FINAL REPORT

EVALUATION OF LAND SUITABILITY AND PRODUCTION ECONOMICS OF HYBRID POPLAR PHASE I AND II

By

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INTRODUCTION

The purpose of this project is to assess the suitability of land to support hybrid poplar and cottonwood (poplar) plantations to produce wood for a 100 megawatt Whole Tree Energy™ facility. The land suitability project is divided into two phases with analyses increasing in specificity in successive phases. The objective of the first phase of the study was to conduct analyses of the soils resource and landowner characteristics within selected units on a multi-state scale. Information was gathered for Phase I on land and climate suitability and Conservation Reserve Program acreage in the states of Wisconsin, Minnesota, the extreme northwestern portion of Upper Michigan and northeastern Iowa.

The purpose of Phase II studies was to summarize land rent and yield data. Cash flow models of the production system were then used to integrate land rent and yield estimates to evaluate wood production costs. Estimates of biomass production costs within the study units were made using various state and federal cost-share options.

PHASE I: EVALUATION OF THE SUITABILITY OF SOILS AND CLIMATE FOR POPLAR PRODUCTION

DESCRIPTION OF THE SOILS DATABASE

The database used in this study is the 1982 National Resource Inventory (NRI) produced by the U.S. Soil Conservation Service (SCS). The NRI is an inventory of rural, nonfederal lands with emphasis on characterization of soil suitability for agriculture. The NRI was used by the DOE Short Rotation Woody Crops Program in previous analyses of land suitability for Short Rotation Forestry in the U.S. (Graham 1992).

The NRI differs from a county-level soil survey in that it is a point sampling inventory and not an exhaustive survey of all farmlands. Because of the point-sampling method used in the NRI and the survey intensity, use of these data are most appropriate for studies on a multi-county scale or larger. After review of other soils information, I felt the NRI was the most appropriate information for purposes of the current study. Although the NRI dataset describes soil characteristics in general terms, this dataset was suited for Phase I analyses because it contains information on land use, is referenced to counties, and provides uniformity in analysis across the entire study area.

STATSGO soil databases were also evaluated for use in this project. STATSGO data contains more detailed soils information than the NRI. However, summarization of soil acreage by counties or specific regions cannot be done without integration of all databases in a GIS environment. Also, land use data are not included in the STATSGO database. These can be obtained from a variety of sources at an additional cost. The STATSGO information may be applicable in more intensive analysis of selected areas. Given these considerations, the decision was made to use the NRI for Phase I and II of the study. NRI data were obtained through the cooperation of the University of Tennessee at Knoxville.

The NRI describes general soil characteristics broken down by three major land use classes: crop, pasture, and forest. Soils information includes the mapping unit identification (allows relation to other non-NRI soils information), surface soil texture, erosion risk, slope, land capability class, previous cropping history and the acreage that a particular soil represents in that county. Over 83,000 NRI sampling points are located in the study area.

Because growth of hybrid poplar and cottonwood plantations is expected to be heavily dependent on water availability, the Phase I analysis focussed on evaluation of land suitability using soil water availability and other criteria such as land use and the SCS land capability class (an index of productivity for agricultural crops) as suitability criteria.

DESCRIPTION OF THE STUDY AREA

In order for the soils suitability study to be geographically compatible with studies of the wood resource on existing forests, the analyses were done within the U.S. Forest Service Forest Inventory and Analysis (FIA) unit boundaries with some of the survey units in Minnesota divided into smaller subunits. Division of some of the FIA units was necessary to provide a more detailed evaluation of soil suitability within the units. The Prairie and Central Hardwood units in Minnesota were considered too large to provide the necessary detail desired in this study. As a result, the Prairie unit was divided into three subunits and the Central Hardwoods unit was divided into two subunits. A total of 174 counties are included in this study. Seven counties in the extreme northeastern corner of Iowa (referred to as the IOWA-NE unit) and eight counties in the western half of the Upper Peninsula of Michigan (referred to as MI-WUP) are included in the study. The survey units and subunits used are shown in Figure 1.

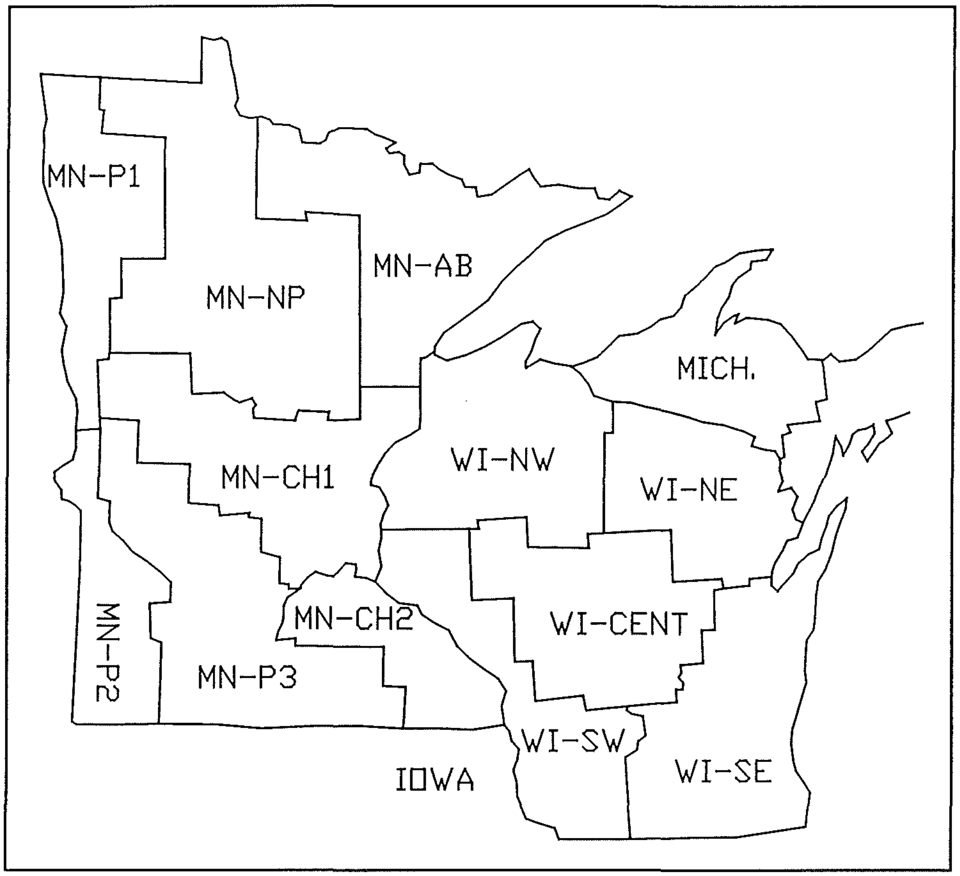

Figure 1.--Forest Inventory and Analysis (FIA) units and subunits used in Phase I analyses.

LAND USE CHARACTERISTICS OF STUDY UNITS

Land use is an important consideration in establishment of poplar plantations. Plans for plantation establishment do not include conversion of currently forested land. Therefore, the appropriate landbase for poplar plantations is land that is currently in crop or pasture. Some of the forest land is not included in this study due to public ownership of forest land in the northern areas of the study region. Because plantations will not be established on forest land, the underrepresentation of forest land does not impact this study. A detailed analysis of forest lands is being done in a companion EPRI project evaluating the existing wood resource. Table 1 shows the distribution of land use compared to total land area surveyed in the study areas.

A total of 63,670,600 acres are included in the study area with crop, pasture, and forest land comprising 57 percent, 11 percent, and 32 percent of the land area, respectively. As expected, land use varies considerably among the study units. The aspen-birch and northern pine units of Minnesota (MN-AB, MN-NP), the northeast and northwest units of Wisconsin (WI-NE, WI-NW), and Michigan have the highest proportion of land in forest cover. These units have limited potential for establishment of poplar plantations although they contain existing forests from which wood can be procured in the short-term. Land use cannot be completely separated from land productivity. Those soils that are productive for agricultural crops were generally converted to agriculture. Land unsuitable for agriculture crops remain forested. It should be noted that the NRI data was collected in 1982 prior to the Conservation Reserve Program. As a result, some of the acreage listed as cropland in this study has been subsequently converted to permanent grass cover.

SOIL PRODUCTIVITY

One of the most important characteristics relative to hybrid poplar production is the inherent soil productivity. Plantation yields are directly affected both by location (climate) and productivity of the soils. The general term "soil productivity" is expressed in the NRI dataset using the SCS Land Capability Class (LCC). The LCC provides an indication of the suitability of a soil for a particular crop and limitations on crop management. Although the LCC is determined both by the inherent productivity and management considerations, as a general rule those soils having a high productivity rating for agricultural production will also be those that are suitable for hybrid poplar production. Suitability of some soils for hybrid poplar production depends on drainage. Soils lower in productivity for agricultural crops due to poor drainage may be suitable for poplar production. However, soils rated low in productivity for reasons of excessive drainage will not be suitable sites for hybrid poplar. Yield data from the USFS/UM network of plantations indicates that relatively high yields of hybrid poplar can be obtained on soils rated low in productivity from the standpoint of traditional agricultural management due to poor drainage. Plantation yields at Milaca, Minnesota are among the highest in the plantation network but the LCC is low due to poor drainage.

Table 1.--Acreage distribution and percentage of crop, pasture, and forest land by survey unit.

Unit	Crop	Pasture	Forest	Total Acreage	% Crop	% Pasture	% Forest
IOWA-NE	1,671,300	287,600	303,500	2,262,400	74%	13%	13%
MI-WUP	122,100	123,700	3,060,800	3,306,600	4%	4%	92%
MN-AB	244,300	153,600	1,901,400	2,299,300	11%	7%	83%
MN-CH1	3,269,500	1,166,500	1,444,800	5,880,800	56%	20%	25%
MN-CH2	2,200,800	439,000	562,900	3,202,700	69%	14%	18%
MN-NP	1,914,800	597,100	2,564,900	5,076,800	38%	12%	51%
MN-P1	4,110,900	347,400	358,300	4,816,600	85%	7%	7%
MN-P2	3,244,400	322,200	15,600	3,582,200	91%	9%	0%
MN-P3	7,947,900	458,200	218,400	8,624,500	92%	5%	3%
WI-CENT	2,350,500	801,400	2,343,200	5,495,100	43%	15%	43%
WI-NE	709,000	220,800	2,253,000	3,182,800	22%	7%	71%
WI-NW	1,035,900	485,700	2,894,900	4,416,500	23%	11%	66%
WI-SE	4,617,400	606,100	763,800	5,987,300	77%	10%	13%
WI-SW	2,685,800	1,157,400	1,693,800	5,537,000	49%	21%	31%

The SCS land capability classes are described below:

Description of Land Capability Classes

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitation that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have limitations impractical to remove that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

The acreage of land in each of the Land Capability Classes was calculated (Table 2). Although analyses were done using all capability classes, it is expected that the land base to be used to the greatest extent for hybrid poplar will be Class II and III lands. Related to this, the average land capability class of soils weighted by acreage in the Conservation Reserve Program in Minnesota is 3.0 (calculated from data in Taff 1993). This indicates that land available for future hybrid poplar plantations will likely be in the Land Capability Classes II and III with some in Land Capability Class IV.

Table 2.--Acreage by SCS Land Capability Class (LCC) and the weighted average LCC (weighted by acreage) of the study units.

Unit	LCC I	LCC II	LCC III	LCC IV	LCC V	LCC VI	LCC VII	LCC VIII	WtAv LCC
IOWA-NE	77,100	981,800	672,400	205,500	30,200	120,500	102,700	0	2.96
MI-WUP	3,100	69,000	102,200	20,700	16,800	25,400	8,600	0	3.36
MN-AB	0	153,300	136,200	71,200	10,400	9,300	17,500	0	3.09
MN-CH1	143,200	1,964,100	1,029,200	862,300	83,600	263,800	89,300	500	2.98
MN-CH2	175,600	1,317,900	717,800	214,200	40,600	87,400	80,000	6,300	2.71
MN-NP	0	1,115,200	681,700	566,900	12,300	111,600	24,200	0	2.96
MN-P1	56,900	3,042,800	794,100	491,300	4,000	49,800	19,400	0	2.45
MN-P2	522,900	2,380,400	475,100	52,900	12,400	93,300	29,600	0	2.17
MN-P3	1,192,200	5,191,900	1,660,200	198,800	41,600	84,700	34,600	2,100	2.18
WI-CENT	11,600	1,304,700	791,500	585,300	36,500	368,300	52,500	1,500	3.21
WI-NE	15,300	443,200	225,500	170,400	12,500	54,600	8,300	0	2.91
WI-NW	20,300	804,100	345,600	133,400	31,400	166,500	20,300	0	2.96
WI-SE	315,700	3,200,300	927,100	386,200	20,800	304,700	63,500	5,200	2.58
WI-SW	69,300	1,088,800	952,400	979,000	33,700	476,800	221,700	21,500	3.58

SLOPE

Land slope is important because it affects plantation establishment and management. On steeper slopes, management practices are needed to prevent soil erosion and control losses of fertilizer or other agricultural chemicals through runoff. Although steep slopes do not preclude plantation establishment, these lands will require more sophisticated establishment practices such as grass strips or alternate cultivation methods compared to management practices on more level terrain. A slope cutoff of 10 percent was used to show differences between the study units. Both crop and pasture land were included in this analysis (Figure 2).

Some striking differences are evident among the study units with respect to slope. Approximately 40 percent of the Wisconsin SW unit's land area is greater than or equal to 10 percent slope followed by the IOWA-NE unit with 27 percent of land area in that category. The Minnesota CH2 unit also has a large area of steeply sloping land in the southern part of the unit. The remaining units have proportionately less acreage of steeply sloping land.

CONSERVATION RESERVE PROGRAM ACREAGE

The amount of acreage enrolled in the Conservation Reserve Program (CRP) is an important factor in assessment of the potential of an area for poplar production. The CRP is a program in which farmers remove land from agricultural production in exchange for annual payments and cost-share for establishment of permanent cover. The overall goal of the program is to remove highly erodible land from production. As such, a portion of the land parcel must meet predetermined erodibility criteria before being accepted into the program. Establishment cost-shares are 50 percent of the cost of establishment with annual payments paid on a bid basis. In most areas the CRP annual payments are comparable to the payment that a farmer would receive if the land were rented to another farmer.

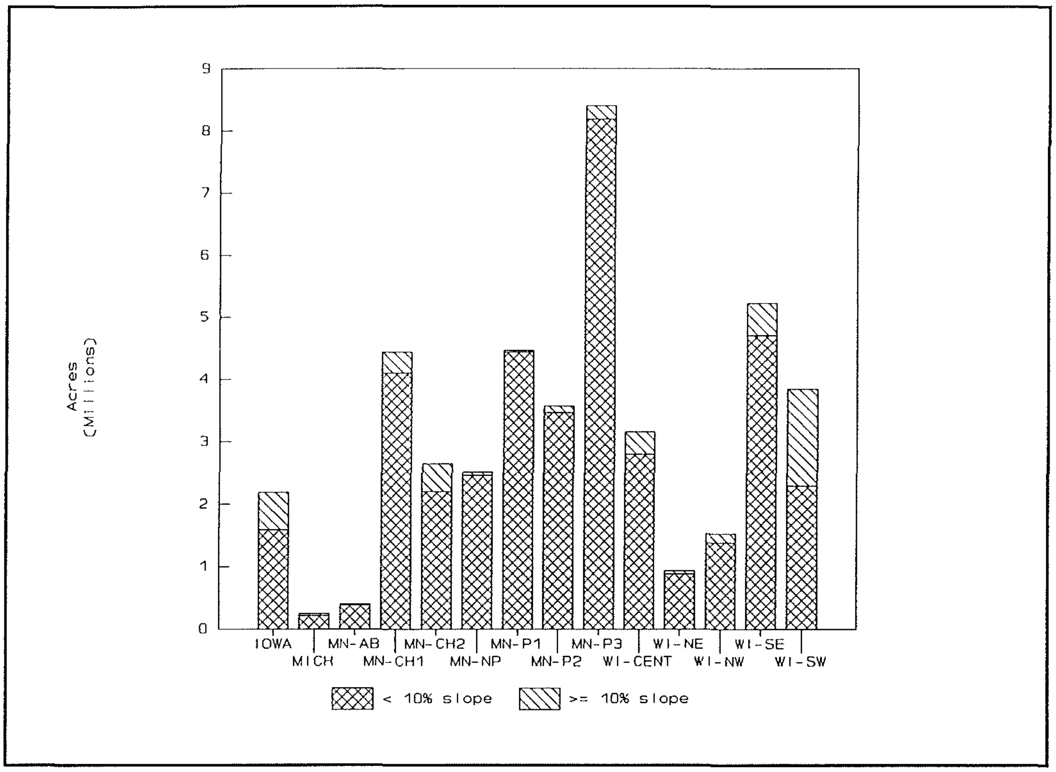

Figure 2.--Crop and pasture land acreage above and below a 10 percent slope cutoff.

The CRP program was done in stages with twelve sign-up periods beginning in 1986 and continuing through 1992. The majority of the CRP acreage across the study region was enrolled during the period 1986 through 1988. As a result, most of the acreage will be coming out of the ten year sign-up period in 1996 through 1998 (Figure 3). Only data for Minnesota are shown in Figure 3 but CRP sign-ups in other states follow a similar pattern over time. Farmers have the option to extend current CRP contracts an additional five years if trees are planted. A discussion of the CRP funding levels, cost shares and impacts on production economics is presented in the Phase II section of this report.

A very small percentage of CRP acreage has been planted to trees. Table 3 shows CRP acreage in the study areas. A total of 1.78 million acres are enrolled in the CRP in Minnesota, 683,195 in Wisconsin, 204,376 in the IOWA-NE study area, and 382 in the Michigan study area. The P1 area of Minnesota has the highest percentage of CRP acreage followed by the Iowa study area and the CH2 and P2 units of Minnesota.

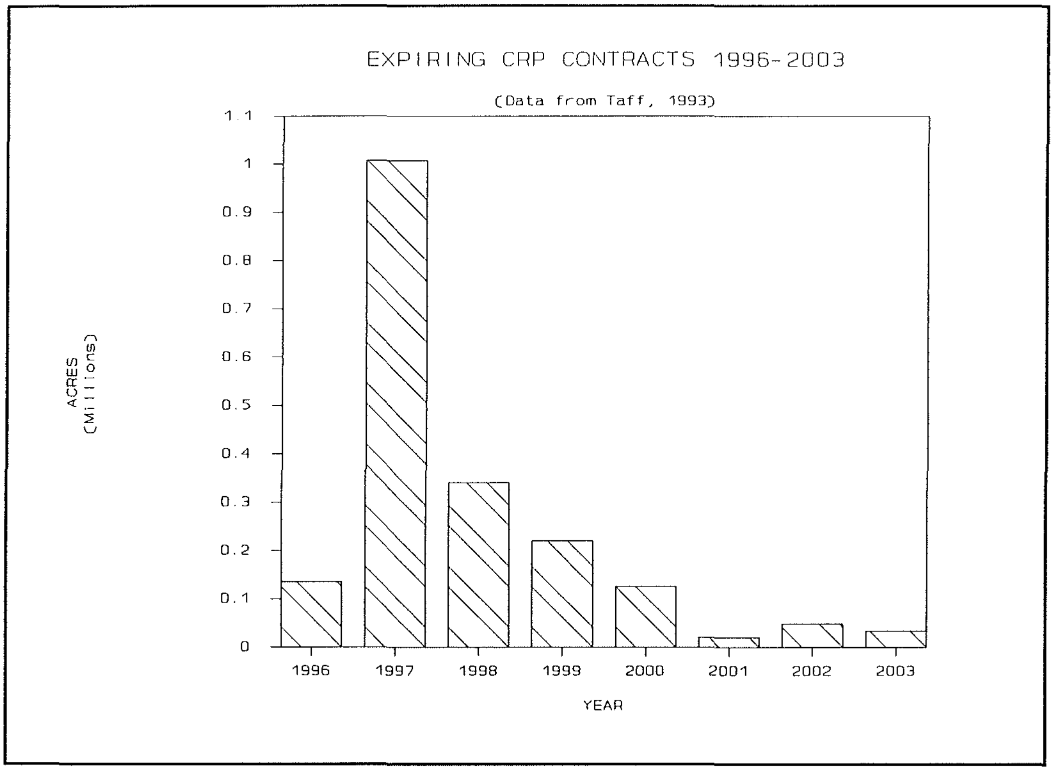

Figure 3.--Acreage of expiring CRP contracts 1996 through 2003 in Minnesota (Taff 1993).

CLIMATE

The analysis was done summarizing county-level information for average growing degree days (GDD) in Table 4, average precipitation in inches during the growing season which include the months of May through September and an index estimating water availability calculated by dividing precipitation by GDD and standardizing these to the mean value (Water Index). This provides a means to preliminarily compare the relative risk of drought stress among units. As might be expected, the extreme southwestern unit of Minnesota is the driest with a relative ranking of 0.81. Also, the more northerly units show less evaporative demand relative to growing-season precipitation. Of the heavily cropped areas, southwestern and southeastern Wisconsin appear to have the most available water relative to estimated evaporative demand primarily because of higher rainfall in the easterly regions of the study area.

Table 3.--Acreage of land enrolled in the CRP, total crop and pasture acreage, and percentage of CRP in the study units.

Unit	Total Acres	CRP Acres	% CRP
IOWA-NE	1,958,900	201,376	10.3%
MI-WUP	245,800	382	0.2%
MN-AB	397,900	2,945	0.7%
MN-CH1	4,436,000	211,977	4.8%
MN-CH2	2,639,800	207,841	7.9%
MN-NP	2,511,900	196,768	7.8%
MN-P1	4,458,300	594,054	13.3%
MN-P2	3,566,600	222,113	6.2%
MN-P3	8,406,100	345,425	4.1%
WI-CENT	3,151,900	78,955	2.5%
WI-NE	929,800	24,099	2.6%
WI-NW	1,521,600	25,575	1.7%
WI-SE	5,223,500	243,439	4.7%
WI-SW	3,843,200	311,127	8.1%

SOIL AVAILABLE WATER CAPACITY

The ability of the soil to hold moisture is an important soil characteristic affecting tree growth. Available water capacity (AWC) is defined as the amount of water that is held between field capacity (the maximum amount held against gravity) and the wilting point. Available water capacity is primarily a function of the distribution of silt, sand, and clay in the soils, referred to generally as soil texture. Surface soil texture was coded into numerical AWC values using SCS published data and NRRI analyses of laboratory data provided by the University of Minnesota, Department of Soil Science. The weighted average AWC was calculated with the AWC being weighted by acreage in each unit (Figure 4). Those units having the highest AWC are located in the IOWA-NE unit, southern Wisconsin and the CH2 unit of Minnesota. Based on this criteria, the four areas having the lowest AWC are the Michigan Unit, Minnesota-Aspen/Birch Unit, Wisconsin-Northeast Unit and Minnesota-Northern Pine Unit.

Table 4.--Summary of GDD, average May through September, precipitation, and estimated water availability index.

Unit	Average Growing Degree Days	Average Precipitation (inches)	Water Index
IOWA-NE	2593	20.1	0.94
MI-WUP	1744	18.5	1.29
MN-AB	1860	17.6	1.15
MN-CH1	2225	17.6	0.96
MN-CH2	2360	18.7	0.96
MN-NP	1979	16.1	0.99
MN-P1	1956	14.3	0.89
MN-P2	2390	16.0	0.81
MN-P3	2394	17.6	0.89
WI-CENT	2146	18.7	1.06
WI-NE	1905	18.5	1.18
WI-NW	2042	18.7	1.11
WI-SE	2220	18.4	1.01
WI-SW	2329	19.2	1.00

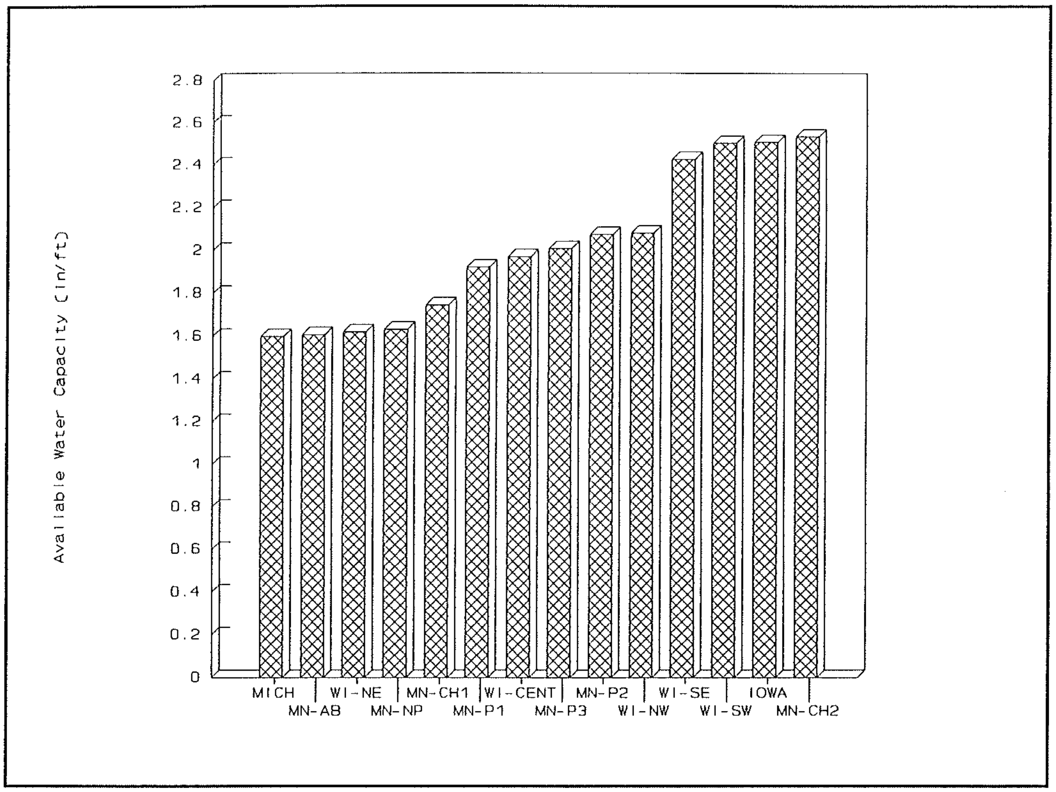

Figure 4.--Weighted average available water capacity of soils in the study regions.

SUMMARY AND CONCLUSIONS: PHASE I

Table 5 summarizes soil and land use characteristics of the study units. Based on these characteristics, the more northerly units of the study area; the MN-Aspen Birch Unit, MN-Northern Pine Unit and the MI-Western UP Unit have less potential for plantation production due to lower quality soils and the relatively low percentage of agricultural land. The Prairie units in Minnesota and the Wisconsin-Southeast unit are characterized by high quality soils. However, drought risk in the MN-P2 unit is likely to be high, making specific site selection for poplar plantations more critical. This will limit the amount of acreage available for poplar production within that unit. These factors as well as land rent and production economics will be considered in the Phase II studies.

Table 5.--Summary of selected characteristics of units studied in Phase I analysis.

Unit	Average Land Capability Class	Proportion of Land with Slope > =10%	Available Water (in/ft)	Proportion in CRP
IOWA-NE	2.96	0.28	2.51	0.0900
MI-WUP	3.36	0.11	1.60	0.0001
MN-AB	3.09	0.03	1.61	0.0010
MN-CH1	2.98	0.08	1.75	0.0360
MN-CH2	2.71	0.17	2.53	0.0640
MN-NP	2.96	0.02	1.63	0.0380
MN-P1	2.45	0.00	1.92	0.1240
MN-P2	2.17	0.03	2.07	0.0620
MN-P3	2.18	0.03	2.01	0.0400
WI-CENT	3.21	0.11	1.97	0.0140
WI-NE	2.91	0.05	1.62	0.0070
WI-NW	2.96	0.09	2.08	0.0050
WI-SE	2.58	0.10	2.43	0.0400
WI-SW	3.58	0.40	2.50	0.0560

PHASE II: ANALYSIS OF LAND RENT, YIELD AND PRODUCTION ECONOMICS

INTRODUCTION

As a result of Phase I analyses of the potential of poplar plantations, existing wood resource and other criteria, the EPRI project team narrowed the scope of the Phase II study. Specifically, two units, the Minnesota P2 and Wisconsin SE units were eliminated from the economic analysis. Phase II analyses concentrated on evaluation of the economic feasibility of hybrid poplar production accounting for all plantation management inputs including site preparation, planting, and weed control.

Although plantation management inputs are important, they are not likely to vary significantly across the study region. Also, a change in the cost of site preparation and planting activities within the accepted range has a relatively small impact on the overall economic feasibility of hybrid poplar. Three factors were identified that have the potential to greatly affect production economics of hybrid poplar and were considered in more detail in the Phase II study. These factors are biomass yield, land rent and cost-share incentive programs.

BIOMASS YIELD

One of the most important considerations in evaluation of production economics of hybrid poplar is biomass yield. Although information from past research is available on smaller plots of closely-spaced plantations at Rhinelander, Wisconsin, yield data from plantations over a complete rotation established at wider spacings in the Midwest is sparse. Data are beginning to become available from production-scale plantations of clones planted at several locations in Minnesota and Wisconsin at the wider spacings appropriate for the WTE™ technology.

Plantation spacing and rotation ages have increased since the beginning of hybrid poplar research in the U.S. for a number of reasons. First, the cost of planting stock is a significant economic input at the time of plantation establishment. Higher planting densities result in proportionately higher up-front costs. Second, yields of repeated coppice, closely spaced plantations, do not appear to be significantly higher than a single-rotation plantation planted at wide spacings. Third, conventional timber harvesting equipment and infrastructure exists to efficiently handle large-diameter trees. Prototype harvesters have been developed for small diameter plantations but have yet to be extensively field-tested in the U.S. For these reasons, research since the mid-1980s has concentrated on clonal screening and yield evaluation on plantations planted at 8 ft-by-8 ft spacings (680 trees/acre).

Through the cooperation of the U.S. Forest Service at Grand Rapids, Minnesota (Mr. Ed Hansen), the Agricultural Utilization Research Institute (Dr. Ed Wene) and the University of Minnesota (UM-Crookston-Mr.Wendell Johnson, NRRI-Mr. Bill Berguson), a network of test plantations have been established throughout Minnesota, Wisconsin, and bordering areas of North and South Dakota (Figure 5). These plantations were established between 1986 and 1991 with most planted during the 1987-1989 period. Information generated from these plantations provide the foundation for estimation of yield and production economics in the following section.

Few hybrid poplar plantations planted at spacings of 8 ft-by-8 ft have grown through a complete rotation. A plantation of Populus tristis established by the U.S. Forest Service at

Rhinelander, Wisconsin, was planted 15 years ago. This plantation provides a means to compare mid-rotation yields of the plantations established since that time over a wider geographic region (Hansen et al. 1993).

Figure 6 compares yields of a subset of these plantations with longer-term yield data from a P. tristis plantation at Rhinelander. Yield data from the UMC/AURI plantations and the U.S. Forest Service trial at Milaca were collected at the end of the 1992 growing season. Yields of P. tristis and DN 17 at Milaca are shown to provide a means of comparison with the more northerly UMC/AURI plantations. More detailed information on the UMC/AURI plantations is given in Table 6.

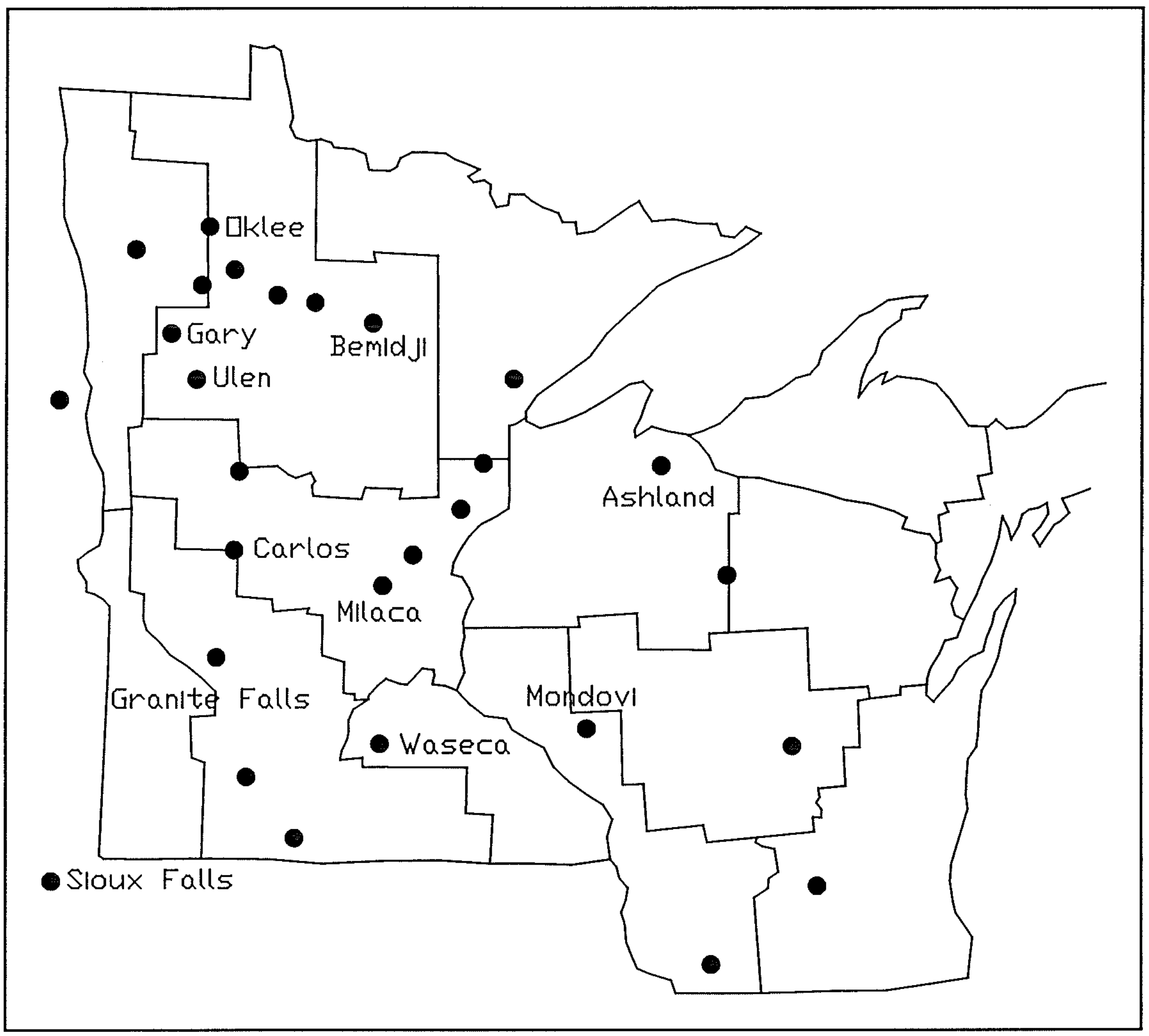

Figure 5.--Location of yield study blocks in the Minnesota/Wisconsin plantation network.

The yields shown in Figure 6 and Table 6 are the mean yield of the clones DN 182 (cv. Raverdeau) and DN 34 (cv. Eugenii). At most sites, DN 34 and DN 182 are very similar in growth. The location of plots from which growth data were taken were chosen at random within the fields and are representative of the total yield of the plantation. Poorly-stocked, lower yielding plots were included along with the well-stocked, high-yielding plots.

Biomass production is expressed as the mean annual increment (MAI) in tons per acre per year. The MAI is calculated by dividing the total aboveground biomass (without leaves) by plantation age. Mean annual production increases over time as tree canopies expand and ultimately achieve full canopy closure. At full canopy closure, the maximum leaf area and the maximum annual biomass production is attained on the site. The MAI lags behind the current annual production because MAI includes all prior years of lower production. This fact is important when interpreting mid-rotation yield data. Using the P. tristis plantation as an example, the MAI of P. tristis at age six is approximately 40 percent of the final average MAI at age ten and beyond.

Because spacing varied among the UMC/AURI plantations (numbered points in Figure 6), yields were adjusted to reflect an 8 ft-by-8 ft spacing which is the spacing of the P. tristis plantation at Rhinelander and DN 34 at Milaca. Competition effects could have an effect on yield particularly in the older, denser plantations (Waseca, Oklee) where canopies have closed. Adjusting for plantation spacing may result in underestimates of yield at those sites. However, analysis of between-tree competition at Waseca after the 1992 growing season shows little effect of competition and adjustment of yield is not likely to reduce 1992 yields. Therefore, yields are comparable across sites at this point in time. Tree survival within the P. tristis plantation is nearly 100 percent and adjustment of yield to 680 trees per acre (8 ft-by-8 ft spacing) is appropriate.

As shown in Figure 6, biomass yields from the UMC/AURI plantations fall between the P. tristis and DN 17-Milaca yields. Although not shown, yields of U.S. Forest Service plantations at Milaca, Minnesota, and Mondovi, Wisconsin, are the highest of those planted by the U.S. Forest Service (Hansen et al. 1993). To put these yields in context, DN 17 is one of the fastest growing clones at all sites in the USFS/DOE network and Milaca is one of the most productive sites in the U.S. Forest Service network. The average annual production (MAI) of

DN 17 across all of the yield blocks in U.S. Forest Service studies is approximately 2.7 tons per acre per year at age six (Hansen et al. 1993).

Extrapolation of mid-rotation yields to age ten or beyond based on the P. tristis growth curve is not recommended. The shape of growth curves is likely to differ among sites due to differences in climate and soils. At this time, yields across the study region are anticipated to range from 3 to 5 tons MAI per acre (Ed Hansen, Wendell Johnson, personal communication). This range was used in the following economic analyses.

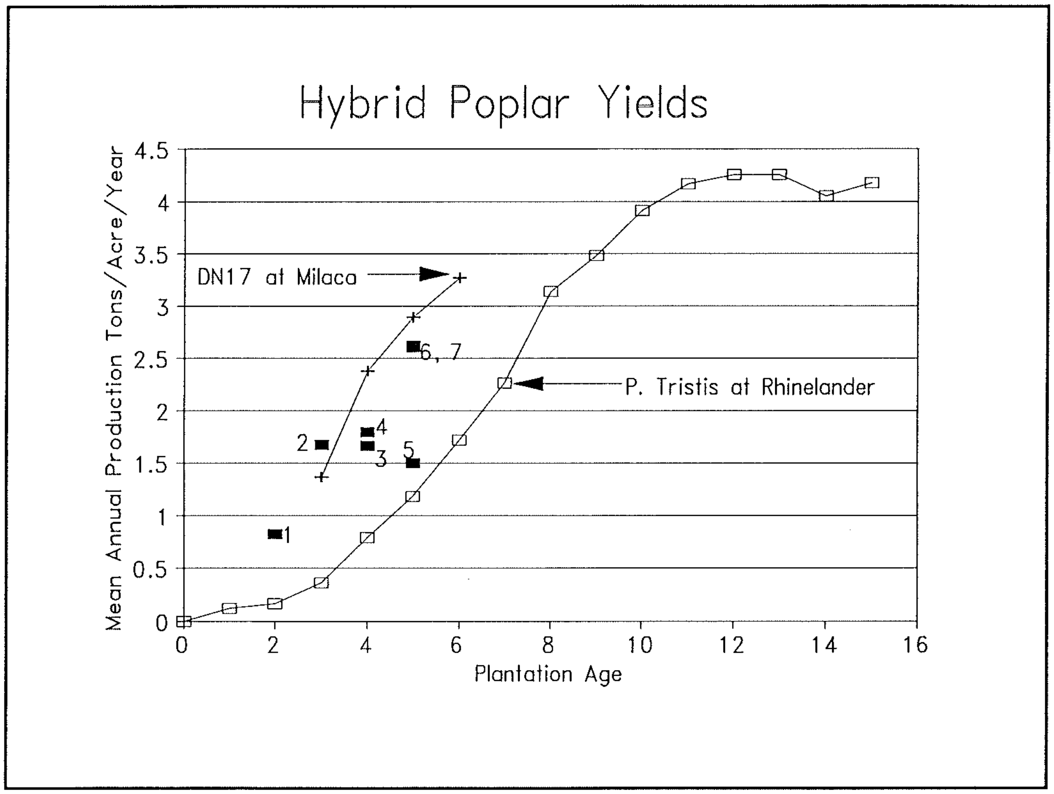

Figure 6.--Comparison of yield of hybrid poplar from the USFS P. tristis plantation at Rhinelander with yields of the UMC/AURI plantations and the USFS plantation at Milaca.

Table 6.--Biomass yields, ages, and densities of plantations shown in Figure 6.

Site	Site Name	Age	MAI (tons/acre/year)	Planted Density (trees/acre)	Adjusted[1] MAI (tons/acre/year)
1	Vickerman	2	0.82	674	0.83
2	Johnson	3	1.37	556	1.68
3	Cronemiller	4	1.03	421	1.66
4	Ulen	4	1.53	579	1.80
5	Oklee	5	1.80	817	1.50
6	Ulen	5	2.08	543	2.60
7	Waseca	5	4.45	1,155	2.62

[1]Adjusted to 640 trees/acre (8 ft-by-8 ft spacing)

PLANTING INCENTIVE PROGRAMS

A variety of programs exist which can be used to cost-share plantation establishment. These programs vary by origin of funds (state or federal) and the level of government at which they are administered. The following section describes both state-level programs and the federal Conservation Reserve Program.

STATE-LEVEL PROGRAMS

Several cost-share incentive programs are available for plantation establishment in addition to the Conservation Reserve Program (CRP). Most of these programs are funded from federal sources and monies are passed through the Agricultural Stabilization and Conservation Service (ASCS) and administered at the state and local levels. The Agricultural Conservation Program (ACP), the Forestry Incentive Program (FIP) and the Stewardship Incentive Program (SIP) are such funds administered by the state Departments of Natural Resources and the county ASCS boards. The ASCS boards in each county recommend and prioritize ACP and FIP practices that occur in their counties. The counties are then allocated funds for the recommended practices. In Minnesota, the Department of Natural Resources writes technical management plans for individual landowners participating in the FIP and ACP. The amount of money allocated to planting of hybrid poplar will depend on the individual county boards and the relative importance placed on establishment of tree plantations at the county level. The total funds allocated to each state, and the historical amounts spent on forestry-related activities (includes tree planting and other practices) under these programs are shown in Table 7. The MI-WUP unit is not shown as this unit has little agricultural land upon which to establish plantations.

Funds allocated for FIP are considerably less than either the ACP or SIP. Total allocations for FIP are $80,000 in Minnesota, $177,000 in Wisconsin and $60,000 for Iowa. FIP monies have historically been allocated for expenditure in heavily forested counties for traditional silvicultural practices such as red pine plantation thinning or site preparation. Given the comparatively low funding levels, the FIP will likely not be a significant factor in establishment of hybrid poplar. Also, although FIP funds can be assigned to counties that are not heavily forested, FIP monies have historically been spent in heavily forested counties.

Based on the total historical funding level of approximately $1 million for tree planting under the ACP and SIP in the states of Minnesota and Wisconsin and assuming a 75 percent establishment cost share (65 percent in Wisconsin), the total amount of acreage that could be planted in those states is approximately 5,000 acres annually ($1 million divided by $200 cost-share per acre). However, the total amount of money available statewide will not be spent in a specific location because of funding demands for other conservation practices statewide. Therefore, availability of cost-share funds for planting hybrid poplar in a specific multi-county area will depend on support for the program at both the state and local levels. In any case, a dramatic shift in funding allocation within these programs would be necessary to cost-share 10,000 acres of hybrid poplar plantation establishment. An additional restriction on ACP funds is a cap on per-farm payments. At this time, the maximum allowable payment to a single farm is $3,500 per year. Assuming a 75 percent cost-share rate and a total establishment cost of $270 per acre, ACP cost-share would provide for establishment of only 17 acres of plantation per year on a single farm. This is obviously too low to accommodate large scale planting of hybrid poplar.

Table 7.--Total funding level and historical amounts spent on forestry-related activities under the ACP and SIP programs.

	ACP		SIP	
	Total Statewide	Tree Planting	Total Statewide	Tree Planting
Minnesota	$2,000,000	$300,000	$400,000	$100,000
Wisconsin	$5,730,806	$439,627	$658,000	$125,000
Iowa	$2,932,000	$22,000	$150,000	$75,000

A program unique to Iowa is the Resource Enhancement Program (REAP) which is funded at a level of $500,000 for fiscal year (FY) 1993. Of this total amount, approximately half was spent on tree planting activities. Although only seven counties in Iowa are included in the study area, the REAP may be a source of additional cost-share funds for those counties.

THE CONSERVATION RESERVE PROGRAM

The Conservation Reserve Program (CRP) is an exception to the other programs in that funds are not allocated specifically to individual states or counties. The program is administered at the county level which reviews applications to the program. The amount of money available for planting in the study area is not predetermined and the amount allocated depends on expressed need. A request to Congress for an appropriation for the CRP is made annually by the USDA. According to personnel at the USDA, an annual appropriation to plant 10,000 acres annually would not be of sufficient size to justify showing it as a line item in the CRP appropriation. Therefore, the CRP could accommodate planting of large acreages of hybrid poplar without a special appropriation.

To put this in perspective, at the current cost-share level of 50 percent for establishment as well as annual payments, the total cost to the federal government to establish 10,000 acres annually over a ten year timeframe under the CRP would be approximately 35 million dollars (1993$). This assumes an annual payment of $45 per acre and an establishment cost-share of $95 per acre when trees are replacing an existing grass cover. The expenditure for CRP annual payments (excluding establishment cost-share) in Minnesota in FY1992 was slightly more than $85 million. Annual costs for a 10,000 acre per year planting scenario increase from $1.4 million in year one to $5.5 million in year ten as acreage is planted each year and the total amount of land in plantations increases.

At this time, the future of the CRP is in question. Although subjective, conversations with natural resource professionals and policymakers indicate that a program similar to the CRP will survive but funds will be significantly reduced. This is due to the feeling that federal funds will be less available than in previous years for agricultural programs in general. However, a tree planting program targeted for a specific geographic area may be possible, particularly if it involves cost-sharing through a public/private partnership. "Life after CRP" questions are currently being debated and input is being sought regarding alternate uses for CRP lands. Resolution of this issue will be forthcoming in the 1995 Farm Bill, which will take effect in FY 1996. It is likely that Congress will begin deliberations on the Farm Bill after the 1994 elections. Officials within the USDA are currently preparing input for this process. As will be shown in the following financial analyses, the CRP greatly affects production costs.

LAND RENTAL RATES

Land rent information was obtained from universities and state agricultural services for the states of Minnesota and Wisconsin. Minnesota rents are from a publication by the University of Minnesota and the State Department of Revenue (April 1993) and are based on a survey of 950 township boards. Land rent data for 1993 in Minnesota are estimates from 1992 land rents. Rental rates differ little between 1992 and 1993. For purposes of this study, land rent in the Minnesota Aspen-Birch Unit (MN-AB) was set at $15 per acre per year because data was unavailable for most of the counties in that unit.

Wisconsin land rent data are from the Wisconsin Agricultural Statistics Service at Madison (June 1993). Rental rates are based on average sales in 1991 and 1992 of land without buildings or other improvements. Only land that is known to be remaining in agriculture was included. All land that is being diverted from agriculture to other uses (e.g., housing developments) was not used in our analyses as it greatly overestimates land values and rents in some counties. Land rent data are not available on a county-by-county basis such as that provided by township boards in Minnesota. Land rental rates were calculated using a combination of the published "capitalization rates" for nine regions of the state and the county-specific 1991-1992 land values. The capitalization rate is the percentage of appraised land value that is charged as annual rent.

An analysis of county land rent in Minnesota and land sales in Wisconsin was done to gain a more complete understanding of land valuation across the region. Analysis of land sales and not land rents in Wisconsin was done because land rents are based on regional capitalization rates and not county-by-county survey data. This analysis was done to provide a tool to allow estimation of land rents assuming a variety of mixes of land types in a given location as well understand the relative effect of climate and land quality on land rent. The average growing degree days, precipitation and the weighted average land capability class for each county from the NRI were regressed against land rents from the survey of township boards in Minnesota and the land sales published by the Agricultural Statistics Service in Wisconsin. These analysis showed a statistically significant relationship between land values (rents and sales) and soil and climatic factors (p-values less than 0.05 for all three factors). Based on these relationships, methods of land valuation are similar in Minnesota and Wisconsin. Predicted average annual land rent per acre in Minnesota for soils in Land Capability Classes I, II, and III is $76, $59, and $43, respectively after adjustment for precipitation and growing degree days. Predicted average land rent in Wisconsin (using an average capitalization rate of 7.5 percent) for land in Land Capability Classes I, II, and III is $82, $64, and $45, per acre per year, respectively. Land rent in Wisconsin on higher quality land (LCC I and II) is approximately 8 percent higher than similar land in Minnesota. Average rents for the units are shown in Table 8. Land rent data for individual counties are shown in Tables A-1, A-2 and A-3.

CASH FLOW ANALYSIS OF HYBRID POPLAR PRODUCTION

A cash flow model was constructed to evaluate production costs of hybrid poplar and the effect of changes in the various cost components of wood cost. Management inputs include costs of site preparation, planting, weed control, and fertilization. For purposes of this analysis, management inputs and costs are derived from information gathered through discussions with individuals involved in plantation establishment in Minnesota (Wendell Johnson, University of Minnesota-Crookston and Ed Hansen, U.S. Forest Service) and are generally agreed to be appropriate for the study area. These inputs, their cost and the year in which they take place are itemized in Appendix B. The cost of some of the inputs, specifically plant materials, are lower than published values because an assumption was made that production of cuttings and management of stoolbeds will be more efficient as larger acreages of plantations are established.

Cash flows were done over an eleven year timespan which includes a ten year rotation and one year of site preparation prior to planting. A discount rate of three percent was used with no real increase in costs occurring over the eleven year time period. In other words, it was assumed that a landowner requires a real after-tax rate of return on investment of three percent per year. A tax rate of 36 percent was applied to all revenues. Obviously, tax rates will vary depending on the financial situation of the individual farmer and the specifics of the farming operation. Some growers may be able to use expenditures in the early years of the rotation to offset current income from other parts of their farming operation while others may not have this opportunity.

The means of comparison for this analysis is cash rent. It is assumed that, other than hybrid poplar production, the option open to the grower is to rent land to another farmer at the prevailing land rent for each study area. The analysis calculated the stumpage price that would have to be paid to equal the value of renting land over the ten year time period. These values are shown in Table 8.

In practice it will be necessary for the wood user to pay annual payments to growers for them to consider hybrid poplar as a viable option. Using this approach, wood could be "forward-contracted" and annual payments arranged with the grower. The wood price calculated in this analysis would need to be increased to account for the higher cost of capital on a utility's annual contribution to the landowner.

Using a combination of average land rent and estimated yield, the stumpage price was calculated for each survey unit assuming cost-share options discussed previously. These options are CRP, ACP, and no cost-share. Harvest and transportation costs are not included in the analyses. Costs of harvest and transportation are not expected to vary significantly among the study areas and can simply be added to the stumpage costs shown below to calculate delivered wood price. Estimates of harvest and transportation costs are currently being made by the EPRI project team.

Table 8.--Stumpage price needed to equal NPV of land rent-only option under various cost-share programs (CRP/ACP/No Cost-Share).

			Stumpage Price Per Oven-dry Ton		
Unit	Average Rent/Acre	Assumed MAI (tons/acre/year)	With CRP	With ACP	No Cost-Share
IOWA-NE	$94	5	$4.85	$27.70	$35.00
MI-WUP	$23	2.5	$13.60	$19.10	$33.80
MN-AB	$15	2.5	$14.45	$14.95	$29.65
MN-CH1	$32	3.75	$8.40	$15.80	$25.60
MN-CH2	$69	5	$5.25	$21.30	$28.65
MN-NP	$17	3	$11.85	$13.30	$25.55
MN-P1	$39	3.5	$8.65	$19.45	$29.95
MN-P2					
MN-P3: 1	$55	4.5	$6.20	$19.70	$27.85
MN-P3: 2	$83	5	$5.05	$24.90	$32.25
WI-CENT	$36	4.5	$6.85	$14.30	$22.45
WI-NE	$23	3	$11.30	$15.90	$28.15
WI-NW	$19	3	$11.70	$14.20	$26.40
WI-SE					
WI-SW	$55	5	$5.60	$17.80	$25.05

SUMMARY AND CONCLUSIONS: PHASE II

Based on Phase II analyses of cost-share programs and production costs, it is obvious that the CRP program has a dramatic effect on wood production costs and overall project feasibility. Average stumpage price across all study units required to equal a land rent option are $10.37, $24.81, and $37.74 using the CRP, ACP, and no-subsidy scenarios. Also, except for the CRP, funding of state-based cost share programs are likely to be insufficient to establish the acreage necessary to fuel a WTE™ facility. These factors underscore the critical need for the CRP or a similar program if wood for the WTE™ facility is to be obtained from poplar plantations at a reasonable cost.

An understanding of the relationship between biomass yield and land rent (a function of land quality) is critical due to the effect these factors have on production economics. Biomass yields used in the analyses are estimates based on the most current information available. Yields of hybrid poplar will be better understood as data are collected from the plantation network.

Those units that appear to have the potential to produce the lowest-cost wood are those in the Prairie and Central Hardwood units of Minnesota, the southern units of Wisconsin, and the Iowa-Northeast unit. Without a subsidy, the Iowa-Northeast and the Minnesota P3:2 are high-cost units primarily because of high land rents. Because the CRP compensates for land rent in the form of an annual payment, high-yield areas such as the Iowa-NE unit are low cost assuming the CRP is available.

Land availability for poplar plantations will depend on a number of factors not considered in this analysis. For example, in areas where dairy operations are common, land is used to produce a crop of immediate value to the farmer to feed dairy cattle. In this case, the availability of land may be of primary concern and cost a secondary consideration. This and other factors will be studied in more detail in the event that the EPRI project team proceeds to Phase III of the study.

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APPENDIX A

AVERAGE RENT, ACREAGE OF CONSERVATION RESERVE LAND AND SURVEY UNITS OF COUNTIES INCLUDED IN THE PHASE I AND II ANALYSES.

Table A-1.--Average 1992 rent, acreage of conservation reserve lands, and survey unit of Minnesota counties.

County	Average Rent 1992	CRP Acres	Unit
Aitkin	$12	3952	MN-NP
Becker	$25	34667	MN-NP
Beltrami	$10	9332	MN-NP
Benton	$21	2730	MN-CH1
Big Stone	$48	19633	MN-P2
Blue Earth	$92	11452	MN-P3
Brown	$90	5438	MN-P3
Carver	$83	1912	MN-CH1
Cass	$9	2562	MN-NP
Chippewa	$77	8525	MN-P3
Chisago	$26	2826	MN-CH1
Clay	$48	42208	MN-P1
Clearwater	$15	6535	MN-NP
Cottonwood	$82	17338	MN-P3
Crow Wing	$11	3464	MN-NP
Dakota	$54	8800	MN-CH2
Dodge	$80	5618	MN-P3
Douglas	$33	37645	MN-CH1
Fairbault	$92	4002	MN-P3
Fillmore	$80	46315	MN-CH2
Freeborn	$82	25634	MN-P3
Goodhue	$78	16417	MN-CH2
Houston	$83	13441	MN-CH2

Table A-1. (cont.)

Hubbard	$7	7179	MN-NP
Isanti	$28	2695	MN-CH1
Jackson	$82	10693	MN-P3
Kanabec	$23	1363	MN-CH1
Kandiyohi	$58	37809	MN-P3
Kittson	$40	79016	MN-P1
Lac Qui Parle	$58	37943	MN-P2
Le Sueur	$76	30874	MN-CH2
Lincoln	$54	60499	MN-P2
Lyon	$68	24509	MN-P2
Mahnomen	$38	8692	MN-NP
Marshall	$35	164474	MN-P1
Martin	$92	3015	MN-P3
Mc Leod	$73	5606	MN-P3
Meeker	$61	21538	MN-P3
Mille Lacs	$27	729	MN-CH1
Morrison	$24	15702	MN-CH1
Mower	$81	14144	MN-P3
Murray	$68	17594	MN-P2
Nicollet	$90	1468	MN-P3
Nobles	$74	5687	MN-P2
Olmsted	$74	32139	MN-CH2
Otter Tail	$31	85321	MN-CH1
Pennington	$27	76677	MN-P1
Pine	$17	310	MN-CH1
Pipestone	$54	12601	MN-P2
Polk	$44	94962	MN-P1
Pope	$45	38875	MN-P3

Table A-1. (cont.)

Red Lake	$32	53644	MN-P1
Redwood	$75	18469	MN-P3
Renville	$79	5658	MN-P3
Rice	$56	30711	MN-CH2
Rock	$71	2244	MN-P2
Roseau	$27	108854	MN-NP
Scott	$61	2293	MN-CH2
Sherburne	$23	627	MN-CH1
Sibley	$85	2592	MN-P3
St. Louis	$4	287	MN-AB
Stearns	$36	32767	MN-CH1
Steele	$88	18726	MN-P3
Stevens	$55	26575	MN-P3
Swift	$55	23613	MN-P3
Todd	$22	17421	MN-CH1
Traverse	$52	11175	MN-P2
Wabasha	$66	16361	MN-CH2
Wadena	$13	6783	MN-NP
Waseca	$82	9808	MN-P3
Washington	$37	1569	MN-CH1
Watonwan	$96	3652	MN-P3
Wilkin	$49	21976	MN-P1
Winona	$63	10487	MN-CH2
Wright	$49	7500	MN-CH1
Yellow Medicine	$63	30222	MN-P2

Table A-2.--Average 1992 rent (based on regional capitalization rates), acreage of conservation reserve lands, and survey unit of Wisconsin counties.

County	Average Rent 1992	CRP Acres	Unit
Adams	$28	5465	WI-CENT
Ashland	$17	0	WI-NW
Barron	$27	7267	WI-NW
Bayfield	$12	98	WI-NW
Brown	$55	5547	WI-SE
Buffalo	$36	13965	WI-SW
Burnett	$17	830	WI-NW
Calumet	$48	1857	WI-SE
Chippewa	$29	8042	WI-CENT
Clark	$31	4224	WI-CENT
Columbia	$75	9508	WI-SE
Crawford	$47	17575	WI-SW
Dane	$88	42770	WI-SE
Dodge	$58	11268	WI-SE
Door	$37	7370	WI-SE
Douglas	$12	0	WI-NW
Dunn	$40	23220	WI-SW
Eau Claire	$39	12665	WI-CENT
Florence	$16	41	WI-NE
Fond Du Lac	$46	12783	WI-SE
Forest	$12	4416	WI-NE
Grant	$70	17908	WI-SW
Green	$68	20271	WI-SE
Green Lake	$55	9565	WI-SE
Iowa	$68	47006	WI-SW
Iron	$15	0	WI-NW

Table A-2. (cont.)

Jackson	$40	10114	WI-CENT
Jefferson	$34	16101	WI-SE
Juneau	$41	7288	WI-CENT
Kenosha	$113	3447	WI-SE
Kewaunee	$36	9098	WI-SE
La Crosse	$116	9751	WI-SW
Lafayette	$68	18825	WI-SW
Langlade	$31	680	WI-NE
Lincoln	$27	171	WI-NE
Manitowoc	$50	11021	WI-SE
Marathon	$52	995	WI-CENT
Marinette	$19	3649	WI-NE
Marquette	$33	3207	WI-CENT
Milwaukee	$187	63	WI-SE
Monroe	$47	14790	WI-CENT
Oconto	$24	9211	WI-NE
Oneida	$28	54	WI-NE
Outagamie	$57	12229	WI-SE
Ozaukee	$59	7204	WI-SE
Pepin	$34	5582	WI-SW
Pierce	$43	29591	WI-SW
Polk	$31	15171	WI-NW
Portage	$35	3343	WI-CENT
Price	$18	45	WI-NW
Racine	$63	4833	WI-SE
Richland	$44	14635	WI-SW
Rock	$87	19948	WI-SE
Rusk	$17	582	WI-NW

Table A-2. (cont.)

Sauk	$71	19625	WI-SW
Sawyer	$17	147	WI-NW
Shawano	$24	5864	WI-NE
Sheboygan	$45	5089	WI-SE
St Croix	$49	46061	WI-SW
Taylor	$27	312	WI-NW
Trempeleau	$38	30812	WI-SW
Vernon	$46	16573	WI-SW
Vilas	$29	13	WI-NE
Walworth	$60	9570	WI-SE
Washburn	$19	1124	WI-NW
Washington	$67	3361	WI-SE
Waukesha	$94	7869	WI-SE
Waupaca	$40	5754	WI-CENT
Waushara	$34	2758	WI-CENT
Winnebago	$48	12670	WI-SE
Wood	$27	313	WI-CENT

Table A-3.--Average 1992 rent, acreage of conservation reserve lands, and survey unit of Iowa counties.

County	Average Rent 1992	CRP Acres	Unit
Allamakee	93	36175	IOWA-NE
Buchanan	90	6332	IOWA-NE
Clayton	106	48597	IOWA-NE
Delaware	93	14719	IOWA-NE
Dubuque	97	24349	IOWA-NE
Fayette	87	25258	IOWA-NE
Winneshiek	89	48946	IOWA-NE

Table A-4.-- Acreage of conservation reserve lands, and survey unit of Michigan counties.

County	CRP Acres	Unit
Baraga	0	MI
Dickinson	364	MI
Gogebic	0	MI
Houghton	0	MI
Iron	18	MI
Keweenaw	0	MI
Marquette	0	MI
Ontonagon	0	MI

APPENDIX B

COST INPUTS AND ASSUMPTIONS USED IN THE CASH FLOW MODEL OF HYBRID POPLAR PRODUCTION.

Table B-1.--Cost inputs and assumptions used in the cash flow model of hybrid poplar plantation production.

Activity	Unit	Cost (1994$)	Year
Clip/Mow	$/Acre	$7.50	0
Herbicide (Glyphosate)	$/Acre	$20.00	0
Plow	$/Acre	$13.42	0
Disk	$/Acre	$7.00	0,0
Plant Cover	$/Acre	$7.50	0
Cover Seed	$/Acre	$3.00	0
Harrow	$/Acre	$10.00	1
Planting	$/Cutting	$0.05	1
Cuttings	$/Cutting	$0.10	1
Herbicide (Linuron)	$/Acre	$20.00	1
Cultivation	$/Acre	$3.73	1,1,1
Herbicide	$/Acre	$24.00	2
Fertilization	$/Acre	$30.00	3
Land Rent	$/Acre	variable	1-10
Establishment Cost-Share	$/Acre	variable	1

Note: Multiple entries in the "Year of Activity" column indicate repeated treatments in the years indicated.