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LARGE-SCALE BIOMASS PLANTINGS IN MINNESOTA: SCALE-UP AND DEMONSTRATION PROJECTS IN PERSPECTIVE

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Abstract

Scale-up projects are an important step toward demonstration and commercialization of woody biomass because simply planting extensive acreage of hybrid poplar will not develop markets. Project objectives are to document the cost to plant and establish, and effort needed to monitor and maintain woody biomass on agricultural land. Conversion technologies and alternative end-uses are examined in a larger framework in order to afford researchers and industrial partners information necessary to develop supply and demand on a local or regional scale. Likely to be determined are risk factors of crop failure and differences between establishment of research plots and agricultural scale field work. Production economics are only one consideration in understanding demonstration and scale-up. Others are environmental, marketing, industrial, and agricultural in nature. Markets for energy crops are only beginning to develop. Although information collected as a result of planting up to 5000 acres of hybrid poplar in central Minnesota will not necessarily be transferable to other areas of the country, a national perspective will come from development of regional markets for woody and herbaceous crops. Several feedstocks, with alternative markets in different regions will eventually comprise the entire picture of biofuels feedstock market development. Current projects offer opportunities to learn about the complexity and requirements that will move biomass from research and development to actual market development. These markets may include energy and other end-uses such as fiber.
Introduction

Minnesota is currently the site of two scale-up research and demonstration (R & D) projects for planting short rotation intensive culture hybrid poplar on private land. The projects are located in central Minnesota near Alexandria and in the northwest near Oklee. The purpose of these projects is to provide a base of experience to launch large scale commercial projects. This step toward larger scale plantings is possible because of more than 15 years of research, species screening and crop development of hybrid poplar. This research has involved many state, local and federal agencies. Universities and individuals alike have been involved in planning, research and development. Scale-ups such as the two described in this paper are the next logical step toward creating a market for wood for energy. Other scale-up projects of hybrid poplar have occurred such as those performed by the forest products industries in the pacific northwest United States. In most regions of the country, wood fiber markets are fairly well developed and identified. Wood for energy is not; especially hardwoods from trees grown for that end use.

It is important to understand the reasons for developing larger scale (R & D) projects, the kinds of information that is collected and data derived from this near-production kind of work, and to understand the development of potential markets and the persons or clients to whom benefits may accrue. When many diverse groups with interests in agriculture, forestry, environment and economics converge, complex interactions with opportunities for mutually beneficial work may come about. We attempt to draw from early experiences and document these carefully so information may be more easily transferred to those who could most benefit from this information.

Most of the remarks in this paper center on the Alexandria project, the one which the authors are most familiar with. Background and comments regarding the Oklee project are also provided as they relate to the Alexandria project.

The next sections of the paper outline the historical perspective from early work in Minnesota and Wisconsin. A third section takes a closer look at the Alexandria project. In the following two sections, we outline interest among private landowners, and specific lessons learned from the scale-up work, respectively. We conclude with a summary of current related work, and recommendations about future issues that are likely to arise.

Historical Perspective and Review

A review of short rotation woody crop (SRWC) work in the state adds some perspective to efforts at Alexandria and Oklee. Regional research into these crops began at the U.S. Forest Service (USFS) Research Laboratory in Rhinelander, Wisconsin during the mid-1970s. Dave Dawson and Ed Hansen led the SRWC research at Rhinelander. Many others were involved. These early efforts helped to build a geographically limited but technologically solid base of knowledge and interested parties.

From 1979 to 1983 the U.S. Department of Energy (DOE) Short Rotation Woody Crops Program at Oak Ridge National Laboratory supported research to evaluate the potential of peat lands for producing woody biomass under short rotation intensive culture. University of Minnesota researchers planted poplar (Populus spp.) and willow (Salix spp.) on peat land to measure growth rates and other differences between clones. Since the proposed end product
was biomass for energy, the plantings were very densely spaced. Peat land was chosen as a site because it was assumed that using more productive land to grow energy was completely out of the question. Growth rates were low and studies ended in 1984.

Interest in SRWC slowly began to build in Minnesota. Collaborative work with the North Central Forest Experiment Station continued to be supported by the DOEs Biofuels Feedstock Development Program at Oak Ridge National Laboratory under researchers Janet Cushman, Jack Ranney, Lynn Wright and others. In 1986, the DOE through Oak Ridge issued a solicitation for cost sharing on 50-acre scale-up plantings which developed into USFS and DOE cooperation on research for a series of 10 and 20 acre clonal trial plots in Minnesota and surrounding states. Eleven of these locations are still closely monitored (Downing and Tuskan, Hansen et al., 1993, 1995). Studies including use of herbicides and cultural techniques were also conducted. Information and research results generated from these plots is used directly on the large-scale biomass plantings in Alexandria and Oklee.

Private sector interest in wood energy led to the choice of Minnesota as a site for the 1986 USFS and DOE field trials. Northern States Power Company (NSP) was involved in the concept of growing trees to burn as fuel. An engineer on their staff, Dave Ostlie, promoted a vision of burning whole trees. NSP supported the project for a few years, but then withdrew their support, leaving Mr. Ostlie to form his own company to further explore the technology of whole-tree burning. Another private sector group interested in SRWC was the Electric Power Research Institute (EPRI). EPRI, which joined the DOE in supporting the early field trials, funded power conversion tests.

By the time the Minnesota Department of Natural Resources (MN-DNR) became involved in SRWC, work was already well under way. Involvement of the MN-DNR was inevitable because the DNRs role is to work directly with landowners whenever state or federal cost-sharing is available for tree planting. DNR field foresters provide technical advice to the owners and ensure that public monies are achieving their mission. A real problem when DNR became involved in 1986 was that they did not have any expertise on hybrid poplar and short rotation planting.

**Oklee and Alexandria Large-Scale Biomass Plantings**

Minnesota has two simultaneous scale-up projects that are very different in their approach and philosophy. In 1992, state cigarette tax revenues were appropriated for a 3,000 acre SRWC project. This evolved into what is now known as the Oklee project. It's original purpose was to provide feedstock for converting to ethanol or thermochemical fuels. Lack of a commercial partner delayed the project until late 1993, when a regional utility, Minnesota Power and Light (MPL), agreed to find a market for the wood (though not necessarily an energy market). Five hundred acres were planted in the spring of 1995, and the remaining 2,500 acres are scheduled for planting in 1996. Site productivity, grower security, and commercial viability (as evidenced by utility participation) are key factors in this scale-up project.

Providentially, during the summer of 1993, DOE, EPRI and others were seeking scale-up projects around the country. With the cigarette tax project on hold, the DNR sought funds for a 1000 acre project as a substitute. The DOE, through the Biofuels Feedstock Development
Program, (successor to the Short Rotation Woody Crops Program) and EPRI provided $227,000 of the $341,000 total to fund the biomass project near Alexandria.

The Alexandria project picked up momentum that temporarily shifted from the delayed cigarette tax project. Conservation Reserve Program (CRP) land was available and federal cost-shares covered $62,000 of the establishment costs plus the annual rent payments. Non-CRP land was not used as CRP was partially cost-covered. Landowners were chosen from those that had indicated an interest. Fortuitously, the CRP allowed landowners to recontract their currently held CRP contracts on qualifying land for tree planting.

In 1993, all partners for the 1000-acre Alexandria project were financially committed in less than two months. Work began by mid-October 1993 and 500 acres of land near Alexandria was prepared for planting before the ground froze. The remaining five hundred acres had to be prepared during the spring of 1994. All 1000 acres were planted with hybrid poplar cuttings in spring 1994. Fourteen-hundred additional acres were planted in 1995 in a second phase. This included a replanting of 400 original acres that had proven unsuccessful due mostly to spring site preparation on heavy sod. To date, 19 landowners have enrolled nearly 1900 acres.

The Alexandria Project

Overall, the main goal of the Alexandria project was to test systems that were developed on smaller research plots in a scale-up context. Researchers recommended only five of the best clones of hybrid poplar for commercial out-planting. The rotation age was set at seven to ten years to allow the trees to reach a size that would fit into existing commercial wood markets if energy markets failed to materialize. The spacing for that rotation age (8 feet by 8 feet) requires about 700 trees per acre.

One of the early steps taken in Alexandria was to hold a meeting, or roundtable, where a variety of stakeholders would be represented. The group included project funders, landowners, researchers, end-users, environmental groups, and natural resource agencies. The purpose of the roundtable was to introduce the project and give stakeholders a chance to ask questions and provide input to the project. The roundtable was modeled after early work of the National Biofuels Roundtable (unpublished draft final report).

It was felt that the scale-up would provide a true test of landowner interest in SRWC. Cultural techniques, such as site preparation, planting, and tending would be tested. The method of dispensing technical advice to landowners using a combination of foresters, crop management consultants, vendors, and others was new and needed field testing and documented evaluation. Even the interaction between the various agencies involved in the United States Department of Agriculture (USDA) CRP was studied.

Not all factors could be tested. Yield was important, but because of a shortage of availability of the newest clones, maximization of yield would not be fully realized. Ultimately, sites were selected more based on environmental impact assessment than productivity. Migratory bird and a small mammal studies were begun and are still being monitored.

Alexandria was chosen for several reasons. Good land prices relative to expected productivity certainly was a factor. CRP rents averaged $40 per acre and there was a great deal of CRP
acreage. It was also helpful to have an enthusiastic DNR staff forester stationed in the area office that successfully promoted the program to landowners. Product champions have proven very instrumental and effective in developing new technologies toward commercialization.

Another good feature of the Alexandria area was the availability of alternative markets. Three major pulp and paper companies expressed interest in the wood, although at this time growers do not have contracts for their wood in hand. From a landscape perspective, Alexandria also was suitable. Historically forested, the land was generally cleared for agriculture between 1880 and 1960. Biomass crops, it was hoped, would more closely mimic the natural forest processes than soybeans and corn could.

Interest Among Landowners

To gain more information about the landowners enrolled in the Alexandria project, a survey was commissioned by the Wes-Min Resource Conservation and Development Area. Questionnaires were mailed to all CRP participants with land in the Alexandria region. Five-hundred thirty landowners representing one-sixth of the CRP acres responded. Results showed that landowners were quite interested in alternative crops. Sixty percent of the respondents indicated an interest in planting trees. About 22,000 acres were offered by owners as land they would consider for planting SRWC (Hybrid Poplar Survey, 1994).

In Oklee, farmer response was so high that only three meetings were needed to secure 10000 acres; only 3000 were needed. The difference in Oklee was that the end market and user was known a priori. In both cases, it appears that about three times as many acres were needed to select the best quality land. For every 1 acre of land needed, 3 acres would have to be considered.

The Hybrid Poplar Survey also provided some interesting fiscal information. Landowners were overwhelmingly (75%) in favor of annual payments instead of a lump sum payment up front. 65 percent of the respondents were interested in forward contracts with an end-user. Interest in joining a wood grower cooperative was expressed by about half of the respondents.

Landowners had reasons beyond economic motivation for participating. It was clear they did need to see a return on SRWC plantings, but not necessarily top dollar compared to other cropping options. The land they enrolled in the poplar program was productive but inconvenient to farm. Some land had lower productivity for corn, but acceptable fertility levels for trees. Some producers possibly were trying to reduce their workload (average survey age was 59). Some landowners sought to diversify their crop base. In some areas the heavy use of the CRP has changed the local farm economy. Not all landowners were full-time farmers. A single economic criterion is that producers must be able to market the product to users at prices they are willing to pay. Coming to terms on that price is next.

Lessons Learned

Many lessons were and still are being learned on both projects. The lessons learned will be incorporated into future plantings and projects. In fact, some of the lessons learned and knowledge gained resulted in changes during the second phase of the Alexandria project.
A key factor to ensuring success is to provide technical advice to landowners. Private sector crop consultants were utilized in Alexandria. Their knowledge of annual crops and weeds was extensive, but training was needed to better prepare them for understanding competition and release among woody crops. The DNR state forestry office, as the project leader, is now providing the bulk of technical advice in coordination with others. However, any forester or consultant getting into SRWC would need to learn more about weed control among hybrid poplar crops. The Oklee project plans to rely heavily on crop consultants in the future.

Some lessons were learned regarding environmental issues. First, environmental groups are interested in participating. Unique resources need to be protected in all planting areas. The National Biofuels Roundtable (1994) was an attempt to foster a landscape approach to solving natural resource problems. Such cooperation usually involves trade-offs and always requires higher levels and sophisticated planning and communication among stakeholders.

As an example, one tract in each of the two projects was pulled from consideration after landowner agreement, before planting, because of concern about proximity to Nature Conservancy reserves. Maps of sensitive sites have since been provided by the Natural Heritage Program. A forester's willingness to work with a stakeholder like the Nature Conservancy will be a positive attribute needed in expanding current planting scope.

In general, landscape level issues can be addressed, but benefits or negative effects on landscape are directly related to project scale. For example, a 100,000 acre project within a 50 mile radius involves less than 2% of the land base. One should look at the appropriateness of the landscape for a crop such as hybrid poplars and discuss general landscape concerns and opportunities. It is, however, impractical to actually plan and implement the best location for each field on a landscape basis, especially on private land.

Finally, immense technical information was gathered. For instance, site preparation must begin the year prior to planting. Shifting from machine planting to hand planting in most cases would permit early growing cycle cross-cultivation. Hand planting costs are similar, but the method allows rows to "checked" or marked evenly for precise placement and planting which would afford cross cultivation later. Cross cultivation is a good option to control weeds within the row.

Standards for planting stock have been established in writing and are rigorously enforced. Planting small cuttings does not afford early season drought resistance before cuttings take root.

The Biofuels Feedstock Development Program at Oak Ridge National Laboratory funded a study of the plantation effects on small mammals and birds on a subset of the Alexandria sites. The initial results clearly demonstrate that biological diversity, while best in natural forest ecosystems, is still higher on SRWC lands than on agricultural food and grain cropped areas.

**Summary and Recommendations**

Researchers are the key to technology transfer. A consortium of hybrid poplar plant material researchers has been an informal research group, partially organized by several universities, forest research laboratories and the Oak Ridge National Laboratory. The Minnesota legislature
recently approved a $200,000 grant through the Natural Resource Research Institute at University of Minnesota - Duluth. The money will be used with other partners such as the USFS Research Laboratory in Rhineland, WI to expand research related to plant breeding of hybrid poplar specific to Minnesota's soil and climatic factors. This grant requires 2:1 private sector matching funds. There are currently only 5 clones selected for their superior growing habit and viability planted on 2000 acres. As production scale planting increases, more clones need to be developed and planted in test blocks for species screening. This will provide the numbers of species that will increase the chances for adaptability on a wider variety of sites and soils and decrease the probability of an outbreak of diseases or pests. Other aspects that will continue to provide necessary production scale information are herbicide trials and environmental and landscape level studies.

The scale-up venture underscores the need to develop a pool of vendors for successful SRWC implementation. Vendors prepare sites, plant trees, tend, and harvest. They might include a subset of the farmer producers or may be comprised of existing crop service or start-up companies. They need to be trained in details such as weed identification and control. They may need specialized equipment and licenses. Some subsidies to encourage a vendor pool may be beneficial.

Not surprisingly, end users play a big role in project success. At a minimum, there has to be some viable market outlet for the wood. Scale-up and demonstration projects such as in Alexandria demonstrate that early phases of projects can rely on risk-takers and subsidies to get enough acres into the project. In the long-run, end-users must be viable and committed. Providing letters of general intent to buy wood is one method. Forward contracting is even better. The higher level of commitment greatly eases the process of involving landowners as was obvious in Oklee when recruiting of owners was achieved in just a few public meetings. Parties involved must have the perception that risk and costs are being shared among all participants.

Grower cooperatives have also been suggested for Alexandria. The cooperatives could market wood and carbon credits. Carbon and other tax credits are being considered in different areas of the country. Grower-producer cooperatives would also jointly own equipment and bid for services.

We are learning that end-users can "smell" a winner in SRWC. Traditional forest industries in Minnesota have become very interested and active based on research work originally done with energy as an end-use option. An agreement entitled “Agenda 2020”, signed November 1994 by the DOE and the American Forest and Paper Association now sets the stage for promotion of industrial growth, energy efficiency, and international competitiveness while preserving the environment. Multiple end-users assure growers of robust market viability.

The scale-up and demonstration work has been given a significant amount of media and political attention. Biomass for energy and for traditional wood products has moved from the “idea” phase to “ground-breaking” reality.

More needs to be learned. New clonal development and testing of herbicides like Quat are examples. The bird and mammal studies need to be ongoing. It is also necessary to continue scale-up to keep the momentum of the nurseries and vendors going. We believe another 5,000 acres of scale-up to further test the infrastructure of vendors, advisors, nurseries, would be
valuable. We believe the private sector is on the edge of implementing the SRWC technology using the knowledge and skills gained to date. Because scale-up projects provide actual data about successful sites, growers, users, decision-makers, and others will be able to further develop production technology and integrate end-use systems in markets.
References


