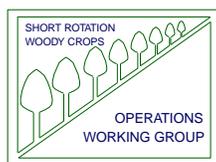

Short-Rotation Woody Crops

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Introduction

The Steering Committee of the SRWCOWG voted in October 2010 to select Dr. Timothy Rials and Dr. Mark Downing as co-chairs of the Group for the 2011-2012 time period. Tim and Mark have accepted this responsibility which primarily involves leading the planning and organization of the next biennial meeting of the group which will be held in the Knoxville, Tennessee area. The following information introduces these gentlemen to the membership of the SRWCOWG.

Dr. Timothy G. Rials is currently at the University of Tennessee serving as director of the recently established Center for Renewable Carbon (www.utbioenergy.org/people).

Dr. Rials trained as a polymer chemist obtaining his Ph.D. in Wood Science and Technology from Virginia Polytechnic Institute and State University in 1986. He began his teaching/research career at the Forest Products Laboratory at the University of California, but quickly moved back east where he joined the staff at the USDA Forest Service's Southern Station as a Research Physical Scientist. He was promoted to a management role at the Southern Station in 1996. He joined the Department of Forestry, Fisheries and Wildlife



at the University of Tennessee in 2001, as professor and director of the Tennessee Forest Products Center. Dr. Rials evidently enjoys management but his research interests include spectroscopic assessment of wood properties, pretreatment chemistry of biomass, and structure of composite interfaces.

Dr. Mark Downing, Senior Scientist at Oak Ridge National Laboratory and Adjunct Professor in the University of Tennessee's Department of Agricultural Economics and Rural Sociology is currently serving as Leader of the Bioenergy Resource and Engineering Systems Group (www.esd.ornl.gov/eess/bioenergy) of the Environmental Sciences Division of Oak Ridge National Laboratory. Mark also provides intergovernmental and industry relations support for the Department of Energy (DOE) Office of Vehicle Technologies as well as support to the DOE Golden Field Office on contract management.

Dr. Downing trained as an agricultural economist, obtaining his Ph.D in Agricultural Economics at Texas A&M in 1992. Mark's Ph.D research dealt with benefits transfer in non-market resource valuation where he studied the feasibility of benefits transfers across geographic regions and across time periods.



He began his research at Oak Ridge National Laboratory in 1992 working on woody crop resource assessments for the Tennessee Valley Region and for specific power plants within the region. As project leader for wood energy scale-up projects involving multiple government institutions and farmers in several areas of the U.S. he gained much experience in contract negotiations and in facilitating coalitions among diverse groups.

2010 SRWCOWG Meeting Highlights

Credits

The meeting hosted by the State University of New York, College of Environmental Science and Forestry in Syracuse, NY on October 17-19, 2010 was a great success, thanks to the hard work of the meeting chair, Tim Volk, many of his co-workers, the ESF Outreach Support Team lead by Maura Stefl, and the Conference Organizing Committee (full list provided at end of newsletter).

Approximately 100 people attended the meeting with excellent representation of industry, academia and government research organizations. The meeting was truly international with excellent representation from US and Canada, and also participants from Brazil, Somalia, United Kingdom, Spain, and Germany. The sponsorship of eleven groups greatly enhanced the quality of the meeting. Information on the program, field tours, and sponsors can be obtained at

www.esf.edu/outreach/pd/2010/srwc . Links to most of the presentations (and published abstracts) mentioned below are available at the above website.

Meeting Highlights from perspective of Lynn Wright

My perspective could be very different from that of others, so I highly recommend reviewing the actual presentations given at the meeting. Hopefully, my 30+ years of managing and reviewing woody crop research will contribute a useful perspective on the recent research results and equipment developments presented at this meeting.

News from Europe

Alistair McCracken of the Agri-Food and Biosciences Institute in Northern Ireland.

- 1000 ha of willow trials have been established in Northern Ireland.
- Early trials obtained average yields of 6-8 dry Mg ha⁻¹ yr⁻¹.
- US genotypes of willow generally do not perform well in Ireland.
- Irish genotypes tested in the US were

susceptible to excessive potato leaf hopper damage.

- Rust has caused complete kill of many genotypes in Ireland.
- Mixtures of genotypes improve yields by delaying rust onset, reducing beetle damage and increasing overall yields. Mixture of at least six genotypes is recommended.
- The value of using willows for waste management of effluents and sludge is beginning to be recognized.
- High chip drying costs are resulting in evaluations of whole stem harvesting. Whole stems do reduce costs, but chipping is more difficult. (Lynn note – perhaps whole stem burning should be considered!).
- Biggest challenge in Ireland is development of confidence by farmers and power producers of a robust supply chain and market.

George von Wuehlisch of the Von Thunen-Institute, Institute for Forest Genetics, Germany

- SRWC area is 17,000 ha in Sweden, 6,000 ha in Italy and 3200 ha in Germany.
- Marginal land available in Germany for energy crops is 0.5 to 1 million hectares.
- Clonal development and testing of SRWC crops is a major focus along with development of agroforestry systems for dry sites (e.g. black locust) and alley cropping systems.
- Research trials across Germany and Austria have resulted in recommending 7 poplar clones and 6 willow clones.
- Willow yields vary from 8 to 18 dry Mg ha⁻¹ yr⁻¹.
- Increasing demand for wood for energy throughout Europe is resulting in both wood imports to and exports from Germany.

Bernado Monteagudo et al. from Universidad Politécnica de Madrid, Spain

- Paulownia spp. produce yields of 36 – 38.5 dry Mg ha⁻¹ yr⁻¹ in Spain.
- The cellulose content is ~ 40%, encouraging consideration for production of bioethanol.

News from North America: Major Programs

The Canadian Wood Fibre Centre (CWFC) Short Rotation Woody Crops Program: Scientific, Operational, and Technical Development Activities

Derek Sidders, a Regional Coordinator for CWFC, reported that the CWFC has been testing and demonstrating SRWC system designs, field operations and species/site suitability on a broad network of sites for the past 10 years. This work is a collaborative effort initiated in 2005 under the Canadian Biomass Innovation Network of Natural Resources Canada. They have a goal of getting 1 billion trees in the ground across the 14,966,200 hectares of potentially suitable land in Alberta, Saskatchewan and Ontario. Normal planting density is 6400 stems/ha. For more information check out: www.cfs.nrcan.gc.ca/subsite/ecoeti

Short Rotation Woody Crop Research at the University of Illinois (UI)

Gary Kling, reported that short rotation woody crops were added in 2010 to the UI biomass species screening trials. Twenty-five woody crop species are being compared with numerous perennial grasses, forbs, corn and soybeans. This work is only a small part of a very large research effort by the Energy Biosciences Institute, funded by a 10-year - \$500 million grant by British Petroleum. Collaborators include the University of California, Berkeley, and Lawrence Berkeley National Laboratory. Feedstock Development is one of 5 major bioenergy research areas, and species screening is small component of the feedstock development work. A major focus is on Miscanthus. For more information see the feedstock development program section of:

www.energybiosciencesinstitute.org

State University of New York, College of Environmental Science and Forestry, Willow/Woody biomass Program

The 8th Biennial SRWCOWG Conference provided a great showcase for the research and development of woody crops that has been ongoing at SUNY/ESF for many years. SUNY/ESF has teamed up with over 20 organizations to facilitate

the commercialization of willow crops and other woody biomass in the Northeast and Midwest United States. The website www.esf.edu/willow contains much valuable information on current research projects, many publications and abstracts, education modules, a downloadable economic model, and links to a number of relevant organizations or websites. The current woody crops research in which SUNY staff and students are participating was highlighted in 10 presentations and 2 abstracts presented at the recent meeting.

Eastern Ontario Hybrid Poplar Plantations – lessons learned

A cooperative effort involving the Ontario Ministry of Natural Resources, Domtar Inc., private land owners and the University of Toronto was active between 1976 and 1995. Domtar continued management of the plantations at some level till 2005, when the Cornwall Domtar mill closed its doors. Jaconette Mirck reviewed the history of activities and summarized the lessons learned. The presentation includes some information on hybrid poplar clonal performance.

Oak Ridge National Laboratory's (ORNL) Biomass Program

Although ORNL no longer manages feedstock development research, there is still a lot of activity around bioenergy and feedstocks at ORNL. Check out: <http://www.ornl.gov/sci/bioenergy/> for a more complete picture. ORNL staff and subcontractors contributed 4 presentations at the meeting. The presentation by Laurence Eaton entitled, "Preview of the billion-ton annual supply assessment" is a great example of current ORNL work. This update of the previous "technically feasible" supply now includes cost-supply analysis and more crops.

U.S. Forest Service Research and Development
Marilyn Buford, the Silviculture Research National Program Leader at Forest Service Headquarters, updated the conference attendees on policy factors that are affecting the rate of deployment of SRWC in the U.S. Evidence of the continued interest of the U.S. Forest service can be found at the website: http://www.fs.fed.us/research/pdf/RD_Bioenergy_Strategy_March_2010.pdf

News from North America: Research Results

SRWC Silviculture – Planting density

Planting density/yield relationship is a topic very close to my heart. One of my first woody crops publications entitled: “Are increased yields in coppice systems a myth?” dealt with this topic in 1988. The issue of optimum planting density has not yet been resolved, especially for single-stem production of wood for energy, and it is still under debate even for coppice production. The main reasons as stated by Jesse Caputo and others from SUNY-ESF, is that establishment costs account for 25% of delivered feedstock prices and planting stock accounts for 60 to 80% of establishment costs in willow plantings established at the recommended level of 15,400 plants ha⁻¹. Caputo’s presentation gives a nice review of key papers discussing density-yield relationships then presents observations and experimental results on yield responses to density.

- An unplanned experiment resulted from variable mortality among four clones (3 willow and 1 poplar clone). First rotation yields were higher across all clones in plots at densities > 10,000 trees ha⁻¹. Total density range was ~2500 to 14,000 trees ha⁻¹. However, by the end of the 3rd rotation, the one willow clone with high initial mortality (resulting in initial densities of most plots between 2500 and 7000 trees ha⁻¹) was consistently outperforming all other clones.
- While the follow-up experiment established in 2007 with four willow clones and a density range of ~ 5800 to 17,500 trees ha⁻¹ has not yet produced yield results, very interesting observations on stem counts and basal areas have already emerged. Most notably at 2 years after the establishment coppice, stem counts were decreasing and basal areas were leveling relative to increasing densities (except 1 clone showing a basal area decrease at higher densities).

This is definitely an experiment to watch and on which we should expect an update in 2012!

SRWC Silviculture – Herbicide Effects

Herbicide trials are one of the more boring but extremely important studies that must be conducted in every location, and repeated often as new herbicides become available. Herbicide trial results top my list for the type of practical information I and others need in order to have any chance of establishing a successful woody crop planting without several years of trial and error.

Raymond Miller has provided excellent information on herbicide effects on shrub willows in the Upper Peninsula of Michigan. Between 2007 and 2010, thirteen herbicides were tested on 3 sites and on eight species of willow. Key conclusions were the following

- Princep caused excessive mortality in the first year – especially on light soils
- Substitution of pendimethalin for Princep with either Goal or Dual improved survival and growth.
- Both Solicam and SureGuard look favorable (particularly at lower rates). Differences were not large in the first year – but effects carried over to the 2nd year.

Comparison trials using the same herbicides have recently been established in New York. (poster by Smart LB, Dunst R., Rak D, Miller RO, and Abrahamson LP.

SRWC Silviculture – Nitrogen Supply & Uptake

A research report by Amos Quaye and Tim Volk provided details about the effects of commercial fertilizer, biosolids compost and digested dairy manure, and controls on nutrient supply rates, bioavailability and uptake. Lots of good information is being produced by this experiment and hopefully publication of the results will occur soon. The abstract keys on the importance of mineralization in supplying plant available N in the spring and also on the importance of soil moisture on nutrient mineralization. From the presentation, a take-home message was that in order to optimize fertilization, one should apply it at decreasing rates since N & K are mineralized in the year of application.

Biomass Yield Data: I recommend examination of the following presentations and/or abstracts available at www.esf.edu/outreach/pd/2010/srwc for updated yield data. All yields are given as dry Mg ha⁻¹ yr⁻¹ or dry Mg ha⁻¹ unless otherwise noted.

- *Above- and below-ground biomass and soil organic carbon inventories of willow biomass crops across a 19 year chronosequence.* Pacaldo RS, Volk TA, Abrahamson LP, and Briggs RD. Comment: All above-ground stems had been growing for 2 years since last cutting at the time of the inventory.
- *Aboveground biomass production of 30 shrub willow and 7 hybrid poplar varieties over four coppice harvest cycles.* Volk TA, Maurer J, Moghariya D, and Abrahamson LP. Comment: Presentation provides long-term data on willow and poplar coppice dry weight yields.
- *Short rotation yields of pure and mixed family plots of loblolly pine.* Nelson CD, Johnsen KH, Butnor J, Lott LH, Foster S, and Nance WL. Comments: Yields are from pine trials at high density (1x1m and 1 x 2m) through age 15. Pure and mixed genotypes were evaluated. Yield comparisons are given in volume units.
- *Selection of pest and disease resistant, high-yielding shrub willows (*Salix spp.*) for biomass production from novel species hybrid pedigrees.* Cameron KD, Abrahamson L, Volk T, and Smart LB. Comment: Yield comparisons among many clones are shown graphically.
- *Roadmap to developing willow biomass plantations in Saskatchewan: the first three years.* Van Rees, KCJ, Hangs RD, Amichev, BY, and Volk TA. Comment: Yields are compared at age 2 among six clones along a gradient of 4 sites. Only the abstract is available since Ken was unable to attend the meeting.
- *The use of agroforestry principles to grow biomass for bioenergy in southern Ontario, Canada – A case study using tree-based intercropping as an example.* Cardinael R, Thevathasan N, and Gordon AM.

Comment: Yield of 3 clones from a standard monoculture are compared with same clones in an agroforestry planting – with the latter being higher. Excellent photos show the contrast.

New Databases or Useful Information Sources

- Ron Zalesny and others (U.S. Forest Service, Northern Research Station) have created a new bibliographic database of North American peer-reviewed publications on poplars between 1989 and 2009. The last Forest Service bibliography by Ostry et al. covered the period 1975-1988. The new bibliography should soon be available for free on a CD-rom and on-line (pending copyright issues). Check at populusdatabase@gmail.com for progress.
- Lynn Wright of WrightLink Consulting has put together a database of published short rotation woody crop biomass yields. Only data sets achieving a mature yield (at (or near) point of maximum mean annual increment) are included. The mature yield information will be published as tables, and the growth curves and associated information will become part of the Bioenergy Knowledge Discovery Framework (KDF) developed at ORNL and sponsored by the Department of Energy. Check the website (<https://bioenergykdf.net>) for site specific information utilizing the database by mid-summer 2011.
- Ron Zalesny et al. have developed GIS-based protocol for identifying suitable testing and deployment sites for poplars in Midwest U.S.A. His presentation provides background information, protocol development information, and geographic output of potential sites. More information is available at populusdatabase@gmail.com.
- Sylvain Masse of the Canadian Forest Service was unable to attend the meeting but his presentation is available. It contains very informative results from a survey of SRWC adoption issues by landowners in Quebec and three Prairie Provinces.

SRWC Economics Topics

- Optimization modeling by Matt Langholtz et al. suggests that the most profitable production strategy for *Eucalyptus grandis* in Florida is to cut the trees at ages between 2-4 years and allow 3 to 4 harvests before replanting.
- The SUNY-ESF model, EcoWillow v1.4 (see <http://esf.edu/willow>) was used to evaluate the economic impact of Federal Incentives on SRWC projects resulting in an information dense presentation. Two of several conclusions follow: (1) From a growers as well as sponsor's perspective establishment grants of 50 to 75% with annual incentive payments for medium to low productivity sites are a good fit; (2) Incentive programs are expensive and need to be tied to proper crop establishment to insure substantial quantities of biomass production. (presentation by Thomas Buchholz)
- McKenny et al. (Canadian Forest Service) used an economic model (published by them in 2006) to evaluate six scenarios of cost and revenue from biomass production and carbon sequestration. Assumptions are given in tables and maps show the spatial variation in estimated break-even chip prices.

Harvesting Technology Topics

- SUNY-ESF and New Holland have been working together for 4 years to develop a single pass cut and chip harvester for SRWC based on a New Holland forage harvester. He claimed that the current New Holland Short Rotation Crop harvesting head can handle single stems or coppice regrowth and cut stems up to 6 inches in diameter. Testing will continue and work will expand to develop efficient handling systems for the wood chips. (presented by Larry Abrahamson)
- Video of the New Holland FR9080 forage harvester equipped with the specially designed New Holland 130 FD Short Rotation Coppice header can be found at the following URL: www.esf.edu/outreach/pd/2010/srwc
- The US Forest Service is involved with a research consortium testing a variety of Short Rotation woody Crop Harvesters with cottonwood and black willow established on a

wet (gumbo mud) site in the lower Mississippi alluvial valley. Eight harvest/collection systems are being evaluated. A swing-to-tree feller buncher on tracks appears to be preferred for single-stem cottonwood harvest because the long boom reach enables doing the harvest with less trafficking on the wet soils. Studies are ongoing. (presentation by Dana Mitchell)

Genetics, Pathology and Wood Science Topics:

Research reported that primarily affects productivity ($\text{Mg ha}^{-1} \text{ yr}^{-1}$) included:

- *Selection of pest and disease resistant, high-yielding shrub willows (*Salix spp.*) for biomass production from novel species hybrid pedigree* - Cameron K D, Abrahamson, L, Volk, T, and Smart L B.
- *Prediction of long-term canker disease damage from the responses of juvenile poplar clones to inoculation with *Septoria musiva** - Weiland J, Stanosz, J, and Stanosz, G.
- *Adaptation to climate change: Identification of climatically resilient hybrid poplar cultivars* - Chhin, S.
- *Varietal susceptibility of shrub willows bred in Sweden and United Kingdom to potato leafhopper and other pests in the northeastern U.S.* – Cameron KD, White C, Loeb G, Abrahamson LP, Smart LB.
- *Diversity of pathogenic fungi affecting shrub willows (*Salix spp.*) grown in short rotation biomass plantations in New York state* - Kenaley SC, Cameron KD, Hudler GW.

Research reported that primarily affects utilization properties of woody crops included:

- *Molecular genetic basis for variation in lignocellulosic biomass composition in shrub willow (*Salix spp.*) bioenergy crop* - Serapiglia MJ, Stipanovic AJ, Cameron KD, and Smart LB.
- *Inter-correlations of physical and chemical properties amongst hybrid poplars grown in Wisconsin, Minnesota, and Iowa* - Francis RC, Bose SK, Hanna RB, Zalesny Jr RS, and Riemenschneider DE (retired).

Hot water extraction of shrub willow and sugar maple chips reduces ash content, increases energy content - Cabrera AM, Hasan A, Amidon T, and Volk TA.

Genetic potential of loblolly pine for hydrolytic conversion to ethanol - Barker DK, McKeand SE, Whetten RW, Fikret I, Park S.

New Woody Crop Research to Watch

- The University of Arkansas is evaluating the performance of black willow, eastern cottonwood and sycamore on marginal land in the Lower Mississippi Alluvial Valley. Study installed in spring 2009. (Jamie Schuler poster.)
- The Saskatchewan Research Council is introducing alley cropping on the Canadian Prairies. First plantings were established in spring 2010. (Shannon Poppy poster)
- Several collaborators in New York and Michigan are testing herbicide phytotoxicity on shrub willows (poster by Smart LB, Dunst R, Rak D, Miller RO, and Abrahamson LP.).
- Sylvian Masse anticipates publication of the survey of Canadian landowners and experts regarding issues related to four short-rotation afforestation and Agroforestry systems in 2011. Project website is:
<http://cfs.nrcan.gc/subsite/ecoeti/overview>
- A Canadian study of six clones across an environmental gradient in Saskatchewan was begun in 2007. Second year yield results were included in an abstract by Ken Van Rees et al. at this meeting , but full rotation yields will be most interesting when available.