Short-Rotation Woody Crops

2005 Administrative Sponsors
National Council of the Paper Industry for Air & Stream Improvement
Oak Ridge National Laboratory
USDA Forest Service

2005 Sustaining Sponsors
Boise Cascade, LLC
GreenWood Resources
Irrigation Mart
Peterson Corporation
Potlatch Corporation

Operations Working Group NEWSLETTER

Number Thirteen **December 2005**

IN THIS ISSUE

- Spotlight on Brian Stanton
- Sidebar on GreenWood Resources
- 2006 Biennial Meeting – Preview
- Steering Committee Mtg Report
- Phytoremediation: paper summaries
- Carbon sequestration: paper summaries
- Minnesota poplar tour notes

Spotlight on Brian Stanton

Brian Stanton, Managing Director of Tree Improvement at GreenWood Resources, was nominated by several of his peers in the hybrid poplar arena to have the spotlight of the current SRWCOWG newsletter focused on him. Brian is an experienced scientist/manager who has unique technical skills of value to the industry, is highly respected by his co-workers and collaborators, and has a great personality.

Dr. Stanton's technical training occurred on the east coast where he received a MS in Forestry from the University of Maine and a Ph.D. in Forest Resources from The Pennsylvania State University in 1984. During the final year of his PhD program, Brian worked for the New York Botanical Garden as a research intern in an urban tree management program. With his Ph.D. degree in hand in 1984, Brian was hired by Crown Zellerbach Corporation to work on poplar genetic improvement in support of their commercial operations in the Lower Columbia River valley at Clatskanie, Oregon and the Mississippi River valley at Fitler, Mississippi. Although Brian's work resume includes the names of several companies (Crown Zellerbach, James River, Fort James, and now GreenWood Resources), the focus of his work has largely remained the same, that is poplar breeding and varietal selection.

Brian Stanton in ~ 1986 showing one of his select hybrid poplar clones during the first year of growth at the Lower Columbia River Fiber Farm.

The career accomplishments of Brian Stanton are considerable. His work has involved research in such varied areas as poplar hybrid reproduction, the design of a multiple stage clonal field evaluation process with the construction of multiple-trait selection indices, and the development of threshold selection protocols for pathogen resistance.

.

Brian's qualifications (and a well developed research proposal) resulted in his selection to be the lead researcher on a Department of Energy (DOE) funded project to breed poplars for traits important to energy conversion. Grant writing continues to be a focus in GreenWood's expansion of it's tree improvement business.

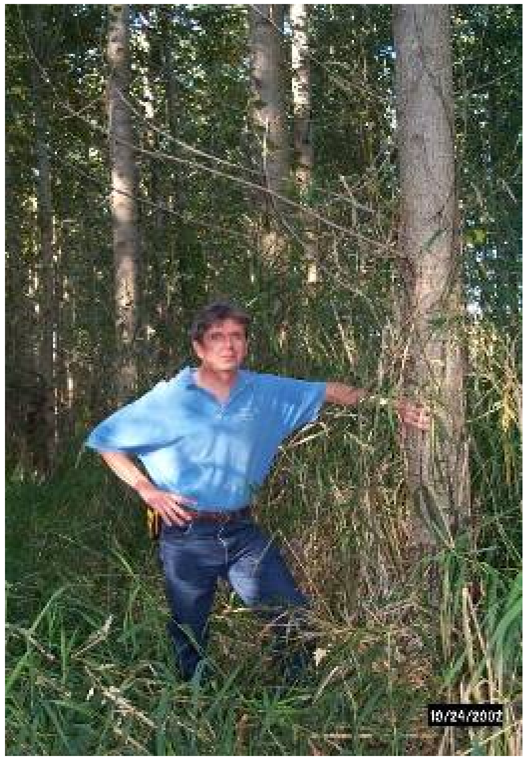
Altogether, Brian's breeding efforts have produced over 30,000 varieties of hybrid poplar that have been tested in the Pacific Northwest, Southeastern U.S., Europe, China and Chile. Select varieties have been proven to be some of the most commercially successful, fast-growing trees in the northern temperate zone. Other companies in the Pacific Northwest have taken advantage of Brian's expertise to help out in the development of their own genetic improvement projects.

Brian's poplar breeding expertise is proving valuable not only to GreenWood Resources and other companies in the Pacific Northwest but also internationally. In China, Brian collaborates with poplar specialists at Beijing Forestry University, the Chinese Academy of Forestry, and Nanjing Forestry University, and is also working with the University of Talca in Chile on establishing a poplar genetic improvement program.

Brian is the Chair of the Poplar and Willow Working Party for the International Union of Forest Research Organizations, the past chair for Forest Genetics and Tree Improvement Working Group for the Society of American Foresters and Adjunct Professor at Washington State University Department of Natural Resource Sciences.

In his personal time, Brian enjoys backpacking and hiking with his wife and keeping fit by biking and running. Most of all, he enjoys spending time with his grandkids, whom he says are "the best".

Brian in 2002 showing a tree being allowed to grow to sawlog size on the site now called the Lower Columbia Poplar Farm.



.

Brian in 2002 showing characteristics of some of the many clones that he has recently produced in the nurseries at the Lower Columbia Poplar Farm

GreenWood Resources

GreenWood Resources is a relatively new company that manages hybrid poplar plantations for timber production in the Pacific Northwest and provides consulting expertise to organizations around the world. The company was founded in 1998 by Jeff Nuss during that decade's downturn in the pulp industry that lead to multiple mergers and re-organizations of several paper companies.

GreenWood Resources grew quickly by being able to acquire valuable assets as other companies refocused their priorities. In 2000, Jeff organized a complex deal to acquire the Lower Columbia River Fiber Farm. The deal involved purchase of the property by a private equity forestry fund that was managed by Renewable Resources, a timber investment company. GreenWood provided all of the tree farm management services. To accomplish that, the company acquired most of the staff, and all of the tree improvement intellectual property and plant material assets historically associated with the Fiber Farm. This included Brian Stanton and all of the new clones that he had developed. The company expanded again in 2003 and 2005 when re-organization of Boise Cascade resulted in divestment of 9,000 acres of their poplar plantations.

GreenWood Resources is now managing approximately 15,000 acres of land in the Pacific Northwest for multiple markets ranging from saw logs for lumber and veneer, to chips for paper and engineered wood products. The company has recently hired a Chief Operating officer to assist in the global expansion of the business. They have also hired two individuals with technical and management expertise to expand company operations in China and Chile. Offices have just been opened in Beijing, China And Los Angeles, Chili. These recent moves support the company's vision to see hybrid poplars developed worldwide as a sustainable and profitable resource, utilizing the many potential values of poplar.

Notes from SRWCOWG Steering Committee Planning Meeting – November 1-2, 2005

The SRWCOWG Steering Committee completed a very productive planning meeting in Minnesota. Members who were able to participate included Jake Eaton (Potlatch), Steve Pottle (Boise), Judd Isebrands (Environmental Forestry Consultants), Erik Schilling (NCASI), Tom Houghteling (Minnesota Power), Lynn Wright (WrightLink Consultants) and John Stanturf (USFS). Bill Berguson hosted the planning meetings at the University of Minnesota, Natural Resources Research Institute (NRRI) offices in Duluth, Minnesota.

<u>Key Points discussed and decisions made included the following</u>:

- Erik Schilling, a new employee at NCASI who assumed the responsibility of being the SRWCOWG treasurer, gave the financial report.
- Lynn Wright will continue to manage the web site and produce our Newsletter through 2006.
- The Committee unanimously accepted the offers from the US Poplar Council and the Canadian Poplar Council to combine annual meetings at the Pasco venue.
- The Committee discussed ways to boost our membership. We will attract many from Canada as a result of joining with the PCC
- The date for the 2006 biennial meeting was set for September 25-28, 2006.
- September 25 will be set aside as a meeting day for the individual organizations, registration, and a reception.
- The venue will be the Pasco, WA Red Lion with plenary sessions on 9/26 and 28, 2006.
- The field day for the meeting will be spent in Oregon at the Potlatch, Boise, and GreenWood industrial plantations on 9/27/2006.
- We will have an optional field tour on 9/29/06 to tour western WA and OR phytoremediation activities.

Action Items:
- The Steering Committee members will send Jake Eaton contact information for potential new members and sustaining sponsors
- Jake will put out a formal invitation to join the SRWC OWG.
- Jake will prepare a letter of invitation to the PCC, USPC, IUFRO task on Temperate Short Rotation Forestry, IEA, and the SAF Agroforestry working group.
- Steve will make the venue reservation at the Red Lion and check on the government rate.
- Steve will pre-reserve busses for the 9/27 field tour and excursion.
- Erik will issue a letter to our current Sustaining Sponsors asking for their continued support for the working group and to make the $500 commitment for 2005.
- Judd will look into possibilities for the Friday optional phyto tour and Jake will help organize.
- Jake will contact Reini Stettler regarding the key note address.

2006 Short-rotation Woody Crops Operations Working Group Meeting Preview:

Proposed Plenary Session Topics

1. Carbon sequestration and the structure/functions of carbon trading markets-
    a. Canadian perspective-Kyoto signatory
    b. Latest research on sequestration in soils and wood fiber
    c. Carbon market perspectives-is there money to be made?
2. Phytoremediation
    a. Clean up of contaminated sites with trees-poplar and willow
    b. Riparian buffers that intercept nutrient rich run off
3. Bioenergy
    a. Market effects of higher oil and coal prices on bioenergy feasibility
    b. Wood pellets
    c. Most feasible conversion technologies
    d. Economics of different feed stocks
    e. Willow-harvesting systems, commercial development
4. Barriers and drivers to SRWC development
    a. Policy issues
    b. Biodiversity (incl. native vs non-native)
    c. Wildlife issues
    d. Economics
5. Production Systems, Wood quality
    a. Silviculture and cultural systems
    b. Harvesting and processing
6. Genetics and Tree Improvement
    a. Update on poplar genomics
    b. Barriers to using GE technology-timeframes, costs and barriers to the use of GM poplars in the US
    c. Operational tree improvement strategies
    d. Poplar genetics and plantation programs in China-Species, GM trees, products
7. Environmental Certification
    a. Plusses and minuses of certification
    b. Market impacts-real world economic realities

Proposed Field Tour Ideas

Potlatch Site:
Nitrogen Use Efficiency Study
Irrigation study
Poplar genetics trial
Other hardwoods
Solid Wood plantations
Drip Irrigation station
Central processing site for lumber & chips

Boise Cascade Site
Harvesting with in-field chipping

GreenWood Resources Site
To be determined

Possible visit to local winery at end of day

Phytoremediation: Summaries of selected published papers.

The following four papers were provided by Judd Isebrands in response to a request for papers describing environmental benefits of poplar plantings. Each is briefly summarized to provide a guide to content.

Westphal, L.M. and Isebrands, J.G. 2001. Phytoremediation of Chicago's Brownfields: Consideration of Ecological Approaches and Social Issues. In: Proceedings Brownfields 2001 Conference, September 24-26, 2001 Chicago Illinois.

This very readable paper gives an excellent introduction to the values of phytoremediation and approaches used for phytoremediation. It begins by pointing out that use of vegetation for brownfield development has not only ecological but social functions. The authors note that phytoremediation principals have been used for centuries in Europe and the Middle East, for example, by establishing plants to buffer streams from animal manure. Phytoremediation has been used extensively in Europe in modern times and has emerged as a viable technology in the US in the last 20 years.

Several phytoremediation processes (phytoextraction, rhizofiltration, phytostabilization, phytodegradation, and phytovolitalization) are defined but the paper suggests that most applications involve planting riparian buffer strips or vegetative filters.

The paper makes clear that there is no such thing as an "off the shelf" phytoremediation solution that can be applied anywhere. The problem is that the best options will depend on general site and climatic conditions as well as the specific type of phytoremediation required and the social setting of the site. Different plants have differing rates of hydrologic uptake, differing affinities for metals, etc. Each situation may require some preliminary testing of plants prior to determining the solution Social responses to tree plantings also need to be taken into consideration in the overall solution.

The paper briefly summarizes a phased remediation strategy being used in Chicago. It also includes a fairly lengthy reference list that could be of value.

Rockwood, D.L., Naidu, C.V., Carter, D.R., Rahmani, M., Spriggs, T.A., Lin, C., Alker, G.R., Isebrands, J.G. and Segrest, S.A. 2004. Short-rotation woody crops and phytoremediation: Opportunities for agroforestry? Agroforestry Systems 61: 51-63.

This paper starts out by providing an overview of worldwide use of biomass (mostly wood) for fuel and summarizing research on short-rotation woody crops. It reviews "dendroremediation" describing several projects around the world and U.S. including a list of projects in the U.S. It ends by presenting the rational for incorporating both short-rotation woody crops and phyto or dendro remediation into agroforestry systems. The basic argument is that economic feasibility will be enhanced. Some general concepts for how this could work are provided.

Licht, L.A. and Isebrands, J.G. 2005. Linking phytoremediated pollutant removal to biomass economic opportunities. Biomass and Bioenergy 28 (2005): 203-218.

This paper elaborates on the potential benefits of linking use of trees for both phytoremediation and production of either biomass energy or traditional wood products. Basic descriptions of how phytoremediation systems work provide the introduction to the paper. It is noted that the design parameter that separates phytoremediation from landscaping is purposefully placing and growing a rootzone reactor volume with predictable pollutant removal performance. A good summary of the intangible environmental and socio-economic benefits of "phyto" treatments is given. Four general types of phytoremediation are described and further elucidated by specific case studies of installed commercial applications. These include the following:

1) Streamside buffers; case history on buffers placed on farmland in Iowa.
2) Vegetation filters for wastewater treatment; case history on a landfill treatment in

Oregon.
3) Vegetative caps; case history on a landfill located in Seattle, Washington.
4) In-Situ phytoremediation plantings; case history the Ashland Chemical, Inc. facility in Milwaukee, Wisconsin.

The paper ends with discussion on how pollutant treatment with trees is different from traditional short rotation woody crops production and requirements of remediation sites for fulfilling environmental outcomes.

Mirck, J., Isebrands, J.G., Verwijst, T. and Ledin, S. 2005. Development of short-rotation willow coppice systems for environmental purposes in Sweden. Biomass and Bioenergy 28 (2005): 219-228.

With the focus on Sweden, the authors describe how the driving force behind development of short-rotation willow coppice has been changing from a focus on production for biomass energy to an emphasis on environmental applications. In most cases commercial plantings of willow coppice are geared toward a combination of biomass feedstock production and environmental goals. This paper presents terminology and definitions of several different types of phytoremediation. It's major contribution is the description of five ongoing phytoremediation activities in Sweden.

Carbon Sequestration: Summaries or abstracts of Selected Papers

Coleman, M.D., Isebrands, J.G., Tolsted, D.N., Tolbert, V.R. 2005. *Comparing Soil Carbon of Short Rotation Poplar Plantations with Agricultural Crops and Woodlots in North Central United States.* Environmental Management, Vol. 33, Supplement 1, pp. S299-S308. (Published online March 4, 2004)

The research reported by this paper attempted to expand the baseline SOC sequestration information on short rotation poplar plantations in comparison to adjacent agricultural crops, switchgrass, and farm woodlots in North Central United States. The research addressed the following questions: 1) will short rotation poplar plantations accelerate soil organic carbon sequestration when compared to agricultural crops; 2) if so, when in the rotation, and 3) how does soil carbon sequestration of short rotation poplars compare to that of adjacent farm woodlots.

The research included 27 study sites spread across 4 states and the paper provides excellent detail on site selection, sampling methods, soil analysis approach, and statistical analysis. Results are well presented with several tables and graphics. The results, however, were not definitive. The first, and key sentence in the results section is; "SOC showed a high level of variation across the 27 study sites". A review of the literature by the authors showed that this type result is fairly common.

Regarding the question of whether short rotation poplar plantations accelerate soil organic carbon sequestration when compared to agricultural crops, the answer, based on this study alone, appears to be no – at least not within plantations between ages 1 and 12 years of age. There was a trend toward higher SOC under poplar plantings less than 4 years of age (3 of 5 sites), but with the addition of the data from older plantations (at 17 additional comparison sites), it was clear there was no statistical difference between SOC in poplar plots compared with adjacent agricultural crops in the top 32 cm of soil at any age. However, this result is in contrast to the results found by Hansen (1993) and the model predictions of Grigal and Berguson (1998) (showing a decline in SOC during the establishment years, followed by a predicted rebound after 5 years). The authors were able to tease out some effects of soil quality – but even this was not consistent. The authors did not discuss the relative yield differences or similarities between the poplars and agricultural crops, but given that the average poplars yields were only 6.7 Mg/ha/year, and that some agricultural crops (such as corn) can have annual biomass yields twice that high in the Lake States, and that some perennial crops were included in the agricultural crop category (such as hay and alfalfa) it is not too difficult to understand why SOC values might not be so different between the poplars and agricultural crops. Given the differences between various observations and the predictions, questions 1 and 2 remain unanswered for the North Central Region.

Regarding question 3, the authors noted that at most sites, the woodlot SOC was higher than that of the short-rotation poplar and agricultural crops. Of 8 comparisons including woodlots, there were only two cases where the woodlot SOC was less than that under the poplars. But the SOC levels in woodlots were only greatly higher in a couple of cases, so the results may not be so clear.

The authors conclude their discussion by highlighting other carbon sequestration benefits of establishing and using woody crops. These include: (1) long-term carbon storage in wood products, (2) reduction in soil carbon losses by erosion through the use of woody crops for riparian buffers, and (3) carbon emission avoidance by using woody crops to displace fossil fuel use in energy production.

References:

Grigal, D.F. and Berguson, W.E. 1998. Soil carbon changes associated with short-rotation systems. Biomass and Bioenergy 14:371-377.

Hansen, E.A. 1993. Soil carbon sequestration beneath hybrid poplar plantations in the north central United States. Biomass and Bioenergy 5:431-436.

Post, W.M., Izaurralde, R.C., Jastrow, J.D., McCarl, B.A., Amonette, J.E., Bailey, V.L., Jardine, P.M., West, T.O. and Zhou, J. 2004. *Enhancement of Carbon Sequestration in US Soils*. BioScience Vol. 54 No. 10: 895-908.

This paper deals generically with what could be done to increase soil carbon levels. The analysis starts by recognizing that "many factors intervene between demonstrating that a particular carbon management practice can enhance carbon sequestration in the soil and determining that widespread application of the method is useful, acceptable, and cost effective" The authors outline a complete and integrated methodology for evaluating alternative approaches to increase terrestrial carbon sequestration. The paper first describes in relevant detail several possible management practices for increasing soil carbon including: cropping intensification, organic amendments, conservation tillage, perennial vegetation (including biomass crops), liming, irrigation, and fertilizer management, and microbial manipulation. Following then, is discussion of evaluation of other environmental impacts and description of a model for doing a full-carbon accounting. The discussion moves onto describing tools for estimating regional carbon sequestration potential, information needed for performing economic comparisons of different methods of greenhouse gas reduction, and considerations that must be taken into account in estimating specific project greenhouse gas offset amounts. The conclusion is that knowledge about the technical aspects of carbon sequestration is growing rapidly; however, "the willingness of public and private buyers to use soil carbon sequestration methods to achieve net greenhouse gas reduction in the atmosphere will depend on the costs and economic benefits, which include unpriced environmental benefits". Many of the references provide information on research results of specific carbon management trials.

Jastrow JD, Miller RM, Matamala R, Norby RJ, Boutton TW, Rice CW, Owensby CE. 2005. *Elevated atmospheric CO_2 increases soil carbon*. To be published in next issue of Global Change Biology and currently published in early online version. Available at the following website: http://www.esd.ornl.gov/facilities/ORNL-FACE/

The abstract follows:

The general lack of significant changes in mineral soil C stocks during CO_2-enrichment experiments has cast doubt on predictions that increased soil C can partially offset rising atmospheric CO_2 concentrations. Here, we show, through meta-analysis techniques, that these experiments collectively exhibited a 5.6% increase in soil C over 2–9 years, at a median rate of 19 g C m^{-2} yr^{-1}. We also measured C accrual in deciduous forest and grassland soils, at rates exceeding 40 g C m^{-2} yr^{-1} for 5–8 years, because both systems responded to CO_2 enrichment with large increases in root production. Even though native C stocks were relatively large, over half of the accrued C at both sites was incorporated into microaggregates, which protect C and increase its longevity. Our data, in combination with the meta-analysis, demonstrate the potential for mineral soils in diverse temperate ecosystems to store additional C in response to CO_2 enrichment

Many others papers resulting from field trials testing the effect of CO_2 enrichment on sweetgum plantations is available at the same website. Information includes description of the research location, the experimental design, the people involved, and provides linkages to online publications or full pdf's to many papers describing the research results. The author promises that the full PDF text will be available at the ORNL website soon.

Richard Norby of ORNL makes the observation that before one can accurately estimate the amount of carbon sequestration that will result from a woody crop planting (above and below ground), it is important that one get the net primary productivity (NPP) estimates correct first. Thus several of the papers on the website relate to measuring or estimating NPP. Other papers on the website recommended by Richard Norby as being relevant to estimating carbon sequestration of woody crop systems are the following.

Norby, R.J., Hanson, P.J., O'Neil, E.G., Tschaplinski, T.J., Weltzin, J.F., Hansen, R.A., Weixin, C., Wullschleger, S.D., Gunderson, C.A., Edwards, N.T., Johnson, D.W. , 2002. *Net primary productivity of a CO_2-enriched deciduous forest and the implications for carbon storage.* Ecological Applications 12(5): 1261-1266.

Matamala, R., Gonzales-Meier, M.A., Jastrow, J.D., Norby, R.J. Schlesinger, W.H. 2003. *Impacts of fine root turnover on forest NPP and soil C sequestration potential.* Science, Vol. 302:1385-1387.

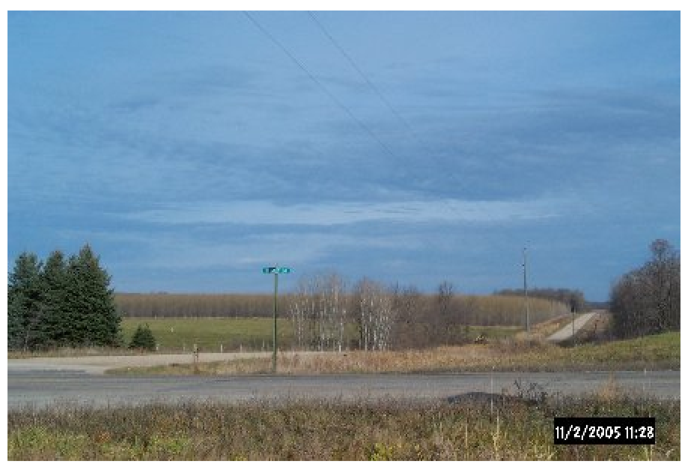
Norby, R.J., Ledford, J., Reilly, C.D., Miller, N.E., O'Neill, E.G. 2004. *Fine-root production dominates response of a deciduous forest to atmospheric CO_2 enrichment.* PNAS 101(26):9689-9693.

DeLucia, E.H., and Moore, D.J. 2005. *Contrasting responses of forest ecosystems to rising atmospheric CO_2: Implications for the global C cycle.* Global Biogeochemical Cycles vol. 19, GB3006, doi:10.1029/2004GB002346, 2005.

Norby, R.J., DeLucia, E.H., Gielen,B., Calfapietra, C. Giardina, C.P., King, J.S., Ledford, J., McCarthy, H.R., Moore, D.J.P., Ceulemans, R., De Angelis, P. Finzi, A.C., Karnosky, D.F., Dubiske, M.E., Lukac, M. Pregitzer, K.S., Scarascia-Mugnozza, G.E., Schlesinger, W.H. and Oren, R. 2005. *Forest response to elevated CO_2 is consedrved across a broad range of productivity.* PNAS 102 (50):18052-18056.

Minnesota Hybrid Poplar Tour, November 3, 2005: Report and Pictures:

Many thanks goes to Mike Young of International Paper company for hosting us on a great tour of IP commercial plantings and the hybrid poplar family and clone genetic selection trials on IP land in Todd County, Minnesota. The selection trials were established by the Minnesota Forest Productivity Research Cooperation. Thanks also goes to Bernie McMahon and Tom Levar of the Natural Resources Research Institute (NRRI) of the University of Minnesota who enthusiastically showed us the selection trials, and shared with us some of the results of years of work. The trip was made pleasant by the exceptionally nice weather that we experienced.



Stand of poplar trees in 5^{th} growing season in vista.

We visited the following types of sites:

1) DN clones planted in 1998, spacing uncertain, possibly 7 x 10 or 8 x 8 ft
2) NM6 clones planted in 2004 at 10 x 10 spacing
3) Selection trial planted in 2001 at 10 x 10 ft. spacing
4) Selection trial planted in 2000 at 10 x 10 ft. spacing
5) NM6 clones planted in 1996 at 7 x 10 ft
6) NM6 clones planted in ~ 1999 (6^{th} growth year)
7) NM6 clones planted in mid-July 2005
8) Rooting trial within 2005 commercial planting

Several informative highlights were gleaned from the tours. Like all companies that have begun the cultivation of hybrid poplars, IP has gone through a learning curve. Over the last eight years, they have modified their clonal mix, changed spacings, modified their weed control procedures, and their fertilization strategy. They have also moved all cutting production in-house and improved on the cutting production procedures. Establishment success appears to be excellent as evidenced by Photo 1 of trees in their 2^{nd} growth year. Mike Young, Manager Hybrid Poplar Fiber Farm for IP's Lake States Region is very pleased with the current silvicultural procedures for the Minnesota IP plantings. IP has demonstrated that NM6 can perform quite well on Minnesota soils that are somewhat marginal for agricultural production (by Minnesota standards). I noted that these soils would be great by Tennessee standards!

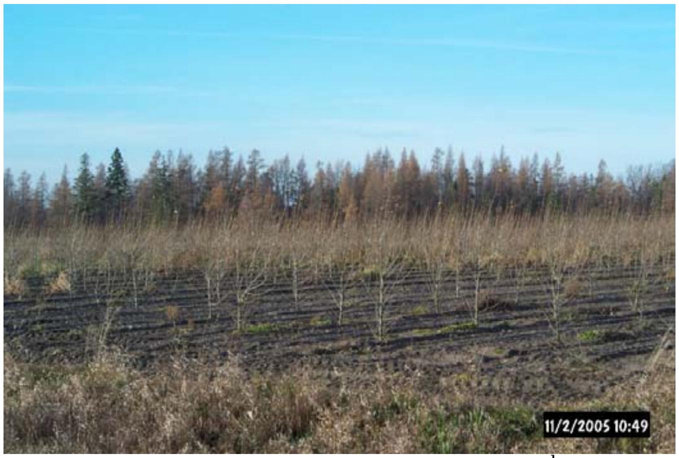


Photo 1 – Hybrid Poplar planting in the 2^{nd} growth year.

In the selection trials Bernie McMahon and Tom Levar pointed out the good, bad and ugly clones (ones scarred or broken due to disease). In general, there were several clones that were averaging better growth than the standards (NM6 and DN2) by 15 to 20%. With the inherent variability that occurs, some few individuals appeared to be showing 100 to 200% improvement in growth compared to the average standard. There were both DN and DM clones showing promise for fast growth and good qualities. A few deltoides parent clones from Carl Mohen collection are excellent parent clones especially D124 (male) and D125 (female)

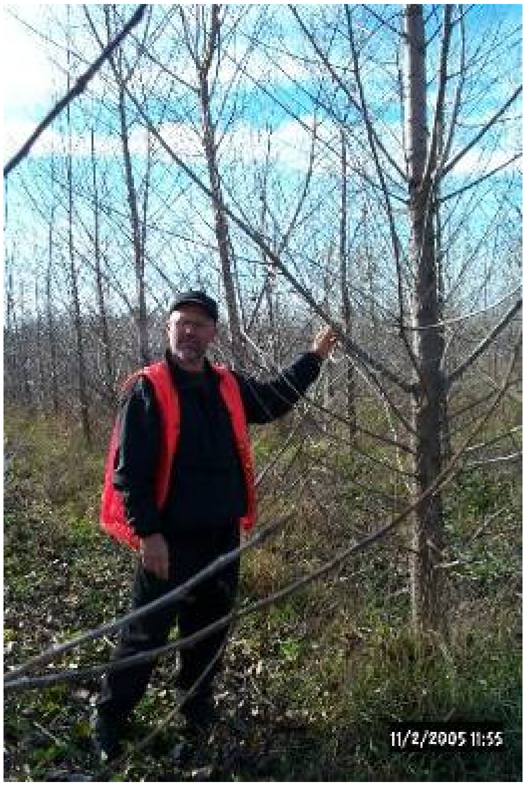


Photo 2 – Tom Levar showing clone D125.

One of the best clones in the trial, DN9732 (photo 3) is a mix of Carl Mohn's best deltoids female (D125), bred with Louie Zuffa's best nigra male (N946). The clone appears to have late season leaf retention, is septoria and rust resistant, and roots better than NM6. Another new clone DM 144-49 also looks very promising (Photo 4). Photo 4 shows the excellent site capture qualities of DM 144-49 along with some of the people on the tour.

Photo 3 – Jake Eaton standing just behind an example of clone DN 9732 in 6th growing year.

Photo 5 – Lynn Wright is standing next to an average NM6 at age 6 – same age as DN9732 in photo 3.

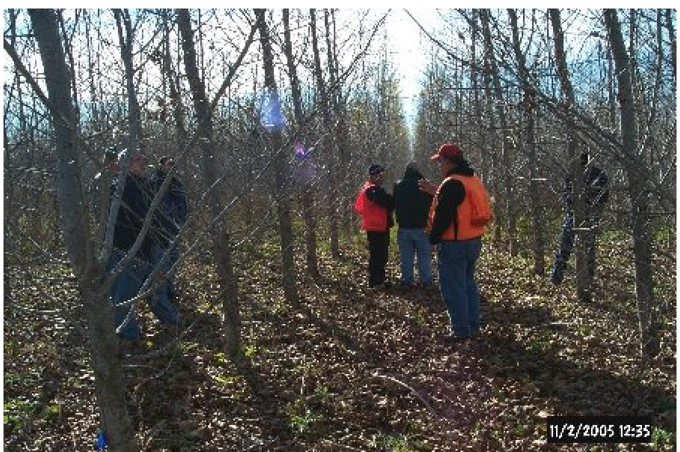


Photo 4 – A test block of clone DM-144-49 in 6th growing year.

In reality, it was difficult to visually confirm that any of the clones were doing better than the NM6 clones in the same trial (photo 5).

Several of the new DM clones had septoria problems (photo 6) or “bad” form which would eliminate them from pulp or timber uses, but they might be quite suitable as biomass feedstock.

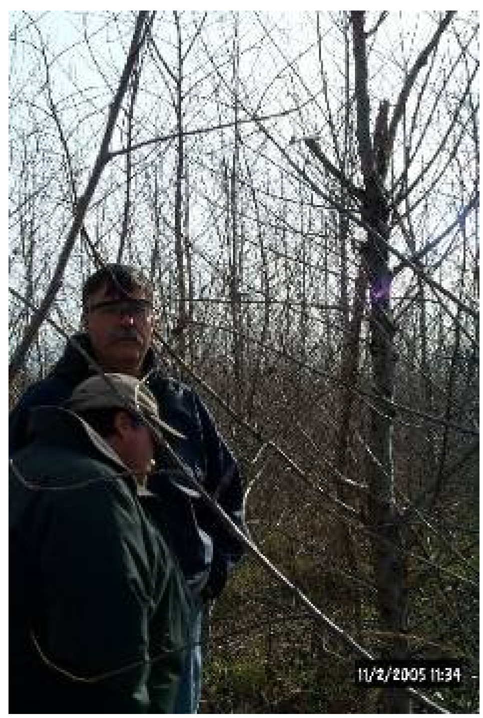


Photo 6 (on right) - Steve Pottle and Mike Young are standing near an example of a DM clone with breakage caused by septoria canker.

Rooting is an issue with many clones, thus Bernie McMahon established a clonal rooting trial within an IP commercial planting (Photo 7) to evaluate the potential of new clones relative to NM6. Results have yet to be fully analyzed, but some new clones are clearly poorer and some look as good or better. Bernie has identified several additional experimental designs that are needed to obtain clearer answers.

Our tour concluded with an excellent lunch in a local Todd country restaurant known for their chili and chicken wings.

The last picture on this page is included just because it shows what a beautiful day we had for the tour. My notes indicate that it shows the canopy of a couple of DN9732 trees.