The Status of Short Rotation Intensive Culture in Minnesota

Three year old Hybrid Poplar Plantation

Minnesota Department of Natural Resources
Division of Forestry

February, 1992

Short Rotation Forestry of Hybrid Poplars

■ Office of Biomass Research ■ University of Minnesota, Crookston, MN 56716 ■

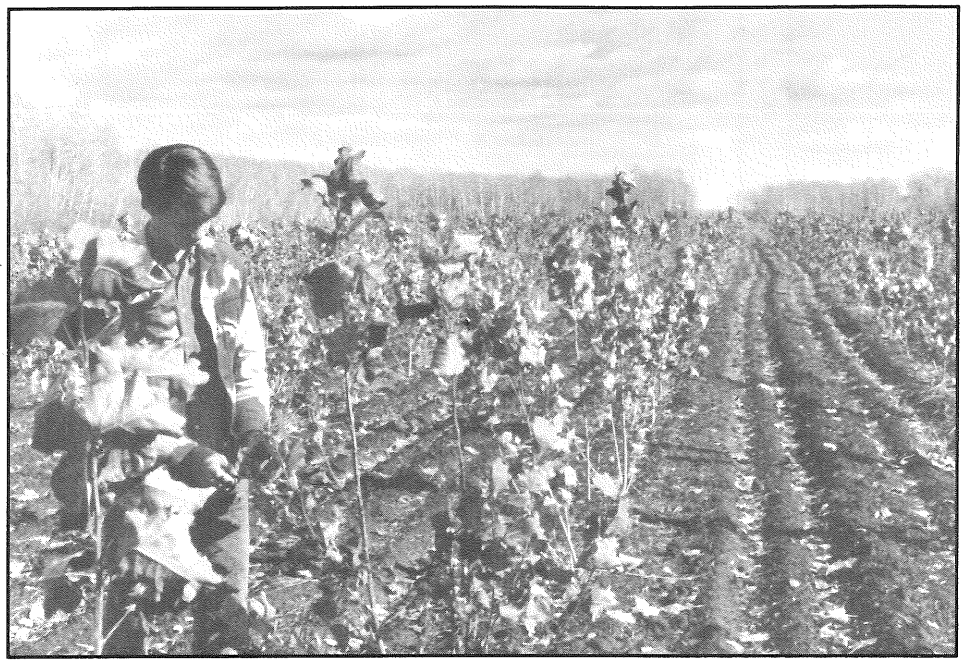


PHOTO 1 -- *Intensively managed hybrid poplars at the end of the first growing season in Norman County, Minnesota (October 1990).*

Why Plant Hybrid Poplars?

1. *To achieve higher yields through intensive management and shorter rotations.*
2. *To quickly establish protection against wind and water erosion.*
3. *To intercept nutrient runoff.*
4. *To establish wildlife habitat.*
5. *To participate in State and Federal Conservation Programs*

Growing Trees as a Crop

The development of very fast growing hybrid poplar trees makes it realistic to think about producing large volumes of wood in rotation cycles more common to agriculture than to forestry. Recent research in Minnesota has shown that hybrid poplars can be an excellent planting choice for conservation purposes or in wood farms to produce materials for fuel or wood products.

In comparison to traditional forestry, short rotation forestry includes thorough site preparation, fertilization, and careful attention to weed control. Compared to yields of 1 dry ton/acre/year in native forest stands, short rotation intensive culture (SRIC) of trees can produce 3 to 6 dry tons/acre/year.

Hybrid poplars can be an attractive cash crop for landowners, especially in areas where trees were the native vegetation or soil and drainage conditions make farming of grain or row crops difficult. Hybrid poplars have been found to be tolerant of many insects and diseases and can withstand most harsh winter conditions.

PHOTO 2 -- *These 14 ft., two-year old hybrid poplars illustrate the growth ➤ potential with good management. (October 1991). These are the same trees shown in PHOTO 1.*

Cropping Practices for Hybrid Poplars

The Choice of Land

The choice of land is always an important factor in achieving good results. Hybrid poplars will grow well under a wide range of soil characteristics. However, it has also been shown that these plants perform better when grown on more fertile soils than on poorer soils, except in areas where limitations (e.g. high pH) may reduce growth.

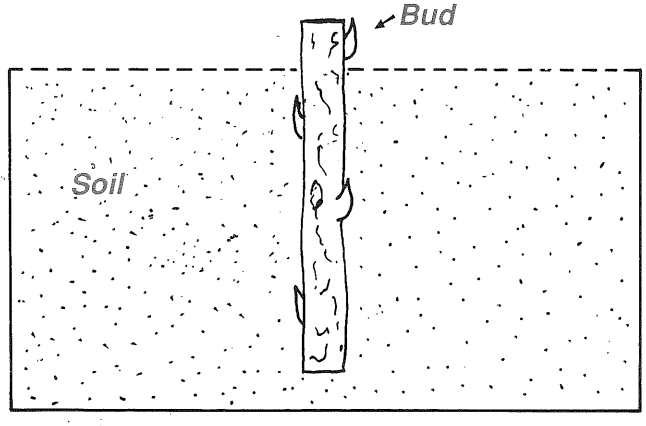
The soils selected should have good moisture holding capacity; the plants are tolerant of wet soils and may tolerate standing water for short periods of time. Hybrid poplars do not tolerate shade well and should be planted in an open area. As with other crops, soil tests for nutrients are always recommended and the advice of a specialist is essential to successful short rotation forestry.

Site Preparation

The preparation of land for SRIC is similar to that used for other common agricultural crops. A glyphosate (Roundup® or Ranger®) treatment is recommended prior to plowing. If prepared area is on erodible soil a late summer cover crop of an annual crop like barley should be planted. Spring tillage involves disking, harrowing or other cultivation, along with pre-emergent herbicide treatment (e.g. linuron -- Lorox®) in keeping with normal seedbed preparation on the site. Standard agricultural equipment can be used for these operations.

Planting

Cuttings are planted by placing them eight to ten inches deep, so that not more than 1 inch of the cutting is above ground. The cuttings must be aligned prior to planting so that the buds are pointing upward. The soil should be packed firmly around the cutting.



Small plots, such as nursery plots, can be planted by hand without special equipment. The planting of larger areas can be either by hand or with a planter which has disks to open a furrow, with a planting mechanism and packer wheels to complete the job.

A Glossary of Terms

Biomass -- the total weight of a plant material produced

Clone -- in hybrid poplars, a cutting from an original seedling plant that maintains the identical genetic character of the original ancestor

CRP -- The Conservation Reserve Program. A voluntary 10-year rental contract with the USDA that will take highly erodible land out of crop production and put it into perennial grass or trees

Cutting -- an 8" to 12" section of dormant stem section that is planted directly into the soil

Glyphosate (Roundup® or Ranger®) -- a non-selective herbicide that, when applied post-emergence, is effective on many perennial grasses and broadleaf weeds

Linuron (Lorox®) -- a herbicide giving selective control of weeds. Pre-emergence application of linuron controls annual broadleaf weeds and some grasses for a limited period of time

ODT -- Oven Dried Ton. Volume equals about one cord of wood

T -- The maximum average soil loss specified for a soil. It is the level of soil loss that may occur and still permit a high level of crop production to be obtained economically and indefinitely

Planting Stock

A key element in SRIC is found in the planting material -- commonly called "cuttings". Cuttings are from genetically identical parent trees, which replicate the superior productivity, disease resistance and hardiness of the hybrid parent plant and are called a "clone".

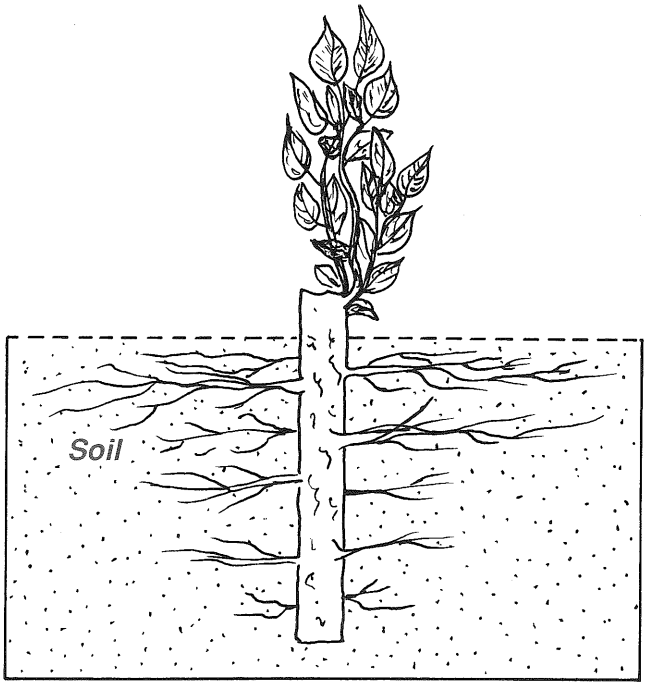
Many clones of hybrid poplar have been developed and screened under varying conditions at many different geographic locations. These tests have shown that certain clones are superior performers under field conditions. It is essential that the best suited clones be selected for the conditions in a particular area. A person familiar with planting material should be consulted in selecting the appropriate hybrids.

- **Planting densities depend on particular management objectives and wood fiber markets.**
- **Spacing of trees ranges between 3 x 1 ft. for a 3-year rotation and 8 x 8 ft. for rotations of 10 to 15 years. It requires 700 trees per acre for the 8 x 8 ft. spacing.**

Weed Control

Hybrid poplars need good weed control for the first 3 to 4 years. Once the hybrid poplar canopy is well developed, its shade is very effective in eliminating further weed competition until harvest.

Weed control may be accomplished by the use of herbicides and by cultivation. Common farm equipment can be used to perform both chemical and mechanical weed control operations. A person familiar with the application of herbicides in short rotation forestry should be consulted on the use of specific herbicides and cultivation practices to ensure good results.



Eighty percent of the young tree's rooting occurs in the top 12 inches of soil, so shallow cultivation is required to avoid root pruning. Only recommended herbicides should be applied to the soil near the trees. Some herbicides may cause stunting of root growth.

Fertility Management

Proper fertility management is as essential to successful hybrid poplar production as it is to most common farm crops. Field tests of poplars indicate a good growth response to fertilizers, particularly nitrogen.

The replacement of nutrients, removed by harvesting, may be necessary to maintain the productivity of the site. A complete soil analysis is essential to ensure that an effective fertility management program is developed for each field. Use guidelines for corn when applying fertilizer.

Soil testing is recommended after the second or third growing season to help develop a plan to supplement the existing fertility.

Planting and Care of Hybrid Poplars

Cutting Care – Do's and Don'ts

1. do keep refrigerated prior to soaking
2. do not remove from plastic bag until time of planting
3. do soak in 2-4" of water in the bags for 2-5 days prior to planting
4. do store, soak and plant cuttings with buds pointing upward
5. do keep the temperature below 70°F during soaking

Planting

1. soil must be tilled to a depth of 10-12"
2. moisture must be adequate - similar to what is needed for planting small grains and corn
3. never plant in mud or standing water
4. plant at soil temperatures above 50°F (usually same time as corn planting)
5. the furrow or hole the cutting is placed in must be large enough to prevent damage to the buds

Weed Control

1. the most successful weed control comes with good site preparation
2. if a pre-emergent herbicide is used, get instructions from a person familiar with herbicide use on young trees
3. two or three cultivations are necessary, but must be shallow, and done with care to avoid root pruning

For More Information Contact: Wendell Johnson (218) 281-6510, ext. 262

Costs of Growing Hybrid Poplar

10 yr. rotation -- 700 trees/a. -- 8 x 8 ft. spacing

Costs

Site Preparation	$20 to 66/acre
Cuttings and Planting	$95 to 125/acre
Management & Fertility	$8 to 45/acre
TOTAL COSTS	$123 to 236/acre

Some Cost Share Programs will pay 50 to 75% of establishment costs.

Some of the Hybrid Poplar Clones Screened for Minnesota

Name	Number	Characteristics
Raverdeau	DN182	• One of the fastest growing Euroamerican hybrids
Eugenei Imperial Carolina Norway	NC-5326 DN-34	• One of the best all around Euroamerican clones • Moderately fast growing • Resistant to canker • Good pH tolerance
	DN-1	• Limited experience in Minn., has only been grown at Granite Falls • has performed well in Canada and Europe
Robusta	DN-17	• Good performer with long history • Previous problems with root rot
Siouxland		• Moderately susceptible to Septoria Canker

Cooperators in preparing this bulletin:
Bill Berguson -- University of Minn. -- NRRI
Scott Erickson -- University of Minnesota
Ed Hansen -- US Forest Service
Paul Helgeson -- Minn. Dept. of Public Service
Tom Kroll -- Minn. Dept. of Natural Resources

Recommended Cropping Practices for Hybrid Poplars

Preparation	**Fall**	***Apply** -- Roundup® or Ranger® **Tillage** -- Plow -- Disc ****Plant** -- Cover crop
Year of Planting	**Spring**	**Tillage** -- Disc -- Cultivate -- Harrow **Plant cuttings** ***Apply**-- Lorox®
	Summer	**Tend** -- Two or three cultivations
Year 1 to 3	**Spring**	***Apply** -- Lorox® or other labeled herbicide
	Summer	**Cultivate**
	Fall	***Apply** -- Roundup® or Ranger®
Year 4+	**Pest Management If Necessary** *****Fertilize** -- N-P-K	

* Optional depending on conditions.
** May be necessary if soil is highly erodible.
*** Soil or tissue test prior to application.

Some of the nurseries carrying hybrid poplar planting materials:

Lee Wholesale Nursery
Fertile, MN 56540
(218) 574-2237

Dean Schumacher's Nursery
RR 2, Box 10
Heron Lake, MN 56137
(507) 793-2288

Hramor Nursery
515 9th Street
Manistee, MI 49660
(616) 723-4846

Insti-Trees Nursery
P.O. Box 1370
Rhinelander, WI 54501
(715) 282-5247

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File 3480

April 16, 1992

To Persons Interested
in Short Rotation Intensive Culture of Trees:

The attached booklet outlines the current status of Short Rotation Intensive Culture (SRIC) in Minnesota. It was created to provide a snap-shot of the present participants and situation regarding SRIC. It also outlines the general feelings of the involved professionals concerning the future of SRIC. We tried to include all interested parties. My apologies to anyone inadvertently omitted.

Short Rotation Intensive Culture is another facet of the many faces of forestry. While still new to many people, it is likely to become more familiar in the future. Naturally, the implementation of SRIC projects must consider the inter-relationships with other aspects of the environment.

With the expanding interest in SRIC, this document will help to guide upcoming decisions. I appreciate the work of the authors and those who contributed.

Sincerely,

Gerald A. Rose
Director

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Abstract

This report is an overview of the status of short rotation intensive culture forestry in Minnesota as of February, 1992. It was initiated by Gerald A. Rose, the Director of the Division of Forestry, Minnesota Department of Natural Resources, as a way to bring together the many players involved in SRIC research and implementation in the state. It will be used to guide and coordinate the expansion of SRIC from research to implementation stages.

The initial project proposal required this report to address:
- Past and current projects and the role of the DNR
- Potential impacts of SRIC in Minnesota, including:
  - Viability of SRIC species
  - Desirable scale and locations of MN SRIC projects
  - Effects on wildlife and the environment
  - Opportunities for rural development & alternative agricultural income
- Potential future projects and the roles of likely participants.

Stakeholders (see list in appendix, page 16) were interviewed regarding past and current projects, concerns, recommendations and opportunities for future development.

There is a general consensus among the key players that enough research has been done to cautiously implement SRIC on a commercial scale. The political climate appears to be favorable and cost-sharing programs are in place to help defer costs of establishment. Several agencies are actively seeking locations for SRIC-using plants.
Researchers believe that enough information is available to move into full-scale plantings, incorporating further research as it is developed. There is a good climate of cooperation and a willingness to ensure a successful project. All involved agencies and individuals would cooperate at the highest level to facilitate productive results.

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SRIC in Minnesota

I. History and Background

Poplar culture has been operational in Europe and the Middle East since the late 1600's. Hybrid poplar has been planted all across the U.S. as a landscape and windbreak tree. It is commonly cloned from cuttings and has been available for over 50 years. Records at the DNR's General Andrews Forest Tree Nursery at Willow River show production of hybrid poplar as early as 1942. This report, however, considers research in the Lake States of the past 20 years. Lake States work has been headed by Edward A. Hansen, silviculturist for the USDA Forest Service North Central Forest Experiment Station (NCFES,) Wendell Johnson, project director of the University of Minnesota's Crookston Biomass Research Programs, and William Berguson, soil scientist for the Natural Resources Research Institute (NRRI) in Duluth.

American research in Short Rotation Intensive Culture (SRIC) began in earnest in 1970 at the U.S. Forest Service North Central Forest Experiment Station at Rhinelander, WI. SRIC was seen as a possible way to grow more fiber on less land, in response to potential conflicts with increasing non-consumptive forest land uses and increasing demand for fiber. Researchers felt that optimum tree growth could be realized by borrowing intensive cultural techniques from agriculture, including the use of hybrids. Most research was done with hardwoods, particularly poplars, because of their rapid growth and ability to resprout when cut. Higher costs of initial establishment would be offset by earlier harvest and eliminating the need to replant after harvest.

Hybrid poplars are frequently planted on agricultural fields using measures such as plowing, discing, cultivating, harrowing, herbicides and sometimes fertilizers, similar to producing a small grain crop for the critical first three years of hybrid poplar establishment. In following years, though, the level of cultural practices tapers off to a much lower level than that needed for grain. A commitment to intensive plantation culture is critical in establishing a viable plantation. Foresters must become familiar with this new paradigm of "agro-forestry" to become successful in promoting SRIC to landowners. Contracted agricultural service consultants may benefit landowners during the first three years of plantation establishment.

Hybrid aspen must be considered separately as it does not require intensive culture. Shortened rotation hybrid aspen research began in Minnesota in 1965, when the first hybrid aspen were planted in a cooperative project between Blandin Paper Company and the Institute of Paper Chemistry. Chris Peterson, Blandin forester, is currently responsible for implementing Blandin's hybrid aspen program. Hybrid aspen research is led by Gary W. Wyckoff and Bailian Li at the University of Minnesota North Central Experiment Station at Grand Rapids for the Aspen/Larch Genetics Cooperative. Most research in hybrid aspen has been based on fiber growth and quality for use in the pulp and paper industry. Hybrid aspen is grown from seed but clonal selections will be propagated, as has been done with poplars, to capture additional gains in growth and

disease resistance. It is most often planted on land that was previously forested. Its management is more akin to traditional forestry than to agriculture.

Interest in SRIC intensified in 1977, when the oil embargo provided impetus for additional funding from the U.S. Dept. of Energy to consider wood as an alternative to fossil fuels. Research in Minnesota on clonal screenings and biomass cash crop development were funded by the Legislative Commission on Minnesota Resources (LCMR) as early as 1983. The motivation for applied research in Minnesota came in 1987 when Northern States Power (NSP) seriously considered whole-tree burning for power generation. Wood fuel is particularly attractive in Minnesota as there are no indigenous fossil fuel sources.

The Department of Natural Resources became involved in resource assessment to determine if adequate wood supply was available for the NSP wood-fired plants. Little wood was available from forest lands surrounding potential power plant conversion sites, so the DNR began plans for implementing large-scale hybrid poplar plantings on Conservation Reserve Program lands near one of the power plants. SRIC was seen as a viable opportunity to reduce the possibility of CRP lands returning to agricultural cropping once contract payments expired.

This report will concentrate on the use of hybrid poplars for SRIC, although other species may have some specialized niches. Hybrid aspen is not suitable for intensive culture, but is an alternative in traditional forestry applications.

II. Current Situation

- Who is involved in SRIC at this time.

Many cooperators are involved in the various facets of SRIC. During this intermediate stage of implementation, it is critical to continue using the expertise of researchers while incorporating the entrepreneurial skills of others wishing to bring SRIC from research to applied levels.

Primary researchers of SRIC in Minnesota, particularly hybrid poplar, are Edward Hansen, USFS North Central Forest Experiment Station (NCFES) at Grand Rapids, and Wendell Johnson, U of M, Crookston. Hansen began his work with hybrid poplar in 1975 as a hydrologist at USFS North Central Forest Experiment Station at Rhinelander, Wisconsin. U.S. Forest Service SRIC research in Minnesota is still managed by the Rhinelander branch of Hansen's project. Johnson has conducted applied research on siting, management and economics of SRIC since the early 1980's. William Berguson at the Natural Resource Research Institute and Mike Ostry, NCFES Pathologist, are the other principal players.

A variety of other agencies, organizations and individuals are closely monitoring research as it unfolds and wish to apply this research on the ground. NREL, the National Renewable Energy Laboratory, is seeking a location for a pilot plant to produce ethanol from SRIC plantations. The Electric Power Research Institute, EPRI, wants to site a 100

megawatt power plant requiring 50-75,000 acres of SRIC trees. AURI, the Agricultural Utilization and Research Institute, is working on marketing hybrid poplars as an alternative farm crop. MetaDynamics, Inc. has assisted in project development, funding and technology transfer, as has the state Public Service Department, Utilities Division. The Soil Conservation Service in several transition zone counties has been involved almost from the beginning through soil and site productivity evaluations. MN-DNR Wildlife, Audubon and Nature Conservancy are concerned about effects of SRIC on bird populations and grasslands, offering input on plantation locations and designs. DNR Forestry, through its involvement in the Conservation Reserve Program has potential for a major influence on acres of SRIC established on private land.

Parallel research is being conducted in hybrid aspen. Although "short-rotation," hybrid aspen needs to grow 20-30 years instead of 7-8 for hybrid poplar. It is preferred for paper and other higher quality uses. Chris Peterson of Blandin Paper Company, Gary Wyckoff and Bailian Li of the U of M are leading the research in Minnesota. The U of M is also researching larch as a shortened rotation species.

Other agencies are currently involved in SRIC research in addition to the individuals previously mentioned. The Electric Power Research Institute (EPRI) in Pasadena, California, Energy Performance Systems of Minneapolis, and the U.S. Department of Energy (DOE) Biomass Production Program at the Oak Ridge National Laboratory in Oak Ridge, Tennessee, are cooperating with the USFS North Central Forest Experiment Station in Grand Rapids in short rotation woody crops trials for energy production in the north-central U.S.

See page 16 in the appendix for a detailed list of people contacted for this report.

- **Plantation locations.**

Approximately 500 acres of hybrid poplar have been established on 20 sites in Minnesota, North Dakota, South Dakota and Wisconsin. In addition, another 500 acres of hybrid aspen has been planted, primarily in the Grand Rapids area.

- **Is it time to implement a project on a commercial scale?**

There is a general consensus among the key players that enough research has been done to cautiously implement SRIC on a commercial scale. The political climate is favorable and cost-sharing programs are in place to help defer costs of establishment. The timing seems to be right, as several agencies are actively seeking locations for SRIC-using plants. There is a good climate of cooperation and a willingness to ensure a successful project. Researchers are somewhat cautious about too rapid a scale-up of commercial plantings. They are confident, however, that enough is known to implement a program, as long as landowners are informed of potential risks in SRIC. About 20 suitable clones have been identified with negligible differences between them and new clones will certainly be developed.

Cost-sharing and annual payments are essential incentives to landowners, as there will be no return on investment for almost a decade. Guaranteed markets for the final crop must be assured so the landowner actually sees a return on his investment. The Conservation Reserve Program is not going to completely facilitate a grower program on its own merits. Perhaps the supporting agencies and companies will have to absorb the risk and cost of any potential losses, plantation failures or future markets. A project should include contract growers and creating a system of vendors to establish, maintain, and harvest plantations.

Carl Mohn, U of M College of Forestry professor, believes that the timing for implementing a SRIC project on a commercial scale is a function of the market place. The large scale successful projects, such as James River Corporation in Washington and Domtar Corporation in Ontario, were direct results of a response to a real demand and a real shortage of wood for a specific product. Because of proximity to the mills, the industries find SRIC production to be valuable. Costs are subsidized as part of their operations.

The forest products industry in Minnesota is optimistic and believes that hybrid poplars will have a place. Locally, fine writing paper manufacturers favor the properties of native and hybrid aspen, although other species could feasibly be used. Oriented-strand board (OSB) and colored paper makers foresee potential use for hybrid poplar as well as native and hybrid aspen. Hennepin Paper, a colored construction paper manufacturer, tested 100 cords of hybrid poplar in 1990. Results were quite positive, with few differences discerned between hybrid poplar and native aspen. Research has shown that it has suitable properties for many uses including OSB.

SRIC hybrid poplar, when planted within reasonable distances from aspen using industries, is expected to supplement the native aspen supply in Minnesota. While the number of acres of aspen has remained relatively constant over the past half-century, much of the aspen now growing is either very young or very old. Because of this age-class imbalance, a "shortage" of mature aspen, lasting 10-15 years, is expected to occur within the next decade. The shortage will disappear as younger aspen matures. During this anticipated aspen shortage, the forest industry will have to compete for available aspen and incorporate other species to help fill the need for fiber. Paper manufacturers can pay higher prices for wood than OSB companies, as there is more profit in paper. OSB and fiberboard producers, therefore, are already beginning to use a mixture of species in addition to aspen. They expect hybrid poplar to be satisfactory for their products.

The ideal next step in the on-going research is to plant 1000 acres in a township-sized area, in larger scale plantations of at least 40 acres. The soil and site relationships could be studied under an operational-scale basis. The data collected would be applied in the next step of thousands of acres. If the political and economic climate is favorable, however, researchers believe that enough information is available to move into full-scale plantings, incorporating further research as it is developed. All involved agencies and

individuals would cooperate at the highest level to facilitate a successful project or projects.

Please see page 33 in appendix: Hybrid Poplar Plantation Network compiled by Hansen.

III. Issues to Consider

- Concerns regarding the introduction of exotic species, insects and disease, conversion of farmland to woody crops, effects on wildlife, water quality or other environmental issues.

While there are many positives regarding SRIC, there are negative factors as well. Disease problems have been prevalent throughout the history of hybrid poplar development. Susceptibility to disease is a primary reason for eliminating clones from consideration early in clonal screening research. Many hybrid poplar clones are particularly prone to Septoria canker, but most clones in common use today are relatively resistant. Hansen points out that Lombardy poplar, a hybrid, has a history of 50 years use in this country without severe problems. Potential for catastrophic disease is the primary justification for recommended planting of several clones per site. Because hybrid poplars are cloned and therefore genetically identical, disease problems could easily eliminate an entire plantation if only one clone or species were planted as a monotype. As research continues, more resistant varieties can be expected.

Mike Ostry, principal plant pathologist for the North Central Forest Experiment Station is considered to be the foremost authority on diseases of hybrid poplars. He states that he has seen too many plantings fail because clones were planted that were either not adapted to the site, poorly tended, or highly susceptible to diseases. He states that they now have a much better understanding of the potential insect and disease problems that can arise in plantings, including the conditions that increase tree vulnerability to pests, and the level of resistance to various diseases among clones. Hansen states that Septoria canker is the most severe disease problem. It is extremely important that clones planted are resistant to pests and have been tested on a wide range of sites. SRIC forestry has high establishment and maintenance costs, so risk must be minimized.

Any single-specie plantation of trees could be considered a monotype. Hybrid poplar plantations, with identical genetic composition and required clean cultivation, are more deserving of this label. On a broad scale, however, even though individual hybrid poplar plantations may be considered monotypes, they would add diversity to some landscapes since few forests or woodlots exist in the agricultural areas targeted for SRIC plantings. Many agricultural areas offer little permanent vegetation for shelter; these plantings may offer oases to some species of wildlife. Approximately 2 million acres are currently enrolled in CRP grasslands. If the targeted 50-75,000 acres of SRIC are actually planted, it would amount to less than 4% of the CRP lands; a minor impact on the landscape. Border plantings of shrub and tree species favoring wildlife would help augment monoculture plantations.

Nationwide goals are to reduce acreage of cropland. Converting corn acres to SRIC results in less energy use, less fertilizer use and more erosion protection. SRIC is a much lower intensity form of agriculture than row crops. SRIC would also help to decrease food surpluses and increase domestic renewable energy supplies. Landowners must be aware, however, of Integrated Resource Management goals and minimize SRIC plantings in or near grasslands and prairie areas.

Janet Green of the Minnesota Audubon Council is concerned about biodiversity. Undisturbed grasslands, including native prairie, old pasture and CRP, are one of the rarest habitat types in Minnesota. CRP incentives to convert cropland to grasslands were a great boon to prairie animal species. DNR non-game wildlife managers report increased numbers of animals such as burrowing owls which were quite rare a decade ago. Audubon, therefore, does not want grass converted to trees, even though the grass may be plowed under once CRP payments end. They are also concerned that planting hybrid poplar in riparian woodlands in agricultural areas and in other natural aspen or hardwood stands would create a monoculture, reducing habitat and species diversity. Hybrid poplar, with its requirements of clean cultivation at establishment, could not feasibly be planted in wooded areas. Hybrid aspen, however, could. Wildlife managers should be consulted before attempting site conversions to hybrid aspen.

Wildlife managers are also concerned about introducing tree plantations into an otherwise agricultural or grassland landscape. According to John Schladweiler, DNR Non-Game Specialist at New Ulm, there is potential for degradation of existing grasslands by introducing large monotypes of poplar. He says "The Section of Wildlife does plant woody cover plantings that may also degradate these [grassland] areas, but their small size, diversity of species and winter cover benefits provide major benefits to resident wildlife species." They are concerned that native bird and animal species are not well adapted to hybrid "exotics" and that trees would interfere with nesting and feeding patterns. CRP grasslands have had a positive impact. DNR Wildlife, the Minnesota Department of Agriculture and others are developing a Prairie Stewardship Partnership to determine Integrated Resource Management goals for the transition and prairie regions. While SRIC has a place in these areas, plantation siting must be coordinated with IRM goals.

Schladweiler offers the following recommendations to make SRIC plantations better suited to wildlife:

1) Avoid SRIC within 1/4 mile of any grassland, wetland, Wildlife Management Area or waterfowl production area.
2) Avoid SRIC within 1/2 mile of Scientific & Natural Areas, Nature Conservancy land or other hi-quality prairie.
3) Include or recommend a 2-4 acre 10-row shelterbelt to provide permanent winter cover and/or shrub planting around perimeter to increase diversity & provide travel lanes.
4) Avoid SRIC within 100 feet of ditches, streams or rivers to avoid beaver problems.

If these criteria cannot be met, then Schladweiler advises foresters to inform landowners of IRM goals and that the Section of Wildlife has some concerns. Grasslands need to be very large to be of benefit for wildlife. Managers believe that grasslands fragmented by SRIC will not be as beneficial as large contiguous areas. Birds to benefit most from SRIC plantations are common or pests: red wing blackbird, cowbird, grackle, great horned owl, species that are doing very well and do not need additional habitat. Wildlife managers would like some safeguards against planting in what they consider the wrong locations. In addition, short rotation management offers little chance for developing dead and down material, favorable to many wildlife species. The DNR Section of Wildlife will provide input on specific projects as they develop, according to Wildlife Chief Tim Bremicker.

The Oak Ridge National Laboratory is providing $50,000 for an environmental impact study and the Audubon Society another $35,000 for the study of birds and small mammals as part of Hansen's on going research.

Wildlife managers prefer native tree species over hybrids as they believe that wildlife species are better adapted. Audubon expresses a concern about the potential of crossing native aspen and hybrid poplar; introducing exotics into the gene pool. This is not expected to be a problem. According to E.J. Schreiner, 1970, Lombardy poplar, a hybrid, was first introduced in North America in the 1780's and has been widely planted since then for windbreaks and landscaping. These are no longer exotic new genes in the U.S. In addition, hybrid poplars are of the black poplar section (ie.: balsam poplar, cottonwood,) most often European black poplar and native cottonwood. Aspen is a white poplar, a different genetic section which does not cross with black poplars. While a hybrid poplar could feasibly cross with native cottonwood or balsam poplar, it is unlikely that the seed would become established and mature to seed-producing age. Were such crosses likely, Lombardy poplar crosses would commonly be seen. Seed-origin cottonwood, balsam poplar or aspen stands are extremely rare today. It is highly unlikely that any seed produced from a hybrid would find favorable conditions to germinate and reproduce.

Soil nutrient depletion has been expressed as a concern. According to Paul Helgeson, a major factor is whether the leaves are left at harvest time, as much Nitrogen is found in the leaves. We should be comparing nutrient needs of SRIC plantations to the needs of other agricultural crops since ag lands will most often be planted. Ed Hansen states that hybrid poplars require less nutrients than corn; in fact, excess nitrate leaching is a potential problem early in establishment when the trees are small and using little Nitrogen from the soil. According to Hansen, the real limiting factor is moisture: water tables, water holding capacity of the soil, and precipitation. Hybrid poplar is known to use large quantities of available water and can actually lower water tables. Initial research by Hansen indicates a significant amount of plantation water table level draw down. This can be considered in a positive or negative light according to local site conditions. (see page 36 by Hansen) Wetter sites throughout the transition zone are ideal. Rick Pierce, DNR forester in Alexandria, believes that as long as adequate moisture is available, a lighter soil such as a sandy loam may be preferred because there is less weed competition and fewer mud problems to hamper cultivation.

Soil erosion from surface runoff during the first years of SRIC establishment needs to be addressed. Clean cultivation of hybrid poplar plantations is critical for establishment during the first few years and the potential for surface runoff exists during this period. Contour grass strips would reduce the impact on erodible sites. Once the tree crowns have closed in, no cultivation is needed, surface runoff is minimal and the net effect will be positive. Better water quality should result compared to annual crop farming.

- Where should or shouldn't projects be located?

Researchers agree that it is critical to select the appropriate site for a SRIC project. Each site must be evaluated for soil suitability, moisture availability, as well as for proximity to wildlife lands, possible markets, etc. Plantation establishment is relatively costly and a yield must be reasonably certain. Wildlife considerations must be incorporated as well as Integrated Resource Management goals for the landscape.

The majority of people interviewed believe that SRIC projects should be located within the prairie-forest transition zone on lands once forested but now in agricultural fields. This area includes counties where CRP is most active. Good soil moisture and climatic precipitation shows a positive relationship for increasing plantation growth. For example, the area between Mora and Long Prairie offers many potentially good sites for SRIC plantations.

Since transportation is a major market cost factor, another consideration would be to locate near existing wood using industries such as Hennepin Paper Co. at Little Falls or Northwood Panelboard at Solway. A large scale power generating plant could consume fiber from 50,000 to 100,000 acres of plantation within a 50 mile radius.

Conservative estimates project yields of 3-5 dry tons/acre/year with a potential of 6-7 dry tons/acre/year. Dry hybrid poplar would constitute approximately 1 cord per ton. Rotation age is determined by the size of wood needed by the market. For "pulpwood" size material, rotations of 6-12 years would be required. Larger sizes would require longer rotations, up to 15-20 years. No plantations have been held this long, however. The few older-aged hybrid poplars in existence are in rows or windbreaks, not plantations. Maximum length of rotation is a function of resistance to disease and stress.

Socio-economic conditions must be considered as well. Projects should be located where landowners and foresters understand the growing techniques. It can not be over emphasized that the first three years of establishing a plantation involves an intensity of farming between that of growing corn and oats. Ostlie considers contracting of corn and soybean producing land for SRIC to be economically feasible. A large scale project of 50 - 100,000 contracted acres would widen the horizon of where the project could be located.

Hybrid aspen plantations are established more in accordance with traditional forest management practices. The best planting opportunities are to convert low quality northern hardwood stands on good sites. Although the growing conditions may be good, these stands are often of poor growth and form due to a stand history of high-grading

or fire. Standard plantation establishment, costing about $200/acre, includes harvest of the existing stand, fallow for a year or two to allow resprouting, spray herbicides (Accord, Garlon, or Arsenal) to eliminate existing vegetation, disk trench, and plant hybrid aspen seedlings at 500-600/acre. The plantation would be allowed to grow with little further release as aspen is fairly sensitive to herbicides. Hybrid aspen matures in 20-30 years, producing approximately 40 cords of merchantable wood per acre.

Plantations of native cottonwood, or other moisture-tolerant species such as willow or silver maple, on flood-prone crop land along major river bottoms presents another opportunity. Planting operation and rotations would be similar to hybrid poplar. Similar projects have been successfully implemented by forest products industries such as James River and Westvaco. Benefits of improved water quality, forest products and long-term retirement of erodible crop land would be realized from this practice.

See SHORT ROTATION FORESTRY OF HYBRID POPLARS by the Office of Biomass Research University of Minnesota, Crookston, page 37 in appendix, or DNR Hybrid Poplar Cover-Type Guidelines, page 24.

- Appropriate size for a project.

If SRIC plantations are to be grown for an eventual market of some sort, then plantations must be of a commercially operable size. Researchers generally agree that 10-20 acres should be the minimum, with 40-80 acres preferred. Plantations must be of a size that can be effectively established and managed. A total of 1,000 acres would be large enough to analyze operational and managerial aspects, providing information that would reduce future mistakes on larger scale projects. 1000 - 4000 acres per year could be feasibly established, potentially increasing to as much as 10,000 acres per year. A 50,000 to 100,000 acre project within a 50 mile radius is possible. There are a total of 5 million acres within a 50 mile radius; 100,000 acres is only 2% of the total land mass.

- Recommended species or varieties, and species availability.

Approximately 20 clones of hybrid poplar have been identified that show good potential for disease resistance and growth characteristics. Individual clones have unique attributes: some are more drought resistant, some have better form, etc. Approximately 500 acres of SRIC production is now in Minnesota, plus another 130 acres of experimental research plantations.

According to research, hybrid poplar offers the best productive potential, although other species may be used in border plantings for diversity. Hybrid aspen, suitable for less intensive shortened rotation forestry, is not as suitable for "agro-forestry" use because it is more sensitive to herbicides. Suitable hybrid poplar clones, from the Hybrid Poplar Cover Type Guidelines from the DNR - Division of Forestry's Forest Development Manual, include DN 1, DN 17 (Robusta), DN 34 (Eugenei, Norway, Imperial), DN 182 (Raverdeau), I 45/51 and Siouxland (a cottonwood cultivar). On-going research is advancing rapidly and clonal recommendations may change.

Hybrid poplars resprout from the stumps when harvested, eliminating the need for replanting. Because of new clones, however, Hansen states that it may be economically feasible to replant today's established plantations after a 10 year rotation. There are newly tested clones that show greater growth and disease resistance than some planted just a few years ago.

As new clones are developed and tested, the research community will have to advise the division on which varieties to propagate and their specific site requirements. Stool beds of certified clones have been established for Hansen at the General Andrews Forest Tree Nursery to provide cuttings for larger scale production.

Species other than poplar have also been grown in SRIC plantations. Willow, cottonwood, silver maple, green ash, black locust, boxelder and alder have all shown some promise. University of Minnesota forestry professor Carl Mohn favors the use of cottonwood because of climatic adaptability and resistance to disease. He feels that native cottonwood would offer fewer long term problems and more flexibility in rotation lengths. The October 9, 1991 Cottonwood Conference, organized by Harold Dickinson of Olivia, addressed the potential of large scale cottonwood plantations along the Minnesota River Valley watershed area. In 1992, General Andrews Nursery obtained native cottonwood cuttings from river bottoms in southeast Minnesota sufficient to raise approximately 50,000 rooted cuttings.

Perhaps other tree species will be found suitable for SRIC as research continues. Further work is needed with these species to identify suitable varieties and growing conditions.

- **Supply of nursery stock in the public and private sectors.**

According to the January 1992 survey of major suppliers (see page 33) approximately 885,000 10-inch unrooted cuttings of suitable hybrid poplar varieties are available from private nurseries. Approximately 320,000 rooted cuttings are also available. With a one year notice, 1.8 million unrooted cuttings could be generated. With a two year notice, the supply could increase to over 7 million. The state nurseries at Badoura and General Andrews have sold 86,000 rooted cuttings as of January 1992. With a one year notice, 400,000 unrooted cuttings could be produced from the state nurseries alone.

Nursery managers will produce an adequate supply of stock to fill demand if required amounts are firmly contracted for in advance. Enough stock is currently available to plant over 1000 acres in 1992. In 1993, there could be enough to plant over 3000 acres, and in 1994 there could be enough to plant 10,000 acres. These figures are based on utilizing present cultural methods to produce 10-inch cuttings of 3/8 inch to 3/4 inch diameter.

Clonal material could also be produced by plant tissue culture methods, as done in greenhouses or by Kathryn Louis' MinnVitro Laboratory in St. Paul.

The supply of hybrid aspen is currently limited, as stock must be grown from seed produced by the U of M Aspen/Larch Genetics Cooperative. Seed availability will increase as new production techniques meed demand.

- What is the best use for SRIC produced wood?

Research on the uses of SRIC wood has been conducted since the mid-1970's, almost concurrently with research on growing SRIC plantations. SRIC wood has been tried in most traditional wood uses and several non-traditional products, including cattle feed and chemical extractives. William B. Hauserman, for instance, project manager at the University of North Dakota's Energy & Environmental Research Center in Grand Forks, recently researched converting SRIC poplar to fuel slurry or hydrogen. Another new use is ethanol production. NREL, the National Renewable Energy Laboratory in Colorado, is seeking three sites nationwide for an ethanol plant. Such a facility would use approximately 3000 acres of hybrid poplar and switchgrass as feedstock to distill ethanol alcohol for fuel. Ethanol has traditionally been made from grain such as corn, but energy input to grow corn is about equal to the energy output of the alcohol. Ethanol produced from SRIC grown trees, however, contains about 5 times the energy that was needed to grow the trees; a net gain. Length of rotation and tree spacing is determined by specific end use. Most common uses, however, are energy from direct combustion and fiber.

Energy plantations were first conceived during the oil embargo in the 1970's. Hardwoods such as black locust were to be grown for residential and commercial firewood. Today, most SRIC energy plantations are expected to be used either for ethanol production or direct combustion. L. David Ostlie, former Northern States Power engineer and founder of Energy Performance Systems, Inc., has developed a system for drying and burning entire trees for electric power production and is seeking to site a plant.

For wood or fiber uses of SRIC trees, several factors must be considered. Juvenile wood, rapid growth, and degree of bark will affect quality. Use of SRIC wood in composition products such as Oriented-Strand Board (OSB) is very promising, but SRIC used in pulp products is more complex. Due to short rotations, SRIC trees are almost entirely juvenile wood, with shorter fibers with thinner cell walls. Juvenile fibers do not intersect as much as longer fibers, but collapse flatter than older fibers to provide a large surface area for bonding, compensating to producing an acceptable paper. Color may be a factor, though, depending on the species grown in SRIC. Whole tree harvesting introduces high percentages of bark. Although the bark is young and thin, it will reduce yields and increase pulping and bleaching costs, making it unacceptable for some uses. Grit should be minimal since SRIC plantation wood is generally not skidded.

Some varieties of hybrid poplar are not considered to be well suited for fine writing paper due to darker color. However, clones can be selected for color characteristics and several fine paper companies, such as James River, are using hybrid poplar. The paper industry in Minnesota would rather use pine and spruce or other hardwoods such as birch, aspen or maple rather than poplar. Hybrid aspen is being developed primarily for

this industry. Hybrid poplar has been shown to work well in coarser textured or colored paper.

One advantage to SRIC wood is uniformity. Plantation grown trees of similar or identical genetic stock can be expected to have similar fiber characteristics, minimizing processing errors and improving yield and efficiency. Clonal selection can target certain characteristics for specific end products to further improve yield and efficiency. Transportation costs can be reduced by locating plantations near existing processing plants. Both James River and Domtar pulpmills use SRIC hybrid poplar and cottonwood grown on plantations located close to the mills on rotations of 7 to 10 years.

Because of uniform smaller size stems, harvesting equipment can be downscaled. James A. Mattson, North Central Forest Experiment Station in Houghton, Michigan, points out that the size of the tree will play a role in harvesting technique. Stems larger than 5 inch diameter can be harvested with conventional logging equipment, whereas smaller trees would be harvested with specialized equipment still in the research stage, similar to corn pickers or combines. Two to three year old willow plantations in Sweden are commercially harvested for fuel chips using comparable machinery.

Hybrid aspen, as stated earlier, is grown primarily for high quality pulp and paper, although it would certainly be suitable for solid-wood or composition products.

Additional benefits of SRIC plantations, regardless of final market for wood, is conversion of previously plowed land to trees. This function in itself provides benefits in erosion control, water and air quality. End-use markets offer a financial incentive for the grower.

- **Realistic potential returns on investments for SRIC plantations.**

To be successful on a large scale, landowners must be guaranteed annual income from land used for SRIC. Any project must have a means of contracting, paying, and vending plantation establishment and maintenance.

Several economic studies have been done by Dave Lothner, USFS economist, Charles Strauss, Pennsylvania State University, and others. As with most other forest management activities, growing hybrid aspen has a good internal rate of return without any subsidies or cost-share payments. Hybrid aspen does not require intensive culture. In SRIC plantings, however, there is no financial incentive for taking cropland out of production without CRP or other cost-sharing. There is simply too much time elapsed before a return on the investment is realized. Cost sharing such as CRP, ACP, FIP, or SIP is essential to provide the landowner with a financial incentive for the intensive plantation care that is crucial to successful plantation establishment. An end-user such as a power plant, pulpmill, or ethanol plant may need to contract with the growers to ensure a feed stock resource, providing adequate compensation for land to be converted to SRIC. Landowners should receive an annual return from SRIC that is comparable to other agricultural crops.

See Short Rotation of Hybrid Poplars, page 37, for costs and revenues.

- Is there a better term to use than "SRIC"?

Most of the research sector is comfortable with the term SRIC, feeling that it is familiar and descriptive. To catch on with the public sector, though, some imaginative marketing may have to be employed. Some ideas to date: wood farming, agro-forestry, short rotation forestry, short rotation woody crops, rapid wood, rocket trees, fastwood, agrowood, or agrotrees. It is important to promote SRIC on its merits and advantages, not on a slick or catchy name.

IV. How to Accomplish

- The role of the DNR in the implementation of an effective program.

The consensus of individuals surveyed is that DNR Forestry should act as coordinator for implementing a SRIC program, particularly considering the potential of CRP lands as planting sites. DNR Forestry's Private Forest Management program offers the network needed to promote an effective program. DNR foresters are adept at writing management plans. They can also perform data gathering and interpreting to assure that multiple use objectives and Integrated Resource Management goals are included in decisions.

The DNR should deliver the program to the landowner, cooperating with as many partners as it can, such as Agriculture Stabilization Conservation Service (ASCS), Soil Conservation Service (SCS), Soil and Water Conservation Districts (SWCD), Resource Conservation & Development Projects (RC&D), Legislative Commission on Minnesota's Resources (LCMR), private companies and others.

The DNR is the technical agent for the cost-sharing programs and as such adds credibility to a project. The DNR must promote the growing of SRIC while avoiding too firm a connection with any particular commercial project which may fail. A key role would be to promote multiple land stewardship benefits of SRIC lands and multiple product use such as biomass, pulp, livestock bedding, or solid wood products. Alternate uses for SRIC grown wood could also be promoted.

- The role of the state tree nurseries.

The state nurseries are producing stool beds of important hybrid poplar clonal varieties under the direction of Edward A. Hansen. The state nurseries provide an early critical role in scaling up of volumes of stock from research to commercial numbers. State nurseries could scale up commercially if deemed feasible by state policy, but DNR State Nursery Coordinator Miles Wiegand stated that the primary goal is to provide plant material to private nurseries. If private nurseries cannot meet the demand for planting stock, then the DNR should help fill the void.

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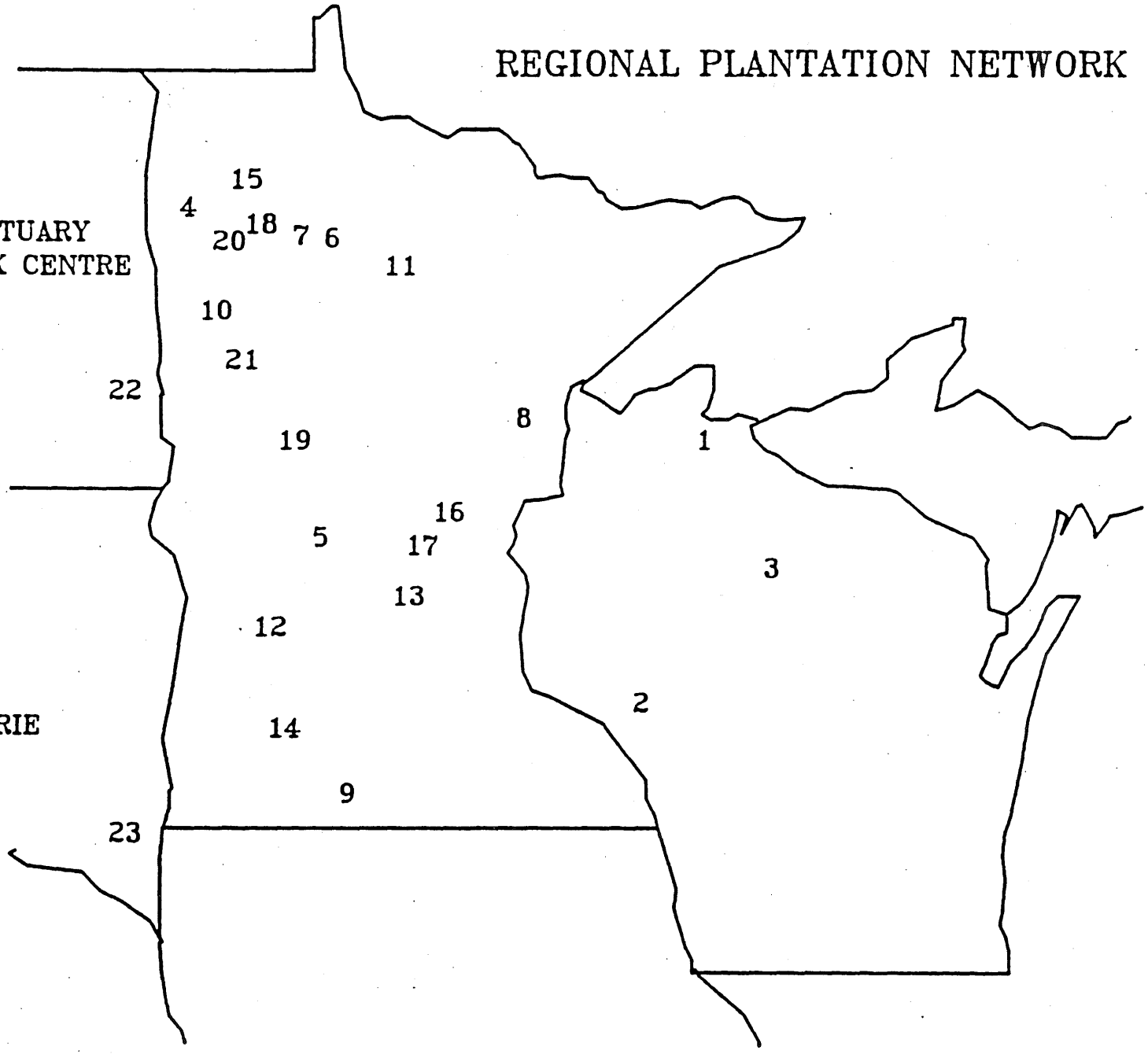
REGIONAL PLANTATION NETWORK

KEY

1 ASHLAND
2 MONDOVI
3 RHINELANDER
4 AUDUBON SANCTUARY
5 BELGRADE/SAUK CENTRE
6 BEMIDJI
7 CLEARBROOK
8 CLOQUET
9 FAIRMONT
10 GARY
11 GRAND RAPIDS
12 GRANITE FALLS
13 HOWARD LAKE
14 LAMBERTON
15 MIDDLE RIVER
16 MORA
17 MILACA
18 OKLEE
19 PARKERS PRAIRIE
20 PLUMMER
21 ULEN
22 FARGO
23 SIOUX FALLS



HYBRID POPLARS

Cover Type Guidelines

MANAGEMENT OBJECTIVES

Manage these stands for high yields of wood fiber. Yields should be in the range of 3.5 to 6 cords/acre/year. Pulpwood or fuelwood are the most likely products. Intensive culture is necessary. Therefore, committed landowners and suitable sites are required. Consider the stand's effect on habitat and habitat improvement.

RECOMMENDED HARVEST SYSTEMS AND ROTATIONS

Harvesting will be accomplished by clearcutting all stems at rotation age.

Rotation ages are not certain at this time. Plan on 10 to 15 years, although the harvest may be delayed as long as trees show net growth. Harvest or destroy affected clones if serious insect or disease damage occurs.

PEST CONSIDERATIONS

Hybrid poplars are at greater risk to diseases and insect pests because all trees of a given hybrid poplar clone are genetically identical. Therefore it is very important to actively avoid pest problems since a serious outbreak will damage or eliminate the clone. Selecting tested clones is the most effective tactic. Poplar clones listed below are suited for the entire state of Minnesota. Planting blocks of different clones will also reduce the potential for pest problems to eliminate an entire plantation. Finally, don't forget to monitor growing stands for insects and disease.

Suitable Clones (Do not recommend untested clones.)

DN 1
DN 17 (Robusta)
DN 34 (Eugenei, Norway, Imperial)
DN 182 (Raverdeau)
I 45/51
NE 19
Siouxland (A cottonwood cultivar)

PREFERRED SITE CONDITIONS

Proper site selection and weed control are critical for success. Since most of the suitable sites are in traditional farming areas, good soil surveys are usually available. Use the following guideline to eliminate soils which are not suitable. This implies that most farm soils are suitable for hybrid poplar.

RECOMMENDED REGENERATION SYSTEM

PLANTING: Choose the site carefully. Prepare the site to agricultural standards. Plant blocks of as many approved clones as are available. Intensive site preparation and weed control are a must to assure establishment and early growth. Plant 400 -700 trees per acre.

PLANTING STOCK: Unrooted cuttings are acceptable in most cases. Soak the cuttings lower half in 50-70 degree water for 2-5 days prior to planting. Plant when corn is being locally planted. Plant the cutting with buds up and leave less than 1 inch exposed. Planting with a slight slant is acceptable. Rooted cuttings are used on drier sites and where weed control may be more difficult.

Time	Activity	Cost/acre (estimated)	
Year 1			
Fall	Spray glyphosate	$ 20	1 qt./acre
	Plow	$ 12	At least 8" deep.
	Disc	$ 6	
Year 2			
Spring	Disc or cultivate	$ 6	
	Harrow	$ 4	
	Buy cuttings 550/acre	$ 83	(unrooted price)
	Plant cuttings 550/acre	$ 55	
	Spray linuron	$ 25	1-2 lbs/acre
Summer	Cultivate	$ 5	Shallow - Avoid
	Cultivate	$ 5	cutting roots!!
Fall	Spray glyphosate	$ 20	1 qt./acre
Year 3			
Spring	Spray linuron	$ 25	1-2 lbs/acre
	Cultivate	$ 5	
	Fertilize N-P-K	$ 25	As needed
		$296.00	Total cost/acre

STUMP SPROUT MANAGEMENT: Following harvest, hybrid poplars will usually stump sprout. Trees over 15 years often sprout less. When stump sprouts are the method of regeneration, thin the sprouts to the best 1 to 3 stems before the second growing season begins. Select vigorous sprouts, originating low on the stump.

CULTURAL PRACTICES

Linuron or Lorox is a labeled pre-emergent herbicide that may control weeds for 6 weeks. Apply 1-2 lbs./acre before bud break or weed germination. After the herbicide loses effectiveness, regular cultivation is essential and must be less than 2 inches deep to avoid root damage.

When the recommended practices shown above are used to establish the trees, there should be little need for weed control after the third year. Fertilizer management should be based on soil tests and should concentrate on nitrogen.

WILDLIFE CONSIDERATIONS

Hybrid poplar plantations are used by a limited number of wildlife species such as deer, fox, robins, blackbirds, grackles, and morning doves. Great horned owls also use the trees to hunt adjacent farm and prairie lands. Whenever possible, plantations should be modified to improve winter habitat, preferably by including 4 or more rows of conifers and fruiting shrubs on the leeward side. Adding the conifers will provide habitat for additional species including pheasant, rabbit, and many songbirds such as chickadees, goldfinches, juncos, and redpolls.

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USE THIS GUIDELINE TO EVALUATE SOILS.

Obtain a Soil Conservation Service (SCS) Soil Interpretations Record (portion below) for each soil in the proposed planting site.

MN0155 SOIL INTERPRETATIONS RECORD

MLRA(S): 103, 90, 102A
REV. HLH,CS, 6-87
AQUIC HAPLUSTOLLS, FINE-LOAMY, MIXED, MESIC

NORMANIA SERIES

THE NORMANIA SERIES CONSISTS OF MODERATELY WELL DRAINED SOILS FORMED IN GLACIAL TILL ON UPLANDS. THE SURFACE SOIL IS BLACK AND VERY DARK GRAY LOAM 17 INCHES THICK. THE SUBSOIL IS DARK GRAYISH BROWN LOAM IN UPPER 9 INCHES AND OLIVE BROWN LOAM IN LOWER 10 INCHES. THE SUBSTRATUM IS GRAYISH BROWN AND GRAY LOAM. SLOPES RANGE FROM 0 TO 5 PERCENT. MOST AREAS ARE USED FOR CROPLAND. (A)

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-17	L	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
0-17	CL	CL	A-6	0-5	95-100	90-100	80-100	60-80	30-40	10-15
17-26	L, CL	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
26-60	L, CL	CL	A-6, A-4	0-5	90-100	85-100	80-90	55-80	30-40	8-15

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-17	22-27	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	-	MODERATE	.24	5	6	4-8	HIGH	LOW
0-17	27-32	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	-	MODERATE	.24	5	6	4-8		
17-26	22-32	1.30-1.40	0.6-2.0	0.17-0.19	6.6-7.8	-	MODERATE	.24					
26-60	22-32	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	-	LOW	.32					

(B) (C) (D) (E) (F)

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT) (H)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			2.5-6.0	APPARENT	MAR-JUN	-		>60		-		B	HIGH

(G)

	Best Conditions	Unacceptable Conditions
A. Narrative	Well and moderately well drained. Soils commonly used for cropland.	Excessively, very poorly, and poorly drained soils. Soils with a described calcareous layer or high free carbonates within 30".
B. Clay (%)	Less than 40% in the surface soil.	More than 40% in the surface soil.
C. Moist Bulk Density	< 1.4; Lower numbers indicate loose, porus, friable soils.	> 1.7; Higher numbers indicate possible hardpan, perched water table, and restricted rooting.
D. Available Water Capacity	> 10" of water in top 60" of soil. (NOTE: Multiply the factor by the depth of each layer and sum all.)	< 6" of water in top 60" of soil. (NOTE: There are 11.0-12.5" of water in top 60" of example soil.)
E. Soil pH	pH = 5.5 - 7.5 in rooting zone.	pH > 8.0 or < 4.5 in upper 40".
F. Organic Matter (%)	> 3%. Higher values mean higher fertility.	< 1%
G. Flooding	None or briefly in spring.	Frequent, long duration flooding.
H. High Water Table	3 to 6 feet is ideal.	> 10 feet or < 1 foot.

northwood panelboard company

A Partnership Managed by Norbord Industries Inc.
Route 1, Box 123, Solway, MN 56678 • Phone 218-751-2023

January 20, 1992

Mr Jeff Edmonds
615 Anne St
Bemidji MN 56601

Dear Jeff:

With this letter, I would like to re-emphasize Northwood Panelboard's support of SRIC (Short Rotation Intensive Culture) forestry.

Three to four years ago, Northwood Panelboard was supportive of the SRIC program even though we used only Aspen in our process. The reasons at that time were: a) present and proposed expansions of the forest industry, creating a greater demand on all existing wood species; b) projected wood demand in Minnesota 10 to 15 years down the road, when SRIC plantings would be reaching harvestable ages; c) the need in our specific industry (OSB) to begin utilizing other species; in the future, since paper mills have an economic advantage to compete for preferred species.

All of these reasons are more valid today than they were three to four years ago (i.e.: plant expansions in the last three years; including Potlatch/Bemidji which was not a proposed expansion three years ago).

I believe it is time to reinforce forestry in a truly agricultural setting (where it should be). Marginal farm land can create environmental advantages by producing trees, and at the same time provide economic return, especially with CRP payments as a jump-start.

Jeff, let me know if I can be of assistance, and please keep me informed.

Sincerely,

Jim Haffner
Procurement Forester

JCH:jml
Enc.

Hennepin Paper Company

P.O. Box 90, Little Falls, Minnesota 56345 • (612) 632-3684 • 1-800-328-8520

July 9, 1990

Mr. Gerald A. Rose
Director, Division of Forestry -
Minnesota Department of Natural Resources
The Lake States Forestry Alliance
265 Metro Square
Saint Paul, Minnesota 55101

As you may know, Jerry - -

- - Hennepin Paper Company agreed in January of 1989 to conduct a full machine trial using hybrid poplar in conjunction with the D.N.R.. Hennepin Paper Company stipulated that it required 100 cords in order to conduct a trial. During 1989 approximately 60 cords were collected by D.N.R. sources, and the balance was received in June, 1990. Although Hennepin Paper Company paid a premium for these cords, it is expected that future shipments will be at competitive pricing.

The machine trial began during the first shift on Monday, July 2, 1990, and continued until approximately 4:00 a.m. on Wednesday, July 4, 1990. From all indications and tests, there appears to be little difference in the performance of hybrid poplar from the standard poplar being consumed.

Runability through the wood plant from the debarker to the stock preparation area, appears to be similar, although the wood received in 1989 did not debark as well. This could be attributed to age since the wood received in 1990 debarked acceptably.

Runability on the paper machine was acceptable. Strength of the hybrid poplar appears to be as high or higher than the standard poplar, so there was no requirement for additional chemical pulp additions to maintain sheet strength for either runability or customer expectations.

Lab test reports are as follows:

STANDARD POPLAR		HYBRID POPLAR	
Mullen	4.4 to 5.9	Mullen	6.1 to 7.8
Freeness	110 to 140	Freeness	140 to 150
Brightness	56 to 68	* Brightness	48 to 52

* Although brightness is lower than expected, this may have been an indication of the age of the wood.

The strength range as measured by the standardized Mullen test had a higher range than traditionally expected. If replicated in future trials, this could be a definite advantage.

The machine performance was acceptable on a range of grades from 40# to 72# (24 x 36 basis).

To recap, Jerry, the performance of the trial throughout the plant was acceptable. There were no surprises, and the machine ran to expectation producing a product readily consumable by our current customers. If you or your staff have any questions, or you feel that we may assist you in any further way, Jerry, please do not hesitate to let us know.

With warm personal regards,

Sincerely yours,

Robert Strasburg /de

Robert Strasburg
Executive Vice President
General Manager

de

cc: Tom Kroll
Department of Natural Resources

Georgia-Pacific Corporation

Industrial Wood Products Division
280 Nymore Beach Road N.E.
P. O. Box 518
Bemidji, Minnesota 56601
Telephone (218) 751-5140

January 28, 1992

Mr. Jeff Edmonds
DNR Forestry
615 Anne Street NW
Bemidji, MN 56601

Dear Mr. Edmonds:

Our company does not own any forest lands in this area so we are not involved in any SRIC or other reforestation projects locally.

My personal opinion is that SRIC should be further developed. I believe timber is currently being harvested at a rate which justifies the expansion of "Hybrid" projects and also more intensive development of better "re-growth" practices.

Sincerely yours,

Gary Wilson
Office Manager

PARTIAL LIST OF COMMERCIAL SOURCES OF HYBRID POPLAR
IN THE LAKE STATES
1992

Orville Lee
Lee Nursery
Fertile, MN 56540
218-574-2237

Schumacher's Berry Farm
Heron Lake, Minnesota 56137
507-793-2288

Don Selinger
Bailey Nurseries, Inc.
1325 Bailey Road
Newport, MN 55055
612-459-9744

Neil D. Nelson
Insti Trees Nursery
P. O. Box 1370
Rhinelander, WI 54501
715-369-2801

Bill Heckrodt
W. 5409 Mielke Road
Menasha, WI 54952
414-734-9455

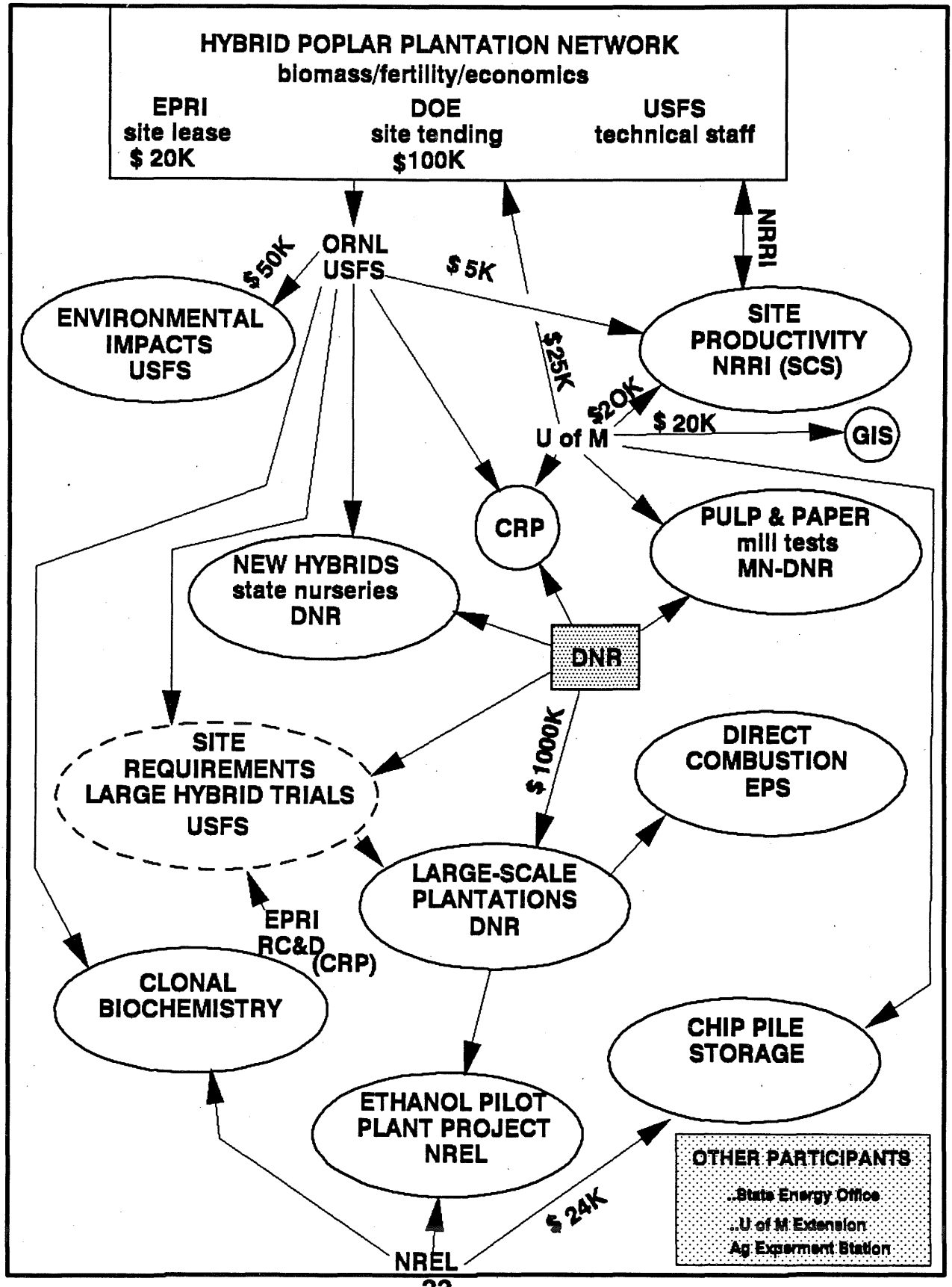
Michael and Priscilla Morin
Hramor Nursery
515 9th St.
Manistee, MI 49660
616-723-4846

Pat McGovern
Timber Valley Nursery
629 Lynch St.
Grand Rapids, MI 49509
616-459-4023

Van's Pines
P. O. Box 733
West Olive, MI 49460
616-399-1620

Mike Hradel
Cold Stream Farm
2030 Free Soil Road
Free Soil, MI 49411
616-464-5809

Greg Morgenson
Lincoln-Oakes Nurseries
Box 1601, Bismarck, ND 58501
701-223-8575


HYBRID POPLAR PLANTATION NETWORK
biomass/fertility/economics
EPRI
site lease
$ 20K
DOE
site tending
$100K
USFS
technical staff
NRRI
$50K
ORNL
USFS
$ 5K
ENVIRONMENTAL
IMPACTS
USFS
SITE
PRODUCTIVITY
NRRI (SCS)
$25K
$20K
$ 20K
U of M
GIS
CRP
PULP & PAPER
mill tests
MN-DNR
NEW HYBRIDS
state nurseries
DNR
DNR
SITE
REQUIREMENTS
LARGE HYBRID TRIALS
USFS
$ 1000K
DIRECT
COMBUSTION
EPS
LARGE-SCALE
PLANTATIONS
DNR
EPRI
RC&D
(CRP)
CLONAL
BIOCHEMISTRY
CHIP PILE
STORAGE
ETHANOL PILOT
PLANT PROJECT
NREL
$ 24K
NREL
OTHER PARTICIPANTS
..State Energy Office
..U of M Extension
Ag Experment Station

Key to Abbreviations

AURI ..... Agricultural Utilization and Research Institute

CRP ..... Conservation Reserve Program

DNR ..... Minnesota Department of Natural Resources

DOE ..... U.S. Department of Energy

EMRC ..... Energy & Mineral Research Center

EPRI ..... Electric Power Research Institute

EPS ..... Energy Performance Systems, Inc.

GIS ..... Geographic Information System

IRM ..... Integrated Resource Management

LCMR ..... Legislative Commission on Minnesota Resources

MN-DNR ..... Minnesota Department of Natural Resources

NCFES ..... North Central Forest Experiment Station

NREL ..... National Renewable Energy Laboratory

NRRI ..... Natural Resource Research Institute

NSP ..... Northern States Power Co.

ORNL ..... Oak Ridge National Laboratory

OSB ..... Oriented Strand Board

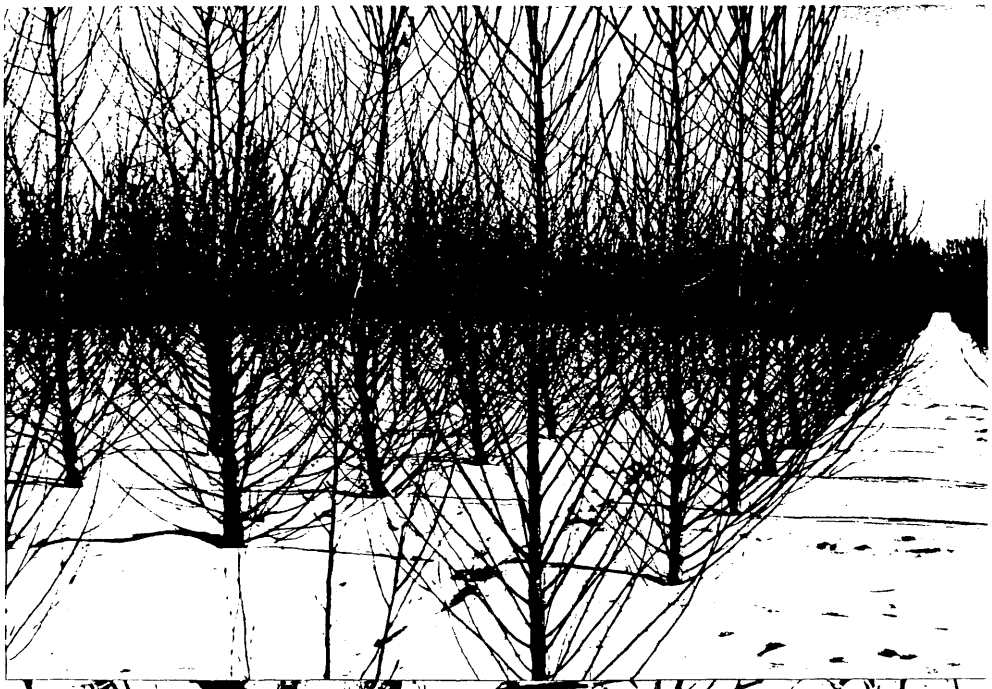
RC&D ..... Resource Conservation & Development

SRIC ..... Short Rotation Intensive Culture

U of M ..... University of Minnesota

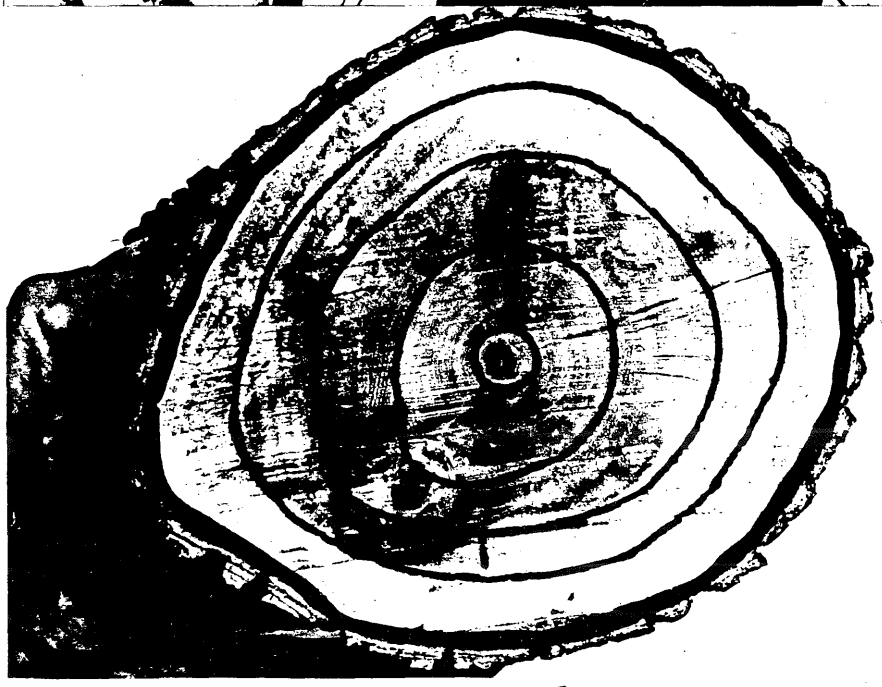
USDA ..... U.S. Department of Agriculture

USFS ..... U.S. Forest Service



Hybrid poplar plantation after 3 years growth. Planted 1989, Milaca, MN.

Five year old hybrid poplar. Planted 1987, Milaca, MN.



Cross-section of five year old hybrid poplar grown at Milaca. (growth rings delineated for visibility.)

MILACA, MN

County:
Mille Lacs

Location:
1987 plantation is 2 miles northeast of Milaca on Highway 23, then 3/4 mile north on 101 (gravel road). The planting is 1/2 mile in back of Gustafson house. Access though their yard.

1989 plantation is located 1/4 north of the 1987 plantation. Access can also be made by continuing north 1/2 mile past Gustafson driveway on 101 then left at intersection for 1/4 mile, just past mailbox turn left, follow field road 1/4 mile south to planting

Legal Description:
A field in the SW1/4 of the NE1/4 of Section 19, Township 38 North, Range 26 West, Mille Lacs County, MN.

Land Owner/Manager:
Richard and Lois Gustafson
Route 1, Box 257
Milaca, MN 56353

612-983-3652

Site History:
1987 site-a hay field harvested annually thru 1985, used as a cow pasture in '86. Hay not harvested in '86.

1989 site-a hay field of timothy and alfalfa harvested annually thru 1987.

Soil Series:
Milaca

Texture:
Silt Clay

Crop Equivalent:
42

Site Preparation:
1987 plantation: Roundup was applied 10/6/86. Moldboard plowing 11/10/86. Note: To finish plowing, two tractors, one pulling the other, were required because of extremely wet conditions. Entire site except NW corner was disked and Lorox L (2 lbs/ai/acre) applied 4/87.

1989 plantation: Roundup at 1 lb/ai/acre was applied 5/89 followed by light rain. Site was moldboard plowed and disked 5/89. Lorox at 2 lb/ai/acre applied following planting

Planting Dates:
4/27/87 and 5/9 & 5/11/89

Acreage Planted:
1987-9 acres
1989-3.3 acres

Figure 4. Watertable depression under the Milaca plantation.