FOREST RESEARCH REPORT

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PRODUCTIVITY OF MANUAL TREE LENGTH HARVEST OPERATIONS IN CENTRAL NOVA SCOTIA

INTRODUCTION

The manual tree length harvest method involves the felling, delimbing and topping of trees at the stump with chainsaws. The trees are then skidded to roadside using either choker or grapple skidders. This method was first introduced in Canada in the mid 1960's and by 1985 represented over 50% of the wood harvested in eastern Canada (Heidersdorf and Gingras, 1987). Its popularity declined with the introduction of full tree logging but still accounts for a significant portion of wood harvested. In Nova Scotia, the majority of wood purchased from private contractors by Scott Worldwide is in tree length form.

The rates established for payment of wood produced in tree length are currently under review by Scott Worldwide and its suppliers. As part of this review, a study was initiated to determine manual tree length production in softwood stands. This report documents the results of that study.

METHODS

Twenty-four predominantly softwood sites (referred to as blocks), from 18 different locations (Figure 1) were sampled for the study. The blocks were selected in central and eastern Nova Scotia from lists provided by Scott personnel and the Central Wood Suppliers. These blocks typically took several days to harvest.

Sixteen different contractors harvested these blocks. Ten of the contractors harvested 1 block, while 4 harvested 2 blocks, and 2 harvested 3 blocks. Crew sizes varied ranging from 1 to 3 persons (including skidder operator). In the 1-man crews, the same person performed both harvesting and extraction operations. For 2-man crews, there was at least one person cutting at all times. The second cutter in these crews was the skidder operator who would spend part of his day felling. This felling time usually did not exceed one hour. For 3-man crews, there were 2 full-time cutters and 1 skidder operator who did not cut.

All wood produced by the crew was manually felled, delimbed and topped using chainsaws. This wood was then skidded to
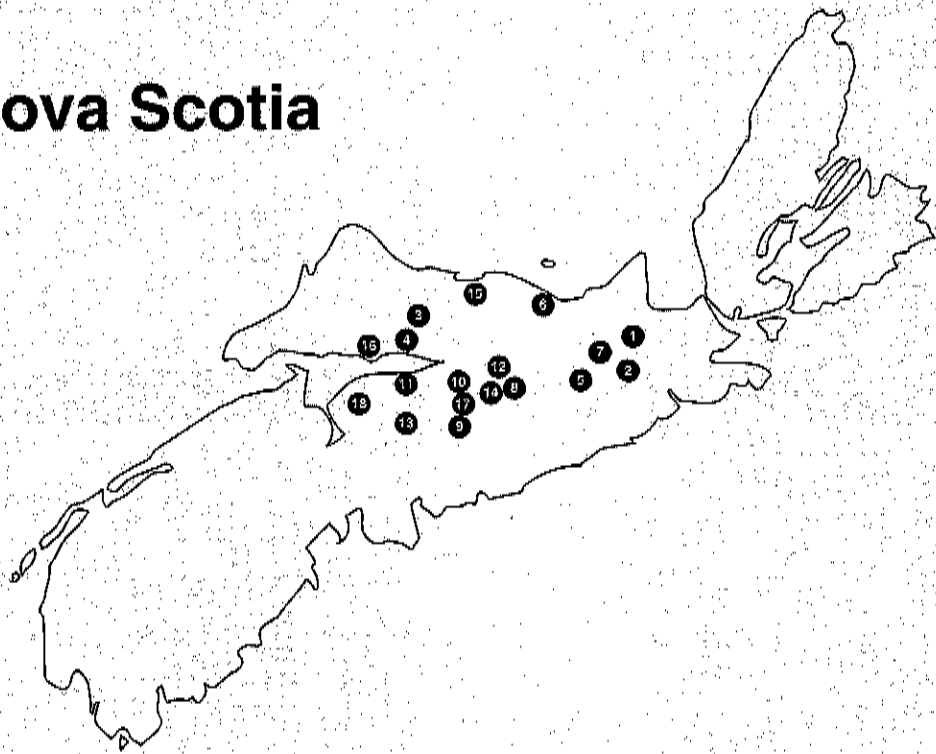
Canadä

Nova Scotia

Figure 1. Study locations for tree length harvesting trial. See Appendix I for additional information.

roadside, tree-length, with cable skidders, with no attempt made to separate each cutters total. All trees that were cut in any one day were skidded to roadside and scaled in tree-length form so that daily production figures could be calculated.

In total, 87 days of harvesting data were collected from the 24 blocks. Thirty-one days were collected on the productivity of 1-man crews, 24 on 2-man crews and 32 on 3-man crews. Fifty-eight days of harvesting were carried out in summer conditions (May-November) and 29 in winter (December-April).

DATA COLLECTION AND CALCULATIONS

Before harvesting, between 5 and 10 prism points were established in each of the study blocks. Recorded at each point (Appendix I) were site (slope, stoniness and drainage) and tree characteristics (diameter, density and height).

While harvesting was being carried out, time studies were performed in each block. Total and productive time worked were recorded for each cutter. Time studies were also performed on extraction operations for each contractor. Continuous timing was performed for one day for each block to estimate the percentage of productive time spent on the various activities associ-

ated with extraction. Distance travelled was also recorded.

Productivity was calculated separately for cutters, skidder operators and on a crew basis. Crew productivity was expressed in terms of:

1) the amount of merchantable wood[1] brought to roadside per productive hour (m³/ total productive hours (TPH): TPH includes time to cut and extract by all crew members),

2) the daily production per man, obtained by multiplying m³/TPH by an assumed work day of 6.2 productive hours, (in m³/man-day), and

3) the daily production per man day based on actual hours worked (m³/man-day).

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[1] All volumes are expressed in solid cubic metres (m³), except where otherwise specified.

Table 1. Crew productivity by crew size and season.

Season [1]	Crew Size [2]	Length of Study [3] (days)	Average Harvested Tree Size (trees/m³)	Productive Hours per day [4] (TPH)	TPH per man [5] (TPH/ man-day)	Volume Harvested [6] (m³/day)	Hourly [7] (m³/TPH)	Productivity Daily (m³/man-day)	
								6.2 PH work day [8]	Actual work day [9]
Summer	1-Man	25	3.9	7.7	7.7	10.8	1.44	8.9	10.8
	2-Man	18	4.8	12.1	6.0	19.8	1.66	9.9	9.9
	3-Man	15	6.6	20.4	6.8	32.7	1.60	9.9	10.9
AVERAGE	ALL	58	4.9	12.4	7.0	19.3	1.55	9.6	10.5
Winter	1-Man	6	8.3	3.8	3.8	5.3	1.15	7.1	5.3
	2-Man	6	5.3	9.9	5.0	14.5	1.40	8.7	7.2
	3-Man	17	3.7	14.8	4.9	29.8	1.96	12.2	9.9
AVERAGE	ALL	29	5.0	11.7	4.7	21.6	1.68	10.4	8.4
Overall	1-man	31	4.8	7.0	7.0	9.7	1.39	8.6	9.7
	2-Man	24	4.9	11.5	5.7	18.5	1.59	9.9	9.2
	3-Man	32	5.0	17.5	5.8	31.2	1.78	11.0	10.4
AVERAGE	ALL	87	4.9	12.2	6.2	20.0	1.59	9.9	9.8

[1] Season of harvest: Summer (May-November) Winter (December-April).
[2] Number of persons working in crew (cutters and skidder operator). A 1-man crew consists of the same person performing cutting and extraction operations.
[3] Number of days in study.
[4] Total productive hours per day (harvesting and extraction combined).
[5] Total productive hours per day per man. Determined by dividing the total hours worked by the number of persons in the crew (cutters and skidder operator).
[6] Volume harvested per day.
[7] Volume harvested divided by total productive hours worked.
[8] Determined by multiplying m³/TPH by 6.2 productive hours (average TPH per man-day).
[9] Actual volume harvested by crew per day divided by crew size.

Cutter productivity was determined by dividing the harvested volume by the number of productive hours required to, fell, limb and top it, expressed in m³/HPH. Regression analyses was performed to determine the influence of stand factors on cutter productivity. Extraction productivity was determined for each crew by dividing the extracted volume by the number of productive hours required to extract it, expressed as m³/EPH.

RESULTS AND DISCUSSION

Crew Productivity
On average, the number of total productive hours (TPH) worked per man-day was 6.2. One-man crews worked longer days than the larger crews, averaging 7.0 TPH/man-day compared to 5.7 and 5.8 TPH/man-day for 2 and 3 man crews respectively (Table 1).

Crew productivity expressed on an hourly basis averaged 1.59 m³/TPH. Productivity was lowest for the 1-man crews and increased as the crew size got larger (1.39, 1.59, and 1.78 m³/TPH for 1-, 2- and 3- man crews respectively). Based on the hourly productivity and the average workday per man, for all crew sizes (6.2 productive hours per man), the daily production for 1-man crews is 22% less than for 3-man crews (8.6 versus 11.0 m³/man-day). Despite this, the 1-man crews produced only 7% less than 3-man crews when based on the actual productivity (9.7 vs 10.4 m³/man-day respectively). This was achieved by working more productive hours per day per man as previously noted.

Cutter Productivity
On average, each crew spent a total of 8.1 productive hours harvesting per day (HPH) varying from 4.5 for 1-man crews to 7.0 and 12.3 hours respectively for 2 and 3-man crews (Table 2). Cutter productivity over 87 days of observation averaged 2.49 m³/HPH and ranged from 0.56 to 5.78 m³/HPH (Appendix II). Based on this average a cutter harvesting for 6 productive hours per day could expect to produce 14.8 m³ (6.7 cords).

Table 2. Cutter productivity by crew size and season.

Season[1]	Crew Size[2]	Length of Study[3] (days)	Average Harvested Tree Size (trees/m³)	Total Productive Hours Harvesting per day[4] (HPH)	Volume Harvested per day (m³/day)	Productivity	
						Trees/HPH	m³/HPH[5]
Summer	1-Man	25	3.9	5.1	10.8	9.5	2.28
	2-Man	18	4.8	7.5	19.8	12.4	2.83
	3-Man	15	6.6	13.8	32.7	14.8	2.36
AVERAGE	ALL	58	4.9	8.1	19.3	11.8	2.47
Winter	1-Man	6	8.3	2.4	5.3	15.2	2.06
	2-Man	6	5.3	5.6	14.5	13.8	2.44
	3-Man	17	3.7	10.9	29.8	10.1	2.73
AVERAGE	ALL	29	5.0	8.1	21.6	11.9	2.53
Overall	1-man	31	4.8	4.5	9.7	10.6	2.23
	2-Man	24	4.9	7.0	18.5	12.8	2.73
	3-Man	32	5.0	12.3	31.2	12.3	2.56
AVERAGE	ALL	87	4.9	8.1	20.0	11.8	2.49

[1] Season of harvest: Summer (May-November) Winter (December-April).
[2] Number of persons working in crew (cutters and skidder operator). A 1-man crew consists of the same person performing cutting and extraction operations.
[3] Number of days in study.
[4] Total productive hours harvesting for all cutters in the crew (excluding personal breaks).
[5] Determined by dividing volume harvested by the total productive hours harvesting (HPH) for the crew.

Regression analyses, including all preharvest site and stand variables, indicated that stand index (SI: merchantable trees/m³) and regeneration (regeneration >1 metre tall) were
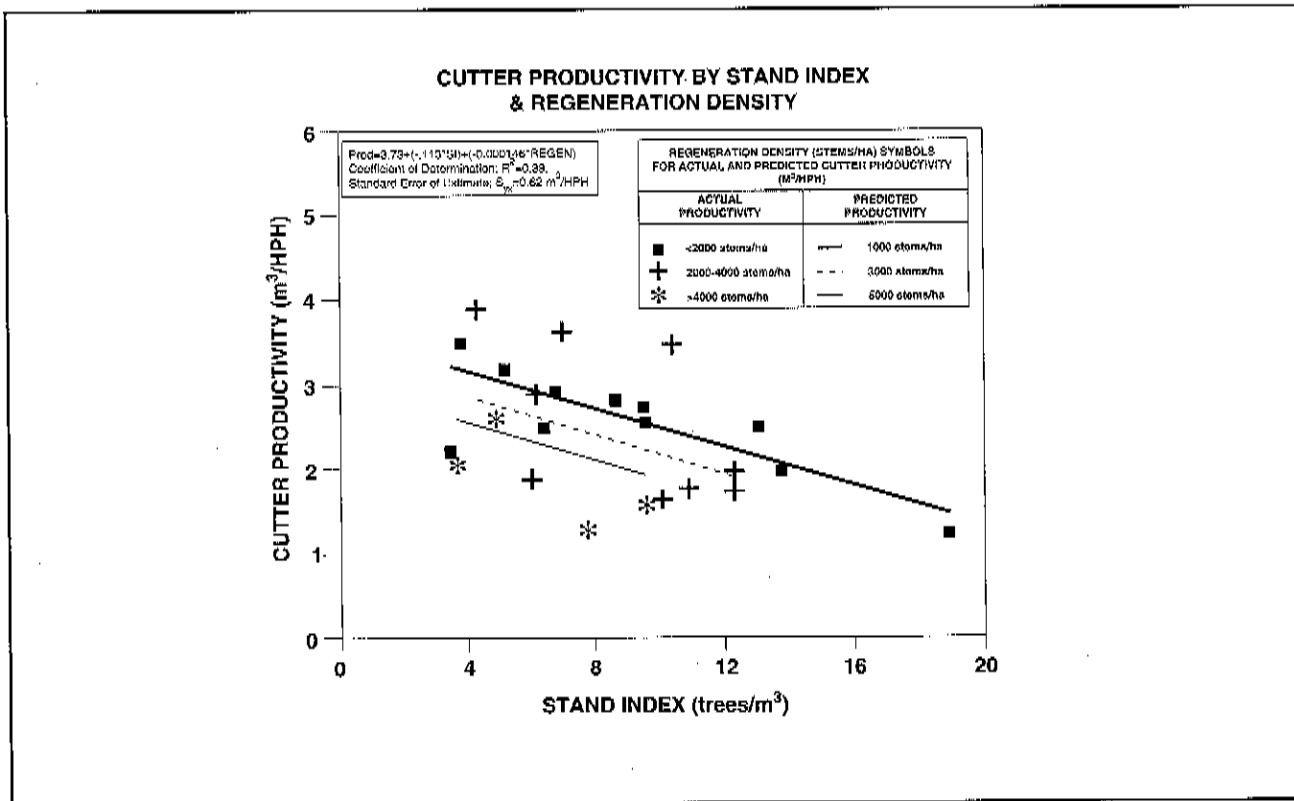

Figure 2. Cutter productivity (Prod; m³/HPH) versus Stand Index (SI; pretreatment merchantable density divided by merchantable volume expressed in trees/m³) and regeneration density (REGEN; stems/ha taller than 1 metre).

Table 3. Extraction productivity by crew size and season.

Season[1]	Crew Size[2]	Length of Study[3] (days)	Average Harvested Tree Size (trees/m³)	Productive Hours per day[4] (EPH)	Average Skid Distance (m)	Volume Harvested (m³/day)	Productivity Trips/EPH	m³/Trip	m³/EPH
Summer	1-Man	25	3.9	2.7	396	10.8	2.3	2.25	4.31
	2-Man	18	4.8	4.7	407	19.8	2.4	2.07	4.45
	3-Man	15	6.6	6.6	306	32.7	2.5	2.00	4.98
AVERAGE	ALL	58	4.9	4.3	376	19.3	2.4	2.12	4.53
Winter	1-Man	6	9.1	1.6	174	5.3	3.6	0.80	2.73
	2-Man	6	5.5	4.3	200	14.5	2.4	1.49	3.52
	3-Man	17	3.6	4.0	321	29.8	2.2	3.34	7.12
AVERAGE	ALL	29	4.8	3.8	266	21.6	2.5	2.37	5.68
Overall	1-man	31	4.8	2.5	354	9.7	2.5	1.96	4.03
	2-Man	24	4.9	4.6	355	18.5	2.4	1.92	4.20
	3-Man	32	5.0	5.3	314	31.2	2.4	2.65	6.08
AVERAGE	ALL	87	4.9	4.1	339	20.0	2.4	2.21	4.85

[1] Season of harvest: Summer (May-November) Winter (December-April).
[2] Number of persons working in crew (cutters and skidder operator). A 1-man crew consists of the same person performing cutting and extraction operations.
[3] Number of days in study.
[4] Stoppages less than 15 minutes were considered productive time.

the most significant factors affecting cutter productivity. Graphical representation of the regression equation is presented in Figure 2. This figure shows harvest productivity decreasing in a linear manner as stand index and the number of regenerating stems increases. For example, a decrease in tree size from 4 to 10 trees/m³, results in a decrease in productivity of 23%, from 2.99 to 2.31 m³/HPH when there are 2000 stems/ha of regeneration. Alternately, when regeneration density increases from 1000 to 6000 stems/ha, productivity decreases 27%, from 2.68 to 1.95 m³/HPH for stands having SI's equal to 8 trees/m3.

Extraction Productivity

The average work day for a skidder operator was 4.1 productive hours (EPH) but varied with crew size. In 1-man crews the average work day was 2.5 EPH, for 2-man crews 4.6 EPH and for 3-man crews 5.3 EPH.

Extraction productivity over 87 days of observation, averaged 4.85 m³/EPH (Table 3) and ranged from 0.91 to 11.4 m³/EPH (Appendix II). Based on an average work day (4.1 EPH), a skidder operator could bring 20.0 m³ (9.1 cord) to roadside daily. Overall, 1-man crews had the lowest production (4.03 m³/EPH) followed by 2-man crews at 4.20 m³/EPH and 3-man crews at 6.08 m³/EPH.

Table 4. Percentage of productive time spent on extraction activities by crew size.

Activity	Crew Size[1] 1-man	2-man	3-man	Average ALL
Travel Empty & Partial	22	30	26	26
Travel Loaded	24	25	23	24
Loading	38	28	33	33
Unloading	9	10	14	11
Piling	8	6	5	6
Productive Hours[2] (EPH/Day)	2.5	4.6	5.3	4.1

[1] The average number of persons working each day (1-man: the same person performs harvesting and extraction operations).
[2] Average number of productive hours worked per day (EPH).

Skid distances ranged from 30 to 930 metres and averaged 339 metres. The average load per trip (m³/trip) was 2.21, ranging from 0.30 to 7.29 m³. The number of trips per PH averaged 2.4.

Travelling accounted for approximately 50% of the work day, while loading and unloading (attaching and releasing chokers) accounted for most of the remainder (44%, Table 4).

SUMMARY

Twenty-four manual tree length harvest operations (87 days of observation) were monitored to determine average worker productivity. The major results of the study are as follows:

1) Crew productivity, expressed as the volume produced per total productive hour (TPH) worked, was 1.59 m³/TPH and ranged from 1.39 m³/TPH for 1-man crews to 1.59 and 1.78 m³/TPH for 2 and 3-man crews respectively. Based on a 6.2 total productive hour day, production per man-day would average 9.9 m³ (4.5 cords).

2) Crew productivity, m³/man-day (based on a 6.2 productive hour work day), varied by crew size, being 22% lower for 1-man crews as compared to 3-man crews, although productivity based on actual hours worked was only 7% lower. Productivity varied from 9.7 m³/man-day for 1-man crews to 9.2 and 10.4 m³/man-day for 2 and 3-man crews respectively, based on actual hours worked.

3) Cutter productivity averaged 2.49 m³/HPH over all crew sizes. Based on a 6 productive hour work day, a cutter could fell, limb and top 14.9 m³/day (6.7 cords).

4) Cutter productivity (P; m³/HPH) was related to Stand Index (SI; merchantable trees/m³) and regeneration density (REGEN; stems/ha >1 metre tall) in a linear manner according to the following equation,

$$P = 3.73 + (-.113*SI) + (-.000146*REGEN) \quad [1]$$

5) Based on equation [1], harvest productivity decreases 23% (2.99 to 2.31 m³/HPH) for an increase in Stand Index (SI) from 4 to 10 trees/m³, when the regeneration density is constant at 2000 stems/ha.

6) Alternately, harvest productivity decreases 27% (2.68 to 1.95 m³/HPH) with an increase in regeneration density from 1000 to 6000 stems/ha, when SI is equal to 8 trees/m³.

7) Extraction productivity averaged 4.85 m³/EPH for average skid distances of 339 metres. The average load per trip was 2.21 m³/EPH and the average number of trips per productive hour was 2.4.

8) Over all crew sizes, productive skidding time averaged 4.1 productive hours and varied by crew size, ranging from 2.5 EPH for 1-man crews to 4.6 EPH and 5.3 EPH for 2 and 3-man crews respectively.

9) Approximately 50% of productive skidding time was spent travelling. The remainder was split between loading and unloading (44%) and piling (6%).

LITERATURE CITED

Heidersdorf, E. and J.F.Gingras. 1987. *A new look at cut and skid operations.* Forest Engineering Research Institute of Canada. Pointe Claire, P.Q. 5 pp.

Summary of pre-harvest stand and site parameters by block

Block #	Location #	Location	County	Season[1] (W/S)	Crew Size[2]	Mean Temp (C°)	Stand Height (m)	Merchantable Stand Characteristics					Site Factors			Regen[7] (stems/ ha)
								Vol. (m³/ ha)	Diam. (cm)	Density (stems/ ha)	Basal Area (m²/ha)	Stand Index[3] (trees/m³)	Slope[4]	Drain-age[5]	Stoni-ness[6]	
1	1	Ohio	Antigonish	S	1	+6	14.8	146	23.9	1139	23.6	7.8	2	1	1.5	6478
2	2	Newtown	Guysborough	S	3	+18	14.9	238	16.5	2261	38.7	9.5	1	1	1	1384
3	3	Westchester	Cumberland	S	1	+12	15.3	256	20.8	1587	42.4	6.2	3	1	2.5	3396
4	4	Montrose	Colchester	S	2	+12	13.1	134	23.4	1380	26.5	10.3	1	1.5	1	3333
5	5	Caledonia	Guysborough	S	1	+11	13.0	175	22.4	1890	33.6	10.8	1	1	1	2264
6	6	Woodburn	Pictou	S	1	+11	13.5	156	19.2	998	29.2	6.4	1	3	1	1132
7	7	Willowdale	Pictou	S	1	+14	19.7	344	28.8	1238	41.3	3.6	2	2	1	5031
8	8	Dean	Halifax	S	2	+18	17.1	254	24.6	940	36.0	3.7	1.5	1.5	1	1572
9	9	Chaswood	Halifax	S	3	+18	14.9	238	16.5	2261	38.7	9.5	1	1	1	1384
10	10	Brentwood	Colchester	W	3	-17	12.3	193	17.2	1930	40.0	10.0	1	1.5	1	3459
11	4	Montrose	Colchester	S	2	+12	13.1	134	23.4	1380	26.5	10.3	1	1.5	1	3333
12	9	Chaswood	Halifax	S	3	+13	14.9	238	16.5	2261	38.7	9.5	1	1	1	1384
13	1	Ohio	Antigonish	S	1	+25	14.8	146	236	1387	23.6	9.5	2	2	1	6478
14	10	Brentwood	Colchester	W	1	-17	12.3	193	17.2	1930	40.0	10.0	1	1.5	1	3459
15	3	Westchester	Cumberland	S	1	+5	15.4	164	25.1	2132	26.0	13.0	2.5	1	2.5	1887
16	11	Maitland	Hants	S	2	+11	13.9	167	19.9	1152	30.0	6.9	2.5	2	2.5	2830
17	8	Dean	Halifax	S	2	+1	16.4	298	20.8	1520	44.0	5.1	1	1	1	755
18	12	Burnside	Colchester	S	3	+4	14.5	164	19.6	1410	27.6	8.6	1.5	1	1	0
19	13	Salem	Hants	S	2	-3	14.1	195	19.4	2379	34.4	12.2	1	1.5	1.5	2892
21	14	Stewarts Hill	Halifax	W	3	+1	17.0	367	24.0	1248	52.5	3.4	2.5	1	1	157
22	15	Denmark	Colchester	W	2	+1	17.0	367	24.0	1248	52.5	3.4	3.5	1	1	157
23	16	Economy	Colchester	W	3	-8	15.7	340	22.2	1632	52.7	4.8	1	1	1	5219
24	17	Wittenburg	Colchester	W	3	-11	17.0	201	24.4	844	28.6	4.2	3	1	1	2075
20	18	Noel	Hants	W	2	+3	15.5	152	22.7	912	24.0	6.0	2.5	1	1	2515

[1] Season of harvest. Winter (W):December-April or Summer (S):May-November.
[2] Average number of persons in crew (cutters and skidder operator). In a 1-man crew the same person carried out harvesting and extraction operations.
[3] Stand Index determined by dividing the pretreatment merchantable density by the merchantable volume.
[4] Slope : 1=0-8%; 2=9-15%; 3=16-30%; 4=31-60%; 5=>61%.
[5] Drainage : 1=Well drained; 2=Imperfectly drained; 3=Poorly drained; 4=Wet.
[6] Stoniness: 1=Stone free; 2=Minor interference to equipment; 3=Moderate interference to equipment; 4=Severe interference to equipment.
[7] Regeneration greater than 1 metre tall.

Summary of Harvesting and Extraction operations.

Block	Day	Crew Size[1] (#)	Cutters Productive Hours[2] (#)	Volume (m³)	Trees (#)	Extraction Productive Hours[3] (#)	Trips (#)	Distance (m)	Productivity Cutting (m³/HPH)	Extraction (m³/trip)	Extraction (m³/EPH)	Crew Production[4] (m³/TPH)
1	1	1	7.2	7.13	38	4.9	8	155	0.99	0.89	1.46	0.59
	2	1	2.8	5.80	38	2.7	10	158	2.07	0.58	2.15	1.05
	3	1	6.6	8.10	41	3.8	8	161	1.23	1.01	2.13	0.78
Total/Av.	3	1	16.6	21.03	117	11.4	26	158	1.27	0.81	1.91	0.75
2	1	3	13.6	14.99	137	6.2	13	210	1.10	1.15	2.42	0.76
	2	3	14.2	14.70	126	6.3	12	215	1.04	1.23	2.33	0.72
	3	3	10.6	17.17	124	5.9	13	265	1.62	1.32	2.91	1.04
Total/Av.	3	3	38.4	46.86	387	18.4	38	230	1.22	1.23	2.55	0.83
3	1	1	2.5	12.60	55	2.5	6	550	5.04	2.10	5.04	2.52
	2	1	5.7	11.93	75	3.0	8	540	2.09	1.49	3.98	1.37
	3	1	3.1	14.59	104	2.7	8	557	4.71	1.82	5.40	2.52
Total/Av.	3	1	11.3	39.12	234	8.2	22	549	3.46	1.78	4.81	2.01
4	1	2	2.6	10.15	41	1.5	3	680	3.90	3.38	6.77	2.48
	2	2	7.7	23.86	105	6.5	11	700	3.10	2.17	3.67	1.68
	3	2	8.8	25.62	129	6.7	11	750	2.91	2.33	3.82	1.65
	4	2	8.9	21.87	111	6.0	9	780	2.46	2.43	3.65	1.47
Total/Av.	4	2	28.0	81.50	386	20.7	34	728	2.91	2.40	4.48	1.67
5	1	1	4.4	8.69	46	1.7	4	305	1.97	2.17	5.11	1.42
	2	1	4.8	9.48	25	1.6	4	305	1.98	2.37	5.93	1.48
	3	1	3.2	8.66	53	2.5	5	305	2.71	1.73	3.46	1.52
	4	2	9.6	11.97	54	2.5	5	305	1.25	2.39	4.79	0.99
Total/Av.	4	1	22.1	38.8	178	8.3	18	305	1.76	2.16	4.82	0.80
6	1	1	6.8	15.22	60	3.9	-	270	2.24	-	3.90	1.42
	2	1	4.8	14.33	59	3.3	4	275	2.99	1.20	4.34	1.77
	3	1	3.6	8.52	37	2.1	4	280	2.37	0.90	4.06	1.49
Total/Av.	3	1	15.2	38.07	156	9.3	8	275	2.50	2.86	4.10	1.55
7	1	1	3.9	8.53	11	1.8	4	725	2.19	2.13	4.74	1.50
	2	1	3.0	10.88	16	2.6	2	730	3.63	5.44	4.18	1.94
	3	1	3.8	7.29	13	2.9	1	725	1.92	7.29	2.51	1.09
	4	1	4.0	3.51	3	1.3	1	725	0.88	3.51	2.70	0.66
Total/Av.	4	1	14.7	30.21	43	8.6	8	725	2.06	3.78	3.53	1.30
8	1	2	7.3	20.08	53	6.5	17	320	2.75	1.18	3.09	1.46
	2	2	6.7	28.83	81	-	18	300	4.30	1.60	-	-
Total/Av.	2	2	14.0	48.91	134	6.5	35	310	3.49	1.40	3.09	1.46
9	1	3	18.0	44.32	260	8.8	20	368	2.46	2.22	5.04	1.65
	2	2	3.0	6.02	27	1.0	2	375	2.01	3.01	6.02	1.51
	3	3	17.0	52.12	291	9.1	21	417	3.07	2.48	5.73	2.00
	4	3	17.6	42.30	287	8.9	17	450	2.40	2.49	4.75	1.60
	5	3	10.0	21.89	154	4.7	12	464	2.19	1.82	4.66	1.49
Total/Av.	5	3	65.6	166.65	1019	32.5	72	415	2.54	2.31	5.24	1.70
10	1	3	5.6	11.65	24	1.4	3	35	2.08	3.88	8.32	1.66
	2	3	6.6	9.89	20	1.5	4	50	1.50	2.47	6.59	1.22
	3	2	3.2	5.83	19	1.2	3	150	1.82	1.94	4.86	1.33
	4	3	3.5	9.32	16	1.7	3	150	2.66	3.11	5.48	1.79
	5	3	4.2	8.77	17	1.7	3	30	2.09	2.92	5.16	1.49
Total/Av.	4	3	23.1	45.46	96	7.5	16	83	1.97	2.84	6.08	1.49
11	1	2	9.0	20.43	151	-	6	350	2.27	3.41	-	-
	2	2	8.3	22.16	173	3.4	6	360	2.67	3.69	6.52	1.89
	3	2	9.9	10.71	77	5.1	8	365	1.08	1.34	2.10	0.71
Total/Av.	4	2	27.2	53.30	401	8.5	20	360	1.96	2.67	4.31	0.92
12	1	3	18.0	47.91	377	9.0	20	460	2.66	2.39	5.32	1.77
	2	3	18.0	49.50	336	9.0	22	480	2.75	2.25	5.50	1.83
	3	3	18.0	50.22	452	9.0	19	514	2.79	2.64	5.58	1.86
Total/Av.	3	3	54.0	147.63	1165	27.0	61	485	2.73	2.42	5.47	1.82
13	1	1	7.0	12.77	21	4.2	10	200	1.82	1.28	3.04	1.14
	2	1	5.5	8.07	15	2.3	8	200	1.47	1.01	3.51	1.03
	3	1	5.3	6.91	10	4.1	6	210	1.30	1.15	1.69	0.74
	4	1	7.5	12.24	30	-	10	210	1.63	1.22	-	-
Total/Av.	4	1	25.3	39.99	76	10.6	34	205	1.58	1.18	2.74	0.77
14	1	1	2.0	3.48	26	1.5	6	75	1.74	0.58	2.32	0.99
	2	1	2.0	4.79	31	1.2	6	75	2.40	0.80	3.99	1.50
	3	1	2.1	1.18	14	1.3	4	90	0.56	0.30	0.91	0.35
	4	1	1.3	2.49	26	1.6	4	130	1.92	0.62	1.56	0.86
Total/Av.	4	1	7.4	11.94	97	5.6	20	93	1.61	0.60	2.19	0.92

Summary of harvesting and Extraction operations.

Block		Cutters				Extraction			Productivity			
	Day	Crew Size[1] (#)	Productive Hours[2] (#)	Volume (m³)	Trees (#)	Productive Hours[3] (#)	Trips (#)	Distance (m)	Cutting (m³/HPH)	Extraction m³/trip	Extraction m³/EPH	Crew Production[4] (m³/TPH)
15	1	1	5.5	6.56	30	1.5	5	480	1.19	1.31	4.37	0.94
	2	1	8.5	24.76	103	2.5	9	480	2.91	2.75	9.90	2.25
	3	1	5.0	12.51	64	1.5	5	480	2.50	2.50	8.34	1.92
	4	1	6.4	19.25	63	3.7	7	490	3.01	2.75	5.20	1.91
Total/Av.	4	1	25.4	63.08	260	9.2	26	483	2.48	2.43	6.96	1.82
16	1	2	6.5	27.89	99	4.6	19	260	4.29	1.47	6.06	2.51
	2	2	8.9	30.19	90	6.7	17	135	3.39	1.78	4.51	1.94
	3	2	7.7	25.39	85	5.8	19	95	3.30	1.34	4.38	1.88
Total/Av.	3	2	23.1	83.47	274	17.1	55	163	3.61	1.52	4.98	2.08
17	1	2	5.0	22.50	58	4.0	11	135	4.50	2.05	5.63	2.50
	2	2	5.3	16.15	84	4.7	14	460	3.05	1.15	3.44	1.61
	3	2	6.3	14.01	80	5.3	12	510	2.22	1.17	2.64	1.21
Total/Av.	3	2	16.6	52.66	222	14.0	37	368	3.17	1.42	3.90	1.72
18	1	3	7.5	25.64	104	3.4	10	100	3.42	2.56	7.54	2.35
	2	3	14.8	38.01	188	6.5	22	130	2.57	1.73	5.85	1.78
	3	3	9.5	28.01	123	4.9	14	135	2.95	2.00	5.72	1.95
	4	3	9.0	23.52	114	3.8	14	145	2.61	1.68	6.19	1.84
Total/Av.	4	3	40.8	115.18	529	18.6	60	128	2.82	1.92	6.32	1.94
19	1	2	12.7	18.80	147	4.5	14	450	1.48	1.34	4.18	1.09
	2	1	5.7	11.74	85	1.9	7	400	2.06	1.68	6.18	1.54
	3	3	10.9	19.98	123	3.9	11	230	1.83	1.82	5.12	1.35
Total/Av.	3	2	29.3	50.52	355	10.3	32	360	1.72	1.58	5.16	1.28
20	1	3	7.6	14.44	81	3.3	8	110	1.90	1.81	4.38	1.32
	3	2	4.5	5.88	27	1.9	4	300	1.31	1.47	3.09	0.92
	4	1	3.4	12.19	61	2.5	8	325	3.59	1.52	4.88	2.07
	5	1	3.5	7.64	64	-	8	350	2.18	0.96	-	-
Total/Av.	5	2	19.0	40.15	233	7.7	28	271	1.87	1.27	4.12	1.11
21	1	3	13.7	34.39	153	-	17	300	2.51	2.02	-	-
	2	3	9.0	18.77	74	3.8	7	325	2.09	2.68	4.94	1.47
	3	3	8.5	19.98	82	4.0	10	750	2.35	2.00	5.00	1.60
	4	3	14.1	27.09	74	4.2	14	775	1.92	1.94	6.45	1.48
Total/Av.	4	3	45.3	100.23	383	12.0	48	538	2.21	2.09	5.46	1.15
22	1	2	6.8	22.52	145	6.6	15	175	3.31	1.50	3.41	1.68
	2	2	7.0	16.96	86	5.8	13	225	2.42	1.30	2.92	1.33
	3	2	5.9	15.56	91	5.3	13	150	2.64	1.20	2.94	1.39
	4	2	6.3	20.01	136	5.1	13	200	3.18	1.54	3.92	1.76
Total/Av.	4	2	26.0	75.05	458	22.8	54	188	2.89	1.39	3.30	1.54
23	1	3	12.7	47.11	201	5.5	12	650	3.71	3.06	8.57	2.59
	2	3	16.5	38.65	180	6.4	13	930	2.34	1.30	6.04	1.69
	3	3	19.1	47.75	216	5.9	12	250	2.50	1.20	8.09	1.91
	4	3	18.1	39.15	199	4.5	11	375	2.16	1.54	8.70	1.73
Total/Av.	3	3	66.4	172.66	796	22.3	48	551	2.60	3.60	7.85	1.95
24	1	3	11.8	43.42	176	4.8	11	180	3.68	3.95	9.05	2.62
	2	3	14.0	60.24	255	6.3	11	150	4.30	5.48	9.56	2.97
	3	3	14.0	38.66	209	6.2	13	200	2.76	2.97	6.24	1.91
	4	3	6.5	37.59	143	3.3	7	200	5.78	5.37	11.39	3.84
Total/Av.	4	3	46.3	179.91	783	20.6	42	183	3.89	4.28	9.06	2.69

[1] Number of persons in crew (cutters and skidder operator).
[2] Total productive hours worked for all cutters in crew.
[3] Total productive hours for extraction.
[4] Volume (m³) produced per productive hour worked by the crew (extraction and harvesting combined).