SESSION I
Paper (a)

ESTIMATING FUTURE MANPOWER NEEDS FOR HARVESTING NEW ZEALAND FORESTS

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1. Introduction

Because one can be relatively certain about the volumes of logs that will be harvested in future, but far less certain about the nature of flows of forest products beyond the forest ride, this paper concentrates on manpower requirements in the harvesting phase only.

Any estimate of future needs of manpower in the transport phase requires a series of dubious assumptions about the direction of transport, the mode of transport, and the location and type of processing plants and markets, however, crude estimates of labour in trucking could be obtained by prorating employment on the basis of changes in the expected harvesting rate through time.

1.1 Cutting Schedules

Table 1A shows the generalised growing and cutting schedule for the 1981 Forestry Conference continuation of management intention scenario.

This indicates expected areas harvested and the associated yield outturn.

1.2 The volume of Thinnings estimated in Table 1A are now considered to be understated e.g. during 1981-85 they were predicted to be 1.9 million m^3/lustrum or 380,000 m^3/year whereas Vaughan's 1983 survey estimates that the volume currently extracted by production thinning is 1.3 million m^3/year and this level will be maintained until 1992.

As Vaughan's survey is more accurate it has been adopted and extended as described in Table 1B below. It will be allowed for later in the manpower forecasts but the next part of this paper will be devoted to describing how the estimates of wage workers employed in harvesting jobs were derived for the 1981 Forestry Conference work.

TABLE 1A

GROWING AND CUTTING SCHEDULE 1 : CONTINUATION SCENARIO

CUTTING SCHEDULE FOR NEW ZEALAND | SPECIES: ALL EXOTICS | OWNERSHIP: ALL | DATE PREPARED: 15.5.81

AREA AT 31 MARCH (rounded)	AGE CLASS (000 ha)													TOTAL YIELD OVER PERIOD (000000 m^3/lustrum)		
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	60+	Thins Logs	C.F Logs	Total Logs
Clearfelling 1981	264.1	238.5	124.5 (0.7)	63.8 (0.3)	35.6 (1.7)	22.6 (5.4)	16.5 (7.6)	6.4 (2.5)	10.4 (4.3)	20.4 (12.2)	27.8 (18.1)	9.8 (4.2)	7.0 (4.5)	1.9	41.2	43.1
1986	255.6	264.1	238.4 (1.5)	123.8 (0.7)	63.5 (7.1)	33.9 (12.0)	17.2 (9.5)	8.9 (6.5)	3.9 (2.8)	6.1 (3.4)	8.2 (6.2)	10.0 (8.1)	6.6 (3.3)	2.6	41.9	44.5
1991	216.2	255.6	264.1 (3.6)	236.9 (3.7)	123.1 (17.5)	56.4 (34.9)	21.9 (15.2)	7.7 (3.6)	2.4 (1.4)	1.1 (0.7)	2.7 (0.8)	2.2 (1.5)	2.7 (1.0)	2.3	51.6	53.9
1996	212.9	216.2	255.6 (3.7)	260.5 (4.7)	233.2 (37.9)	105.6 (76.0)	21.4 (12.0)	6.6 (2.3)	4.0 (1.7)	0.9 (0.4)	0.4 (0.3)	1.9 (1.2)	1.7 (0.9)	3.7	86.0	89.7
2001	260.5	212.9	216.2 (4.8)	249.4 (8.6)	255.8 (36.9)	195.3 (118.5)	29.6 (16.9)	9.0 (1.9)	4.2 (2.0)	2.2 (0.8)	0.5 (0.5)	0.1 (0.1)	1.5 (0.8)	3.1	117.4	120.5
2006	267.9	260.5	212.9 (6.0)	209.8 (4.3)	240.8 (26.9)	218.7 (100.1)	76.8 (60.0)	11.5 (2.1)	7.1 (3.8)	2.2 (0.7)	1.4 (1.3)	0.1 (0)	0.6 (0.2)	3.1	131.8	134.9
2011	263.3	267.9	260.5 (7.7)	205.9 (6.6)	202.0 (21.8)	213.9 (101.5)	118.6 (83.8)	16.8 (5.4)	9.3 (5.0)	3.2 (0.8)	1.4 (0.9)	0.1 (0)	0.3 (0.1)	2.5	150.9	153.4

Establishment in 000ha/lustrum

Lustrum	New Planting	Restocking	Total
1981/85	194.1	61.5	255.6
86/90	155.1	61.1	216.2
91/95	129.0	83.9	212.9
96/00	119.4	141.1	260.5
01/05	76.1	191.8	267.9
06/10	57.9	205.4	263.3

YIELD TABLE

Age	15	20	25	30	35	40	45	50	55	60	65
m^3/ha of c/fell logs	138	283	558	650	726	720	736	709	918	717	649

(Figures in brackets are clearfelling during lustrum)

NB. The opening stocked area less the area clearfelled over a lustrum does not always quite equal the closing stocked forest area. This is mainly due to rounding affects. Some minor errors which were not located and corrected on computer file because of lack of time, also. are included

Table 1B : Volumes of Utilization Thinnings Expected (Modified Vaughan Estimate)

	000 m^3/lustrum	000 m^3/year
1981-85	6500	1300
1986-90	6500	1300
1991-95	6500	1300
1996-00	9750	1950
2001-05	9750	1950
2006-10	9750	1950
2011-15	9750	1950

2. Estimates of Wage Workers Employed in Harvesting Jobs Made for the 1981 Forestry Conference

Using the physical variables described on Table 1A, and other assumptions that will be described later, the numbers of wage workers in harvesting gangs were estimated as in Table 2.

Table 2 : Estimated Mean Number of Wageworkers in Harvesting by Lustrum (from 1981 Forestry Conference Proceedings)

	Numbers of Harvesting Gang Wage Workers in Full Time Person Equivalents
1981-85	3320
1986-90	2720
1991-95	3260
1996-00	5010
2001-05	6969
2011-10	7460

3. Elaboration of the Derivation of Employment Estimates

To understand how these employment estimates were derived we shall focus on one planning period, 1986-90. Table 3 shows the basic variables used to project manpower needs for clear felling during that period. These data are largely extracted from the cutting schedule described in Table 1. Other relevant material was averaged from all the component crop types gathered for the 1981 forestry conference work.

Table 3 : Basic Variables Used to Project Manpower Needs for clearfelling 1986-90

Age (Years)	(1) Area (000 ha) Clearfelled per lustra	(2) Yield in m^3/ Mean Tree Harvested	(3) Proportion in Each Age Area Class that is Hauler Terrain	(4) Yields in m^3 m^3/ha
11-15	1.5	0.18	0.37	106
16-20	0.7	0.42	0.35	283
21-25	7.1	1.71	0.35	558
26-30	12.0	1.65	0.30	650
31-35	9.5	2.05	0.27	726
36-40	6.5	1.93	0.31	720
41-45	2.8	1.62	0.40	736
46-50	3.4	1.62	0.56	709
51-55	6.2	2.03	0.16	918
56+	13.4	1.75	0.10	717

3.1 Table 4 outlines some of the necessary variables that are derived from those in Table 3.

3.1.1 Column (5) of Table 4 shows the estimate of tractor gang production in m^3/year. This will be described more fully by Tom Johnson but it is as follows for say trees felled at age 30 years.

27467 m^3/gang year = 0.6436*((1.65)**o.57)*32080)

Where 0.6436 = gang efficiency reduction factor
1.65 = mean trees size harvested
0.57) = constants dervied by workstudy.
32080)
* multiply
** raise to power of

3.1.2 Column (6) shows the estimate of hauler gang production for the same age (and average tree size). This formula is the same as that used to estimate tractor gang production except it is reduced by multiplying by a hauler reduction factor of 0.62.

3.1.3 Column (7) is derived by multiplying column (1) by (1-colume (3)) from Table 3, 4 i.e., by multiplying the area clearfelled by the proportion that is to be harvested by tractor.

Table 4 : Derived Variables Used to Prosect Manpower Needs for Clearfelling 1986-90

Age (Years)	(5) Mean Tractor Gang Prodn m^3/year	(6) Mean Hauler Gang Prodn m^3/year	(7) Tractor Area Felled (000 ha) per lustrum	(8) Hauler Area Felled (000 ha) per lustrum	(9) Tractor Felled Yield 000 m^3/ per lustrum
11-15	7768	4816	0.94	0.56	100.17
16-20	12592	7807	0.45	0.24	128.76
21-25	28032	17380	4.61	2.48	2575.17
26-30	27467	17029	8.40	3.60	5460.00
31-35	31084	19272	6.93	2.56	5034.81
36-40	30034	18621	4.48	2.01	3229.20
41-45	27181	16852	1.68	1.12	1236.48
46-50	27181	16852	1.49	1.90	1060.66
51-55	30911	19165	5.21	0.99	4780.94
56+	28404	17610	12.06	1.34	8647.02

3.1.9 Column (8), i.e. the estimate of hauler area clearfelled is derived in a similar manner i.e. it is derived by multiplying columns (1) by column (3) from Table 3.

3.1.10 Column (9), tractor-felled yield in 000 m^3/lustrum is derived by muliplying column (7) by yield in m^3/ha, i.e. column (4).

3.1.11 Column (10) (see table 5) is calculated by dividing the appropriate yield in 000 m^3/lustrum by mean tractor gang production m^3/year x 5 i.e. column (9) by column (5) x 5.

3.1.12 Column (11), hauler felled yield in 000 m^3/lustrum is derived by multiplying column (8) by yield in m^3/ha, i.e. column (4).

3.1.13 Column (12), is calculated by dividing column (11) by 5 x column (6), i.e. total hauler yield by hauler gang production.

3.1.14 Column (13). Full time equivalent wage workers in tractor gangs are derived by multiplying the number of tractor gangs (column (10)) by 8 workers.

3.1.9 Column (14). Full time equivalent wage worker is hauler gangs are derived by multiplying the number of hauler gangs (column (12)) by 10 workers.

Table 5 : Derived Variables Used To Project Manpower Needs for Clearfelling during 1986-90, Plus the Projections of Wageworkers needed by Logging Class

Age (Years)	(10) Equivalent Tractor Gangs Employed Full Time	(11) Hauler-Felled Yield 000 m^3/ lustrum	(12) Equivalent Hauler Gangs Employed Full Time	(13) Full Time Equivalent Wage Workers In Tractor Gangs	(14) Full Time Equivalent Wage Workers In Hauler Gangs
11-15	2.58	58.83	2.44	20.63	24.43
16-20	2.05	69.33	1.78	16.36	17.76
21-25	18.37	1386.63	15.96	146.98	159.57
26-30	39.76	2340.00	27.48	318.05	274.81
31-35	32.39	1862.19	19.32	259.15	193.25
36-40	21.50	1450.80	15.58	172.03	155.82
41-45	9.09	824.32	9.78	72.78	97.82
46-50	7.80	1349.93	16.02	62.43	160.20
51-55	30.93	910.66	9.50	247.46	95.03
56+	60.88	960.78	10.91	487.08	109.11

3.2 Comparing the Results With Table 2 : Gang Efficiency Factors

If columns (13) and (14) are added and totalled across the age classes an estimate of total full time equivalent wage workers in clearfelling jobs of 3091 as derived.

Referring back to Table 2, some quick witted person in the audience might say "Aha you said 2720 not 3091 for period 1986-90!"

The answer to that observation lies mainly with the gang efficiency reduction factor (see back to section 3.1.1 of this report). Remember the gang production formula is currently; 0.6436*((mean tree size**0.57)*32080).

Where 0.6436 is the gang efficiency reduction factor.

In the derivation of Table 2 this gang efficiency factor was adjusted over a period of 20 years up to 1.0 as follows.

	Gang Efficiency Reduction Factor
1981-85	0.6436
1986-90	0.8
1991-95	0.9
1996-00	1.0
2001-05	1.0
2011-10	1.0

This gang efficiency reduction factor has a major impact on the number of workers employed.

The use of a factor of 0.8 instead of 0.6436 reduces the estimate of 3091 wage workers in harvesting to 2312 for 1986-90.

To the 2312 people directly employed in clearfelling 172 utilization thinning workers, and 233 pre harvest roading workers were added to reach the rounded number of 2720 workers for period 1986-90. (See Table 2).

3.3 Employment in Utilisation Thinning Operations

As was mentioned in Section 1.2 better estimates of the volume of wood produced by Thinning Operations are available. It is intended to adjust for these but use the same formula and other data assumptions for employment in utilization thinnings that were used for the 1981 forestry conference work.

Table 6

	Mean Tree Size for Utilization Thinnings in m3/tree
1981-85	0.17
1986-90	0.27
1991-95	0.30
1996-00	0.29
2001-05	0.18
2011-10	0.27
2011-15	0.22

To estimate employment in Thinning the same gang production formula used for clearfelling is used, but it is assumed that the average number of men per Thinning Gang is 4.

i.e. employment in Thinning during 1986-90 is

(6500000/(5*.8*((.27**0.57)*32080))*4

= 427 full time person equivalent.

Where 6500000 = the volume in m^3 harvested during 1986-90
5 = 5 years in lustrum
0.8 = gang efficiency reduction factor
0.27 = mean tree size harvested
4 = number of men per gang
0.57, 32080 = constants derived by work study.

Results of these revised estimates of direct employment in utilization thinning operations are included in Table 7.

3.4 Employment In Pre Harvest Roading Operations

The following equation was used to estimate the numbers of wage workers in road and landings construction including the associated log salvage prior to thinning or clearfelling operations.

Wageworkers = (((THR*THA)*TPFR) + ((CFR*CFA)*CPFR))/235

Where THR = area utilization thinned in ha
THA = man days to road for utilization thinning/ha
CFR = man days to road for clearfelling/ha (0.5)
TPFR = proporation of utilization thinned crop which is first rotation
CPFR = proportion of clearfelled crop which is first rotation
235 = number of man days per year.

This equation is rather simplistic. It could be improved by adjusting for terrain, road maintenance and other factors.

However, the results described on Table 7 were derived for the model.

3.5 Employment In Pre Harvest Inventory Work

Pre harvest inventory work is assumed to employ 1.1 wage workers per 1 million m^3 harvested p.a. (1981 Forestry Conference Yield Data was used).

3.6 Supervisors and Managers Employed

Staff i.e. supervisors and managers are calculated on the following basis.

1 to every 2 pre-harvest inventory worker
1 to every 8 pre-harvest roading worker and
1 to every 30 workers in utilization thinning or clearfelling gangs.

4. Acknowledgements

Mr T. Johnson is thanked for providing the Work Study Data, and Messrs W. Evans, P. Painter and L. Vaughan are thanked for providng advice on multipliers of various sorts.

Table 7 : Summary of Estimates of Employment in Harvesting in Full Time Person Equivalents

	Wage Workers				Staff i.e.	Totals
Period	Pre-harvest Inventory	Pre-harvest Roading	Utilization Thinning	Clear Felling	Supervisors and Managers	
1981-85	9	212	691	2907	151	3969
1986-90	9	233	427	2312	125	3106
1991-95	11	302	357	2831	149	3650
1996-00	18	438	492	4389	226	5563
2001-05	24	538	646	6104	304	7616
12006-10	27	515	512	6790	321	8165

Reference:

Levack H. and Gilchrist C. 1981.
"Land, labour, machinery, buildings costs, revenue, return on investment and other within - forest resources flows associated with five alternative national afforestation strategies" 1981 Forestry Conference background paper".

Vaughan L.W. 1983 "New Zealand's Exotic Smallwood Resource - 1983-1992" Proceedings of LIRA June 1983 Seminar 'Research and Development in Tree Harvesting and Transportation'.