excellent for native warm season (C₄) perennial grasses (~1.5%/yr) (not as moisture limited like C₃ grasses).
At 1 month after planting, superior plants (tall erect and single tiller) are selected for improved seedling vigor and low tillering.
10 Years of Breeding to Improve Cave-in-Rock

1st year Space Plant Nursery following Fall 2006 seed collection of old field in QC

Annual transplants uniform and erect by August 2015

By August 2016, mature stand of upland switchgrass has been transformed to an erect canopy like lowland switchgrass
REAP’s Comprehensive Breeding Strategy to Improve Warm Season Grasses

1. Genetic strategies to build a better solar collector and improve fibre quality

2. Optimize the diversity of beneficial growth enhancing biological organisms in plants
Research and Development of Biological Organisms

• REAP’s native grass field breeding research has been undertaken without fertilization since the 1990’s to encourage plant growth-promoting bacteria
• Elite selections of high biomass producing native plants are ideal candidates for sourcing crop beneficial fungal endophytes
• University of Guelph/REAP-Canada partnership to identify crop beneficial endophytes in REAP’s elite breeding selections of big bluestem
• McGill University/REAP-Canada partnership to identify and characterize endophytes in elite switchgrass selections made by REAP-Canada. Subsequent patenting of an endophyte strain (Bacillus methylotrophicus B-26) and method of using the strain to increase drought resistance in other crops.
Switchgrass Breeding Innovations

1) REAP evolved an annual breeding cycle in 2013 (all U.S. programs were using 2-7 year breeding cycles on upland switchgrass)

2) Emphasis on juvenile plant selection from large numbers of plants (3000) per annual cycle in the greenhouse

3) Development of a creeping nursery concept within the annual breeding cycle (pollen is transferred from best plants of old nurseries to new)

4) Tightly spacing plants to create a sward like effect in evaluation nurseries

5) The only long term temperate warm season grass breeding program to not apply fertilizer to encourage diverse Plant Growth-Promoting organisms
Summary

• Farmers are embracing warm season grass biomass feedstocks as a means to grow the bioeconomy and the agri-food sector
• A comprehensive market study is urgently needed
• Innovations in rapid morphological selection methods of breeding perennial biomass crops are being made
• Significant potential for development of PGP organisms through plant breeding
Selected References


REAP-Canada
Resource Efficient Agricultural Production

Research Partners in Warm Season Grass Plant Improvement