UNDRAINED PEATLANDS FOR SHORT ROTATION FORESTRY

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EXECUTIVE SUMMARY

The purpose of this project was to investigate the potential to establish Short Rotation Intensive Culture (SRIC) plantations of hybrid poplar and hybrid willow on peatlands which have not been drained. The elimination of drainage of these lands would prevent the potential negative impacts of peatland drainage on water quality and quantity. If a method could be found to allow the establishment of forest plantations on undrained peatlands, these lands could be used to produce high yields of wood fiber with little impact on the natural environment.

Peatland drainage has the potential to negatively impact the environment. The drainage of peatlands can alter water quality (Clausen, 1980) and quantity (Guertin, 1984). Studies on a reed-sedge peatland in Minnesota have shown suspended solids, potassium and iron, as well as other compounds, may increase with peatland drainage (Clausen, 1980; MDNR, 1985). Research conducted by Clausen (1980) revealed that the impacts of peatland drainage on water quality depend on the specific peat type being drained. Research on drainage of peatlands in Finland has also shown the potential to affect water quality.

The presence of forest cover on peatlands can influence water table levels. The additional surface area of the forest canopy foliage acts to increase water usage and lower water table levels through evapotranspiration. In addition, the forest canopy intercepts rainfall which evaporates off leaf surfaces, reducing the amount of water reaching the forest floor. Numerous studies cited by Kittredge (1973) show that interception can reduce the amount of precipitation reaching the forest floor from 10 to 80 percent depending on the intensity of rainfall.

This project was based on research done in the southern United States on poorly drained floodplain soils. Research was done on loblolly pine (Pinus taeda), slash pine (Pinus elliottii), and cottonwoods (Populus deltoides), to determine the effects of raised planting beds to enhance survival and forest production on these wet soils. Raised beds or mounds provide a locally drained site for seedlings to become established. The mounds, being raised from the surrounding soil surface, provide increased aeration, allowing root growth of seedlings. As these plantations grow and expand in leaf area, the plants begin to naturally drain the surrounding rooting zone through increased evapotranspiration. As a result, water table levels are gradually lowered.

This project had two research goals - plantation establishment and economic analyses. With the purpose of this project to determine the potential to establish SRIC plantations on undrained peatlands, study plantations were established at the Fens Research Facility, a 500 acre peatland administered by the NRRI. Based on initial results of clonal screening studies at this site, four clones were chosen for use in these studies, two willow and two hybrid poplar. Using a variety of plant material, the effect of mounding on a genus more adaptable to poorly drained conditions (willow) and one less adaptable to these conditions (poplar) could be compared.

The experiment was a factorial design incorporating the four clones, two soil treatments (mounded/unmounded) and two fertilizer treatments (fertilized/unfertilized). Two study areas were established in each of the two years of the project for a total of four replications per treatment combination. Thirty two plots were established each year for a total planted area of over four acres.

Soil mounding was found to have a statistically significant positive effect on the growth of the poplar clone "Raverdeau" and no effect on the two willow clones. This indicates that mounding is most effective on species that are naturally less tolerant of wet conditions.

Soil samples were collected to determine the effect of initial plantation growth and evapotranspiration on soil moisture. Soil moisture sampling was done during June of 1989 on two year-old plantations. Regression analyses were used to assess the effect of tree biomass on soil moisture content. A statistically significant negative correlation was found between plantation growth and soil moisture, which indicates that the trees are significantly influencing the water regime on the site even at an early stage of plantation growth.

A model was developed to allow analysis of the economic feasibility of short rotation forestry and to assess the economic impact of incorporating mounding into plantation management. This model was developed from an overall system perspective and not from that of an individual landholder. Analyses were done comparing a plantation with ditching and one with mounding alone with no ditching.

Using baseline cost inputs, two plantation systems were compared, one with mounding on an undrained peatland and the other using traditional peatland drainage. As the up-front costs of ditching and mounding are approximately $89 and $25, respectively, the rate of return is higher in a mounded plantation. Internal rates of return are 9.5 percent for ditched and 10.2 percent for mounded peatland systems. Accounting for a 5 percent rate of inflation which was built into the model, the real rates of return are approximately 4.5 percent and 5.2 percent for ditched and mounded peatland systems, respectively.

Based on results of research to date, the potential exists to successfully establish short rotation forests on undrained peatlands using mounding techniques. Plantations of hybrid poplar, in particular, are positively affected by mounding. Also, results of soil moisture analyses show that these plantations are significantly impacting the drainage of the site even at a relatively young stage of the plantation. The natural drainage of these sites is likely to increase in direct proportion to the development of the forest canopy.

These experiments were conducted, however, during a period of abnormally low rainfall and more definitive results will be obtained as these plantations grow and periods of more representative rainfall are encountered. These studies will be maintained by the Natural Resources Research Institute over the entire length of the rotation. Data will continue to be collected annually to determine the effects of mounding on the future growth and survival of these plantations.

INTRODUCTION

The purpose of this project was to investigate the potential to establish Short Rotation Intensive Culture (SRIC) plantations of hybrid poplar and hybrid willow on peatlands which have not been drained. The elimination of drainage of these lands would prevent the potential negative impacts of peatland drainage on water quality and quantity. If a method could be found to allow the establishment of forest plantations on undrained peatlands, these lands could be used to produce high yields of wood fiber with little impact on the natural environment.

Peatland forestry is practiced throughout the world, particularly in Scandinavian countries where peatlands comprise a large portion of the total land area. Peatlands in Minnesota occupy approximately six million acres, ten percent of the state's total land surface. The majority of peatlands are found north of the metropolitan area although commercially important deposits occur to a lesser extent in southern Minnesota.

Peatlands can be generally described as beds of organic material which have accumulated due to poor drainage conditions. Poor drainage prevalent during peatland formation limited the natural activity of microbes that decompose organic matter and allowed the accumulation of this organic matter over time. As a result, peatlands in their natural state are poorly drained, relatively unproductive soils.

Peatlands vary in natural productivity depending on botanical origin, degree of decomposition, physical and chemical properties, landscape position, and their location in the state. The majority of peatlands are composed of remains of reeds and sedges (Reed-Sedge Peat) with a lesser area occupied by Sphagnum peats. Reed-sedge peats are moderately to highly decomposed, have a higher density, higher pH, and are more rich in nutrients than Sphagnum peats. Sphagnum peats are characterized by a relatively acid pH (pH 3.0-4.5) and are less productive than reed-sedge peats. Due to their higher inherent productivity and relative abundance, the type of peat most likely to be used for plantation forestry in the future is reed-sedge peat. Historically, the commercial use of peatlands for crop production has necessitated drainage to improve soil aeration and increase the bearing capacity for agricultural equipment.

EFFECTS OF PEATLAND DRAINAGE

Peatland drainage has the potential to negatively impact the environment. The drainage of peatlands can alter water quality (Clausen, 1980) and quantity (Guertin, 1984). Studies on a reed-sedge peatland in Minnesota have shown suspended solids, potassium and iron as well as other compounds may increase with peatland drainage (Clausen, 1980; MDNR, 1985). Research conducted by Clausen (1980) revealed that the impacts of peatland drainage on water quality depend on the specific peat type being drained. Research on drainage of peatlands in Finland has also shown the potential to influence water quality.

In addition to water quality, peatland drainage can alter the rate and amount of flow in receiving waterways (Guertin, 1984). When a peatland is drained, ditches provide a route for more rapid discharge of water. This rapid discharge occurs particularly after high rainfall events and spring snowmelt. This effect is particularly noticeable during the spring when soils have not thawed sufficiently to absorb rainfall. As a result, water flows more quickly through the drainage system causing higher spring runoff peaks (Guertin, 1984).

The presence of forest cover on peatlands has been shown to influence water table levels. The additional surface area of the forest canopy foliage acts to increase water usage and lower water table levels through evapotranspiration. In addition, the forest canopy intercepts rainfall which evaporates off leaf surfaces, reducing the amount of water reaching the forest floor. Numerous studies cited by Kittredge (1973) show that interception can reduce the amount of precipitation reaching the forest floor from 10 to 80 percent depending on the intensity of the rainfall event. Related to this, water table levels after clear-cutting a forested peatland have been shown to rise after harvest (Verry, 1980). This research indicates that the potential exists to naturally drain peatlands without ditching by exploiting the natural drainage effect of forests.

SHORT ROTATION FORESTRY

Short rotation forestry, also known as Short Rotation Intensively Cultured (SRIC) forestry, can be described as the combination of superior hybrids, intensive plantation management, and mechanized harvesting with the goal to produce high fiber yields. SRIC plantations are unique in that hardwoods are the primary species used as opposed to conifers.

SRIC plantation research began in the late 1970's in response to the energy crisis. Research in Minnesota has continued through the funding of the Legislative Commission on Minnesota Resources, the US Department of Energy, and the US Department of Agriculture. Much of this research has concentrated on field testing of hybrid poplar and willow on mineral soils and peatlands, and plantation management research on marginal agricultural soils in northwestern Minnesota. Minnesota has a well developed forest products industry, and SRIC has the potential to increase wood fiber supplies for forest products. In addition, SRIC could decrease the state's dependence on fossil fuels.

Plant materials used in SRIC plantations have several common characteristics. They are vegetatively propagated and re-sprout from the existing stump when harvested (stump sprouting or coppicing). Plants are vegetatively propagated through the use of hardwood cuttings. Hardwood cuttings are sections of parent plants which are collected during the winter months when plants are dormant. This method of propagation produces genetically identical offspring called clones. Some sections of the poplar genus (Cottonwoods and Balsam poplars) and most willows can be propagated by this method. Aspens and other white poplars either cannot be propagated using this method or survival is too low to allow the use of this method on a large scale.

Clones used in SRIC have the ability to vigorously re-sprout from the parent rootstock after harvest. Second-growth stands grow rapidly due to the large existing underground rootstock. These rootstocks can rapidly absorb water and nutrients and have large carbohydrate reserves produced by the previous stand. As a result, re-sprouting stands grow near their maximum potential rate during the early years of the rotation. As these clones re-sprout from the existing stump and not the root system, the row orientation of the plantation is maintained allowing mechanized harvesting of successive stands.

Clonal Screening

A wide variety of clones suitable for SRIC have been developed in breeding programs throughout the world. These clones vary widely in growth rate, tree form, disease resistance, and frost tolerance. Studies on clonal selection of willow on peatlands have shown that yields of superior clones have the potential to grow ten times faster than less adaptable clones. Currently over 100 of these hybrids are being screened in trials on mineral and organic soils across Minnesota. The US Forest Service at Grand Rapids, the UM at Crookston, and the Natural Resources Research Institute, are conducting cooperative screening trials of poplar and willow hybrids. The NRRI is maintaining a large screening trial of hybrid willow on peatlands in St. Louis County. Selection of plant materials for the Undrained Peatlands study was based on the results of these trials.

Plantation Establishment

SRIC plantation sites are prepared for planting in a manner similar to site preparation for agronomic crops. If necessary, the site is drained and existing weeds are eradicated. Fields are plowed and disked to increase soil aeration. Soils tests are done and fertilizer applied to increase growth rates. Plantations are established using hardwood cuttings at spacings ranging from 3.0 X 3.0 feet to 8.0 X 8.0 feet depending on the intended end-product. Wider spacings produce longer rotations and larger diameter material with the intended end-product used in forest products such as waferboard or oriented strandboard. More densely spaced plantations are intended to produce wood for energy.

Weed competition during the early stages of the plantation is controlled through mechanical means or through the use of herbicides. On peatlands, broadcast spraying of soil-active herbicides is not done as these chemicals are rendered ineffective due to the high organic matter content of these soils. Weed control on peatlands is done by cultivation during the first two to three years of the plantation until tree canopy closure. Canopy closure will prevent further weed competition through shading of shade-intolerant weeds.

PROJECT BACKGROUND

This project was based on research done in the southern United States on poorly drained floodplain soils. Research was done on loblolly pine (Pinus taeda), slash pine (Pinus elliottii), and cottonwoods (Populus deltoides), to determine the effects of raised planting beds to enhance survival and forest production on these wet soils. Raised beds or mounds provide a locally drained site for seedlings to become established. The mounds, being raised from the surrounding soil surface, provide increased aeration, allowing root growth of seedlings. As these plantations grow and expand in leaf area, the plants begin to naturally drain the surrounding rooting zone through increased evapotranspiration. As a result; water table levels are gradually lowered.

Research done in North Carolina (Gregory, 1989) showed that, after full canopy development, over 80 percent of the total precipitation was either evaporated off of the leaf surfaces before reaching the ground or returned to the atmosphere through transpiration. Only 17 percent of the total precipitation was removed through the drainage network. Due to this marked effect of interception and transpiration, the soil is naturally drained and plantation growth is increased. This "naturally draining" effect is the basis of this project. The progression of tree growth on a mounded area and the projected effect on water table level is shown in Figure 1.

PROJECT SCOPE

This project had two research goals - plantation establishment and economic analyses. The purpose was to determine the potential to establish SRIC plantations on undrained peatlands using soil bedding techniques developed in the southern United States.

Study Site Description and Preparation

Field plots are located at the Fens Research Facility, a 500 acre peatland site located on a large reed-sedge peatland in south-central St. Louis County. This site was chosen because it is representative of the majority of peatlands in the state and, being administered by NRRI, long-term maintenance and monitoring can be done without additional lease arrangements.

As parts of the study site had been previously drained, the site was prepared by filling in ditches in and around the study area. An undrained buffer zone of 400 feet was left around the study area. Studies conducted near the Fens Research Facility on an identical peat type have shown that water table levels return to natural depth at a distance of 200 feet from a drainage ditch (MDNR, 1985). Based on this data, a buffer zone of 400 feet was established around the study area to ensure a natural, undrained state within the study site boundary.

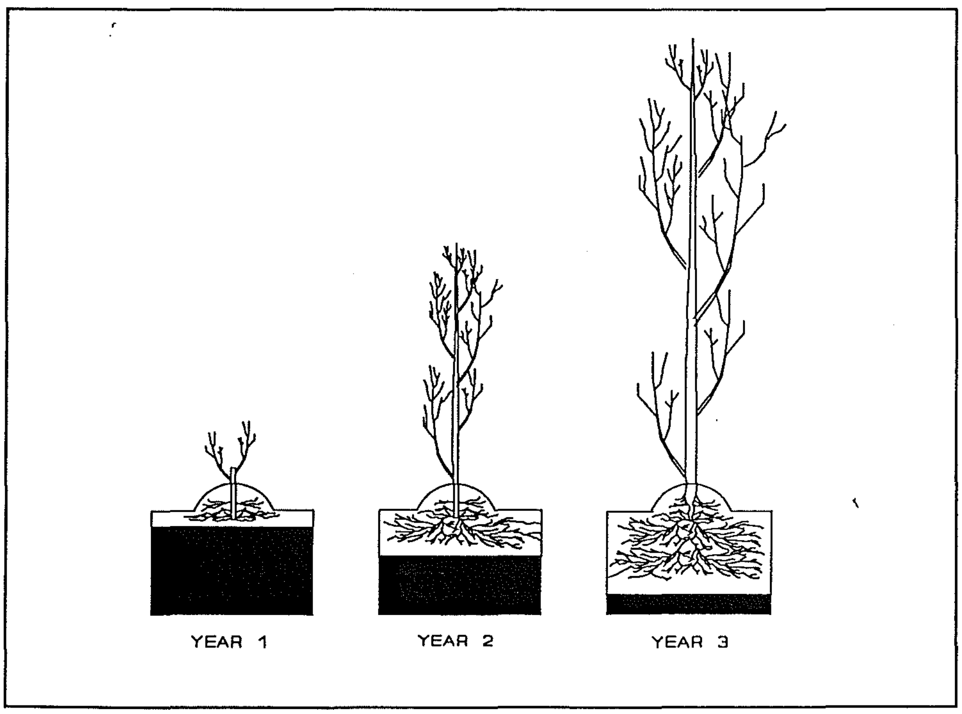

Figure 1.--Theoretical relationship between plantation growth and water table depth over time in a mounded peatland.

Existing ditches were filled in the fall of 1986 using a large screw leveller. Peat material was filled into the ditches and allowed to settle over the winter. The peat surface was levelled in the spring of 1987 before mounding, weed eradication and planting.

Mounding

Several manufacturers provide equipment to produce mounded beds for vegetable production on mineral soils. This was found to be unsuitable for peatland conditions due to the comparatively low bulk density of peat soils. Equipment use to hill potato production fields on peatlands were used as the prototype for this study. Two moldboard plows were mounted in a frame facing each other to turn the soil and produce a mound. A packing device was mounted following the plows to form the mound and increase the bulk density, stabilizing the mound. This device consists of three articulating metal rollers connected in a frame. The rollers were able to move over the soil surface and conform to variation in the mounds.

Study Design

As mentioned earlier, the NRRI maintains a large clonal screening study at the Fens Research Facility with over 250 hybrids currently being tested. Based on initial results of these studies, four clones were chosen, two willow and two hybrid poplar, for use in this project. Using a variety of plant material, the effect of mounding on a genus more adaptable to poorly drained conditions (willow) and one less adaptable to these conditions (poplar) could be compared. The clones used in this study and parentage of these clones is shown in Table 1.

In addition to the assessment of soil mounding, experiments were designed to test the interaction of fertilization with soil mounding. Previous research done in the southern US has shown that phosphorus can increase the effectiveness of mounding by promoting root growth. In previous experiments done by the NRRI, nitrogen and potassium were found to be limiting on this peatland. Therefore a mix of nitrogen, phosphorus, and potassium fertilizer was prepared and applied prior to planting.

The experiment is a factorial design incorporating four clones, two soil treatments (mounded/unmounded) and two fertilizer treatments (fertilized/unfertilized). Two study areas were established in each of the two years of the project for a total of four replications per treatment combination. Figure 2 shows the plot layout and experimental design established in each of the two establishment years. Thirty two plots were established each year for a total planted acreage of over four acres.

Plantation Establishment

Stem sections of clones shown in Table 1 were collected in the winter of 1986 in preparation for this study. These sections were stored in a refrigerator at approximately 28°F in plastic bags to prevent moisture loss. The stem sections were cut into hardwood cuttings eight inches long for planting. After mounding, weeds were eradicated using a contact herbicide. Planting was done by hand and completed by the second week of June in each year.

Table 1.--Clone names and parentage of clones used in experiments.

Clone	Parentage
Raverdeau	Populus deltoides X nigra
NE 372	Populus deltoides X trichocarpa
Alba Calva	Salix alba clone "Calva"
Fragilis 55	Salix fragilis clone 55

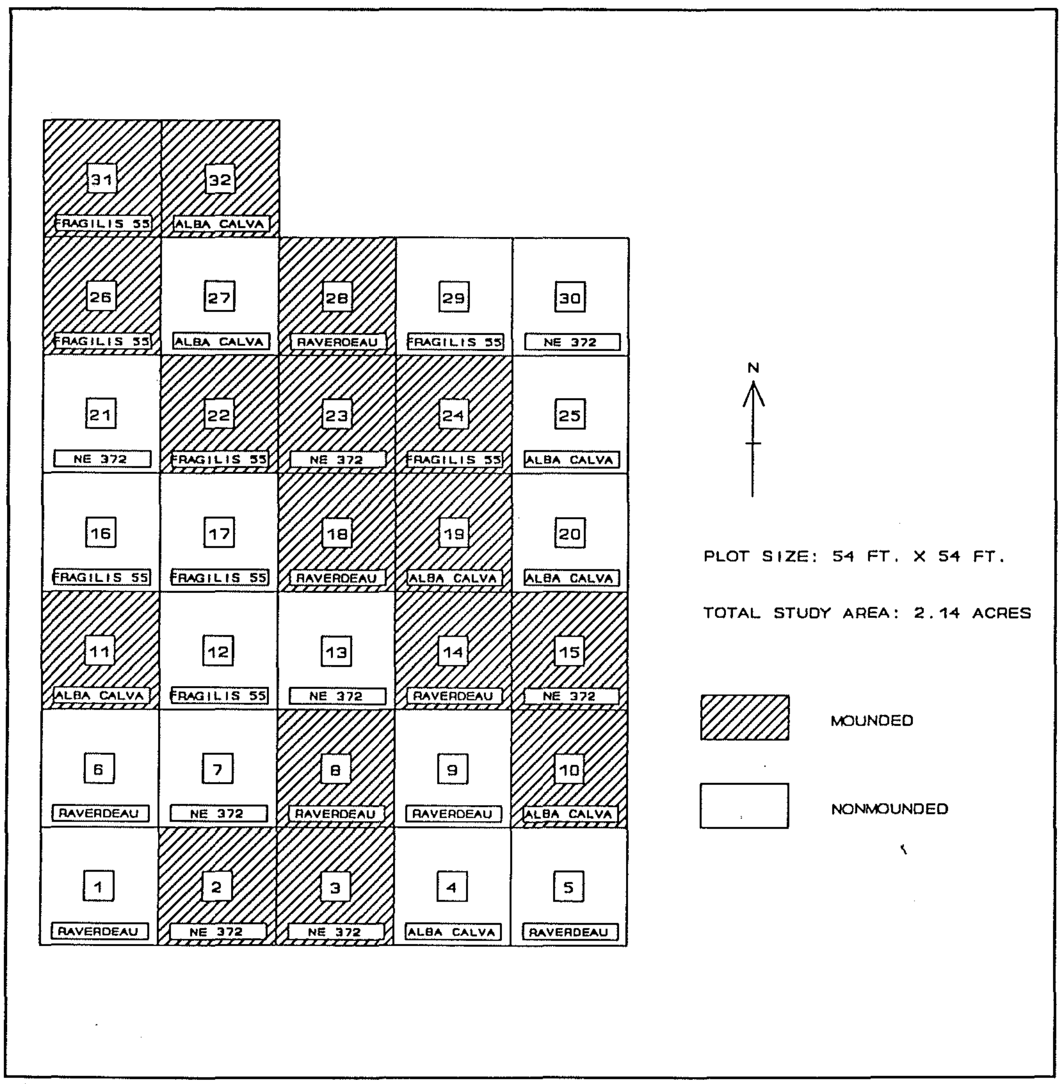

Figure 2.--Plot layout for Undrained Peatlands Project experiments.

PRELIMINARY RESULTS

Results reported are considered preliminary at this time. Two factors prevent the immediate formulation of conclusive results. First, the two planting years, 1987 and 1988 were abnormally low in precipitation. This abnormally low rainfall obscures the initial results of these studies. In addition, water table levels are directly influenced by the amount of leaf area, and the resultant evapotranspiration rate at a given time. As these plantations have not achieved complete canopy closure, the full effect of evapotranspiration will not be evident for one to two years (1990 and 1991). Evapotranspiration will directly influence the amount of water removed from a site. Because of this, it is necessary to allow for complete canopy development before the full effect of these plantations on water table levels will be evident.

Statistical analyses of growth in both plantings were done using height for one year old plantations and biomass of two year old plantations. Survival of both plantings was analyzed at the end of the first year, of establishment. Results were analyzed by clone to assess the variation in growth and survival of individual clones. Table 2 shows the growth and survival of four clones after two years.

As can be seen in Table 2, growth of clones were variable with the willow clone, "Alba Calva", having the highest yield. Growth and survival of the poplar clone NE-372 is too low to be considered for future planting on these wet sites. Growth of the poplar clone, Raverdeau, is considerably higher although not approaching that of the two willow clones.

Mounding Effects

Tree biomass data were used to determine the effect of mounding on tree growth two years after planting. Growth of clones was analyzed separately. Mounding was found to have a statistically significant positive effect on the growth of the poplar clone "Raverdeau" and no effect on the two willow clones, which indicates that mounding is most effective on species that are naturally less tolerant of wet conditions.

Fertilizer Effects

Foliar tissue samples were collected in the fall of 1988 from the two year old planting to assess nutrient status and determine the utility of using tissue sampling in making fertilizer

Table 2.--Growth and survival after two years in mounded plots.

Clone	Growth (grams/tree)	Survival %
Raverdeau	8.0	64.7
NE 372	3.9	44.8
Fragilis	39.9	83.2
Alba Calva	54.2	86.0

recommendations. Samples were analyzed for a range of elements including nitrogen, phosphorus, potassium, calcium, magnesium, and other minor plant nutrients. Analysis of tissue samples revealed a significant (alpha=0.05) correlation between biomass production and potassium and manganese levels in most clones.

Effect of Tree Growth on Soil Moisture

Soil samples were collected to determine the effect of initial plantation growth and evapotranspiration on soil moisture. As mentioned previously, the transpirational effect of forest canopies exerts a strong influence on the drainage of the site. Soil moisture sampling was done during June of 1989 in individual plots of the two year old plantations. Regression analyses were used to assess the effect of tree biomass on soil moisture content. Figure 3 shows the relationship of tree biomass to soil moisture content. Soil moisture is expressed as the percent by weight of the water over the wet soil weight (wet wt basis).

As shown in Figure 3, tree biomass has a negative correlation with soil moisture. Statistical analyses verified that tree biomass is significantly affecting soil moisture at this stage of the plantation (alpha=0.05). Tests were also done to determine if the position of plots within the field were significantly related to soil moisture. These analyses showed no relationship of soil moisture to plot location. This verifies that baseline soil moisture levels and drainage is uniform across plots. This result indicates that all variation in soil moisture content between plots is directly attributable to the influence of the existing tree canopy.

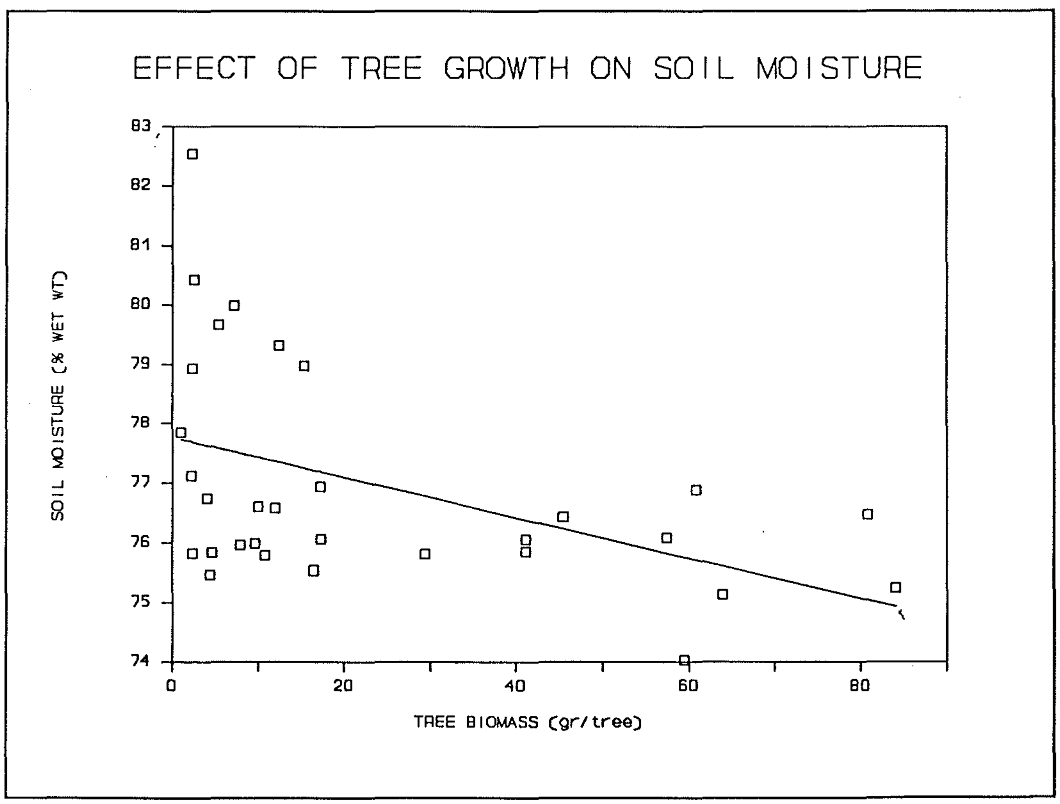

Figure 3.--Effect of plantation growth on soil moisture two years after planting.

ECONOMIC ANALYSIS

An economic model was developed to allow the analysis of the economic feasibility of short rotation forestry and to assess the economic impact of incorporating mounding into plantation management. This model was done from an overall system perspective and not from that of an individual landholder. As such, all management costs are included and charged against final revenue with no intermediate sale of timber stumpage. Cost inputs for land purchase, land clearing, ditching or mounding, as well as other plantation establishment costs are included. Analyses were done comparing a plantation with ditching and one with mounding alone with no ditching.

The plantation size, 19,440 acres, was scaled to the projected maximum seasonal harvest capacity of a prototype harvester. This plantation assumes that 1,296 acres are established each year in a number of areas. The prototype harvester, the FB-12 Biomass Harvester (Hyd-Mech Engineering, Woodstock, Ontario) is projected to harvest 500 twelve-inch trees per hour (Curtin and Barnett, 1985). A similar harvester, the FB7, has been tested and production rates were verified to be near the projected pre-test estimates (Dennis Curtin-personal communication).

Plant spacing is ten feet by ten feet with an anticipated rotation length of 15 years. Cutting costs were based on the assumption that a stool-bed would be maintained on-site and cuttings processed annually from this bed. Planting costs were based on a planting rate of 15,000 cuttings/day (Wendell Johnson, personal communication-LCMR Biomass Cash Crop Project). Actual cost information for the processing and planting of hardwood cuttings were determined from large scale plantation establishment research done in northwestern Minnesota by the University of Minnesota, Crookston. As peatlands in northwestern Minnesota are generally not enrolled in the Conservation Reserve Program, no subsidy payments were included in the analyses. Baseline input costs and prices used in the economic analyses are shown in Table 3 on the following page.

A wood price of $15 per green ton is used in these analyses. This is an assumed baseline price for energy chips including transportation. The other potential product from a short rotation plantation of this type could be roundwood for forest products, particularly composite materials such as waferboard or oriented strandboard. Whether wood is chipped for energy production and sold as tonnage or harvested as roundwood and sold as cords for forest products, the price on a weight basis is roughly equivalent at this time. Using a price of $15 per green ton for chips, a cord-equivalent price is $31.50 per cord which is an approximate delivered wood price for forest products mills in Minnesota. In the case of roundwood production, a portion of the chipping costs could be substituted for the cost of limbing for roundwood.

The variable used to determine the ultimate economic success or failure of the plantation is internal rate of return (IRR). If this rate is greater than an assumed inflation rate (in the case of this analysis 5 percent per year), then the operation is projected to be profitable. Likewise, if the internal rate of return is less than 5 percent, the enterprise is not returning a profit. Results of these analyses were done to assess the effect of various cost inputs on the ultimate IRR associated with the enterprise.

Table 3.--Baseline cost and price assumptions used in economic analysis of short rotation forestry on peatlands.

Activity	Unit	Cost
Land purchase/clearing	$/Acre	$300.00
Ditching	$/Acre	89.00
Mounding	$/Acre	25.00
Herbicide	$/Acre	25.70
Fertilization	$/Acre	55.00
Cuttings	$/Cutting	.02
Planting	$/Cutting	.0015
Cultivation	$/Acre	25.00
Administration	$/Acre	5.00
Harvest	$/Green Ton[1]	4.00
Chipping	$/Green Ton	3.00
Transportation		
cost per ton/mile	$/Ton-mile	.10
distance miles	20	
Wood price	$/Green Ton	15.00
Wood yield	Dry tons/ac/yr	6

Taxation was built into the model assuming the plantation is being held as part of a diversified enterprise which was generating taxable income during the pre-harvest years when no revenues were obtained directly from the plantation. This is important in that annual losses during the pre-harvest period were used to reduce the tax liability for income generated from other divisions of the corporation. Taxation was not a major emphasis of this study as corporate tax rates and methods to apply them are subject to change. During the revenue producing years of the plantation, revenues were taxed at a flat rate of 27 percent with no capital gains treatment. Obviously, the future success or failure of a short rotation plantation is heavily dependent on future tax laws. Specifically, changes in capital gains tax legislation would have a great impact on the economic feasibility of plantation forestry as forest management is a relatively long-term endeavor.

Results

Using the baseline cost inputs shown in Table 3, two plantation systems were compared, one with mounding on an undrained peatland and the other using traditional peatland drainage. As the up-front costs of ditching are approximately $89 and for mounding $25, the rate of return is higher in a mounded plantation. Internal rates of return are 9.5 percent and 10.2 percent for ditched and mounded peatland systems, respectively. Accounting for a 5 percent rate of inflation which was built into the model, the real rates of return are approximately 4.5 percent and 5.2 percent for ditched and mounded peatland systems, respectively. Whether these rates are sufficiently high to attract investment into SRIC depends on the intent of each investor and tax treatment or incentives associated with SRIC plantation management.

Obviously, a critical assumption influencing the economics of SRIC plantations is the value of the wood produced from the plantation. It is difficult to project future wood prices as raw material prices are dependent on a wide variety of factors. In general, given the age class distribution of the aspen forest in the state, prices are expected to rise. The rate of rise and ultimate price depends on considerations such as the amount of alternate species (birch, maple, other hardwoods) used to substitute for aspen. Also, the amount of wood actually brought to market by owners and managers of commercial forest land will determine the actual supply and, in turn, the future price. The assumptions used in the projection of future wood prices will have a profound impact on the decision to invest or not to invest in short rotation forestry.

CONCLUSIONS

Based on results of research to date, the potential exists to successfully establish short rotation forests on undrained peatlands using mounding techniques. Plantations of hybrid poplar, in particular, are positively affected by mounding. Also, results of soil moisture analyses show that these plantations are significantly impacting the drainage of the site even at a relatively young stage of the plantation. The natural drainage of these sites is likely to increase in direct proportion to the development of the forest canopy.

These experiments were conducted however during a period of abnormally low rainfall, and more definitive results will be obtained as these plantations grow and periods of more representative rainfall are encountered. These studies will be maintained by the Natural Resources Research Institute over the entire length of the rotation. Data will be collected annually to determine the effects of mounding on the future growth and survival of these plantations.

Results of this research on peatlands and that of others on mineral soils throughout Minnesota indicates that it may be economically feasible to produce wood on SRIC plantations for use as fuel and raw material for forest products. Questions remain regarding the suitability of this material for use in forest products although tests conducted to date have shown suitable performance in composite products such as waferboard. Clonal variation in wood quality and the effect of this variation on suitability in forest products will be a factor in the future use of SRIC-produced wood. Research on wood quality in addition to research to more accurately determine plantation yields on a variety of soil types throughout the state is required. This information will be useful to determine the overall potential of SRIC in Minnesota.

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