A FINANCIAL ANALYSIS OF HYBRID ASPEN PRODUCTION FOR PULPWOOD BY PRIVATE LANDOWNERS IN NORTHWESTERN SASKATCHEWAN.

FIONA J. SALKIE[1] AND WILLIAM A. WHITE[2]

FEBRUARY 1995

[1]Research Associate, Department of Rural Economy, University of Alberta
[2]Senior Economist, Northern Forestry Centre, Canadian Forest Service

Edmonton, Alberta

This publication was fundcd by Canadian Forest Service under the Canada-Saskatchewan Partnership Agreement in Forestry.

Project No. S5013-a

The study on which this report is based was funded by Canadian Forest Service under the Canada/Saskatchewan Partnership Agreement in Forestry.

The views, conclusions and recommendations are those of the authors. The exclusion of certain manufactured products does not necessarily imply disapproval nor does the mention of other products necessarily imply endorsement by Canadian Forest Service or Saskatchewan Environment and Resource Management.

Additional copies of this publication are
available at no charge from:

Canadian Forest Service
Saskatchewan District Office
Northwest Region
1288 Central Ave.
Prince Albert, Saskatchewan
S6V 4V8

Telephone (306) 953-8544
435-7210
FAX (306) 953-8649

or

Canadian Forest Service
Regional Development
5320 - 122 Street
Edmonton, Alberta
T6H 3S5

Telephone (403)

FAX (403) 435-7359

or

Forestry Branch
Saskatchewan Environment and Resource Management
800 Central Ave.
Box 3003
Prince Albert, Saskatchewan
S6V 6G1

Telephone (306) 953-2225
FAX (306) 953-2360

ABSTRACT

New markets for aspen in northwestern Saskatchewan have created interest in intensive management of hybrid aspen. This paper investigates the feasibility of a private landowner establishing a hybrid aspen plantation on owned or rented land in the Meadow Lake area of Saskatchewan. The threshold prices for a variety of plantation scenarios are calculated using a spread sheet. The results are tested for sensitivity to land type, land quality, discount rate, value of standing bush, and stocking rates. The results suggest that hybrid aspen plantations may not be financially feasible on private land and future biological research should concentrate on improvements to native aspen, rather than the development of hybrids.

ACKNOWLEDGEMENTS

Funding for this research was provided by the Canada-Saskatchewan Partnership Agreement in Forestry. The authors would like to thank Dave Cheyne, David Harman, Dave Cubban, Harvey Yoder, Dr William Phillips, Dr. Martin Luckert, and Gary Wyckoff for their assistance with this research.

TABLE OF CONTENTS

LIST OF TABLES

A Financial Analysis of Hybrid Aspen Production for Pulpwood by Private Landowners in Northwestern Saskatchewan.

Fiona J. Salkie and William A. White

INTRODUCTION

Technological change, changing consumer preferences, and increasing pressure on public timber resources, has created new interest in aspen production in Saskatchewan. Aspen is now an important input into pulp production and, of the two pulp mills in Saskatchewan, one relies on aspen as its primary source of fibre. In 1991, 58% of the pulpwood produced in Saskatchewan was hardwood, a large proportion of which was aspen (Canadian Council of Forest Ministers 1992). Currently, industrial forest products firms are allocated timber from Crown forests through tenure agreements with the Provincial government. Although current timber allocations are sufficient to support tenure holders processing plants, the long-term availability of this timber is uncertain. Many firms believe that their current allocation of timber will be reduced in the future because of increasing pressure on public forest resources from other stakeholders such as aboriginal communities, environmental groups, and recreational users. This has lead many industrial forest products firms to consider alternative sources of fibre including: intensive management of existing stands, the establishment of plantations of either native or improved aspen, and/or harvesting fibre from privately owned land.

The objective of this paper is to examine the economic feasibility of intensive management of hybrid aspen on private land in northwestern Saskatchewan. The research focuses on a case study around Meadow Lake, Saskatchewan however, the results of this analysis may be relevant for the Mixedwood Belt of Saskatchewan, and similar regions across the prairie provinces. Threshold analysis is used to identify the break-even price under three scenarios: a plantation established on bush land[1]; a plantation established on pasture[2] land; and a plantation established on hay land. The paper first provides background to the study, the assumptions of the model are then outlined, and the base parameters defined. The results are tested for sensitivity to changes in a number of variables. The paper concludes with some discussion of the findings and suggestions for future research.

---

[1]In Saskatchewan, land that is tree covered is frequently referred to as bush land. In this study, bush land refers to any land with a merchantable stand of aspen.

[2]Pasture land refers to land that is used for grazing. Such land is typified by some tree cover, swamp or marsh, and grassland. The land differs from bush land in that, although there may be trees on the land, they are not merchantable.

BACKGROUND

Aspen may be managed through either extensive or intensive forest management. Extensive and intensive management can be differentiated by the amount of money invested in silviculture, the frequency and intensity of harvesting, and the balance between concern for future returns versus concern for immediate returns (Smith 1986). Extensive forestry is more common in remote areas and/or poor sites. Anderson (1980) describes an intensive management system as one in which there is gene pool manipulation, land preparation, fertility and pest management, and selection and control of stocking levels. Intensive management of aspen may increase the value of a stand by increasing yields.

One form of intensive management is hybridization[3]. Anderson (1980) suggests that aspen is well suited to hybridization because it is very adaptable to different ecological conditions; has shown great potential for improvements to growth, form and wood properties; has produced rapid genetic gains through selection and breeding; and has demonstrated hybrid vigour. Hybrid aspen may also be suitable for other forms of intensive management, such as site preparation and disease control, because of their form, natural pruning, rapid growth, and suckering habits (Einspahr and Wyckoff 1978).

Plantations of intensively managed hybrid aspen could be established on either private or public land, however they may be more suited to private land because of the increased risk, and heavier regulation, on public land. On Crown land, forest products companies are allocated access to Crown timber reserves through Forest Management License Agreements (FMLA's). These agreements are usually for periods of twenty years, thus they do not guarantee tenure holders access to land for a whole rotation. Although FMLA's are renewed every five years for a twenty year period, there is no guarantee that they will continue in perpetuity, or that requirements will not be imposed or legislation changed in such a way that continued access to the land becomes effectively impossible. Furthermore, management decisions on public land must be approved by the provincial government and are subject to public scrutiny, thus it may be impossible for companies to undertake certain management activities such as herbicide use. On private land however, the owner purchases the right to use the land in perpetuity and land use regulations are less likely to be imposed. Forest managers may have more latitude in management systems, and be able to pursue a wider variety of harvesting options, on private land. Although public pressure may be equally intense if herbicides are used on private land, the government is less likely to invoke the Saskatchewan Environmental Assessment Act and require an Environmental Impact Assessment. An analysis of production by industrial landowners can be found in Salkie and White (1995).

---

[3]Hybridization is the process of crossing genetically unlike parents to produce offspring (Wyckoff et al 1992)

Hybrid aspen production on private land may also be desirable because timber production on private land may benefit the agricultural community and woodlots may be complementary to agricultural operations (Salkie 1993). Declining farm incomes and uncertainty regarding the future of traditional agricultural crops has affected individual farmers and has had a negative impact on the stability of rural communities. Diversification into private forestry may improve farm incomes and community stability. Furthermore, many farmers own land that, while marginal for crop production, may be good for producing trees and may already be tree covered.

Studies have investigated the feasibility of hybrid aspen production. A study by the Institute of Paper Science and Technology Aspen/Larch Cooperative at the University of Minnesota (Wyckoff 1991) analyzed the economic potential of growing hybrid aspen in the Lake States. Using a Faustmann[4] approach they maximized Soil Expectation Values (SEV) for hybrid aspen production under a variety of scenarios and compared the relative profitability of growing hybrid aspen, native aspen, and northern hardwoods. Hybrid aspen were more profitable than other species in all situations. Given a 4% discount rate, hybrid aspen production was feasible at stumpage prices of $\$_{US}10$/cord[5] (approximately $\$_{CDN}$ 5.7/m^3). At higher discount rates however, the stumpage price required for stands to yield a positive return increased until, at a 10% discount rate, a price of $30/cord (approximately $\$_{CDN}17/m^3$) was required. Although at the time of the study these prices were considered unrealistic, aspen stumpage recently sold for $\$_{US}30$/cord (approximately $\$_{CDN}17/m^3$) at sales in Minnesota[6]. A study by the Ministry of Natural Resources, Government of Ontario (MNF 1983) investigated hybrid poplar plantations. They found that at stumpage rates of $8/ODT (approximately $22.65/m^3) an operation could not cover the cost of land rental or purchase. Similar studies have not been conducted in the prairie region.

The economic feasibility of producing native aspen under extensive management systems in Saskatchewan and Alberta was also investigated. The Farm Woodlot Association of Saskatchewan (FWAS 1991) commissioned a report to evaluate Saskatchewan's private forest resource that included an economic evaluation of alternative woodlot operations. In this analysis they found that delivered wood prices needed to increase from $18.82/m^3 (the delivered price at the time the study was undertaken) to $33/m^3 before a grain farm - farm woodlot operation would cover all expenses and provide a return to labour of at least $10/hour. A study conducted by D.A. Westworth and Associates (1994) into the feasibility of native aspen

---

[4]For an explanation of the Faustmann approach see Pearse (1990) or Nautiyal (1988).

[5]An exchange rate of $\$_{CDN}1.40$ to $\$_{US}1$ was used in this study.

[6]Personal communication with Gary Wyckoff, Project Leader, Aspen/Larch Genetics Cooperative, University of Minnesota on February 6, 1995.

production in three locations around Alberta found that stumpage prices needed to increase from current prices of $1 to $2/m^3, to between $4 and $6.50/m^3 before a pulp wood producing operation could break even. Both these studies imposed a sustained yield requirement and woodlots had to produce revenue regularly throughout the rotation.

The assumption of sustained yield was relaxed in this study; stands were assumed to be harvested according to the optimal economic rotation. This methodology does not make cash flow more important than the present value of an operation. Rather than generate a regular income from periodic harvests, an income could be generated by harvesting large areas less frequently and investing the proceeds elsewhere to generate regular income. If it is more profitable to harvest the entire stand, and the non-market costs of doing so do not outweigh the financial benefits of harvesting, then, according to economic theory, the stand should be harvested and regenerated, and the capital invested elsewhere.

METHODS

The study area was defined as the area within 100 km of Meadow Lake Saskatchewan. This location was selected for its proximity to the Millar Western Pulp Mill in Meadow Lake; a closed loop BCTMP mill that uses aspen as its primary input. Separate analysis was conducted for plantations on land that was purchased and plantations on land that was rented. In all scenarios the fibre was sold to Mistik Management Ltd, the company that runs the woodlands division of the pulp mill, as stumpage (standing timber).

Land prices were based on recent land sales in the region; however actual prices may vary depending on the exact location and quality of the land. Real estate markets for forested land are relatively undeveloped in the region and land prices for bush do not capture the value of standing aspen. Thus, it is still possible to purchase forest land for approximately $155/ha and subsequently sell the standing bush for $350/ha. This is likely because markets for aspen are relatively new, and potential sellers and buyers are frequently unaware of opportunities to sell wood fibre. Owners were also responsible for property taxes with tax levels being identified in consultation with local governments. Rental rates were based on current rates for alternative uses of the land[7]. Grazing was assumed to be the alternative use of bush and pasture land and rental rates were derived according to the average carrying capacity of the land, assuming the land was grazed five months per year. The rent paid for hay land was set according to rates charged to rent land for hay production.

[7]Personal communication with Dave Cubban, Saskatchewan Agriculture and Food on May 13, 1994.

Table 1 summarizes the land prices, rental rates, and annual taxes used in this analysis.

Table 1 Land purchase price, rental rates, and annual taxes

Land Type	Purchase Price[7] ($/ha)	Rental Rate[8] ($/ha/year)	Annual Taxes[9] ($/ha/year)
Bush land	$154.44	$25.00	$1.50
Pasture land	$278.00	$50.00	$1.75
Hay land	$386.10	$50.00	$2.35

[7]Personal communication with Stuart McNabb, Farm Credit Corporation Canada, April 13, 1994.
[8]Personal communication with Dave Cubban, Saskatchewan Agriculture and Food, May 13, 1994.
[9]Tax rates were provided by the Rural Municipality of Meadow Lake no. 588 and the Rural Municipality of Beaver River no. 622 on April 27, 1994.

Growth and yield data for hybrid aspen are not readily available. Very little research has occurred on the prairies and, although research into hybrid aspen has occurred in the Lake States and Ontario, growth and yield relationships have not been identified in these areas. Li et al (1993) suggest that hybrid aspen may have double the volume growth, better wood density, longer fibres, and better wood/pulp properties than native aspen. Einspahr (1984) indicated that better triploid aspen grows approximately twice as fast as native aspen. Li, Wyckoff and Einspahr (1993) estimated that the volume growth of hybrids would likely be double that of native aspen due to increased height and dbh. According to these references and personal communication with Dave Cheyne[8] and Gary Wyckoff a modified yield table was developed to estimate the growth of hybrid aspen. Yields were developed by increasing 'medium site' yields[9] of native aspen stands in the Mixedwood belt of Saskatchewan by 50% in the poor scenario, by 100% in the medium scenario, and by 200% in the high scenario. A straight line growth function between the ten year increments identified by Kirby (1957) was assumed

[8]Dave Cheyne is Aspen Specialist with the Aspen Resource Centre, Canadian Forest Service, Natural Resources Canada.

[9]Kirby (1957) developed yield tables for native aspen stands in the Mixedwood belt of Saskatchewan. The tables are based on three site conditions: low; medium; and high.

in order to develop modified yield tables at five year increments. This modified yield table is included as Table 2.

Table 2 Estimated yields of hybrid aspen stands in the Mixedwood Belt of Saskatchewan

Age (years)	Poor Merchantable Volume (m^3/ha)	Medium Merchantable Volume (m^3/ha)	High Merchantable Volume (m^3/ha)
30	10.65	14.20	21.30
35	32.10	42.80	64.20
40	53.55	71.40	107.10
45	93.90	125.20	187.80
50	134.25	179.00	268.50
55	185.40	247.20	370.80
60	236.55	315.40	473.10
65	263.78	351.70	527.55
70	291.00	388.00	582.00
75	308.48	411.30	616.95

It is difficult to project prices in a new market. Historical records could not be used to estimate future prices because, until 1991, no substantive markets existed for aspen in Saskatchewan. However markets have existed for softwoods in Saskatchewan, and for native aspen in the mid-west United States for some time. These markets may give an indication of future price levels because these products may be considered substitutes for hybrid aspen in Saskatchewan. Softwood stumpage in Saskatchewan is approximately \$17/m^3 (\$20/t) and aspen recently sold for $\$_{us}$30/cord (approximately $_{CDN}\$$ 17/m^3) at auction sales in Minnesota. One approach to this analysis could be to identify the maximum SEV given the current stumpage price of \$2/m^3, the softwood stumpage price of \$17/m (\$20/t), and the price in Minnesota of approximately \$17/m^3. The analysis, however, would be based on unsubstantiated prices, and prices for native aspen (which differ from hybrid aspen). An

alternative approach is to calculate the threshold price required to break even in each scenario. This methodology is based on the Faustmann criterion in which the SEV, or soil rent, is maximized. Rather than maximizing the SEV, however, threshold analysis identifies the price at which the Net Present Value (NPV) equals zero, and thus identifies a break even price.

A strategy for site preparation, stand establishment, and stand management was developed for each scenario in consultation with selected silvicultural and agricultural experts: Dave Cheyne, Canadian Forest Service; Dave Cubban, Saskatchewan Agriculture and Food; Harvey Yoder, Alberta Agriculture and Food; and Derek Sidders, Canadian Forest Service. A minimum stand size of ten hectares was assumed to meet economies of scale associated with land clearing, stand establishment, and harvesting. The aspen was managed as an even aged stand with each hectare planted at the beginning of the rotation, clear cut at the economically optimal rotation, and allowed to regenerate naturally through suckering. The initial planting was assumed to keep the land forested in perpetuity; however, a replant of 10% was included after each harvest to allow for losses due to damage, compaction, and disease. Although the Ministry of Natural Resources, Government of Ontario (MNF 1983) suggested that a root system can only support four to ten rotations, in this analysis it was assumed that one stand could support an infinite number of rotations[10]. Minimal management would be required after planting because, with adequate site preparation, planted aspen should out-compete weeds. An annual management expense of $1/ha was allocated to cover costs associated with visiting the site, telephone and office expenses, pest control, and other management activities. Landowners are not responsible for road construction or maintenance when selling stumpage to Mistik Management Ltd.

A base stocking rate of 2000 trees/ha was assumed. The suggested stocking rate ranged from approximately 1000 trees/ha to 4000 trees/ha (Wyckoff 1991; MNF 1983; Lester, In Process). Different stocking levels may affect stand density, growth, and disease and pest resistance (Lester, In Process) however, due to the poor growth and yield data available, it was not possible to estimate the affect of these changes on aspen yields. To illustrate some of the effects that different stocking levels may have on yields, the percentage yield change needed to achieve the same threshold prices at different stocking levels was calculated. The results were tested for sensitivity to stocking rates of 1400 trees/ha and 2700 trees/ha. Planting stock were assumed to cost $.20/tree and tree planting $0.15/tree[11].

---

[10] Note that this assumption does not affect the results because expenses and income derived after the fourth rotation do not change the present value of the operation.

[11]These costs were taken from Lester (In Process), MNF (1983), and from personal communication with David Harman, Mistik Management Ltd.

Prior to planting hybrid aspen on bush land the native aspen is harvested and the root system is eradicated. Suckers from native aspen will likely out-compete planted seedlings if the root system is not controlled because native aspen suckers are more shade and frost tolerant, have better initial growth, and produce a denser tree cover than seedlings (Sims et al 1990). It is not necessary to remove tree stumps and convert the bush land to a field prior to planting because seedlings can be planted in uneven terrain. Any grasses, herbaceous weeds, and shrubs on the site are controlled through a combination of cultivation and chemical treatments. Table 3 details the associated management regime and costs.

The analysis assumes all merchantable timber is sold as stumpage. The value of standing aspen varies considerably between sites[12] with standing volumes ranging from $100m^3$/ha to $200m^3$/ha, and prices from \$1/m^3 to \$3/m^3. A representative value of \$350/ha was assumed based on a volume of 175 m^3/ha sold at \$2/m^3.

Table 3 Management regime and associated revenues and costs required to eradicate standing aspen and establish hybrid aspen on bush land

Year of Activity	Management Activity	Cash Flow (\$/ha)
0	harvest in winter	350.00
0	strip shear blade	-250.00
0	mechanical control with a forestry mixer	-150.00
0	spray	-70.00
1	spray	-33.36
1	2 passes with cultivator	-14.52
1	Planting at 2000 trees/ha	-700.00

To establish a hybrid aspen plantation on pasture or hay land, some weed control is required. A combination of chemical and mechanical vegetation control are used in this analysis. Since pasture land was assumed to have minimal tree coverage, no

[12]Expected volumes and stumpage prices were obtained through personal communication with David Harman on May 12, 1994.

additional site preparation would be required over that required to prepare hay land for planting, however the cost of site preparation on pasture would increase with increasing tree cover. Table 4 outlines the management activities, and associated costs, required to plant pasture or hay land with hybrid aspen.

Table 4 Management regime and associated costs required to establish hybrid aspen on pasture or hay land

Year of Activity	Management Activity	Cash Flow ($/ha)
0	spray in late summer with glyphosate	-33.36
0	3 weeks later 4 passes with cultivator	-29.04
1	Planting at 2000 trees/ha	-700.00

The analysis was executed on a spreadsheet developed using Quattro Pro 5.0. The optimum economic rotation and threshold price for each scenario were identified using discount rates of 3%, 4%, 6%, and 8%. The results were tested for sensitivity to changes in discount rates, stocking rates, and the value of standing bush.

RESULTS

The stumpage price at which hybrid aspen plantations would break even on owned and rented bush, pasture and hay land were calculated; the results are presented in Table 5. Observations of more established markets, such as those for softwoods in Saskatchewan and hardwoods in the United States, suggest that prices may easily rise to $\$17/m^3$. Under some assumptions the results of this analysis were consistent with this expectation, however in several scenarios the break even price exceeded $\$100/m^3$. To reach $\$100/m^3$ within 60 years, the price would have to increase 6.7% per year. Since the lowest threshold price was $\$175.64/m^3$ when a discount rate of 8% was assumed, this analysis is not presented in the paper.

Table 5 Threshold stumpage price for hybrid aspen production

	Owned Land			Rented Land		
	Poor Yield	**Medium Yield**	**High Yield**	**Poor Yield**	**Medium Yield**	**High Yield**
Discount Rate = 3%:						
Bush Land ($/m^3)	23.38	17.54	11.69	36.78	27.58	18.39
Pasture Land ($/m^3)	23.81	17.86	11.91	51.99	38.99	26.00
Hay Land ($/m^3)	26.55	19.91	13.27	51.99	38.99	26.00
Discount Rate = 4%						
Bush Land ($/m^3)	44.50	33.37	22.25	62.62	46.97	31.31
Pasture Land ($/m^3)	45.38	34.04	22.69	84.09	63.07	42.04
Hay Land ($/m^3)	50.54	37.91	25.27	84.09	63.07	42.04
Discount Rate = 6%						
Bush Land ($/m^3)	138.52	103.89	69.26	170.60	127.95	85.30
Pasture Land ($/m^3)	141.49	106.12	70.75	212.51	159.38	106.25
Hay Land ($/m^3)	157.49	118.12	78.75	212.51	159.38	106.25

The optimum economic rotation age for hybrid aspen ranged from 55 to 60 years depending on the assumed discount rate. At discount rates of 3% and 4% the optimum economic rotation was approximately 60 years, and at 6% it was 55 years. The rotation age was not affected by either the type of land or the expected growth rate.

Sensitivity analysis was used to investigate the impact of changing the stocking level from 2000 trees/ha. Alternative scenarios were run using stocking levels of 1400 trees per hectare and 2700 trees per hectare. When the stocking rate was increased or decreased by 35% on owned pasture and bush land, the yield had to either increase or decrease, respectively, by approximately 22% and 19% to maintain the initial threshold price. On owned hay land, yields had to increase by approximately 20%, or decrease by approximately 17%, in order to retain the same threshold price. The effect of stocking rate on rented land was less than on owned land, with yields needing to decrease by between 8% and 16% to compensate for lower stocking rates, or to increase by 10% to 18% for higher stocking rates. The results are presented in Table 6.

Table 6 **Yield changes required to retain a constant threshold price for hybrid aspen production at different stocking levels on medium level land**

	Owned Land			Rented Land		
	1400 trees/ha	**2000 trees/ha**	**2700 trees/ha**	**1400 trees/ha**	**2000 trees/ha**	**2700 trees/ha**
Discount Rate = 3%:						
Bush Land ($/m^3)	-18.9%	0	+22.1%	-12.0%	0	+14.1%
Pasture Land ($/m^3)	-18.5%	0	+21.6%	-8.5%	0	+9.9%
Hay Land ($/m^3)	-16.6%	0	+19.4%	-8.5%	0	+9.9%
Discount Rate = 4%:						
Bush Land ($/m^3)	-19.2%	0	+22.4%	-13.6%	0	+15.9%
Pasture Land ($/m^3)	-18.7%	0	+21.9%	-10.1%	0	+11.8%
Hay Land ($/m^3)	-16.8%	0	+19.6%	-10.1%	0	+11.8%
Discount Rate = 6%:						
Bush Land ($/m^3)	-19.4%	0	+22.7%	-15.8%	0	+18.4%
Pasture Land ($/m^3)	-19.0%	0	+22.1%	-12.6%	0	+14.7%
Hay Land ($/m^3)	-17.0%	0	+19.9%	-12.6%	0	+14.7%

The model was also examined for sensitivity to changes in the value of standing bush. Each hectare of bush was assumed to have a stumpage value of $350/ha in the base case, reflecting an average volume of 175 m^3/ha sold at $2/$m^3$. When the value of the standing bush was increased to $600/ha, to represent a scenario in which the initial volume of 200 m^3/ha sold for $3/$m^3$, the threshold prices decreased by approximately 24% on owned land, and between 14.5% and 20% on rented land. Table 7 presents the results of this sensitivity analysis.

Table 7 Threshold stumpage and percentage decreases price for hybrid aspen production on bush land when the value of standing aspen increases from $350/ha to $600/ha

	Owned Land			Rented Land		
	3%	4%	6%	3%	4%	6%
Poor Land ($/$m^3$)	18.05	34.03	104.72	31.45	52.16	136.8
Medium Land ($/$m^3$)	13.54	25.52	78.54	23.59	39.12	102.6
High Land ($/$m^3$)	9.03	17.02	52.36	15.73	26.08	68.4
Percentage Decrease	22.8%	23.5%	24.4%	14.5%	16.7%	19.8%

DISCUSSION

The results of this analysis suggest that, in some situations, hybrid aspen production may be financially feasible on private land in Saskatchewan. Hybrid aspen production is generally most profitable on bush land; on owned land the break even price of a plantation established on bush land was approximately 2% lower than one established on pasture, and 13% lower than one on hay land. However this is due to failures in the markets for bush land. At the present it is possible to purchase an area of bush land for less than the value of the timber growing on the land. As the market corrects this failure, the benefit of producing hybrid aspen on bush land will likely decrease and, since the cost of preparing bush land for a hybrid aspen plantation exceeds the value of harvesting the standing bush, plantations on bush land are likely to become the least feasible of the three land types. Hay land may have a higher threshold price because it costs more to purchase and has higher tax rates. Although planting trees on an area of land may change the tax rate in the

future, it does not currently affect the tax rate. If tax rates were to increase or decrease, the threshold price would also rise or fall respectively. However, because taxes represent a small proportion of the total costs of operating a hybrid aspen plantation, the effects of such changes on the feasibility of a plantation would likely be negligible.

On rented land there was no difference between the break even price on pasture or hay land because the assumed site preparation and annual rental costs for the two sites were the same. However, pasture land with more tree cover would require more extensive site preparation thus the threshold price would increase. The break even price on rented bush land ranged from 42% to 24% less than the break even price on pasture and hay land, depending on the discount rate. Rented land was more sensitive to changes in the discount rate than was owned land because the cost of land procurement is spread out over the life of the investment. In this case the discount rate affects both land costs and the value of future crops, instead of just the value of future crops as is the case when the land is owned.

The model was very sensitive to changes in the discount rate, due to the long time periods between harvests. Many of the costs and revenues in hybrid aspen production occur 50 to 60 years after planting, thus they are less significant to the profitability of the operation than small changes in the cost of stand establishment, or in the volume and value of standing timber. Furthermore, hybrid aspen plantations are likely only feasible if the discount rate is 3% or 4%. When the discount rate is 6% or greater, stumpage prices would have to rise to $\$69.26/m^3$ for an operation to be economically viable in any scenario.

Sensitivity analysis was used to examine the influence of changes in a number of parameters. Although the study was limited by the lack of information about growth and yield of hybrid aspen, sensitivity analysis demonstrated that the stocking level has considerable effect on the feasibility of a plantation. Yields have to change substantially at different stocking levels in order not to impact the threshold price. As the value of standing bush increased, the threshold price for a plantation established on bush land decreased. However, since higher standing bush values actually reflect on the existing stand of native aspen, and not on the hybrids planted on the site, the same effect would be observed if the land was left in native aspen, or cut and converted to some alternative land use.

Alternative land uses were not considered in this analysis. Land suitable for hybrid aspen plantations could also be used for grazing, crop production, hay production, and plantations of other trees. Even if a decision had been made to produce wood fibre on a tract of land, native aspen may be a more feasible production option when the plantation is established on bush land. Other studies, that imposed a sustained yield requirement, found that break-even prices ranged from $4 to $\$6.50/m^3$ for stumpage, to a delivered price of ^{3} $33/m . Given these results it seems

likely that native aspen plantations may be more feasible than hybrid aspen plantations when established on bush land. If the stand were established on pasture or hay land however, the threshold price would be lower for hybrid aspen than for native aspen because both plantations have to cover the cost of site preparation and planting but, since hybrids grow faster than native aspen, they may be more profitable.

CONCLUSIONS

Hybrid aspen production on private land in northwestern Saskatchewan may be viable in some situations, however the profitability depends on the assumed discount rate, establishment costs, and growth rates of the hybrids. Aspen plantations also provide a number of non-market benefits, in addition to the market benefits of fibre production. If the value of these non-market benefits are added to the value of the timber, hybrid aspen plantations may be feasible in a greater variety of situations.

A more detailed analysis of hybrid aspen production would require more information about the silvics of hybrid aspen. Genetic research is needed to develop hybrid aspen suitable for production in northwestern Saskatchewan, and to identify reasonable growth and yields for such stands. Further research is also required to identify: optimum stocking rates, and the effect of changes in stocking rates on biomass production; requirements for stand establishment and vegetation control; the risk of loss to disease and pests, and possible control mechanisms; and likely responses to management techniques such as fertilization and irrigation.

Even when growth and yield triples through hybridization, however, it may be more profitable to manage existing native aspen stands than to replant a bush area with hybrids. Hybrid aspen may only out perform native aspen when plantations are established in pasture or hay fields. If the costs for genetic research and seedling development were incorporated into a feasibility study of aspen production, then native aspen production may be more profitable in all situations. This analysis suggests that research should focus on improving native aspen stands rather than developing a hybrid aspen program.

REFERENCES

Anderson, H.W. 1980. Intensive management of hybrid populus. The Forestry Chronicle, 56(4): 171-173.

Canadian Council of Forest Ministers. 1992. Compendium of Canadian Forestry Statistics 1991. National Forestry Database.

D.A. Westworth & Associates. 1994. Aspen wocdlot feasibility study. Publication No. I/529, Canada-Alberta Partnership Agreement in Forestry.

Einspahr, D.W. and G. Wyckoff. 1978. Growth response of hybrid aspen to intensive forest management, Tappi, 61(3): 49-52.

Einspahr, D.W. 1984. Production and utilization of triploid hybrid aspen, Iowa State Journal of Research, 38(4): 401-409.

Farm Woodlot Association of Saskatchewan. 1991. A current evaluation of Saskatchewan's Private Forest Resources. A report prepared for the Saskatchewan Agriculture Development Fund, Regina, Saskatchewan.

Kirby, C.L. 1957. Growth and yield of aspen in Saskatchewan. Saskatchewan Department of Natural Resources and Industrial Development, Forestry Branch. Technical Bulletin 3. Regina, Saskatchewan.

Lester, D.T. In Process. Feasibility of plantation silviculture using poplars on agricultural lands of western and central Alberta. A report to be published under the Canada-Alberta Partnership Agreement in Forestry.

Li, B., Wyckoff, G.W., and D.W. Einspahr. 1993. Hybrid aspen performance and genetic gains, Northern Journal of Applied Forestry, 10(3): 117-122.

Ministry of Natural Resources, Government of Ontario. 1983. New forests in eastern Ontario: hybrid poplar. Science and Technology Series, Volume 1.

Nautiyal, J.C. 1988. Forest economics: Principles and applications. Canadian Scholars' Press Inc., Toronto.

Pearse, P.H. 1990. Introduction to forest economics. University of British Columbia Press, Vancouver.

Salkie, F.J. 1993. An economic analysis of sustainable forest management on farm woodlots in Saskatchewan. Unpublished M.Sc. Thesis. Department of Rural Economy. University of Alberta.

Salkie, F.J. and W.A. White. 1995. A financial analysis of hybrid aspen production by a pulp mill in northwestern Saskatchewan. PAIF report.

Sims, R.A., Kershaw, H.M., and G.M. Wickware. 1990. The autoecology of major tree species in the north central region of Ontario. COFRDA report 3302, Canada-Ontario Forest Resource Development Agreement, and NWOFTDU Technical Report 48, Ontario Ministry of Natural Resources.

Smith, D.M. 1986. The practice of silviculture. John Wiley and Sons, New York.

Statistics Canada. 1991. Logging Industry, 1991. Catalogue 25-201 Annual.

Wyckoff, G.W. 1991. Report Two: A progress report to cooperative members. University of Minnesota, Institute of Paper Science and Technology. Aspen/Larch Genetics Cooperative.

Wyckoff, G.W., Bailian, L. and T. Humenberger. 1992. Report Three: A progress report to cooperative members. University of Minnesota, Institute of Paper Science and Technology. Aspen/Larch Genetics Cooperative.