

# SELECTION AND FIELD TESTING OF NEW, HIGH-YIELDING VARIETIES OF SHRUB WILLOW FOR BIOENERGY, BIOFUELS, AND BIOPRODUCTS

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Shrub willow crops, grown in short-rotation culture, have outstanding potential to serve as a dedicated feedstock for the production of bioenergy, biofuels, and bioproducts (Volk *et al.* 2006). They can provide a long-term, sustainable replacement for fossil fuels, while promoting rural development and offering numerous positive environmental benefits. The main factors influencing the cost of willow crops and discouraging wide adoption are yield, harvesting expense, and establishment costs. The goal of this project is to develop varieties with consistently greater yields and optimal wood chemistry for low-input pretreatment, fractionation, and conversion in the biorefinery.



Mechanical planting of cuttings from whips    8" cutting    3-year growth cycle    Mechanical harvesting and chipping of stems    Truck delivery and wood chip storage pile    Lyonsdale Biomass cogen    Coppice regrowth

**THERE IS GREAT POTENTIAL FOR GENETIC IMPROVEMENT OF SHRUB WILLOWS**

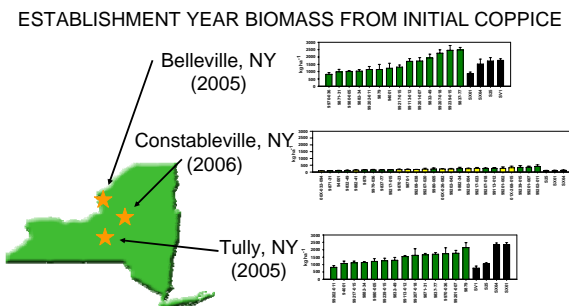
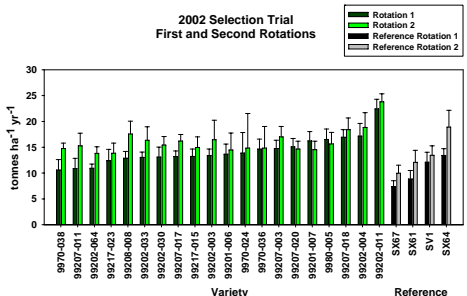
- There is wide genetic diversity among willows (Argus, 1997) and many shrub willow species can hybridize, resulting in hybrid vigor
- Efforts to breed *S. viminalis* in Sweden and the U.K. have produced yield increases of 12 – 67% (Larsson, 2001) and 8 – 143% (Lindegaard *et al.*, 2001), respectively
- A long-term breeding program focused on species adapted for the Northeast is likely to produce yield increases of 25-100% within 10 years (Smart *et al.*, 2005)

## BREEDING AND SELECTION FOR IMPROVED YIELD

- Over 575 crosses have generated 200 families with >4000 progeny individuals since 1998
- Progeny were screened in nursery trials and 82 of the best progeny from breeding in 1999 were propagated and evaluated in a replicated **SELECTION TRIAL=4 PLANTS PER PLOT x 8 REPS**
- At two years post-coppice, all stems per plot were harvested and weighed (4 plants per plot x 8 reps) in Dec. 2004 (1<sup>st</sup> rotation) and Dec. 2006 (2<sup>nd</sup> rotation).
- Due to problems with herbicide toxicity at planting, only plots with >50% survival were included.
- Mean yield increased 6.2% from 1<sup>st</sup> to 2<sup>nd</sup> rotation. In 2<sup>nd</sup> rotation, 24 varieties had greater yield than SV1; 99202-011 ("Tully Champion") had 77% greater yield than SV1.

## FIELD TESTING IN REGIONAL YIELD TRIALS

- Elite individuals chosen from selection trials were scaled-up in nursery beds and then planted in regional **YIELD TRIALS = 78 PLANTS PER PLOT (18 PLANTS MEASURED) x 4 REPS**
- Establishment-year stem biomass was measured for 18 plants per plot at the Tully and Belleville yield trials in 2005 and at Constableville in 2006. Growth at Constableville was much lower due to poor soils, late planting, and shorter growing season at this site.



- First-year post-coppice stem diameters were measured in late 2006 for 18 plants per plot at both the Tully and Belleville yield trials and used to calculate total stem area per plot.

## SCALE-UP AND COMMERCIALIZATION

- Two plant patents issued, five others allowed by USPTO
- 18 varieties have been transferred to a commercial nursery - **Double A Willow - in Fredonia, NY**

Based on biomass yield in the 2002 Selection Trial and with consideration of genetic diversity, a number of new varieties have been selected for scale-up and are currently being commercialized by Double A Willow.



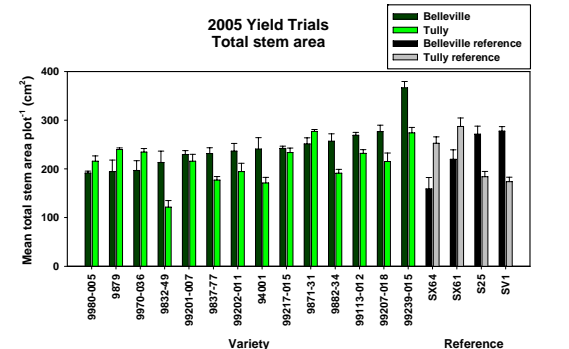
Dennis Rak, owner of Double A Willow, among mid-season growth of cutting nursery beds.



Processing facility and storage freezer addition with capacity for 10 million willow cuttings.

ESF ID #	Cultivar name
	*U.S. patent pending
99207-018	'Owasco' *
9980-005	'Oneida' (PP17,682)
99201-007	'Otisco' *
99202-004	'Fabius' *
99202-011	'Tully Champion' *
9970-036	'Canastota' *
99207-020	'Truxton' *
99113-015	'Millbrook' (PP17,646)
9871-31	'Sherburne' *
9882-34	'Fish Creek' *
99113-012	'Onondaga' *
99239-015	'Allegany' *
SV1	
S365	
SX61	
SX64	
SX67	
S25	

- Mean stem area of 99239-015 and 9871-31 were significantly greater than that of reference variety 'SV1'.
- Stem area of 99239-015 was **40% greater** than that of 'SV1'.
- Stem areas of many new varieties exceeded those of two of the reference varieties on each site.



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