Forest industry investment in tree improvement – a wise business decision or a bottomless pit? Answers from a new tree improvement valuation model for Alberta, Canada

by Stefan G. Schreiber¹ and Barb R. Thomas¹

ABSTRACT

Continued investment in tree improvement (TI) in Alberta is currently at a crossroads despite the demonstrated benefits of TI worldwide. According to private industry, the major roadblock for further investment is the minimal amount of genetic gain currently recognized in the annual allowable cut (AAC) set by the provincial government. In order to better understand the key parameters that drive profitability in TI programs, we developed the “Tree Improvement Investment for Forestry in Alberta” valuation model (TIIFA). Besides the large effect of the annual discount rate, sensitivity analyses using the TIIFA model revealed that not only genetic gain, but also the area on which improved seed is deployed represent key parameters influencing the profitability of TI programs. Furthermore, results show that the benefits of TI programs largely outweigh associated program costs, whether they were set at \$1, \$3 or \$5 million dollars per decade. We conclude that despite the current levels of genetic gain recognized in the AAC for private industry, investment in TI still remains a profitable enterprise and a viable option for increasing or maintaining timber supply, if the area planted is maximized on which improved seed is deployed.

Keywords: Alberta forestry, annual allowable cut (AAC), allowable cut effect (ACE), cost-benefit analysis, genetic gain

RÉSUMÉ

On remet présentement en question le maintien des investissements en amélioration génétique des arbres (*tree improvement-TI*) en Alberta malgré les avantages reconnus de cette pratique ailleurs sur la planète. Aux dires de l'industrie, le principal obstacle à la poursuite des investissements réside dans la faible portion de gain génétique pris en compte à l'heure actuelle dans la possibilité annuelle de coupe (*annual allowable cut-AAC*) calculée par le gouvernement provincial. Dans le but de mieux comprendre les paramètres-clés de la rentabilité pour les programmes d'amélioration (TI) nous avons élaboré un modèle d'évaluation intitulé « Meilleur investissement en amélioration génétique des arbres en Alberta » (TIIFA). Mis à part l'effet important du taux annuel d'actualisation, les analyses de sensibilité à l'aide du modèle TIIFA ont montré que ce n'est pas seulement le gain génétique, mais aussi la superficie sur laquelle on utilise les semences améliorées qui influencent le plus la rentabilité des programmes d'amélioration. De plus, les résultats indiquent que les avantages des programmes d'amélioration surpassent de beaucoup les coûts du programme, qu'ils soient de 1, 3, ou 5 millions de dollars par décennie. Nous en sommes venus à la conclusion que, malgré les niveaux actuels de gain génétique pris en compte dans le calcul de la possibilité annuelle de coupe pour l'industrie, les investissements en amélioration demeurent une option viable et rentable pour accroître ou simplement stabiliser l'approvisionnement en matière ligneuse, à condition de maximiser les superficies plantées avec des semences génétiquement améliorées.

Mots clés : foresterie en Alberta, possibilité annuelle de coupe (AAC), effet de possibilité, analyse coûts-bénéfices, gain génétique

Stefan G. Schreiber

Barb R. Thomas

Introduction

Alberta practices sustainable forest management where harvest takes place on designated Crown forest lands with cut levels approved by the Government of Alberta (GOA) through an annual allowable cut (AAC). Forest companies operate in a Forest Management Agreement (FMA) area where the FMA is renegotiated every 20 years with the GOA (SRD 2011). This area-based tenure system provides a steady timber supply for the operating forest company, which in turn is responsible for the management of the forest within their respective FMA areas, such as providing infrastructure, silvicultural treatments and post-harvest reforestation. Every FMA holder is required to prepare a Forest Management Plan

¹Department of Renewable Resources, University of Alberta, 442 Earth Sciences Building, Edmonton, AB T6G 2E3, Canada; corresponding author's email: stefan.schreiber@ualberta.ca

(FMP), which is a collaborative process involving the public, First Nations, the forest industry, other resource users and various provincial agencies. FMPs are renegotiated and submitted every 10 years and cover a forest planning horizon of 200 years (SRD 2011).

The AAC given to private industry is determined by the GOA by means of permanent sample plots and statistical methods to predict future growth (SRD 2006, 2013). In order to access more cubic metres of wood, forest companies have the possibility to engage in a range of silvicultural activities, including tree improvement (TI), in order to increase volume gain and ultimately harvest. The objective of TI is to select and propagate trees with desired traits in order to attain high yielding, sustainable and healthy stands for reforestation. Large-scale tree improvement started in the 1950s and has since spread across the globe (Zobel and Talbert 1984, White *et al.* 2007). Tree improvement programs represent long-term investments especially for slow growing species such as those found in the boreal regions of Canada.

In Alberta, rotation ages vary from 80-100 years for species such as lodgepole pine (*Pinus contorta* Dougl. ex Loud.) and white spruce (*Picea glauca* (Moench) Voss) (AAF 2016a). These programs require a stable budget and a long-term commitment to maximize the benefits of TI. However, waiting 80-100 years for a return on investment is economically not feasible for the private sector. Yet to encourage private investment in TI and silvicultural treatments on Crown forests, the annual allowable cut effect (ACE) was discussed as a policy instrument in Canadian forestry (Luckert and Haley 1995) and was implemented in the Alberta Forest Management Planning Standards a decade ago (SRD 2006). The ACE was coined by Schweitzer *et al.* (1972) and defined as an “immediate increase in today’s allowable cut which is attributed to expected future increases in (timber) yields.” Whether or not the ACE is a legitimate policy instrument is not part of this study. The interested reader is referred to Luckert and Haley (1995), Hegan and Luckert (2000), Weetman (2002); however the possibility of having an ACE has motivated firms in the private sector to engage in TI where rotation lengths of 80-100 years alone would provide no incentive to invest. The expected future increases in growth due to silvicultural treatments or to tree improvement (genetic gain) have to be demonstrated via calculations based on permanent sample plots (as mentioned earlier), or ideally by establishing genetic realized gain trials (Stoehr *et al.* 2010), the latter currently in the planning phase for Alberta. Presently, there are seven tree improvement programs in Alberta (known as Controlled Parentage Programs) with an approved height gain of 2.3% on average (pers. comm. July 22, 2016, Andy Benowicz, Forest Genetics Specialist, Government of Alberta). Of these, only three companies incorporate the additional gain into their FMA Forest Management Plan (pers. comm. July 20, 2016, Darren Aitkin, Manager Forest Biometrics Group, Government of Alberta).

However, forestry companies in Alberta are concerned about the profitability and certainty of TI and therefore are reluctant to continue investing in already established TI programs. “*The low levels of genetic gain and its translation into the desired ACE, the long timelines for TI program development*

(i.e., decades), and the lack of certainty and risk aversion with Government approvals do not justify the expenses involved in TI” (pers. comm. February 1, 2016, Bob Winship, Forest Resources Manager, Weyerhaeuser Company Ltd.). This illustrates why private TI work in Alberta is currently at a crossroads to further investments and may not represent an attractive strategy to increase future harvest volumes.

Efforts to facilitate communication and co-operation between industry and government have been made. This communication started with a critical, industry-funded and internal (unpublished) report by Sklar (2012) entitled “*Tree Improvement Structure in Alberta*” (see Supplementary Material S1 for full report, provided with permission), which contributed to the development of an Industrial Research Chair in Tree Improvement at the University of Alberta. Sklar (2012) makes a strong point that: “*There is a serious risk of losing the tree improvement resources (expertise, facilities and materials) that have been developed to date. These resources will be needed in the next decade to address timber supply reductions from Mountain Pine Beetle surge cuts ending, land-base reductions, and adaptation to climate change [...]. Scarcity of financial and human resources will require that choices will have to be made and risks will have to be accepted. It will be impossible to please everyone and do everything. A structure with clearly assigned roles and responsibilities working towards clear goals is needed to efficiently use the available resources.*”

Since recommendations to elevate “enthusiasm” for TI work in Alberta were already made by Sklar (2012), the goal of this study was to develop a model that allows us to test the effects of different input values such as genetic gain, area planted with improved stock, costs associated with improvement, discount rates, in order to identify when TI programs become a viable investment option for forest industry. To the best of our knowledge, there is no cost-benefit analysis present in Alberta that seeks to answer this question. In British Columbia however, the TIIP model (Tree Improvement Investment Priorities and Value in British Columbia) has been developed and is used to value and rank TI programs across the province in order to prioritize investment for publicly-owned land (Woods 2002). In BC, most breeding and progeny testing costs are borne by the provincial government, with input on priorities from the Forest Genetics Council (FGC) of BC, a government-industry-university cooperative. With permission from the author (J. Woods, FGC Manager), we largely modified the TIIP model to reflect our goal as well as the situation in Alberta and renamed it to “Tree Improvement Investment for Forestry in Alberta” valuation model (TIIFA) which is publicly available in the Supplementary Material (Supplementary Material S2: TIIFA valuation model).

In summary, our first objective was to develop a model that helps private industry to evaluate whether or not investment in tree improvement is a profitable enterprise. Our second objective was to identify the key drivers that maximize wood volume and revenue in industry-held tree improvement programs. Our third objective was to assess which of these drivers are the most promising ones to manipulate for private industry under current forest management policies.

Model description

To assess the value of tree improvement in industrial programs in Alberta, three Excel spread sheets were developed to allow individual companies to input information specific to their own Controlled Parentage Programs (CPPs) and calculate the additional volume of wood (m³) and associated revenue in the form of net present values (NPVs) over a 200-year planning horizon (i.e., roughly two rotations). This cost-benefit analysis is built under the assumption of receiving the allowable cut effect (ACE), which is an increase in the near-term annual allowable cut based on expected increases of future harvest volumes due to tree improvement and other silvicultural activities.

The TIIFA valuation model consists of three working sheets named INPUTS, VOLUME, and NPV (net present value). The INPUTS sheet requires values for all cells which are highlighted in red (see also Table 1). Changing these values will automatically update the output values in the VOLUME and NPV sheets. The VOLUME sheet calculates the amount of wood volume generated with and without tree improvement work. Note that genetic gain in Alberta is calculated as height gain and not volume gain. In order to translate height gain into volume gain, which is required as a model input, it is multiplied by the factor two until more data is available to refine this conversion of gain (pers. comm. July 15, 2016, Darren Aitkin, Manager Forest Biometrics Group, Government of Alberta). The NPV sheet calculates the net present values, or in other words, the discounted difference between revenue and costs per decade over a 200-year planning horizon.

Input values

Note: Our chosen input values only represent an example of possible values. Depending on who evaluates those numbers they may be too conservative and not realistic. Our intent was to demonstrate the effect of different values and how it changes the model output. Ultimately, each program manager should input more realistic numbers to obtain more accurate predictions.

- a. **Present volume gain (%)** (cell C7): Current volume gain in percent for the tree improvement program under consideration.

- b. **Annual discount rate (%)** (cell C8): The rate used to discount costs and benefits over a 200-year planning horizon, see NPV (net present value) work sheet.
 - i. The **decade discount rate** is calculated as: $((1 + \text{discount rate})^{10}) - 1$ (see cell C10).
 - ii. **Year 1 PV as a ratio of gross non discounted value** (10-year period) calculated using the following formula in Excel: $(\text{NPV}(\text{discount rate}, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100)) / 1000$ (see cell C11).
- c. **Total number of seedlings planted per decade** (cells C16–C35).
- d. **Number of seedlings planted per hectare** (cells D16–D35).
- e. **Average dollar value per m³ wood** (cells E16–E35): This can be different for different organizations and should be taken into account as it will affect the net present value calculations. In our case, this value represents a comprise between unsecured “open market” purchase price for timber (\$60–\$80) and what industry is willing to pay for a 20-year allocation (quota) of annual allowable cut (AAC).
- f. **Total area planted per decade (ha)** (cells F16–F35): This is calculated from *Total number of seedlings planted / Number of seedlings planted per hectare* and is not needed as a separate input value.
- g. **MAI (m³/ha/yr)** (cells G16–G35): Mean annual increment in growth in cubic metres per hectare and per year until harvest, (i.e., rotation age).
- h. **Rotation age** (cells H16–H35): Years from planting to stand harvest.
 - i. **Expected volume gain per decade (%)** (cells I16–I35): Expected gain in stand volume with improved seed relative to wild seed expressed as a percentage.
 - j. **Area planted with improved seed per decade (%)** (cells J16–J35): A percentage of the total area (F16–F35) which receives improved stock.
 - k. **Tree improvement program costs per decade** (cells K16–K35): This considers all costs related to tree improvement.

Output values

- I. **VOLUME** (expressed in million cubic meters (mm m³) per decade)

Table 1. Input values per decade for the TIIFA valuation model, fixed (A) and variable (B), i.e., used as inputs for sensitivity analysis

A Fixed input values		
Present volume gain (%)		4
Total number of seedlings planted per decade (millions)		50
Number of seedlings / hectare		1800
Average dollar value / m ³ wood		110
MAI (m ³ /ha/yr)		3
Rotation age		80
B Variable inputs (sensitivity analysis)		
Discount rate (%)		4, 8, 12
Expected volume gain (%)		1, 2, 3, 4 increase per decade until maximum of 30% is reached
Area planted with improved seed (%)		5, 10, 15, 20 increase per decade until 100% is reached
TI ¹ program costs per decade (million dollars)		1, 3, 5

¹Tree Improvement

- a. Without (w/o) tree improvement (TI)
 - i. **Total volume (million m³) w/o TI per decade** (cells C5–C24) = $MAI \times (Rotation\ age) \times Total\ area\ planted\ per\ decade\ (ha)$.
- b. VOLUME: Volume with tree improvement (TI)
 - i. **Volume from TI (million m³) per decade** (cells E5–E24) = $Total\ volume\ (million\ m^3)\ w/o\ TI\ per\ decade \times [Expected\ volume\ gain\ per\ decade\ (\%) - Present\ volume\ gain\ (\%)] \times Area\ planted\ with\ improved\ stock\ per\ decade\ (\%)$.
 - ii. **Volume increase from TI (%) per decade** (cells F5–F24) = $Volume\ from\ TI\ (million\ m^3)\ per\ decade / Total\ volume\ (million\ m^3)\ w/o\ TI\ per\ decade$.
- II. Net present value (NPV) (expressed in million dollars (mm\$) per decade)
 - a. **Timber sales discounted to year 1 of decade (million dollars)** (cells C7–C26) = $Average\ dollar\ value\ per\ m^3\ wood \times Volume\ from\ TI\ (million\ m^3)\ per\ decade \times Annual\ discount\ rate\ (\%)$.
 - b. **Program cost discounted to year 1 of decade (million dollars)** (cells D7–D26) = $TI\ program\ costs\ per\ decade\ (million\ dollars) \times Year\ 1\ PV\ as\ a\ ratio\ of\ gross\ non-discounted\ value\ (10y\ period)$.
 - c. **NPV per decade (million dollars)** (cells E7–E26) = $Timber\ sales\ discounted\ to\ year\ 1\ of\ decade\ (million\ dollars) - Program\ cost\ discounted\ to\ year\ 1\ of\ decade\ (million\ dollars) / (1 + discount\ rate)^{n-1}$, where n is the decade (1–20).

Model assumptions

“Essentially, all models are wrong, but some are useful.”

GEORGE E. P. BOX

The Tree Improvement Investment for Forestry in Alberta valuation model (TIIFA) is subject to assumptions and therefore represents a simplification of reality. The TIIFA model cannot guarantee whether its predictions will be realized. Nonetheless, the model may represent a useful tool in evaluating future tree improvement (TI) investments in order to gauge whether or not TI programs will be profitable in the long run. TIIFA assumes that:

1. Harvest and planting levels are constant. However, the model allows adjustment of each input value on a per-decade basis (see Supplementary Material S2: TIIFA model), which allows for flexibility with respect to future planting, growth and harvest scenarios over the 200-year planning horizon.
2. Mean annual increment (MAI, m³/ha/yr) estimates are derived from other statistical procedures and hence subject to assumptions made by the specific models used to derive those values, e.g., GYPSY (SRD 2009b) or MGM (Bokalo *et al.* 2013).
3. All planting is single species.

Results and Discussion

Our analysis revealed that *discount rate*, *genetic gain* and *area planted with improved stock* are the most sensitive parameters in the TIIFA valuation model. The discount rate has the biggest effect on profitability in tree improvement programs (Table 2A, B, C). For example, a potential scenario of 2% increase in volume gain per decade and 15% increase of area planted with improved stock per decade at a discount rate of 4, 8 and 12% results in net present values (NPVs) of \$59.35 mil-

Table 2. Sensitivity outputs of the TIIFA for the parameters, genetic volume gain and area planted with improved stock, expressed in net present values (million dollars) at 4, 8 and 12% discount rates (A, B, C) as well as volume increase (million m³) due to tree improvement (D). Costs associated with tree improvement were set at \$ 5 million/decade. All tables have a 200-year planning horizon. Dark grey represents net present values ≤ 0 dollars; light grey > 0 but ≤ \$ 5 million; no shading indicates net present values > \$ 5 million

Increase in area planted with improved stock per decade (over 200 years)					
	A	5%	10%	15%	20%
Genetic volume gain increase per decade (over 200 years)	1%	7.53	17.33	23.7	27.76
	2%	27.04	46.6	59.35	67.47
	3%	43.45	71.53	90.64	102.82
	4%	52.32	85.13	108.67	123.82
	B	5%	10%	15%	20%
	1%	-2.22	-0.76	0.58	1.71
	2%	1.82	4.74	7.41	9.67
	3%	5.81	10.16	14.18	17.56
	4%	7.89	13.19	18.13	22.29
	C	5%	10%	15%	20%
	1%	-2.39	-1.96	-1.54	-1.14
	2%	-0.61	0.25	1.09	1.89
	3%	1.17	2.45	3.72	4.91
	4%	1.88	3.44	4.98	6.43
	D	5%	10%	15%	20%
	1%	10.8	13.1	13.5	13.7
	2%	17.9	22.4	23.3	23.6
	3%	19.7	25.2	26.5	27.1
	4%	20.3	26.2	27.9	28.6

lion, \$7.41 million and \$1.09 million, respectively (assuming TI costs of \$5 million per decade). Although there is a large decrease in NPV as a function of the chosen discount rate, all three scenarios are profitable, i.e., NPV > \$0. The corresponding volume increase of this scenario by decade can be seen in Fig. 1.

With respect to increasing volume, we found that genetic gain has the largest potential to increase volume of merchantable timber in industry-owned tree improvement programs. However, we also observed that the area planted with improved seedlings can further increase timber volume significantly (Table 2D). Currently, deployment of improved seed represents approximately 15% of the area planted and is therefore a valuable parameter that can be increased by the forest companies. According to the new Alberta Forest Genetic Resource and Conservation Standards (AAF 2016a), FMA holders can deploy up to 100% improved seed on their land base if certain requirements such as maintaining effective population sizes are met. Therefore, maximizing improved seed deployment rates represents a valuable opportunity for forest companies to increase profitability of TI programs irrespective of additional increases in genetic gain. At

Fig 1. Volume gained from TI/decade in absolute (A) and relative (B) numbers. A 15% increase in area planted/decade was used as well as a 2% genetic volume gain increase/decade.

this point we should also note that on October 11, 2016, the Government of Alberta released the “Mandatory Use of Improved Seed for Reforestation” directive with the goal to enhance the deployment of improved seed for reforestation in Alberta (AAF 2016b). While increasing the deployment levels of improved seed on the land base appears to be a worthwhile effort, it also requires sufficient amounts of available seed. This is currently a limiting factor. However, in order to expand seed availability, the establishment of new seed orchards as well as breeding and progeny testing, requires additional investment. To test the effect of *Tree improvement program costs per decade (million dollars)* on overall profitability of TI programs, we conducted a sensitivity analysis with TI costs set at 1, 3, and 5 million dollars per decade representing 100, 300 and 500 thousand dollars per year, respectively (Note: These numbers are over estimations for the sake of the analysis; the actual number is closer to 50-70 thousand dollars

Fig 2. Influence of TI costs/decade at 4, 8 and 12% discount rates over a 200-year planning horizon. A 15% increase in area planted/decade was used as well as a 2% genetic volume gain increase/decade.

per year, or 500-700 thousand dollars per decade). The analysis showed that TI costs do not play a significant role in the overall profitability of TI programs at a given discount rate (Fig. 2). It therefore seems feasible to further invest in new seed orchards in order to maximize the amount of improved seed and increase the deployment rates as a means of increasing the amount of merchantable timber. Even with volume gain increments per decade as low as 2%, as long as the area planted with improved stock increases by 10% or more per decade and TI costs do not exceed \$5 million dollars per decade (Table 2), the continued investment will prove profitable.

According to the TIIFA model outputs, investments in TI is a business decision worth consideration if TI programs continue to grow over time and continuous investments are being made – either through selection and breeding in order to increase the genetic gain of the planting stock, by maximizing the area planted with improved stock, or both in combination. If maximizing the land area planted is the option selected, it is an interesting alternative approach to increasing the amount of merchantable timber as it does not require government approval and is therefore solely in the hands of private industry. Lastly, we would encourage everyone who is involved in tree improvement to test this model and suggest feedback to the authors for further improvement.

Acknowledgements

We would like to acknowledge in particular the assistance of Mr. Shane Sadoway, Blue Ridge Lumber, Mr. Bob Winship, Weyerhaeuser Company Ltd., Mr. Andy Benowicz and Mr.

Darren Aitken from the Government of Alberta and Mr. Jack Woods, Manager Forest Genetics Council of British Columbia and CEO SelectSeed Ltd., for their insight and time in the preparation of this manuscript. Funding for this manuscript has been provided through the Industrial Research Chair in Tree Improvement held by Dr. B.R. Thomas supported by the Natural Sciences Engineering Research Council (NSERC), Alberta-Pacific Forest Industries Inc., Alberta Newsprint Company Timber Ltd., Canadian Forest Products Ltd., Millar Western Forest Products Ltd., Huallen Seed Orchard Company Ltd., West Fraser Mills Ltd. (including: Alberta Plywood, Blue Ridge Lumber Inc., Hinton Wood Products, Sundre Forest Products Inc.), and Weyerhaeuser Company Ltd., (Pembina Timberlands and Grande Prairie Timberlands). Additional funding was also provided by the Government of Alberta.

References

- AAF. 2016a.** Alberta Forest Genetic Resource Management and Conservation Standards. Alberta Agriculture and Forestry, Government of Alberta, Edmonton, Alberta, 165 p.
- AAF. 2016b.** Directive: Mandatory use of improved seed for reforestation. Forestry Policy 2016, No. AF-FP-2016-02, Alberta Agriculture and Forestry, Government of Alberta, Edmonton, Alberta, 3 p.
- Bokalo, M., K. Stadt, P. Comeau and S. Titus. 2013.** The validation of the Mixedwood Growth Model (MGM) for use in forest management decision making. *Forests* 4:1–27.
- Hegan, R. and M.K. Luckert. 2000.** An economic assessment of using the allowable cut effect for enhanced forest management policies: An Alberta case study. *Can. J. Forest Res.* 30: 1591–1600
- Luckert, M. K. and D. Haley. 1995.** The allowable cut effect as a policy instrument in Canadian forestry. *Can. J. Forest Res.* 25: 1821–1829
- Schweitzer, D.L., R.W. Sassaman and C.H. Schallau. 1972.** Allowable cut effect: Some physical and economic implications. *J. Forest* 70: 415–418
- Sklar, D.A. 2012.** Tree Improvement Structure in Alberta. Unpublished report (see Supplementary Material S1 of this publication).
- SRD. 2006.** Alberta Forest Management Planning Standard. Alberta Sustainable Resource Development, Government of Alberta, Edmonton, Alberta, 114 p.
- SRD. 2009b.** A growth and yield projection system (GYPSY) for natural and post-harvest stands in Alberta. Alberta Sustainable Resource Development, Government of Alberta, Edmonton, Alberta, 22 p.
- SRD. 2011.** Forest Management Plans - Facts & Statistics. Alberta Sustainable Resource Development, Government of Alberta, Edmonton, Alberta, 5 p.
- SRD. 2013.** Annual Allowable Cut - Facts & Statistics. Alberta Sustainable Resource Development, Government of Alberta, Edmonton, Alberta, 9 p.
- Stoehr, M., K. Bird, G. Nigh, J. Woods and A. Yanchuk. 2010.** Realized genetic gains in coastal Douglas-fir in British Columbia: Implications for growth and yield projections. *Silvae Genet.* 59: 223–233
- Weetman, G. 2002.** Intensive forest management: Its relationship to AAC and ACE. *Forest. Chron.* 78: 255–259
- White, T.L., W.T. Adams and D.B. Neale. 2007. *Forest Genetics*. Cabi, Cambridge, MA, 682 p.
- Woods, J. 2002.** Tree Improvement Investment Priorities and Value in British Columbia, Forest Genetics Council of British Columbia, (Unpublished report).
- Zobel, B. and J. Talbert. 1984.** *Applied Forest Tree Improvement*. John Wiley & Sons, 505 p.

Tree Improvement Structure in Alberta

Recommendation

D. (Doug) A. Sklar

4/30/2012

Contents

Introduction	2
Benchmarking	3
Alberta Situation.....	5
Recommendations and Rationale.....	7
Conclusion.....	10

Executive Summary

To maintain effort in tree improvement activity in Alberta, two recommendations are advanced:

- (1) Set objectives for the use of improved seed and growth rates on reforested areas
- (2) Create an independent organization to focus on tree breeding and marketing of seed

Introduction

The enthusiasm for tree improvement work is at a low ebb in Alberta, primarily because timber yield increases from tree improvement are not seen as material in the short term. There is a serious risk of losing the tree improvement resources (expertise, facilities and materials) that have been developed to date. These resources will be needed in the next decade to address timber supply reductions from Mountain Pine Beetle surge cuts ending, landbase reductions, and adaptation to climate change. This report recommends changes in structures that are intended to encourage ongoing investment in tree improvement work and the efficient enhancement of tree improvement resources.

To date the focus on forest genetics has been essentially two-fold: conservation and tree improvement. Conservation and adaptation is primarily delivered by government whereas tree improvement is primarily delivered by the forest industry. The conservation and adaptation of forest genetic resources is a principle embedded in the philosophy of sustainable forest management and is addressed through policies such as seed zones and seed transfer rules, regulation of parent tree population size in tree breeding programs and limits on the deployment of improved seed. Genetic conservation work is a more passive than active endeavor, primarily attained through regulation. Tree improvement work on the other hand, requires active investment over a timeframe expressed in decades. In such a long time span, many uncontrollable factors (e.g. technological advances, social movements, political events) influence the economic and social valuation of forests, and timber. It is easy to see why enthusiasm for investment in tree improvement is difficult to maintain in a constantly changing business and political environment, so it is prudent to seek a structure that would encourage and facilitate ongoing investment. Since tree improvement work is largely delivered by industry, but is regulated by government, therefore a structure that promotes facilitation and co-operation, rather than one that is focused on conflict resolution, is in order.

Scarcity of financial and human resources will require that choices will have to be made and risks will have to be accepted. It will be impossible to please everyone and do everything. A structure with clearly assigned roles and responsibilities working towards clear goals is needed to efficiently use the available resources.

The following recommendations were developed by reviewing structures in other jurisdictions (benchmarking), assessing the current situation in Alberta, and then, relying on experience and insight, to create recommendations for a structure in Alberta. It is assumed that dramatic, large changes in structures are impossible to implement, so the recommendations focus on small changes that will generate significant results, relying on existing resources as much as possible.

This report does not include extensive review of the details but refers the reader to webpages with the information.

The recommendations will require a commitment to a new partnership, co-operative management, government leadership, and a resource commitment by both partners to long term goals. The recommendations are strategic rather than operational so do not address all the details that would need to be sorted out. It is assumed a results-oriented executive management system would provide the necessary leadership to address the operational matters efficiently.

Benchmarking

There is little useful information available on tree improvement structure in most of Canada. In Ontario, there are several industry co-operatives running orchards but there is virtually no provincial government involvement in tree improvement, other than some discussions on assisted migration to address climate change. New Brunswick has a government funded tree improvement program but there is little information available on provincial structures. After several unsuccessful attempts to contact tree improvement practitioners in eastern Canada, the effort was simply dropped to pursue more fruitful work.

British Columbia (BC) has active structure that warrants close examination. The Tree Improvement Branch in the Ministry of Forests, Lands and Natural Resource Operations (MFLN) has a very informative webpage (<http://www.for.gov.bc.ca/hti/>). This webpage, in conjunction with discussions with the Manager of the Forest Genetics Council of British Columbia (FGC), Jack Woods, provided a good understanding of how the tree improvement system works in BC. The key points are as follows:

- (1) The FGC has fourteen members representing MFLN, industry, the Canadian Forest Service and University of BC. ENGO's are not included. Seven Technical Advisory Committees (TAC) provide technical expertise. In total, there is a large number of people involved.
- (2) The FGC's mandate is to "lead" a provincial tree improvement program, by providing a forum for stakeholders to set objectives (aligned with MFLN objectives) and to "oversee" the development and delivery of business plans to meet these objectives. The FGC's management activities are reported in a five year strategic plan, annual business plans/budgets and annual reports (all available on the webpage). The FGC manager is the person primarily responsible for

facilitating (and mediating) the discussions needed to develop the plans and reports and keep the work moving ahead.

(3) The FGC operates seven subprograms:

- a. Genetic conservation-delivered by UBC and MFLN
- b. Tree Breeding – development of parent trees. Delivered by MFLN
- c. Operational Tree Improvement – increase quantity and quality of seed produced in orchards. Administered by MFLN and delivered in various orchards.
- d. Expansion of Orchard Seed Supply – SelectSeed Company Ltd formed to expand orchards. Also provides program management for FGC (approximately \$260K of a \$1.014 million budget in 2010-11). SelectSeed earns revenue (@\$350K in 2010-11) from sales of improved seed. The ultimate objective is to be cost neutral.
- e. Extension and Communication – managed by MFLN
- f. Genetic Resource Decision Support – no projects in 2010-11
- g. Cone and Seed Pest Management – delivered by MFLN

(4) The FGC business plans are approved and funded by the Provincial Chief Forester. The annual funding provided by the Chief Forester has recently been approximately \$3.5 million. Additional unquantified funds are derived from other stakeholders and all stakeholders provide additional in-kind support. Much of the work seems to be done by MFLN.

(5) Forest genetic resource management is seen as a co-operative effort. The MFLN leads most activities while both the MFLN and private industry manage seed orchards for the operational production of seed. Research is carried out by the MFLN, universities and the Canadian Forest Service.

(6) MFLN sets key objectives and standards. MFLN has set objective of an additional 7.1 million meters of timber supply in 65 years, 4.3 of which is expected to be provided through tree improvement. Section 7 of the Chief Foresters Standards for Seed Use requires that registered seed with a genetic worth of at least 5% be used for reforestation, if it is available.

(7) MFLN operates the seed centre and charges fees for the services provided. It is not mandatory to use the seed center to test and store seed for registration, but these tasks are so difficult that virtually all seed is handled through the MFLN seed center.

(8) The FGC was formed in the late 90's and it took a decade for the communication between the various specialties (geneticists, growth and yield staff, timber supply analysts, silviculturists) to become functional. The full-time manager of the FGC was often the mediator/facilitator to keep the discussions moving.

(9) The full-time FGC manager is pivotal in making the structure work.

The forest genetics and tree improvement structure in BC is large in scope and scale, very thorough, and very professional. The MFLN clearly dominates the structure and funds the activities. The FGC is essentially an arm of government that provides a vehicle for co-operative decision-making and consensus building amongst stakeholders. SelectSeed Ltd. introduces a business ethic to the production of improved seed. A simplistic summary of the roles and responsibilities is that MFLN provides the funding, scientific expertise and parent trees and then private industry takes over and grows the improved seed.

The objectives and standards set by MFLN incent and drive the work. The mandatory seed use standard in conjunction with the target for improved timber supplies are sufficient motivation to encourage productive co-operation.

Alberta Situation

Compared to BC, there is a much smaller forestry community in Alberta. There are fewer companies, fewer practitioners, and a relatively smaller government forestry department (SRD). Additionally, the energy industry dominates the political scene in Alberta and the political tone in the province is conservative and not amenable to big government. Consequently, it is assumed that there is a very low probability of emulating the level of government funding evident in BC.

The author assumes the readers are familiar with the current structure in Alberta so will not attempt to summarize the entire system but rather focus on the most relevant factors. For a refresher on forest genetics in Alberta, the webpage of the Alberta Forest Genetics Resources Council (AFGRC) (<http://www.abtree.com/>) provides an excellent summary for the reader.

There are several factors to be considered in a modified structure:

- (1) Performance survey results and related issues - several years ago the system for performance surveys changed from a plot-based free-to-grow standard to one that estimates MAI on reforested areas. Preliminary anecdotal results to date indicate that the MAI on many reforested sites is projected to be 20-30% greater than natural MAI's, although further work to verify these values is needed. This could be due to improved silvicultural practice (better site prep and better planting stock) when the free-to-grow standard was introduced in the early 90's, use of herbicides, or optimistic projections by the MAI model used (GYPSY), or some combination of these factors. With respect to GYPSY, SRD will be very cautious about granting large yield increases until confidence in the model projections can be improved. With respect to planting and herbicides, anecdotal opinions are that without the use of herbicides, planting would not be successful on many sites. It will be necessary to sort out these issues in order to determine how much improved seed will be needed in the future. This needs to include an assessment of the effectiveness of silviculture work by seed zone to determine how much planting is needed and the effect of improved seed on performance survey results, and, resolution of growth and yield protocols (GYPSY verification and genetic gain at minimum).
- (2) Deciduous standards - Although standards for seeds pertain to all species, in the development of the Alberta Forest Genetic Resources Management and Conservation Standards (FGRMS) (2009) (the equivalent of the Chief Foresters Standards for Seed Use in BC), the development of standards for clonal deployment (e.g. aspen or poplar species) was limited until further discussions could be held jointly between industry and government staff to address a more comprehensive set of standards. This review is currently underway. In the 2009 FGRMS, which are the current standards, clonal deployment of improved deciduous stock is limited to a

maximum of 15% of an opening or cutblock, and wellsites up to 2 hectares in size. Modified deployment rules for both reforestation (e.g. failed deciduous cutblocks), and reclamation of mine sites and linear features, are being addressed. With the recent approval of the first clonal CPP for balsam poplar in Dec. 2011, time is of the essence to encourage optimal utilization of material being produced from this program.

- (3) Conservative emphasis in Alberta's forest genetic standards - in comparing Alberta and BC's standards, it is noted that there is a greater emphasis in Alberta on conservation. This is manifested throughout the standards in and appears to be a considerable damper on tree improvement work in Alberta and could be relaxed with little increase in risk.
- (4) Risk management – policy requires a regular review of forest management plans and timber supplies to address changing circumstances and conditions. The goal is to use current information to gain feedback and adjust activities accordingly, i.e. implement the plan-do-check-adjust management system. Ongoing monitoring is critical and systems beyond traditional PSP's and RSA surveys are in order. In the event of unanticipated, catastrophic events (e.g. large fires, MPB) the plans are adjusted more frequently. Immediate reforestation with well-adapted, rapidly growing trees is the primary tactic assumed in the revised plans to minimize negative impacts of catastrophic changes in forest cover, consequently, the need for operational quantities of improved seed. .
- (5) Administrative mechanism - it is very difficult for SRD to administer work (e.g tender and administer contracts, hire employees, manage multi-year funding, attain grants or other sources of revenue) so several independent organizations (e.g. FRI, FRIAA) have evolved to address this matter. To advance tree breeding work, the administration will have to be done by an independent organization.
- (6) Granting and Softwood Lumber Agreement (SLA) compatibility – most grants are available only for research or work that is not an industry responsibility. Any government funding must not conflict with terms of the SLA, i.e. not fund work that is an industry responsibility. For example parent tree selection and testing would be considered operational research and thus eligible in whole or part for grant funding. Program administration costs would be considered a government expense and eligible for grant funding without SLA problems being created.
- (7) The carbon economy – it would seem there should be opportunities for revenue from carbon offsets from improved forest growth. Due to the complexity and nature of the protocols around carbon offsets this has proven difficult but effort on this topic should continue . Experience has shown that there is merit in pursuing credits from emission reductions (e.g. from eliminating slash burning, increased utilization) and currently this is where most of the effort is going.
- (8) Adapting to climate change – this concern is addressed in the work done by geneticists to develop stock adapted to the anticipated environmental conditions and in the delineation of seed zones and seed transfer rules. There is considerable interest in this topic and considerable grant funding available (e.g. CCEMC program) to partially address this concern in tree breeding work.
- (9) Human resources – there is a concern that much of the expertise needed is on the verge of retiring and that there are very few replacements available. This problem will most likely have

to be addressed by scaling back expectations on how much can be accomplished and focusing the available human resources on the most important work. The intensity of the problem would be alleviated if there were a secure long-term program to attract the available talent.

- (10) Forest Policy – SRD is in discussions to initiate work on a strategic “Forest Policy” to raise the awareness of forestry in the province. This policy may be the appropriate place to establish clear goals for tree improvement work.
- (11) Tree Improvement Alberta (TIA), the organization being formed to administer the CCEMC Tree Adaptation project, has established a comprehensive MOU with FRI to handle administrative and financial matters, and has a comprehensive terms of reference (e.g. includes project managers, scientists, management boards, etc). The Tree Adaptation project will need to address proposed expansion of orchards and development of climatically adapted improved seed so it would be logical to have TIA add a program to address the production of improved seed.

Recommendations and Rationales

The following recommendations are focused on the tree improvement since this is the work that is primarily delivered by a co-operative effort between government and industry.

Several options are considered, as follows:

- (1) No change – leave the structure pretty much as is, let it function and deliver what it can. Funding has been acquired (FRIAA and CCEMC) that will keep resources engaged for several years, by which time there may be more enthusiasm for tree improvement. Orchards are being funded by industry and government, and are producing enough improved seed to support limited planting. AAC adjustments that reflect performance survey results are scheduled to start being implemented in 2013, which will require SRD to clarify yield protocols and will require industry to commit to specific silviculture practises to continue earning the AAC adjustments. MPB surge cuts are scheduled to continue for another decade, at which time the falldown will likely be addressed by industry consolidation, even though this will mean the demise of some mills in some communities. This is the easiest course of action in the short term and may generate results that are as good as can be expected, all things considered, although it would also result in the greatest reduction in timber supplies. This option is not recommended
- (2) Create a full scope, full scale genetics council - create a council similar to the FGC in BC. This would create means to enhance government and industry co-operation in forest genetics work. However, it would require considerable government funding (which is unlikely) and would require more staff (again, unlikely). The management effort required to get something

like this off the ground is substantial and it is doubtful that it would do much to advance tree improvement given the large scope and scale to be addressed with limited resources. This option is not recommended

- (3) Create an entity to focus on tree improvement – focus resources to advance tree improvement results. This would be done mostly with existing staff and funding by focusing the effort. This would generate the most impact on tree improvement and timber supplies with the least cost. This is the preferred recommendation. There are two components to address.

First, SRD, with the support of the majority of the forest industry, needs to set two key objectives. In the discussion above about the structures in BC, it was noted that the government had set these objectives and they were critical to sustain co-operative effort. The situation is the same in Alberta. Without some inspiring targets, something to work towards, the system will just flounder and resources will be wasted. It would be important that the forest industries representing most of the timber allocation in the province support these objectives.

- a. Modify the genetic standards to include mandatory use of improved seed where available and define improved seed as that with at least a 10% genetic worth gain over natural seed. Target 75% of all planting to be done with improved seed by 2030

Discussion: These targets will require effort but are achievable. Although there is currently little effort going to second generation orchard management, there could easily be gains in excess of 10% in second generation orchards. By making use of improved seed mandatory, “where available”, there would be an assured market for such improved seed to incent orchard development. To determine how much improved seed would be needed, the analysis of silviculture systems discussed above, which should be lead by SRD with the full co-operation of industry, would be required. The potential cost savings to industry, from well-designed and focused silviculture that would result, are significant. The production of operational quantities of advanced generations improved seed would take up to a decade, and is the focus of structures proposed in the second recommendation.

- b. Publish a directive setting a target of a one-third increase over the natural growth rate on reforested stands by 2030 .

Discussion: As with the seed target above, this will require effort but is achievable, given the performance survey results to date along with growth increases from second generation seed. In addition to the silviculture analysis recommended above to describe the optimum silvicultural practises, this will require a focus on verifying GYPSY, and careful consideration in timber supply analyses. For example, it is likely unwise to try to improve growth on all sites but rather focus work on sites with the most growth potential.

This objective does not differentiate between coniferous and deciduous stands at this time, which needs more careful thought. Forest management plans throughout the province include provisions for the maintenance the various landbases and replacement of incidental volumes but there is clearly a difference in costs between deciduous and coniferous reforestation. Deciduous reforestation is primarily through suckering, and is quite prolific, whereas coniferous reforestation requires considerable effort. The directive might establish different targets to address these complexities.

These objectives are very socially desirable. Given the expected reduction in timber supplies due to the MPB outbreak, the landbase losses created by energy developments, and the desire for more protected areas, it is very prudent to do whatever is practical and reasonable to maintain timber supplies in the interest of community sustainability. Given the hundreds of millions of dollars Alberta has put into the attempt to control the MPB outbreak, political leaders will view support from the forest industry for these objectives as being very prudent, and may be open to the idea of using funding from the MPB program to support these recommendations.

Second, form an Independent Forest Tree Seed Organization (study SelectSeed in BC for details on operational matters). Alberta has had several committees over the years that have worked on genetics issues. Most recently the AFGRC did excellent extension work (e.g. see the webpage mentioned above to view the annual reports published) and was a key vehicle for developing the genetics standards, but, beyond this, it was just another committee with no money. It is recommended that a more empowered, funded group be formed, as a non-profit society, with a mandate as follows:

- (i) Develop and support a review of silvicultural effectiveness by seed zone to underpin a quantitative estimate of need for improved seed
- (ii) Develop adequate numbers of parent trees that meet the 10% genetic worth improvement target
- (iii) Develop the orchard capacity to produce the improved seed needed by 2030
- (iv) Market sufficient registered seed for reforestation and reclamation work to earn revenue to be cost neutral

With respect to administrative details, it would be simplest to develop an additional program managed by TIA, since it already has an MOU with FRI as well as a terms of reference that addresses the management of forest genetics programs. Start-up funding would likely need to come from SRD grants and industry funds. Initial funding could also be supported by donations of registered seed for sale.

The program would be based on the understanding that tree breeding (selection, development and testing of parent trees) is a government responsibility whereas production of seed for reforestation is an industry responsibility. This would enable access to grants and research funding for tree breeding. Actual seed production in orchards is considered an industry obligation but it is anticipated that the costs will be recoverable from seed sales.

SRD would need to continue to provide the services of the seed center free of charge. Additionally, SRD may need to provide additional scientific expertise in tree breeding. This could be a problem for SRD since they retain responsibility for the conservation of genetic diversity, policy and research and pulling existing staff from these functions to focus on tree improvement would be significant policy shift if new staff cannot be retained.

Once acceptable parent stock is available, it is industry responsibility to use it to produce seed in orchards.

The intent is to consolidate the management of tree breeding and improved seed production under one independent organization for economies of scale and to have this organization actively seek revenue from grants and seed sales to be cost neutral to the owners. The co-op should actively seek markets in the energy industry related to their reclamation obligations and should market both coniferous and deciduous material. At this time it would be reasonable to be doubtful that such an organization could become cost neutral, but, any revenue earned would reduce industry and government costs. It is assumed that a results-oriented management approach would achieve the goal of cost neutrality.

A review of the forest genetics standard should be done concurrently with the activities proposed in these recommendations to ensure that the emphasis in the genetics standard is synchronized with objectives and creation of the seed organization. Rather than proceeding stepwise, these activities should proceed concurrently and be co-ordinated by SRD in consultation with industry partners

Conclusion

The preferred recommendation is operationally practical and feasible, though not without its share of conflicts and problems. If there is agreement between SRD and the industry committee to proceed with the recommendation, the proposed objectives should be announced and TIA should be engaged quickly. The development of a preliminary five-year plan for the seed organization program would be the best place to sort out the issues. It may be wise to consider utilizing a neutral facilitator to address difficulties that will undoubtedly arise in the formative stage of the program and to provide balanced advice to executive levels of industry and government.

The preferred recommendation represents a new partnership between SRD and the forest industry that will require a long term commitment. Leadership of tree breeding activities will require resources from SRD and commitment to improved growth rates on reforested sites will require industry

resources. In the end, the sustainability of Alberta's forests and forest-based communities will be enhanced.

“Tree Improvement Investment for Forestry in Alberta” valuation model (TIIFA) - Version 1.0

Controlled Parentage Program (CPP)	Region C
Current volume gain (%)	4%
Annual discount rate (%)	8.00%
Decade discount rate (%)	115.89%
Year 1 PV as a ratio of gross non discounted value (10y period)	0.67

INPUTS

Input values (Note: some values need to be entered **per decade** not per year)

Decade	Total number of seedlings planted per decade	Number of seedlings / hectare	Average dollar value / m ³ wood	Total area planted per decade (ha)	MAI (m ³ /ha/yr)	Rotation age	Expected volume gain per decade	Area planted with improved seed per decade	TI program costs per decade
1	50,000,000	1,800	\$110	27,778	3	80	6%	15%	\$5,000,000
2	50,000,000	1,800	\$110	27,778	3	80	8%	30%	\$5,000,000
3	50,000,000	1,800	\$110	27,778	3	80	10%	45%	\$5,000,000
4	50,000,000	1,800	\$110	27,778	3	80	12%	60%	\$5,000,000
5	50,000,000	1,800	\$110	27,778	3	80	14%	75%	\$5,000,000
6	50,000,000	1,800	\$110	27,778	3	80	16%	90%	\$5,000,000
7	50,000,000	1,800	\$110	27,778	3	80	18%	100%	\$5,000,000
8	50,000,000	1,800	\$110	27,778	3	80	20%	100%	\$5,000,000
9	50,000,000	1,800	\$110	27,778	3	80	22%	100%	\$5,000,000
10	50,000,000	1,800	\$110	27,778	3	80	24%	100%	\$5,000,000
11	50,000,000	1,800	\$110	27,778	3	80	26%	100%	\$5,000,000
12	50,000,000	1,800	\$110	27,778	3	80	28%	100%	\$5,000,000
13	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000
14	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000
15	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000
16	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000
17	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000
18	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000
19	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000
20	50,000,000	1,800	\$110	27,778	3	80	30%	100%	\$5,000,000

VOLUME w/o TI			VOLUME with TI		
Decade	Volume (million m ³) w/o tree improvement per decade		Volume (million m ³) from tree improvement per decade	Volume increase from tree improvement per decade	
1	6.67	6.67	0.02	0.30%	
2	6.67	6.67	0.08	1.20%	
3	6.67	6.67	0.18	2.70%	
4	6.67	6.67	0.32	4.80%	
5	6.67	6.67	0.50	7.50%	
6	6.67	6.67	0.72	10.80%	
7	6.67	6.67	0.93	14.00%	
8	6.67	6.67	1.07	16.00%	
9	6.67	6.67	1.20	18.00%	
10	6.67	6.67	1.33	20.00%	
11	6.67	6.67	1.47	22.00%	
12	6.67	6.67	1.60	24.00%	
13	6.67	6.67	1.73	26.00%	
14	6.67	6.67	1.73	26.00%	
15	6.67	6.67	1.73	26.00%	
16	6.67	6.67	1.73	26.00%	
17	6.67	6.67	1.73	26.00%	
18	6.67	6.67	1.73	26.00%	
19	6.67	6.67	1.73	26.00%	
20	6.67	6.67	1.73	26.00%	
	Total: 133.33		Total: 23.29

Net present value (NPV) outputs

Note: The net present values (NPVs) are calculated under the assumption of receiving the Allowable Cut Effect (ACE) as a result of planting of improved stock. This allows return on investments within the decade of planting and does not require to wait until rotation age to access the revenue from timber sales.

Decade	Timber sales discounted to year 1 of decade (million dollars)	Program cost discounted to year 1 of decade (million dollars)	NPV per decade (million dollars)
1	1.48	3.36	-1.88
2	5.90	3.36	1.18
3	13.29	3.36	2.13
4	23.62	3.36	2.01
5	36.91	3.36	1.54
6	53.14	3.36	1.06
7	68.89	3.36	0.65
8	78.73	3.36	0.34
9	88.57	3.36	0.18
10	98.41	3.36	0.09
11	108.26	3.36	0.05
12	118.10	3.36	0.02
13	127.94	3.36	0.01
14	127.94	3.36	0.01
15	127.94	3.36	0.00
16	127.94	3.36	0.00
17	127.94	3.36	0.00
18	127.94	3.36	0.00
19	127.94	3.36	0.00
20	127.94	3.36	0.00
			NPV: 7.41