forest management note

Note No. 4 Northern Forest Research Centre Edmonton, Alberta

PLANTATION PERFORMANCE IN PERSPECTIVE

Many tree planting operations attempt to maximize area regenerated at minimum cost. Establishment costs are often ranked higher in priority than future field performance when plantation prescriptions are being considered. Consequently, minimum cost options such as inadequate site preparation, inexpensive stock, and high daily planting rates are often chosen over more expensive alternatives. Subsequent plantation performance is commonly evaluated only in terms of percent survival.

Recognizing that survival alone is not an adequate measure, Mullin and Reffle (1980) in Ontario have used aggregate height (percent survival X plantation height) for evaluating field performance of plantations up to 20 years old. Because the first 5 years are critical in plantation establishment, an index in terms of dollar cost per metre of height at the end of this period is proposed here for comparing performance of various plantations and reviewing cost options.

Several types of hand-held calculators (such as Texas Instruments TI-58C) can be programmed to compound all costs for each plantation at known interest rates to provide a total cost 5 years after planting. The following field data are required for each plantation:

1. Regeneration survey cost— $/ha
2. Site preparation cost— $/ha
3. Planting density— M/ha
4. Stock cost— $/M
5. Planting cost— $/M
6. Plantation appraisal survey cost— $/ha
7. Survival at 5 years— 0.00 (expressed as a decimal fraction)
8. Average height at 5 years— m

A 116-step program that compounds costs at any interest rate is keyed into the calculator as shown in Table 1. In this program, costs were compounded over a 5- to 7-year period; regeneration surveys were carried out 2 years prior to planting, and site preparation occurred 1 year prior to planting. The program can be easily altered, beginning at Step 45, to compound costs over any period. Variables 0-8 are then stored in registers 0 through 8, and three calculations can be executed by pressing label keys B, C, and D, respectively:

B = total cost: regeneration survey cost compounded for 7 years + site preparation cost compounded for 6 years + stock cost compounded for 5 years + planting cost compounded for 5 years + plantation appraisal survey cost

C = aggregate height (planting density X survival X average height) at 5 years

D = performance in terms of dollars per metre of height at 5 years (total cost ÷ aggregate height)

Using this third criterion, the forest manager can review plantation case histories and evaluate component cost options.

Actual plantation cost and performance data from planting trials on two Saskatchewan sites are listed in Table 2. Using the program outlined in Table 1 and data from Treatment 1 as an example, columns 0-8 are entered into the calculator to determine the performance criteria B, C, and D as follows:

Procedure	Press	Display
Enter program		0
Fix decimal	2nd Fix 2	0.00
Interest rate	0.10 STO 00	0.10
Regeneration survey cost	5 STO 01	5.00
Site preparation cost	0 STO 02	0.00
Planting density	1.5 STO 03	1.50
Stock cost	40 STO 04	40.00
Planting cost	100 STO 05	100.00
Plantation appraisal survey cost	5 STO 06	5.00
Survival	0.78 STO 07	0.78
Average height	0.190 STO 08	0.19
Compute total cost	B	352.95
Compute aggregate height	C	222.30
Compute performance	D	1.59

Comparing treatments 1 and 2 on the hazel site (A), the cost per metre of height at 5 years was $0.34 less on bulldozed areas than on untreated areas. Similarly, for treatments 4 and 5 on the wet alder site (B), the cost per metre of height was $0.18 less on the shoulders of Finn-ploughed furrows than in the rough between furrows. In terms of cost per metre of height at 5 years, it is evident that for these four treatments the site preparation options costing $95/ha and $120/ha should be preferred to planting in the rough.

The forest manager can consider a variety of options for a planting program. At present, planting density (which must reflect species, site, and final wood product requirements) is likely the easiest variable to control and has a major influence on the performance index when site preparation is part of the planting prescription. For example, assume that Treatment 4 planting density is changed from 1500 to a bare minimum of 750 trees/ha:

1. Total establishment cost would decrease 28% (from $517.22/ha to $372.28/ha).

2. Aggregate height would be halved (from 643 to 321 m/ha).

3. Cost per metre of height would increase 45% (from $0.80 to $1.16). Similar results can be obtained for treatments 2, 3, and 6.

If plantation data are collected as outlined, the performance of each prescription can be determined and alternatives based on the data collected can be examined. For example, suppose Spencer-Lemaire (Hillson) container seedlings had been used instead of BC/CFS styroblock-2 seedlings in Treatment 4. Assuming these 150-cm^3 container seedlings cost $0.15 each to produce in 1974 and given that 5-year-height of white spruce reared in this larger container is generally double that of the smaller (35 cm^3) styroblock-2 seedling

1. total establishment cost would increase 46.7% (from $517.22/ha to $758.80/ha),

2. aggregate height would double (from 643 to 1286 m/ha), and

3. cost per metre of height would decrease 26.3% (from $0.80 to $0.59).

At present, 50% mortality and slow growth at 5 years are not uncommon in plantations in Manitoba, Saskatchewan, and Alberta. As large-scale tree planting programs such as those supported by DREE (federal Department of Regional Economic Expansion) are undertaken, close scrutiny of the various components of establishment costs is required. Cost data as outlined above can be collected for every plantation, and comparisons can be made in terms of cost per unit of height. Inexpensive programmable calculators (requiring no knowledge of computer languages) can help busy field foresters with the arithmetic, answer many hypothetical questions, and put the plantation picture into better perspective.

W.J. Ball
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REFERENCE

Mullin, R.E. and R.J. Reffle. 1980. Effects of dates of lifting and planting on success of frozen spring storage at Swastika nursery. Ontario Ministry of Natural Resources. Nursery Note 66.

NOTE

The exclusion of certain manufactured products does not imply rejection nor does the mention of other products imply endorsement by the Canadian Forestry Service.

Table 1. Program for calculating plantation performance using a Texas Instruments TI-58C hand-held calculator

Step	Program keystrokes	Purpose/comments
	OFF/ON LRN	Clears calculator and enters learn mode
000	2nd Lbl A STO 0 R/S STO 1 R/S STO 2 R/S STO 3 R/S STO 4 R/S STO 5 R/S STO 6 R/S STO 7 R/S STO 8 R/S	Store interest rate, regeneration survey cost, site preparation cost, planting density, stock cost, planting cost, plantation appraisal survey cost, survival, and average height
029	2nd Lbl B	Calculating total cost
031	RCL 0 + 1 = STO 11 RCL 1 X RCL 11 y^x 7 + (RCL 2 X RCL 11 y^x 6) + (RCL 3 X RCL 4 X RCL 11 y^x 5) + (RCL 3 X RCL 5 X RCL 11 y^x 5) + RCL 6 = STO 9 R/S	Regeneration survey cost compounded for 7 years + site preparation cost compounded for 6 years + planting density X stock cost compounded for 5 years + density X planting cost compounded for 5 years + plantation appraisal survey cost
088	2nd Lbl C	Calculating aggregate height
090	RCL 7 X RCL 3 X RCL 8 X 1000 = STO 10 R/S	Survival X density X height X 1000
107	2nd Lbl D	Calculating performance
109	RCL 9 ÷ RCL 10 = R/S	Total cost ÷ aggregate height
116	LRN	Exit learn mode

LRN Learn key.

Lbl Label key. The calculator automatically begins running the program, starting calculations from the first instruction following the label.

STO Store key. Stores the number held in the display register into the data register indicated. Clears any data previously stored in the register.

R/S Run/stop key. Leaves a hole in the program so that you can key in a data entry.

RCL Recall key. Brings contents of data register indicated into the display register.

Table 2. Plantation costs and performance for two Saskatchewan sites

Registers									Labels		
0	1	2	3	4	5	6	7	8	B	C	D
Interest rate	Regeneration survey cost—$/ha	Site preparation cost—$/ha	Planting density—M/ha	Stock cost—$/M	Planting cost—$/M	Plantation appraisal survey cost—$/ha	Survival at 5 years—0.00 (expressed as a decimal fraction)	Average height at 5 years—m	Total cost—$/ha	Aggregate height—m/ha	Performance—$/m
Treatment 1. Site A.											
0.10	5	0	1.5	40	100	5	0.78	0.190	352.95	222.3	1.59
Planting BC/CFS styroblock-2 white spruce plugs under a hazel shrub cover with no site preparation at Greenbush near Hudson Bay, Saskatchewan. Average after-planting height 4.6 cm based on 50, 16-week-old seedlings planted July 8, 1972.											
Treatment 2. Site A.											
0.10	5	95	1.5	40	70	5	0.86	0.279	448.78	359.9	1.25
Planting BC/CFS styroblock-2 white spruce plugs on bulldozed strips. Average after-planting height 4.8 cm based on 80 seedlings planted July 8, 1972. Same planting stock as in Treatment 1.											
Treatment 3. Site A.											
0.10	5	95	1.5	40	70	5	0.90	0.356	448.78	480.6	0.93
Planting BC/CFS styroblock-2 black spruce plugs on bulldozed strips. Same site, age of stock, and date of planting as in Treatment 1. After-planting height 9.1 cm based on 94 seedlings.											
Treatment 4. Site B.											
0.10	5	120	1.5	50	70	5	0.94	0.456	517.22	643.0	0.80
Planting overwintered 17-month-old BC/CFS styroblock-2 white spruce plugs on Finn-ploughed furrows. Productive site, well-drained by furrows and shaded by alder. After-planting height 7.5 cm based on 150 seedlings planted June 6, 1974.											
Treatment 5. Site B.											
0.10	5	0	1.5	50	100	5	0.85	0.303	377.11	386.3	0.98
Planting overwintered BC/CFS styroblock-2 white spruce plugs between Finn-ploughed furrows. Same site, stock, age, and date of planting as in Treatment 4. Planted in the rough, but site improved by drainage. After-planting height 7.6 cm based on 150 seedlings.											
Treatment 6. Site B.											
0.10	5	120	1.5	60	100	5	0.77	0.392	613.86	452.8	1.36
Planting white spruce bare-root (2+2) stock on Finn-ploughed furrows. After-planting height 11.2 cm based on 150 seedlings. Bare-root stock planted about May 24, 1974.											

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