

Chapter Three

WORKED EXAMPLES OF THE MODELS

Brief characterization of the breeds used in the examples

The breeds used in the examples are the Australian Merino and Border Leicester. The Merino is suitable for wool production and is good in mothering ability. It is characterized by hardiness, and can be used as a prime dam in crossbreeding programs. The Border Leicester is an English long wool breed, and since its introduction to Australia has made an enormous contribution to the development of Australia's Prime Lamb industry. This breed is good in twinning, milking, mothering ability, fast growth rate and valuable long wool attributes (Shands, 1987).

Notes on the input parameters

Most of the input parameters were obtained from Cottle (1991); Ponzoni (1986); Atkins (1987), and McGuirk (1978). Also, in addition to the derivation of values for a few parameters from intuition, in some cases reasonable assumptions in this regard were necessarily made, following consultation with the national LAMBPLAN Coordinator Dr. R. Banks, and Mr. Allan Luff - N.S.W. Agr., Cavri.

Some explanations on the input data seem to be necessary. There are a few input data for the Border Leicester which are not included on the input data sheets. Nor are these data referred to separately in the equations. These data are assumed to be the same as those for the Merino. For instance, (=E6) means that the value of the trait for the Border Leicester equals that for the Merino in the cell E6.

The economic lifetime of the Merino ewes was assumed to be 6 years and that of the border Leicester 5.5 years. Therefore, the ewe replacement rates on the input data sheets are calculated as follows:

As mentioned earlier, the ewes deliver their lambs at 2 years of age. It follows that as the Merino ewes are sold at 6 years of age, therefore, the hogget ewes are replaced after 4 years. Accordingly, the ewe replacement rate for the Merino will be $100\% / (6 - 2) = 25.0\%$. Similarly, the replacement rate for the BL ewes is $100\% / (5.5 - 2) = 28.5\%$.

Meanwhile, all of the sheep are grazed on pasture. Costs of husbandry include costs of marking, mulesing, dipping, jetting, drenching, and vaccination. These costs were considered to be the amount of \$1.05, and \$1.1 per ewe and per hogget per year, respectively (Ponzoni, 1986). The heterosis for total costs of feed and husbandry has been taken into account as a single datum, for each breed.

The cull-for-age ewes are sold after they have weaned their lambs for 4 months since the commencement of each crossbreeding Year at which, they deliver their lambs. This period of weaning is optional, as can be seen on the input data spreadsheet for the models which shall be given later in this chapter.

An approximate annual inflation rate of 4% (Dr. Donald J. Wright, personal comm.) was considered for the currency in Australia. This rate has been used to obtain the discount factor, in order to compute the cumulative net discounted profit. The models divide all the costs and profit per year by the discount factor, and calculate the cumulative discounted net profit for each Year. If the breeder does not include the inflation rate in the models therefore, the discount factor should be considered 1.00 in the input data.

Cells L55 and M55 are connected to the input data and to the corresponding equations presented earlier in Chapter Two.

Initial composition of the flocks

A number of 500 purebred Merino sheep was allocated as the population size of the crossbreeding systems in "Year -1" for the DYN CVRBL.XLS model. This number is quite optional and can be changed by typing any desirable number in the related cell, which has been allocated for this purpose on the input data sheet. Number of the ewes in Year -1 in the

DYNCSTBL.XLS has been worked out through different trials resulting in the same statistically equal cumulative net profit in Year 8 for both of the models in order to facilitate a proper comparison of them.

In both of the models, in "Year -1", numbers of the ewes in flock 1 and flock 2 (add to the total number of the ewes to commence with) are determined by the computer models for an optimal structure through adjusting the related Variable cells.

There are no crossbred hoggets until year 1. Accordingly, the DYN CVRBL.XLS model did not propose any number of ewes in flock 2 for the first two initial Years, and Flock 2 is established in Year 1. Also, from Year 1 on, we have only two flocks without any terminal crossing.

It was assumed that in Year -1 proportion of the hogget ewes (maidens) equals that of the replacement rate of the ewes, and the whole complex of the sheep flocks are bought in with the same proportion of the hoggets. Thus, the proportion of the adult ewes in Year -1 is equivalent to the survival rate of the Merino ewes. All the adult and maiden ewes are conceived before purchase, and deliver their lambs at the beginning of the crossbreeding program, in Year -1.

Therefore, the whole population of the sheep is purchased with the corresponding proportion of the hoggets shown in the relevant diagrams in the next Chapter, and the prices of the pure Merino hoggets in Year -1 and Year 0 have been included in the models. These prices have been included in the "costs of ewes and hoggets" in Year -1 and in Year 0. In the other Years no hoggets are purchased, but the other costs of them are taken into account as part of the above-mentioned costs.

Complementary information on the DYNCSTBL.XLS and DYN CVRBL.XLS models

All the ewes in flocks 1 and 2 are the purebred Merino, in Year -1 and Year 0. For maximum efficiency of the system i.e., to benefit from the utmost crossbreeding advantages, the rams used in both of the flocks 1 and 2 in the two first Years are the Border Leicester, being mated to the Merino ewes to produce crossbred hoggets for Year 1. The reason is that the flocks are self-contained in regard to the replacement hoggets, and the first mating of the hoggets is supposed to take place at 2 years of age.

In the meantime, from Year 1 onward the Merino rams are introduced, as the crossbred hoggets from Year -1 are now ready for mating with these rams being representative for the second breed, to cross over all the purebred and crossbred ewes in the flocks.

It should be worth noting that the weaning rates in Years -1 and 0 are those of the purebred ewes, but, because from Year 1 on, we have a mix of the purebred and crossbred ewes in the flocks, therefore for simplicity, the average rate of the lambs weaned after the ewes are crossed with the sires, is presented as the same rate in the diagrams concerned.

The flow of the overlapping generations together with the related details are demonstrated in the diagrams provided for the models. As can be seen, the replacement hoggets for any existing flock (from Year 1 on) are predestined two years previously.

The costs of these hoggets are included in the same Year they are born as the costs of birth to yearling, and also in the following Year (as the costs from yearling to hogget), in the costs of ewes and hoggets for each Year and Flock in the related Tables in the diagrams.

Similarly, the net profit of wool, in addition to this value for the mature ewes, is consisting of the profit earned from shearing the hoggets too; part in the first Year (to yearling), and part in the next Year at 2 years of age (yearling to hogget) in the same flock.

As said earlier, having specified the total population size of the ewes in flocks 1 and 2 in Year -1 by the breeder, number of the ewes in flock 1 and flock 2 will automatically be determined by the computer models. Therefore in Year -1, a single Variable is allocated for this purpose in both of the models. These Variables and the like are incorporated in the equations concerned being offered in the previous Chapter, affecting the numbers of the animals presented in the main related *year-by-year* diagrams, directly or indirectly.

At the same time, numbers of the ewes in the DYNCSTBL.XLS model are stable in all of the Years, and number of the purebred replacement hoggets in Year 0 is computed through the equations concerned using the ewe replacement rates. Therefore, no Variable exists in this Year. In Year 0 in the DYNCVRBL.XLS model, there is a number of Variables to determine the number of the ewes and the proper number of the purebred hoggets for each of the flocks 1 and 2. These numbers cannot be determined using the ewe replacement rates, as the flock sizes are variable. Additionally, as said earlier, it must be emphasized that the

actual ewe replacement rates can be stable although the flock sizes are variable. This is because a larger or smaller number of the replacement hoggets, compared with the actual number of them in a regular production system, is entered into the related flocks at the beginning of each Year.

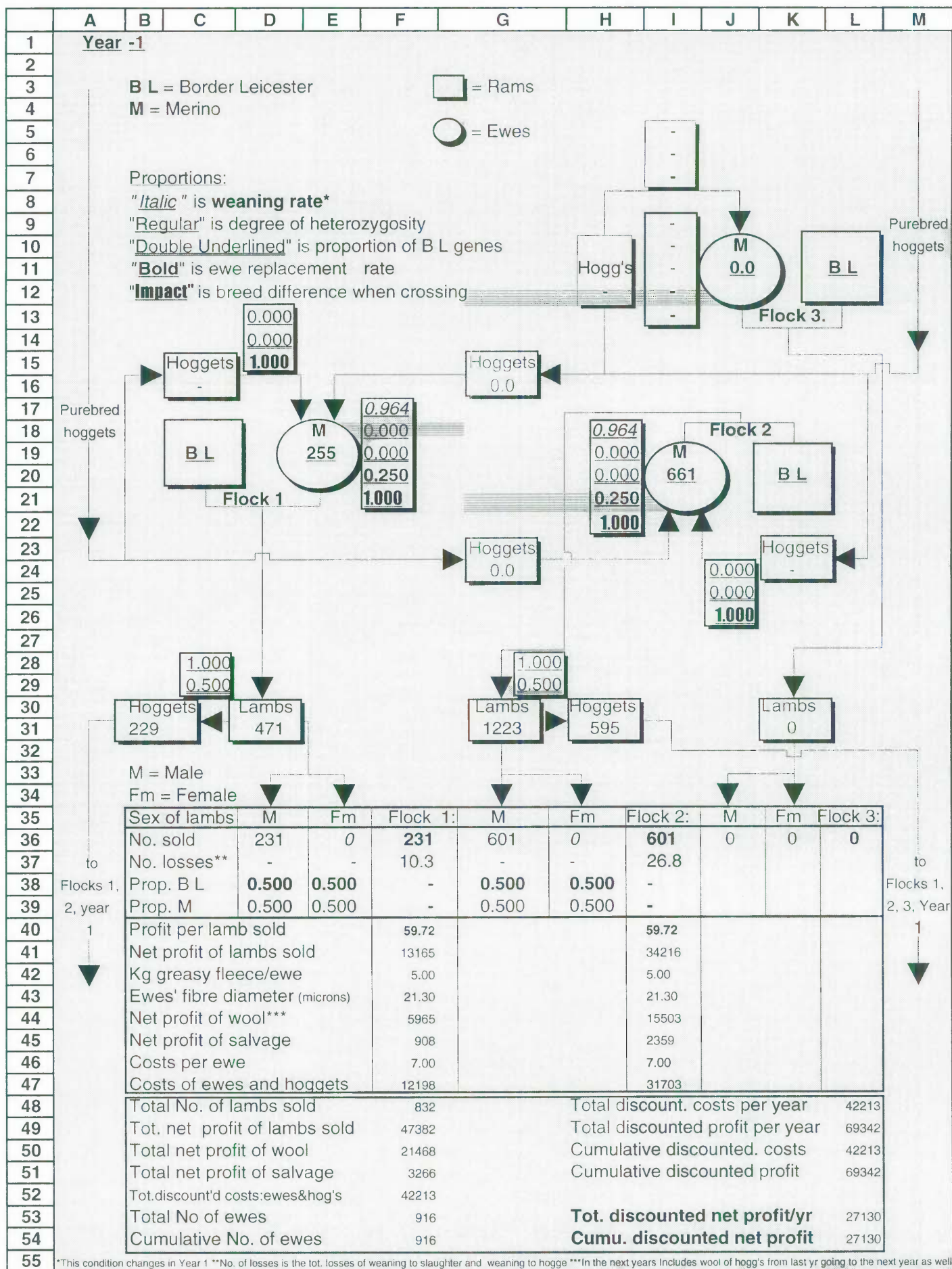
Also, in Year 1, in both of the models, one Variable or more (Q129 in the DYNCSTBL.XLS, and Q135 together with Q131 and Q132, in the DYNCVRBL.XLS) are used to compute the number of the hogget ewes in flock 3 being used for a possible recommended terminal crossing. Before this stage, this flock doesn't exist. As in the DYNCSTBL.XLS model numbers of the ewes in all of the flocks are stable, and number of the replacement hoggets in flock 3 is determined based on the ewe replacement rate of flock 3 in the previous Year, therefore from Year 2 on, this Variable is no more needed and has been dropped from this model. In other words, as can be seen in the related diagrams for the same model, the Variable Q129 is used just to determine the number of the hogget ewes in flock 3 for establishment of this flock. This number will be stable in all of the Years. So, no similar Variables are needed in the following Years, as flock 3 with a particular number of the ewes has already been established.

It follows that as in the DYNCVRBL.XLS model, number of the ewes in each flock can be different from that in the previous Year(s), therefore, a larger number of the Variables are incorporated in this model.

In the DYNCVRBL.XLS, the very small number of animals in flock 3 is presented as zero, although the value of the related traits are given in the output data through the corresponding diagrams.

Details of the crossing systems proposed by the models can be seen in the year-by-year diagrams coming next, and in the modeling equations in Chapter Two. Note that for the purpose of comparison, both models are aimed at the same cumulative net profit in the final year. So, the initial number of the ewes for crossbreeding is different between the two worked examples. Also, in the final Year, all the ewes of varying ages are sold as the salvage animals. The worked examples of the DYNCSTBL.XLS and DYNCVRBL.XLS models are illustrated in the following year-by-year diagrams.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Input data:			Purebreds ¹							Heterosis		
2				B L	M			Price (\$/Kg)			♂	♀	
3	Weaning rates ² :										B L x M	M x B L	
4		maiden		0.8	0.7			-			0.946781	0.600000	
5		mature		1.4	1.052			-			0.436712	0.533151	
6	Weaning age (months):			(=E6)	4			-			-	-	
7	Slaughter weight:			55	40			-			0.093290	0.116203	
8													
9	Price per Kg live lamb (\$):			1.2	1.1			-			-	-	
10													
11	Cull for age ewes:												
12		body weight (Kg)		65	45			-			0.106904	0.129176	
13		price/Kg (\$)		0.45	0.4			-			-	-	
14													
15	Ewe replacement rate ³ :			0.285	0.250			-			-0.010000	-0.015000	
16	Greasy fleece weights:												
17		Kg/ewe		6	5			-			0.047619	0.095240	
18		Kg/hogget		5.485	4.570						0.065398	0.091558	
19		Kg/yearling		3.36	2.8						0.047619	0.095240	
20	Clean fleece wt of 21 microns:			-	-			7.60				-	
21		yield		(=E21)	0.68						-	-	
22	Fibre diameter:												
23		1 micron increase											
24		from 21 microns/Kg.		-	-			-0.55			-	-	
25		Microns		35.9	21.3			-			-0.048950	-0.031469	
26													
27	Mortality rates:												
28		ewes/year		0.028	0.022			-			-	-	
29		weaning to hogget		0.03	0.025			-			-	-	
30		weaning to slaught.		0.018	0.016						-	-	
31													
32	Costs per ewe per year (\$):												
33		husbandry &		1.05	1.05			-					
34		feed		7.8	5.95			-					
35											-0.020000	-0.030000	
36	Costs of feed & husbandry (\$):												
37		slaughter lambs		3.1	2.5			-			-	-	
38		birth to yearling		5.05	4.05			-			-	-	
39		yearling to hogget		6.15	5.05						-	-	
40	Prices of purebred sheep (\$):												
41		Merino hoggets		-	47			-			-	-	
42		Merino ewes (avg.)		-	35			-			-	-	
43	Cost of marketing/ewe (\$):			(=E43)	2.36			-			-	-	
44													
45	Cost of wool harvesting and												
46		marketing/ewe (\$)		(=E 46)	5.09			-			-	-	
47													
48	Discount factor ⁴			1.040									
49													
50	Total No. of ewes in 4 Year -1 :			916									
51	press F5, click on the desired Year in the Go To box and then choose the OK button.												
52	¹ M = Merino, B L = Border Leicester.												
53	² Here, weaning rate means the rate of lambs weaned per ewe joined.												
54	³ The replacement hogget ewes at the beginning of each year have to be conceived. See "Input data" in the text for clarification.												
55	⁴ Discount factor (as an input datum for this program) = 1+ per cent inflation rate, e.g. : = 1 + 0.04 = 1.04												



*This condition changes in Year 1 **No. of losses is the tot. losses of weaning to slaughter and weaning to hogge ***In the next years Includes wool of hoggs from last yr going to the next year as well

Year 0

Legend:
 B L = Border Leicester
 M = Merino
 [] = Rams
 () = Ewes

Proportions:
"Italic" is weaning rate
"Regular" is degree of heterozygosity
"Double Underlined" is proportion of Border Leicester genes
"Bold" is ewe replacement rate
"Impact" is breed difference when crossing

Table 1: Lamb Sales and Losses

Sex of lambs	M	Fm	Flock 1:	M	Fm	Flock 2:	M	Fm	Flock 3:
No. sold	231	178	410	601	260	861	0	0	0
No. losses	-	-	8.5	-	-	24.2	-	-	-
Prop. B L	0.500	0.500	-	0.500	0.500	-	-	-	-
Prop. M	0.500	0.500	-	0.500	0.500	-	-	-	-

Table 2: Profit and Costs

	Flock 1:	Flock 2:	Flock 3:
Profit per lamb sold	59.72	59.72	
Net profit of lambs sold	23315	49026	
Kg greasy fleece/ewe	5.00	5.00	
Ewes' fibre diameter (microns)	21.30	21.30	
Net profit of wool	7570	20499	
Net profit of salvage	908	2359	
Costs per ewe	7.00	7.00	
Costs of ewes and hoggets	5996	16500	

Table 3: Total Profit and Costs

Total No. of lambs sold	1271	Total discount. costs per year
Tot. net profit of lambs sold	72341	Total discounted profit per year
Total net profit of wool	28069	Cumulative discounted. costs
Total net profit of salvage	3266	Cumulative discounted profit
Tot. discount'd costs:ewes&hog's	20799	
Total No. of ewes	916	Tot. discounted net profit/yr
Cumulative No. of ewes	1832	Cumu. discounted net profit

[illegible]

Year 1

B L = Border Leicester
M = Merino



☐ = Rams
☐ = Ewes

Proportions:
"Italic" is weaning rate **after crossing**
"Regular" is degree of heterozygosity
"Double Underlined>" is proportion of Border Leicester genes
"Bold" is ewe replacement rate
"Impact" is breed difference when crossing

Sex of lambs	M	Fm	Flock 1:	M	Fm	Flock 2:	M	Fm	Flock 3:
No. sold	181	10	191	522	297	819	334	334	668
No. losses	-	-	7.4	-	-	20.5	-	-	11.9
Prop. B L	0.063	0.063	-	0.563	0.563	-	0.750	0.750	-
Prop. M	0.938	0.938	-	0.438	0.438	-	0.250	0.250	-
Profit per lamb sold			54.21			60.58			63.03
Net rofit of lambs sold			9856			47307			40113
Kg greasy fleece/ewe			5.19			5.19			5.76
Ewes' fibre diameter (microns)			22.78			22.78			27.20
Net profit of wool			6530			15898			6572
Net profit of salvage			1031			2679			3356
Costs per ewe			7.19			7.19			7.77
Costs of ewes and hoggets			2512			6871			3806
Total No. of lambs sold			1678						11725
Tot. net profit of lambs sold			97276						118540
Total net profit of wool			29000						74737
Total net profit of salvage			7066						283737
Tot.discount'd costs:ewes&hog's			11725						
Total No. of ewes			1511						106815
Cumulative No. of ewes			3343						209001
								Tot. discounted net profit/yr	
								Cumu. discounted net profit	

[illegible]

Variable 1	0.973227
Variable 2	0.000029
Variable 3	0.000022

	A	B	C	D	E	F	G	H	I	J	K	L	M
166	Year 2												
167													
168	B L = Border Leicester  = Rams												
169	M = Merino  = Ewes												
170													
171													
172	Proportions:												
173	<i>"Italic"</i> is weaning rate after crossing												
174	<i>"Regular"</i> is degree of heterozygosity												
175	<u>"Double Underlined"</u> is proportion of Border Leicester genes												
176	"Bold" is ewe replacement rate												
177	"Impact" is breed difference when crossing												
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from Flock 1, Year 0

Hoggets 35

M

Flock 1:

255

Hoggets 29

Hoggets 17

Lambs 136

Lambs 279

M = Male
Fm = Female

Sex of lambs

	M	Fm	Flock 1:	M	Fm	Flock 2:	M	Fm	Flock 3:
No. sold	137	0	137	358	98	457	334	334	668
No. losses	-	-	5.7	-	-	15.2	-	-	11.9
Prop. B L	0.110	0.110	-	0.610	0.610	-	0.750	0.750	-
Prop. M	0.890	0.890	-	0.390	0.390	-	0.250	0.250	-

Profit per lamb sold

Net profit of lambs sold

Kg greasy fleece/ewe

Ewes' fibre diameter (microns)

Net profit of wool

Net profit of salvage

Costs per ewe

Costs of ewes and hoggets

Total No. of lambs sold

Tot. net profit of lambs sold

Total net profit of wool

Total net profit of salvage

Tot. discount'd costs: ewes & hog's

Total No. of ewes

Cumulative No. of ewes

1261

74046

27827

7058

11346

1511

4854

Hogg's 158

1.000
0.500
0.500

1.142
1.000
0.500
0.265
0.500

Flock 3:

595

B L

from Flock 2, Year 0

Flock 2:

661

B L

Hoggets 150

Lambs 729

Hoggets 257

Lambs 680

1.102
0.440
0.220
0.257
0.780

1.000
0.500
0.500

1.000
0.500
0.500

0.220
0.110

0.780
0.610

to Flocks 1, 2 Year 4

to Flocks 1, 2, 3, Year 4

Tot. discounted net profit/yr		81770
Cum. discounted net profit		290770

[illegible]

Year 3

B L = Border Leicester
M = Merino

□ = Rams

○ = Ewes

Proportions:

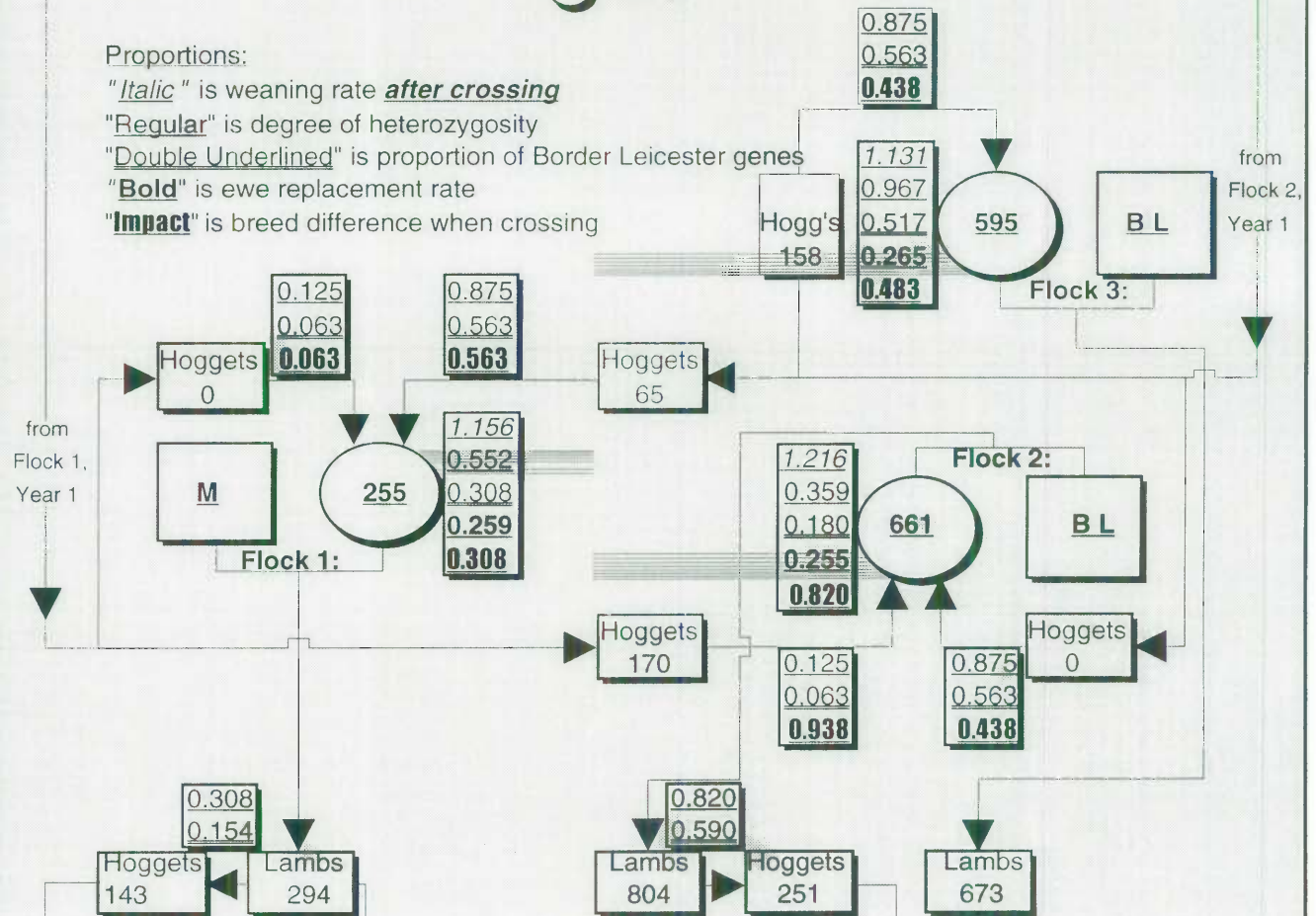
"*Italic*" is weaning rate *after crossing*

"Regular" is degree of heterozygosity

"Double Underlined" is proportion of Border Leicester genes

"**Bold**" is ewe replacement rate

"**Impact**" is breed difference when crossing



M = Male

Fm = Female

Sex of lambs	M	Fm	Flock 1:	M	Fm	Flock 2:	M	Fm	Flock 3:
No. sold	145	0	145	395	142	537	331	331	661
No. losses	-	-	6.1	-	-	16.4	-	-	11.8
Prop. B L	0.154	0.154	-	0.590	0.590	-	0.758	0.758	-
Prop. M	0.846	0.846	-	0.410	0.410	-	0.242	0.242	-
Profit per lamb sold			57.15			60.95			63.13
Net profit of lambs sold			7898			31202			39793
Kg greasy fleece/ewe			5.45			5.28			5.77
Ewes' fibre diameter (microns)			25.01			23.44			27.48
Net profit of wool			7036			13494			6238
Net profit of salvage			1166			2702			3133
Costs per ewe			7.48			7.27			7.80
Costs of ewes and hoggets			2880			6627			3821
Total No. of lambs sold			1343						10955
Tot. net profit of lambs sold			78893						92600
Total net profit of wool			26769						97038
Total net profit of salvage			7001						469453
Tot. discount'd costs: ewes&hog's			10955						
Total No. of ewes			1511						81645
Cumulative No. of ewes			6365						372415
			Total discount. costs per year			Total discounted profit per year			
						Cumulative discounted. costs			
						Cumulative discounted profit			
						Tot. discounted net profit/yr			
						Cumu. discounted net profit			

[illegible]

	A	B	C	D	E	F	G	H	I	J	K	L	M
276	Year 4												
277													
278	B L = Border Leicester												
279	M = Merino												
280													
281													
282	Proportions:												
283	<i>"Italic"</i> is weaning rate after crossing												
284	<i>"Regular"</i> is degree of heterozygosity												
285	<i>"Double Underlined>"</i> is proportion of Border Leicester genes												
286	"Bold" is ewe replacement rate												
287	"Impact" is breed difference when crossing												
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[illegible]

Year 5

B L = Border Leicester
M = Merino

□ = Rams

○ = Ewes

Proportions:

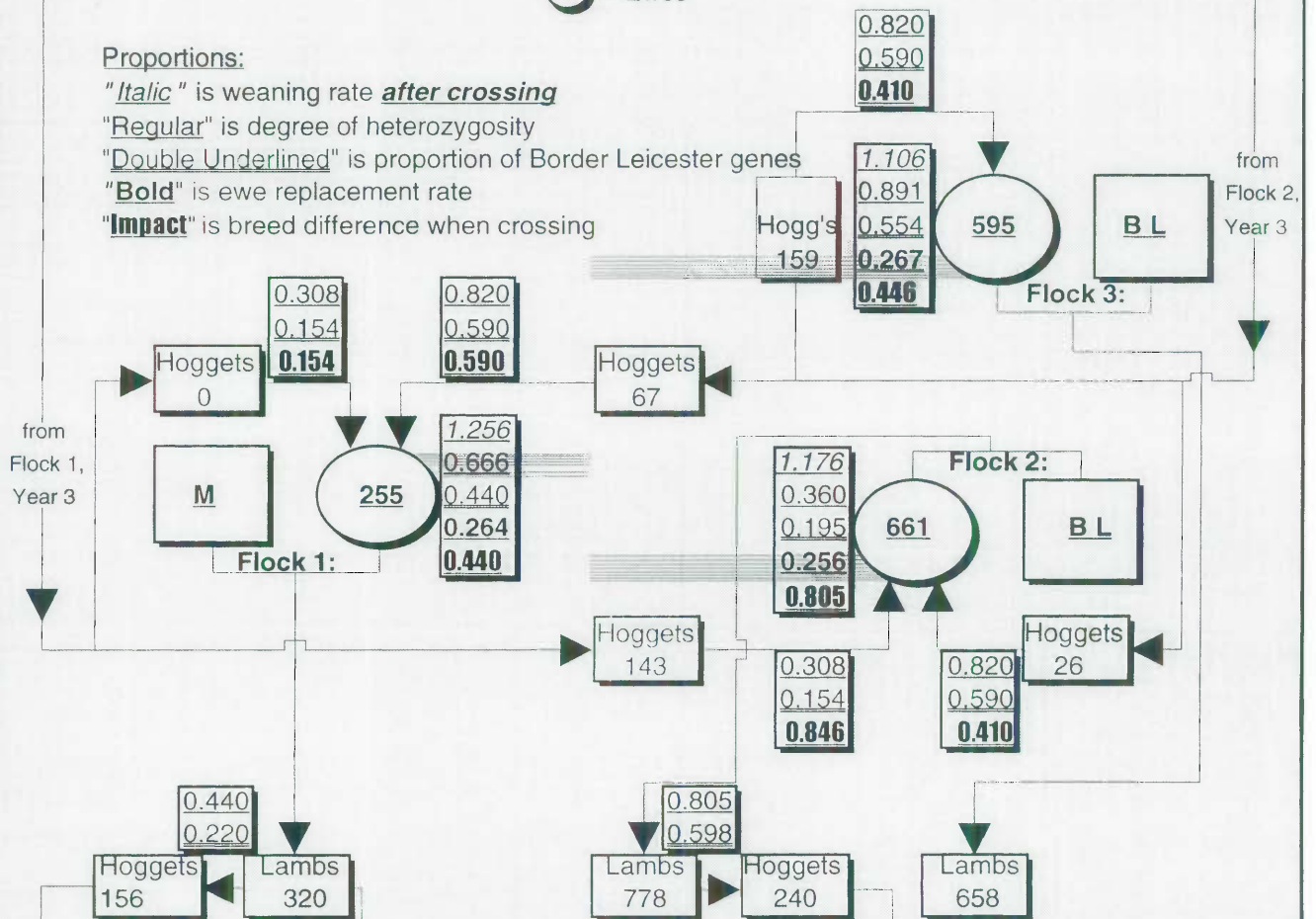
"Italic" is weaning rate *after crossing*

"Regular" is degree of heterozygosity

"Double Underlined>" is proportion of Border Leicester genes

"Bold" is ewe replacement rate

"Impact" is breed difference when crossing



M = Male

Fm = Female

Sex of lambs	M	Fm	Flock 1:	M	Fm	Flock 2:	M	Fm	Flock 3:
No. sold	157	0	157	382	140	522	323	323	647
No. losses	-	-	6.7	-	-	15.9	-	-	11.6
Prop. B L	0.220	0.220	-	0.598	0.598	-	0.777	0.777	-
Prop. M	0.780	0.780	-	0.402	0.402	-	0.223	0.223	-

to
Flocks 1,
2, Year 7to
Flocks 1,
2, 3, Year 7

Profit per lamb sold	59.33	61.05	63.37
Net profit of lambs sold	8912	30368	39056
Kg greasy fleece/ewe	5.62	5.32	5.79
Ewes' fibre diameter (microns)	26.76	23.72	28.11
Net profit of wool	6311	13226	5469
Net profit of salvage	1270	2758	3204
Costs per ewe	7.71	7.30	7.88
Costs of ewes and hoggets	3073	6516	3856
Total No. of lambs sold	1326	Total discount. costs per year	10217
Tot. net profit of lambs sold	78336	Total discounted profit per year	84028
Total net profit of wool	25006	Cumulative discounted. costs	117842
Total net profit of salvage	7233	Cumulative discounted profit	641001
Tot. discount'd costs: ewes & hog's	10217		
Total No. of ewes	1511	Tot. discounted net profit/yr	73811
Cumulative No. of ewes	9388	Cumu. discounted net profit	523159



[illegible]

	A	B	C	D	E	F	G	H	I	J	K	L	M
386	Year 6												
387													
388	B L = Border Leicester												
389	M = Merino												
390													
391													
392	Proportions:												
393	<i>"Italic"</i> is weaning rate after crossing												
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Year 7

B L = Border Leicester
M = Merino

 = Rams
 = Ewes

Proportions:
"Italic" is weaning rate **after crossing**
"Regular" is degree of heterozygosity
"Double Underlined" is proportion of Border Leicester genes
"Bold" is ewe replacement rate
"Impact" is breed difference when crossing

Flock 1:

From Flock 1, Year 5: 0 Hoggets, 255 Ewes (M)

Flock 2:

From Flock 2, Year 5: 156 Hoggets, 661 Ewes (B L)

Flock 3:

From Flock 3, Year 5: 14 Hoggets, 595 Ewes (B L)

Lamb Sales and Wool Production:

Sex of lambs	M	Fm	Flock 1:	M	Fm	Flock 2:	M	Fm	Flock 3:
No. sold	164	164	328	383	383	767	320	320	639
No. losses	-	-	5.5	-	-	13.4	-	-	11.4
Prop. B L	0.256	0.256	-	0.609	0.609	-	0.787	0.787	-
Prop. M	0.744	0.744	-	0.391	0.391	-	0.213	0.213	-
Profit per lamb sold			60.54			61.20			63.49
Net profit of lambs sold			19005			44732			38675
Kg greasy fleece/ewe			5.71			5.38			5.80
Ewes' fibre diameter (microns)			27.70			24.06			28.44
Net profit of wool			4795			12297			5076
Net profit of salvage			1330			2809			3240
Costs per ewe			7.83			7.32			7.92
Costs of ewes and hoggets			2487			5370			3874
Total No. of lambs sold			1734						8243
Tot. net profit of lambs sold			102411						92711
Total net profit of wool			22167						135940
Total net profit of salvage			7379						814348
Tot. discount'd costs: ewes & hog's			8243						
Total No. of ewes			1511						84469
Cumulative No. of ewes			12410						678408

Tot. discounted net profit/yr
Cumu. discounted net profit