Value gains from using genetically improved radiata pine stock

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ABSTRACT

Paired plots were established in a 17-year-old stand consisting of stock of two different levels of genetic improvement. The more improved stock had 11% greater live volume than the less improved stock. Results from computer simulation indicated that there was also a shift in log grade distribution, particularly in stems marked as thinnings. The improved stock had a higher percentage of sawlogs, resulting in increased value per hectare of the improved stand well in excess of the percent gain in live volume.

INTRODUCTION

Since 1984 there has been sufficient seed orchard seed of radiata pine *(Pinus radiata* D. Don) to meet all industrial planting requirements. Forests resulting from this improved seed are reported to be faster growing, straighter, and less malformed than previous plantings (FRI, 1987 and Carson, 1987). The impact of the genetic improvement in form on log quality has received less attention than genetic gains in volume. Both Cleland (1985) and Gleed (1981) have shown that stands derived from seed orchard seed resulted in the production of more merchantable wood in a pulp-wood thinning operation, compared with less improved stands, than live-volume figures indicated. Carson (1988) has examined the impact of genetic changes in branch habit on log grades. His findings indicate that the proportion of logs in various log grades can differ between seed lots.

Improvements made in tree size and form through breeding should result in an overall improvement in log assortment, through larger piece sizes with a reduction in stem sweep and forking. Depending on the prices of various log grades, a change in log grade distribution due to genetic improvement could have more impact on the value of a stand than the impact of increased volume per hectare.

In 1986 a 17-year-old open-pollinated progeny test was due for commercial thinning. Because the trial had a number of felling select plots within it, an opportunity existed to examine the differences in both volume per hectare and log quality of stands with two different levels of genetic improvement.

The actual level of genetic improvement of the seed used in the progeny test is less than that of a seed-orchard lot, since the female parents would have been selected less intensively than current orchard parents and the pollen parents were of unselected origin. The gain represented by the trial should therefore define a point lower than an appropriate benchmark of gain attained by orchard seed.

Stand History

In 1969 a 25ha trial was established in Compartment 1350, Kaingaroa Forest, to progeny test open-pollinated offspring of 600 plus-tree selections. Blocks of felling-select origin stock were planted throughout the study, and the same stock was also used as surround plantings.

The material of felling-select origin was from seed collected from the best 50 trees per hectare in old-crop stands; its improvement rating being approximately GF3 (FRI 1987, Vincent 1987). In contrast, the clones progeny tested were selected in 1969 in stands 15 to 25 years old. The best tree found in each 2.5 hectare grid quadrat was selected and cones were obtained from these trees. The improvement rating of this seed collection is estimated at GF10.

The study was established at a spacing of 2.74 × 2.74m (1332 s/ha). A selective thinning was carried out at age five (from planting) to bring stocking to approximately 666 s/ha. Inside the progeny test each 10-tree progeny row was reduced to the best five trees. In the felling-select blocks thinning was not restricted to rows. After thinning it was apparent that the felling-select areas (GF 3) were reduced on average to a slightly lower stocking than the progeny test (GF 10). The only pruning carried out was a 100% low prune to two metres at age five.

METHODS

Field Procedure

In December 1986 eight sets of paired plots were established throughout the trial after the stand had been marked for thinning by contract crews (Table 1). Care was taken to ensure each pair of adjacent subplots were on the same slope and aspect.

TABLE 1: Plot descriptions

Plot	Type	Area	Stocking Live	Stocking Dead	Live SPH	MARVLed
A	PT	.090	55	1	611	Yes
B	FS	.090	51	4	567	Yes
C	PT	.120	75	3	622	Yes
D	FS	.120	73	7	606	Yes
E	PT	.151	96	4	636	Yes
F	FS	.151	79	8	523	Yes
G	PT	.151	98	2	649	No
H	FS	.151	79	8	523	No
I	PT	.151	91	4	603	No
J	FS	.151	76	2	503	No
K	PT	.151	88	6	583	No
L	FS	.151	78	2	517	No
M	PT	.075	43	3*	573	Yes
N	FS	.075	50	1	667	Yes
O	PT	.075	47	3	627	Yes
P	FS	.075	47	3	627	Yes

* 6 trees were felled in 1979 for selection purposes and not included as live or dead trees.

All trees in the 16 sub-plots (eight sets of paired plots) were assessed for dbob (DBH), straightness score (STR), malformation score (MALF), branch habit (BH), acceptability as a crop

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tree (ACC), and status (marked for thinning or a remaining crop tree). Straightness and malformation scores are subjective ratings with 9 being the best and 1 being the worst. Five of the plot pairs were also assessed using MARVL techniques (Deadman and Goulding, 1979), a method for the assessment of recoverable volume by log types.

Each tree in the MARVL plots was assessed using methods described by Manley, Goulding, and Whiteside (1987) and Manley, Goulding, and Lawrence (1987). The stem of each tree is classified into sections of uniform quality in order to derive available log assortments according to length, size and quality. Ten trees in each MARVLed subplot were measured for height and used in developing height-diameter equations.

Calculations

Stocking generally differed between plots within pairs (Table 1). This was primarily due to thinning practices, rather than mortality. At age-five thinning the felling select (GF3) plots were, on average, reduced to lower stocking because thinning was not as closely monitored as in the progeny test (five trees per ten-tree row plot). In one instance the felling select subplot (N) was at a higher stocking due to additional thinning around a plus-tree located in the progeny test subplot (M).

Higher-stocked subplots have an advantage in accumulating volume per hectare since the site would have been fully occupied for a long period of time. Conversely, individual-tree diameter should on average be larger in the lower-stocked subplots and the felling-select plots would tend to be favoured by the lack of row-by-row selection within them. An attempt was made, therefore, to adjust the subplots to represent equal stocking. This was done by first summing all live and dead trees in each of the paired subplots. The smallest live trees in the higher-stocked subplot were discarded until stocking for both subplots equated. Any bias that could result from this would be to reduce the apparent volume gain in the GF 10 subplots which generally were the higher-stocked subplots.

Mean diameter, mean quality scores, and percentage of stems acceptable for final crop trees in each subplot were tabulated using the PROC MEANS procedure of the SAS statistical package.

Volume-per-hectare predictions of various log types were calculated for five pairs of plots using MARVL. The three remaining main plots not MARVLed only had estimates of volume per hectare.

The log grades used in this study for the MARVL runs are shown in Table 2. Log grade definitions are those developed for the Conversion Planning Model System and are more clearly defined in Whiteside and Manley (1987). Because the stand was only pruned to two metres there were no pruned logs and the relatively high stocking density resulted in very few logs with branches greater than 6 cm in diameter. As a result the L log grades (those with branch(es) greater than 6 cm in diameter) were combined with the S log grades for everything except the L4s, which were combined with pulp. Sawlogs greater than 400 mm small-end diameter (SED) did not exist, so the S1 log grade was unnecessary.

TABLE 2: Description of log grades

Log Grade	Min. Length (m)	Max. Length (m)	Min. SED (cm)	Defect*
S2 Long	8.6	12.2	30	B
S2 (+L2)	3.0	6.1	30	SB
S3 (+L3)	3.0	6.1	20	SB
S4	4.0	6.1	15	
Pulp	3.0	6.1	–	SB

* Allowable defects:
S = Log under 4 m   B = Branch(es) > 6 cm diameter

RESULTS AND DISCUSSION

Means of the two stand types are shown in Table 3. Individual DBH, straightness, and malformation scores were significantly better (a=.05) in the GF 10 plots. The 11% higher volume per hectare in the GF 10 plots compared with the GF3 plots was not significantly different according to a Students t test (a=.05), even though it had more volume in each of the eight main plots. The small degrees of freedom for the comparison (7) and the wide range of differences (4-28%), resulted in the non-significance. Notwithstanding the t test, the GF 10 almost certainly has more volume, since the probability of it being greater by chance eight out of eight times is 1:256.

The improvements in growth and form (Table 3) resulted in a significant shift in log grades as shown in Table 4. While the two stand types did not differ significantly in the quantity of S2 material, the Gf 10 stand has significantly more volume in the S2 and S3 log grades combined than the GF3 stand. This was due to both increased volume and a higher percentage of logs being in the better log grades (Table 5).

A shift of pulpwood to sawlogs can outweigh any increase in volume alone. Given the assumption that sawlogs are worth five times the price of pulpwood (Table 92, in MOF 1987), the increase in percentage sawlogs from 64% to 82% shown in this study would increase crop value by 20%. This would be in addition to any gain in volume.

The major shift in log grades occurred in the thinnings component. In absolute dollar terms this represents the lower-valued stand component; however, this can be harvested sooner than the crop component. Thus while the shift in log grades of the thinnings component may represent less in absolute dollars than the shift in the crop component, it still represents a major gain in value since it is discounted for a shorter period of time.

CONCLUSIONS

Gains found here should provide a lower benchmark for expected seed-orchard gains, since the improved stand in this study was of poorer genetic quality than any stand of seed-orchard origin. Actual gains from seed orchard stock should be higher, given the same environmental constraints. The genetically improved stand (GF10) had 11% more volume per hectare than the stand of less improved stock (GF3). Equally as important as the increased volume found in the GF 10 stand was an increased proportion of logs in the higher-valued log grades owing to increased tree diameter and improved form.

TABLE 3: Means adjusted for unequal stocking in eight paired-plots.

	Vol/ha (m^3)	DBH (mm)	STR (1-9 score)	MALF (1-9 Score)	Acc stems %	Live Stocking
All Trees						
GF10	565	334	6.48	6.90	68	558
	(11)	(10)	(31)	(22)	(79)	
GF3	508	303	4.94	5.65	38	561
Crop Trees						
GF10	323	370	6.95	8.12	91	261
	(6)	(3)	(25)	(15)	(34)	
GF3	305	360	5.57	7.07	68	261
Thinned Trees						
GF10	242	303	6.04	6.09	46	297
	(19)	(19)	(38)	(39)	(318)	
GF3	203	255	4.39	4.38	11	300

* Figures in brackets show % improvement of GF10 over GF3

TABLE 4: Per hectare estimates and standard errors of cubic metres by log grade, for the five main plots that were MARVL assessed

Stock Type	----- ALL Trees ----- GF10	GF3	----- Crop Trees ----- GF10	GF3	----- Thinnings ----- GF10	GF3
Log Grade	m^3 ± SE	m^3 ± SE	m^3 ± SE	m^3 ± SE	m^3 ± SE	m^3 ± SE
Long S2	22 ± 7.5	16 ± 6.8	22 ± 7.5	16 ± 6.8	0 ± 0	0 ± 0
S2	87 ± 8.8	55 ± 6.5	75 ± 5.8	48 ± 6.5	14 ± 5.3	6 ± 1.0
S3	238 ± 19.8	153 ± 16.2	148 ± 7.3	111 ± 8.2	93 ± 14.2	43 ± 9.5
S4	38 ± 6.3	20 ± 5.0	16 ± 2.1	13 ± 3.5	20 ± 4.8	7 ± 2.4
Pulp	85 ± 19.7	137 ± 21.0	27 ± 4.2	67 ± 10.2	57 ± 15.4	67 ± 10.2
Total Recoverable	470 ± 28.8	381 ± 14.6	288 ± 9.8	256 ± 5.1	184 ± 25.1	124 ± 12.5
Total Live Volume	586	514	342	311	246	202

The shift in log-grade percentages is likely to be of more value than the increase in volume alone. When one considers both the increase in log value and the 11% increase in volume, the GF10 stand at age-17 was probably over 20% more valuable than the GF3 stand.

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TABLE 5: Percentage distribution (by log volume) of log grades by improvement class

Stock Type Log Grade	--All Trees-- GF10	GF3	--Crop Trees-- GF10	GF3	--Thinnings-- GF10	GF3
Long S2	3-6*	2-6	5-10	4-9	0	0
S2	17-20	13-16	24-28	16-21	5-10	4-6
S3	46-55	36-44	49-54	40-47	43-58	27-42
S4	7-9	4-7	5-6	4-6	8-13	4-8
Pulp	14-22	30-41	8-11	22-30	23-29	46-62

* range = ((mean ± std error) / Total) 100

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