ECONOMICS OF FINAL CROP STOCKING AT THE TIKITERE AGROFORESTRY TRIAL. PART 2: ECONOMIC COMPARISONS

J. PIERS MACLAREN

New Zealand Forest Research Institute,
P. O. Box 29237, Fendalton, Christchurch, New Zealand

and R. LEITH KNOWLES

New Zealand Forest Research Institute,
Private Bag, Rotorua, New Zealand

(Received for publication 19 June 1996; revision 5 February 1999)

ABSTRACT

Data produced by the "Method for Assessment of Recoverable Volume by Log Type" (MARVL) from the Tikitere Agroforestry Trial were used to compare the economic consequences of a range of final-crop stockings of *Pinus radiata* D. Don on a typical farm site with understorey grazing. The 93-ha 21-year-old trial included stockings at 400, 200, 100, and 50 stems/ha; intermediate stockings were simulated using the stand growth program STANDPAK as calibrated by the MARVL data.

The highest stocking examined (400 stems/ha) yielded the highest revenue per hectare. Whereas it is conceivable that rising premiums for large pruned logs could enable 200 stems/ha to yield an equivalent revenue, premiums would have to almost double before 100 stems/ha could achieve this.

In terms of Internal Rate of Return (IRR), the most profitable investment—given that current log specifications do not include many important features of internal wood quality—is clearly to harvest at or before age 21, and to adopt low final-crop stockings (100–200 stems/ha). On the other hand, if the Net Present Value (NPV) approach is used and combined with discount rates that are markedly lower than the IRR (11–14%), then the optimum felling age occurs as late as age 31 and optimum final-crop stockings are as high as 400 stems/ha. The preferred method (IRR or NPV) will depend on the objectives of the decision-maker.

Keywords: stocking; final-crop stocking; MARVL; internal rate of return; discount rate; rotation age; grazing.

INTRODUCTION

The first part of this report (Maclaren & Knowles 1999) described the volumes of wood, by log type, obtainable from the Tikitere Agroforestry Trial for a range of final-crop stockings. For those stockings included in the trial (50, 100, 200, 400 stems/ha) MARVL assessments were used; intermediate stockings were simulated using the stand growth program STANDPAK as calibrated by the MARVL data. The assessments were carried out at stand age 21 years, and wood volumes at subsequent ages were simulated using a combination of STANDPAK and GROMARVL models.

In this second part of the report, we address the management issues of final-crop stocking on this fertile ex-farm site. What are the relative costs and revenues, including the revenues from understorey grazing? Which tree stocking yields the greatest revenue per hectare, the best return on capital, the greatest net present value? How do the conclusions vary with input factors, and which factors have the greatest influence on the results? Finally, what guidelines can be given to small-scale growers, who often do not have access to sophisticated models or specialised knowledge?

METHODS

Stumpage Prices

Using a flat rate for pruned logs

There is no recognised method of selecting representative stumpage prices. Long-run averages give a fairer indication than spot prices, but long-run trends may not continue. There are various sources of information, but many are confidential and cannot be quoted. Complications arise because prices are not given in the same units (tonnes, cubic metres, or cubic metres JAS), at the same price point (FOB, on wharf, at mill, on truck, at ride, or on stump), in the same currency (US$ or NZ$), or in the same year (i.e., they are not adjusted for inflation). Data sources cover varying years and intervals of data, and differ in reliability and sample size. Stumpage prices depend on the cost of harvesting and transport to the point of sale, and these factors vary with the topography and location of individual stands.

For the study reported here, the price list in Table 1 was used to determine how each tree was divided into logs.

TABLE 1–Stumpage prices assumed for the MARVL analysis (with a flat rate for pruned logs)

Log grade	Stumpage price ($/m^3)
Pruned	172
S1 sawlogs	55
S2 sawlogs	43
L1 sawlogs	50
L2 sawlogs	30
Pulp	11
Waste (e.g., firewood)	1

Sensitivity of pruned log prices to small-end diameter and clearwood content

It would be misleading to analyse final-crop stocking solely with a fixed value for pruned logs, as in Table 1, regardless of small-end diameter (s.e.d.) or clearwood content. Low stockings have a low volume of pruned material per hectare, but a high individual piece size. We know that large-diameter logs have considerable advantages to the sawmiller—firstly, because the large size enhances the number of sawing options, the sawn recovery, and the proportion of high-premium timber grades, and secondly because, for a fixed defect core, large small-end diameters imply a greater proportion of clearwood. The figure obtained when the defect core diameter is subtracted from the s.e.d. is known as the clearwood index

(CWI). The intrinsic value of a pruned log is therefore proportional to both the s.e.d. and the CWI. Pruned log price assumptions that were used in the base scenario, and for two variations on the base scenario, are given in Table 2.

TABLE 2–Assumptions of stumpage differentials for pruned logs (whereby pruned log prices are proportional to s.e.d. and CWI)

Age (years)	Stocking (stems/ha)	S.e.d. (mm)	CWI	Base stumpage ($/m³)	Reduced differential	Increased differential
21	400	401	112	147	160	97
	350	405	123	152	162	112
	300	414	126	153	163	115
	250	424	138	158	165	130
	200	437	158	166	169	154
	100	492	179	176	174	184
	50	502	217	191	182	229
25	400	428	141	159	166	133
	350	435	153	164	168	148
	300	445	158	166	169	154
	250	459	174	173	173	175
	200	479	199	183	178	205
	100	544	232	197	185	247
	50	559	274	214	193	298
28	400	445	159	167	170	157
	350	453	172	172	172	172
	300	465	178	174	173	178
	250	481	195	181	177	199
	200	503	223	193	183	235
	100	574	261	210	191	286
	50	593	308	228	200	340
31	400	461	174	173	173	175
	350	469	188	178	175	190
	300	482	195	181	177	199
	250	499	213	189	181	223
	200	522	243	201	187	259
	100	598	285	219	196	313
	50	619	334	238	205	370

Sensitivity of pruned log prices relative to unpruned log prices

The base scenario from Table 2 was both halved and doubled, in order to reduce and increase the price of pruned logs relative to the unpruned logs (Table 3).

Determining Forestry Costs

It is important to include costs in a comparison of final-crop stockings in direct regimes, because higher stockings clearly involve higher costs. For example, there are twice as many trees to prune in a 400 stems/ha stand as in a 200 stems/ha one. Silvicultural costs for modern regimes that could be used to create the range of final-crop stockings modelled here are listed in Appendix 1. Sensitivity analysis was not considered necessary to explore cost

TABLE 3–Assumptions of pruned log prices relative to unpruned logs (where pruned log prices are proportional to s.e.d. and CWI). *See* Table 1 for unpruned log prices.

Age (years)	Stocking (stems/ha)	SED (mm)	CWI	Pruned log prices ($/m^3)		
				Base stumpage	Halved stumpage	Doubled stumpage
21	400	401	112	147	74	294
	350	405	123	152	76	304
	300	414	126	153	77	306
	250	424	138	158	79	316
	200	437	158	166	83	332
	100	492	179	176	88	352
	50	502	217	191	96	382
25	400	428	141	159	80	318
	350	435	153	164	82	328
	300	445	158	166	83	332
	250	459	174	173	87	346
	200	479	199	183	92	366
	100	544	232	197	99	394
	50	559	274	214	107	428
28	400	445	159	167	84	334
	350	453	172	172	86	344
	300	465	178	174	87	348
	250	481	195	181	91	362
	200	503	223	193	97	386
	100	574	261	210	105	420
	50	593	308	228	114	456
31	400	461	174	173	87	346
	350	469	188	178	89	356
	300	482	195	181	91	362
	250	499	213	189	95	378
	200	522	243	201	101	402
	100	598	285	219	110	438
	50	619	334	238	119	476

variations, in contrast to price assumptions, because they are unlikely to differ greatly from the assumed values.

Logging costs vary according to volume per hectare and piece size, and are therefore affected by stocking. In Appendix 2 it is assumed that lower stockings are cheaper to log on both a per hectare and a per cubic metre basis but, in practice, the greatly increased trimming costs for the lower stockings could more than offset any gains. In the absence of hard data on trimming costs, this factor has been omitted from the calculations, which were derived using the STANDPAK harvesting module.

Determining Agricultural Revenues

The model AGRO (a module of STANDPAK: Cox *et al.* 1998) was used to estimate the livestock-carrying capacity in the various final-crop stockings under modern regimes (Appendix 3).

The livestock-carrying capacity was multiplied by $25, as that is a typical current gross margin per livestock unit for sheep. Note that labour and fixed costs are not included in an agricultural gross margin, and so the "revenues" obtained by this method are highly optimistic. If real revenues were used, they would be close to zero. For example, the non-planted paddocks at Tikitere are currently not grazed because the grazing rental that would be obtained is insignificant and would not cover the costs of fence maintenance. Gross margins are applicable only if the understorey grazing is "at the margin" of a farming operation, so that all fixed costs (including the farmer's labour) are paid for by the main farm and the understorey grazing is a genuine bonus.

Financial Analysis

Spreadsheets were constructed to calculate total stumpage revenues for the various scenarios, and from them Internal Rates of Return (IRR%) and Net Present Values (Tables 4 to 7). For the latter, a range of discount rates was used.

RESULTS

The base-scenario revenues per hectare (Table 4) for pruned logs and unpruned logs, and for total volume, produced the following observations.

- Revenue was highest at the highest stockings. It would be interesting to observe the effect of stockings higher than 400 stems/ha, because it is not possible to extrapolate trends from lower stockings. Tree density at very high stockings must reach the stage where the majority of pruned logs fail to meet the specifications for small-end diameter, and very high stockings would incur excessive mortality at advanced ages, again depressing revenue. We suspect, therefore, that no great advantages are to be gained with stockings higher than 400 stems/ha in regimes in which every tree is pruned.
- Revenue for the pruned logs was *not* highest at the highest stockings, at least not until age 28. This reflects the fact that the higher stockings do not carry a substantially higher *pruned* volume at younger ages, and the clearwood content of pruned logs is lower for higher stockings.

Sensitivity analyses on the pruned log prices are given in Tables 5 and 6.

- The highest stocking—400 stems/ha—yielded the greatest harvest revenue even with substantially increased premiums for large piece sizes and high clearwood yields. The same result occurred with changes in the premium for pruned logs relative to unpruned logs.
- * Whereas it is conceivable that premiums for large pruned logs could rise to the stage where 200 stems/ha could yield a total revenue equivalent to 400 stems/ha, premiums would have to almost double before this could be achieved with 100 stems/ha.

Internal rates of return (IRR) and net present values (NPV) for seven stockings at four rotation ages are given in Table 7. In this Table are incorporated the estimated silvicultural costs, the estimated harvesting costs, and the revenues from understorey grazing, all of which vary with stocking.

- The highest IRRs are at the earliest age modelled, consistent with the shorter time that capital (land, stand establishment, and silvicultural costs) is "tied up" in the investment.

TABLE 4–Harvest revenues of treatments at four ages

Age (years)	Stocking (stems/ha)	$/m^3$ pruned	Total $/ha pruned	Total $/ha unpruned	Total $/ha	$/m^3$ pruned needed to equal revenue from 400 stems/ha
21	400	147	30 973	17 749	48 772	147
	350	152	32 361	12 488	44 849	170
	300	153	32 467	10 757	43 224	179
	250	158	31 711	9 116	40 827	198
	200	166	30 312	7 557	37 869	226
	100	176	22 616	3 599	26 215	352
	50	191	13 294	1 218	14 512	683
25	400	159	40 768	22 332	63 100	159
	350	164	41 295	17 179	58 474	182
	300	166	41 068	15 530	56 598	192
	250	173	40 341	13 912	54 253	211
	200	183	38 686	10 946	49 632	247
	100	197	29 373	5 170	34 543	389
	50	214	18 018	1 894	19 912	727
28	400	167	46 827	25 585	72 412	167
	350	172	46 681	20 497	67 178	191
	300	174	46 162	18 838	65 000	202
	250	181	45 286	17 021	62 307	221
	200	193	44 081	13 129	57 210	260
	100	210	33 831	6 211	40 042	411
	50	228	21 455	2 352	23 807	745
31	400	173	52 056	28 399	80 455	173
	350	178	50 783	23 187	73 970	201
	300	181	50 354	21 680	72 034	211
	250	189	50 354	19 284	68 953	233
	200	201	48 542	15 213	63 755	270
	100	219	37 427	7 200	44 627	429
	50	238	24 180	2 783	26 963	764

The last column is the price premium that would be required for pruned logs to provide the same total revenue per hectare as the 400 stems/ha stocking. It should be compared with the third column, which is the assumed intrinsic value of the pruned logs. For example: at age 21, the pruned logs in the 200 stems/ha treatment are estimated to be worth $166/m^3$ but would have to be worth $226/m^3$ for the 200 stems/ha to yield the same revenue as the 400 stems/ha.

Conclusion: For stockings 200 stems/ha or less, a very large increase in pruned log prices would be required to ensure the same total harvest revenue per hectare as that generated by the 400 stems/ha treatment.

In practice, however, there is increasing recognition of the inferior wood quality that is usually associated with very young stands, and therefore some discounting of such stands is taking place (R.Bawdon pers. comm). Indeed, very young stands are often unsaleable.

- The highest IRRs are at low stocking rates (200 or 100 stems/ha). This reflects the fact that such regimes have very low costs, even though the harvest revenues per hectare may not be spectacular.

TABLE 5–Sensitivity of harvest revenues ($/ha stumpage) to price premium for s.e.d. and CWI of pruned logs

Age (years)	Stems/ha	Base scenario	Halved premium for high s.e.d. and CWI	Tripled premium for high s.e.d. and CWI
21	400	48 724	51 358	38 189
	350	44 841	46 970	36 325
	300	43 217	45 233	35 154
	250	40 821	42 226	35 202
	200	37 863	38 411	35 672
	100	26 213	25 956	27 241
	50	14 511	13 850	17 156
25	400	63 096	64 762	56 429
	350	58 464	59 472	54 436
	300	56 590	57 332	53 621
	250	54 248	54 131	54 714
	200	49 625	48 462	54 276
	100	34 537	32 673	41 992
	50	19 912	18 144	26 985
28	400	72 410	73 111	69 606
	350	67 167	67 167	67 167
	300	64 990	64 725	66 052
	250	62 298	61 172	66 802
	200	57 191	54 793	66 784
	100	40 031	36 971	52 275
	50	23 803	21 168	34 342
31	400	80 445	80 295	81 047
	350	73 959	73 103	77 382
	300	72 023	70 771	77 030
	250	68 943	66 709	77 878
	200	63 733	60 231	77 740
	100	44 614	40 598	60 679
	50	26 953	23 600	40 364

The highest stocking gave the greatest revenue and was insensitive to premiums for small-end diameter and clearwood index.

- The choice of discount rate is critical if NPV is used. At low discount rates, highest NPVs are obtained with long rotation ages and high stockings. At high discount rates, highest NPVs are obtained with short rotation ages and low stockings. To complicate matters, rotation age and stocking interact (Table 8).
- No solution was obtained in which 100 stems/ha yielded the highest positive NPV. Higher gross margins for livestock would favour lower tree stockings, until a point is reached where it pays to plant no trees. This point has not been identified.

DISCUSSION

A similar MARVL study (Maclaren 1990) involving a range of stocking treatments on a forest site (Kaingaroa) produced conclusions about the interaction of stocking and rotation age which were very similar to those obtained here (Table 8). In the earlier study, Maclaren

TABLE 6—Sensitivity of harvest revenues ($/ha stumpage) to price premium for pruned relative to unpruned logs

Age (years)	Stems/ha	Base scenario	Doubled premium for pruned logs	Halved premium for pruned logs
21	400	48 724	33 238	79 697
	350	44 841	28 661	77 202
	300	43 217	26 984	75 684
	250	40 821	24 966	72 532
	200	37 863	22 707	68 174
	100	26 213	14 905	48 829
	50	14 511	7 864	27 805
25	400	63 096	42 712	103 863
	350	58 464	37 817	99 760
	300	56 590	36 056	97 658
	250	54 248	34 076	94 591
	200	49 625	30 282	88 311
	100	34 537	19 851	63 910
	50	19 912	10 902	37 931
28	400	72 410	48 996	119 237
	350	67 167	43 826	113 848
	300	64 990	41 909	111 153
	250	62 298	39 655	107 584
	200	57 191	35 150	101 272
	100	40 031	23 116	73 862
	50	23 803	13 076	45 258
31	400	80 445	54 417	132 501
	350	73 959	48 567	124 742
	300	72 023	46 846	122377
	250	68 943	44 108	118 612
	200	63 733	39 462	112 274
	100	44 614	25 901	82 041
	50	26 953	14 863	51 134

The highest stocking gave the greatest revenue, and was insensitive to premiums for pruned logs relative to unpruned logs.

varied site index and clearwood price in addition to discount rate and rotation age. He showed that stockings from <117 to 350 stems/ha could be justified, as could rotation ages from <25 to >35 years. In general, however, the forest-site study indicated that optimal solutions occurred at considerably lower stockings and higher rotation ages than for equivalent circumstances at Tikitere (fertile ex-pasture site). Some of the Kaingaroa results are compared with the Tikitere analysis in Table 9.

CONCLUSION

Under all the assumptions examined, the highest stocking at Tikitere (400 stems/ha) generated the highest revenue at harvest. Stockings much in excess of this are unlikely to yield significantly greater returns, because suppression of some trees would occur. Suppressed trees would fail to meet log specifications for the more valuable log grades.

TABLE 7–Internal Rates of Return and Net Present Values for seven levels of final-crop stocking at four rotation ages (the figures in bold are the maxima for each age and discount rate or IRR)

Stocking (stems/ha)	IRR%	NPV ($/ha) at the following discount rates: 4%	6%	8%	10%	12%	14%
Age 21							
400	13.56	**29 599**	**14 265**	**7 158**	**3 347**	1 135	–207
350	13.48	26 895	12 928	6 452	2 979	963	–262
300	13.86	26 556	12 887	6 540	3 129	1 142	–69
250	14.25	25 753	12 617	6 507	3 214	**1 290**	111
200	**14.40**	24 055	11 838	6 146	3 072	1 270	**162**
100	14.19	17 475	8 623	4 478	2 224	890	61
50	12.81	10 263	4 955	2 447	1 068	241	–283
Age 25							
400	12.25	**33 294**	**14 623**	**6 490**	2 421	229	–997
350	12.23	30 565	13 402	5 925	2 182	165	–964
300	12.56	30 242	13 412	6 066	2 378	383	–741
250	12.97	29 744	13 361	6 193	**2 582**	618	–496
200	**13.10**	27 549	12 434	5 808	2 461	**634**	–408
100	13.04	19 908	9 035	4 239	1 795	445	**–338**
50	12.16	12 226	5 487	2 482	928	53	–467
Age 28							
400	11.32	**34 159**	**13 882**	**5 482**	1 504	–512	–1 565
350	11.31	31 443	12 759	5 017	1 349	–510	–1 483
300	11.60	31 060	12 770	5 175	1 565	–276	–1 247
250	11.97	30 512	12 735	5 332	**1 797**	–17	–984
200	12.11	28 332	11 898	5 038	1 752	**58**	–851
100	**12.14**	20 547	8 703	3 723	1 312	49	–644
50	11.58	13 066	5 517	2 300	713	–139	**–622**
Age 31							
400	10.49	**33 765**	**12 623**	**4 310**	595	–1 170	–2 025
350	10.41	30 632	11 375	3 809	430	–1 173	–1 948
300	10.70	30 507	11 531	4 054	699	–905	–1 690
250	11.04	29 904	11 510	4 236	955	–627	–1 413
200	11.20	27 959	10 854	4 072	**1 001**	–490	–1 239
100	**11.28**	20 216	7 938	3 029	775	**–341**	–919
50	10.94	13 171	5 197	1 954	430	–351	**–774**

The NPV in the table is for multiple rotations at the given stocking at rotation age.
Where NPV is negative it would be irrational to plant trees.

TABLE 8–Optimum stocking rate and rotation age as determined by NPV

Discount rate (%)	Optimum stocking (stems/ha)	Optimum rotation age (years)
4	400	28
6	400	25
8	400	21
10	400 (if rotation = 21) 250 (if rotation = 25, 28) 200 (if rotation = 31)	21
12	250 (if rotation = 21) 200 (if rotation = 25,31)	21
14	200	21

TABLE 9–Optimum stocking at Tikitere (ex-pasture site) compared to results from a study at Kaingaroa Forest (8% discount rate and high clearwood price)

Rotation age	Tikitere Site index = 33.5 m	Kaingaroa Site index = 32.3 m
25	400	175
28	400	200
31	400	200

Although high stockings yield the most revenue, they also incur the greatest cost. The optimum rate of return will depend on the importance that growers place on "cash up front" *versus* "cash at harvest", in other words on the chosen discount rate. This depends on the circumstances of the individual and no general guidelines can be provided.

ACKNOWLEDGMENTS

The authors are grateful to the reviewers Paul Smale, Graham West, Andy Gordon, and Bruce Manley for their valuable criticism of this paper, to Wayne Blundell for his assistance in estimating logging costs, and to the dozens of scientists and field workers who have been involved in the establishment, maintenance, and measurement of the Tikitere trials for more than two decades.

REFERENCES

COX, O.; McGREGOR, M.; MACLAREN, P. 1988: Agroforestry components of the radiata pine stand model. Pp. 175–182 *in* Maclaren, P. (Ed.) "Proceedings of the Agroforestry Symposium, Rotorua, 24–27 November 1986. *New Zealand Ministry of Forestry, FRI Bulletin No.139.*

MACLAREN, J.P. 1990: Optimisation of final crop stockings for clearwood regimes of radiata pine. Pp. 171–183 *in* James, R.N.; Tarleton, G.L. (Ed.) "New Approaches to Spacing and Thinning in Plantation Forestry". Proceedings of IUFRO Symposium, Rotorua, 10–14 April 1989. *New Zealand Ministry of Forestry, FRI Bulletin No.151.*

MACLAREN, J.P.; KNOWLES, R.L. 1999: Economics of final-crop stocking at the Tikitere Agroforestry Trial. Part 1: Volume and quality comparisons. *New Zealand Journal of Forestry Science 29(1)*: 165–174.

APPENDIX I

SILVICULTURAL COST ASSUMPTIONS

	Year	Stocking (stems/ha)						
		50	100	200	250	300	350	400
Physical assumptions:								
Initial stocking (stems/ha)		180	360	720	900	1080	1260	1440
Stocking after first thin (stems/ha)		80	160	320	400	480	560	640
Stocking after second thin (stems/ha)		50	100	200	250	300	350	400
Dbh (cm) after first thin		10	10	10	9	9	9	9
Dbh (cm) after second thin		24	24	22	21	20	19	18
Cost assumptions ($/ha):								
Planting (incl. tree stocks)	0	103.5	198	378	450	540	630	720
Releasing	0	16.1	30.8	58.8	70	84	98	112
Low pruning	4	73.6	140.8	268.8	320	384	448	512
Medium pruning	6	69	132	252	300	360	420	480
High pruning	8	69	132	252	300	360	420	480
Waste thinning @ low pruning	4	17.25	33	63	75	90	105	120
Waste thinning @ high pruning	8	12.65	24.2	46.2	55	66	77	88

- Land was priced at $1800/ha (from June 1994, Bay of Plenty Farm Costs & Prices)
- Annual overheads were $100/ha
- The 250 stems/ha treatment was the base case, for which costs were obtained from J.Cawston, Forest & Woodlots Consultants NZ Ltd., PO Box 549, Rotorua
- Stockings above 250 stems/ha are more expensive on a pro rata basis
- Stockings below 250 stems/ha are considered to have extra costs (due to increased walk time):
  - 200 stems/ha + 5%
  - 100 stems/ha +10%
  - 50 stems/ha +15%

APPENDIX 2

LOGGING COST ASSUMPTIONS ($/ha using a skidder)

Stocking (stems/ha)	Age of clearfell			
	21	25	28	31
100	3 428	4 279	4 743	5 219
200	5 543	6 688	7 369	8 011
250	6 156	7 825	8 564	9 244
300	7 032	8 793	9 579	10 269
350	7 817	9 636	10 454	11 152
400	8 505	10 379	11 216	11 857

APPENDIX 3

LIVESTOCK-CARRYING CAPACITY ASSUMPTIONS

Stand age	Livestock-carrying capacity (LSU/ha) @						
	50 stems/ha	100 stems/ha	200 stems/ha	250 stems/ha	300 stems/ha	350 stems/ha	400 stems/ha
1	0	0	0	0	0	0	0
2	2.40	2.40	2.40	2.40	2.40	2.40	2.40
3	7.20	6.00	6.00	6.00	6.00	6.00	6.00
4	12.00	10.75	9.19	8.50	7.41	6.45	6.29
5	9.96	10.38	8.48	7.63	6.29	5.13	4.77
6	10.08	9.31	9.07	8.30	7.01	6.19	5.63
7	11.52	9.99	7.72	6.70	5.06	4.48	3.94
8	11.04	10.18	8.09	7.14	4.47	4.00	4.52
9	10.8	9.86	7.25	5.99	3.27	3.90	3.17
10	10.68	9.31	6.18	4.72	1.43	3.77	2.02
11	10.56	8.65	5.08	3.55	0.92	2.55	1.20
12	10.44	7.92	4.06	2.22	0.58	1.62	0.66
13	10.2	5.66	2.43	1.55	0.30	0.96	0.35
14	9.36	4.89	1.81	1.06	0.20	0.56	0.18
15	8.52	4.21	1.33	0.70	0.13	0.32	0.09
16	7.68	3.59	0.90	0.50	0.08	0.18	0.05
17	7.56	3.05	0.70	0.31	0.04	0.10	0.02
18	6.24	2.55	0.50	0.20	0.03	0.05	0.01
19	6.36	2.14	0.36	0.13	0.02	0.03	0
20	5.4	1.81	0.26	0.09	0.01	0.01	0
21	4.8	1.52	0.19	0.06	0.01	0.01	0
22	4.2	1.29	0.13	0.04	0	0	0
23	4.2	1.09	0.10	0.02	0	0	0
24	4.2	0.92	0.07	0.02	0	0	0
25	4.2	0.79	0.05	0.01	0	0	0
26	4.2	0.67	0.04	0.01	0	0	0
27	4.2	0.58	0.03	0	0	0	0
28	4.2	0.50	0.02	0	0	0	0
29	4.2	0.43	0.01	0	0	0	0
30	4.2	0.37	0.01	0	0	0	0
31	4.2	0.32	0.01	0	0	0	0

- Open pasture was assumed to possess a livestock-carrying capacity of 12 LSU/ha, and the gross margin for each sheep livestock unit was assumed to be $25.
- If livestock-carrying capacity dropped below 1.2 LSU/ha, it was omitted from calculations.