RISK FACTORS FOR WEANER DEER BODYWEIGHT

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During a pilot study, an holistic epidemiological approach called "health and production profiling" (Morris, 1991) was used to explore basic health problems and production in farmed red deer The background of this research and some prelimnary results have been published in the previous proceedings (Audigé *et al.*, 1993)

This paper presents preliminary results of analysis of risk factors for deer calf bodyweight on April 1, ie at 4 months of age

MATERIALS AND METHODS

A 2-year observationnal study was conducted on 15 commercial red deer farms in The North Island of New Zealand About 2700 hinds were individually monitored for reproductive success During farm visits in September 1992 and 1993, each hind was scored for body condition The composition of calving groups from hind tag identification, calving and weaning management practices, grazing history and food allowance for each hind were recorded At weaning, calves were identified according to the calving mob they come from Weaning weights and subsequent weights recorded after April 1 enabled the estimation of individual weaner weights on April 1(W4) on each farm

Risk factors potentially affecting W4 were identified and classified according to the area of data collection they describe Codes and description of each group of variables (or variable block) are presented in Table 1 The first block includes individual deer characteristics which were recorded from the 6 farms that identified dam-offspring pairs either at birth (while ear-tagging) or before weaning Variables describing lactation and weaning management practices were grouped in block 2, while post-weaning management variables constitute the third block In the fourth block, are two distinct groups of biological markers, one including individual calf blood characteristics, the other, mean weaner blood characteristics and mean calf faecal egg and larvae counts within farms Blocks 1-3 were analysed separately at the individual animal level (outcome variable individual W4), while weaner biological markers were investigated at the farm level with mean weaner stag and hind bodyweight (MW4) as outcome variables Data were analysed separately for weaner stags and hinds

Preliminary data analyses were carried out to identify associations between single descriptive variables and individual calf weight on April 1 (W4) or mean mob or farm calf weight (MW4) depending on variables analysed Categorical variables were analysed with the T-test using SAS (SAS Institute Inc , Cary, NC, USA) Continuous variables were analysed with the Spearman correlation coeficient using Stastistica (Statsoft Inc , Tulsa, OK USA) Variables which showed sufficient evidence of an association in these analysis ($p<0\ 20$) for both stag and hind calves were included in path analyses which allow the identification of risk factors having statistically significant direct or indirect effects on weaner bodyweight (Pedhazur, 1982) Potential risk factors are sequentially ordered and hypothesised biologically sound causal relationships are indicated by arrows Each variable with arrows leading to it were regressed in multivariable linear stepwise

Table 1 : Codes and descriptions of risk factors for individual (W4) or mean mob (MW4) calf bodyweight on April 1

Risk factor Code	Unit*	Description
1st BLOCK : Individual animal characteristics		
Individual dam variables at or prior to calving		
AGE3	D	Dam at least 3 years old at calving
NZD	%	Percentage of New Zealand blood lines
ADVC	D	Dam conceiving before May 1 (advanced conception)
BCSS		Post Winter body condition score recorded in September (score from 1(lean) to 5(fat))
WD6	kg	Post-mating live weight calculated on June 1
CHW9C	kg	Liveweight change between September and November
Individual calf variables		
BIRTHD	day	Number of days between November 1 and the date of birth
NZC**	%	Estimated percentage of New Zealand blood lines
WAPC**	%	Estimated percentage of Wapiti or Elk blood lines
2nd BLOCK : Lactation and weaning management		
Grazing management and food supplementation		
ISWH	cm	Mean pasture sward height at start of grazing period
RSWH10	D	Residual sward height over 10 cm at end of grazing period
CLOVER	1-3	Pasture clover score
PASTT	1-3	Average pasture type score
RAG	0-3	Average ragwort score
THISTLE	0-3	Average thistle score
STOCK		Number of times the mob composition was changed
SHIFT		Number of times deer were shifted between paddocks
TDEER		Average number of deer in the mob
MJME/Ha	MJME/Ha	Mean daily energy requirements per hectare
M%AH	%	Mean percentage of adult hinds in the mob
OTHERST	D	Paddocks shared with stock other than deer
STAGS	D	Paddocks shared with yearling or adult stags
FSUP	D	Food supplementation of deer
Environmental variables		
FAREA	Ha	Mean grazed paddock area
SUR	%	Percentage of time spent in paddocks close to road, buildings or houses
TOPO	1-3	Average paddock topography score
2rd BLOCK (Cont'd)		
Environmental variables		
TREES	0-3	Average paddock tree score
SHELT		Average paddock shelter score shelter index combining scores of trees, hill, gully and shelter belt
AVMIT	C	Average of minimum temperatures
AVMAT	C	Average of maximum temperatures
AVMMT	C	Average of daily temperature ranges (maximum-minimum)
RAIND	mm/d	Daily average rainfall
SUN	0-1	Average daily sunshine
AVWIND		Paddock average wind exposure index = Average of wind strength over potential wind protection scores from trees, hill, gully and shelter belt
Weaning management and disease prevention management practices before April 1		
WEAND		Number of days between January 1 and weaning
YARDBW	D	Calves handled in yards before weaning
VCLOST	D	Injection of Clostridial vaccine (5-in-1)
VYERS	D	Fisrt dose of "Yersiniavax" vaccine before April 1
SIPC		Number of days between January 1 and the starting date of internal parasite control (first drench)
NANTH		Number of anthelmintic treatments
3rd BLOCK : Post-weaning grazing management (from weaning to April 1)		
Same variables as in the 3rd BLOCK plus		
ODEER	D	Weaners grazing with yearling or adult deer
4th BLOCK : Biological markers		
Individual and mean calf blood biological characteristics recorded in March 1992 and 1993		
White Cell Count (WCC), neutrophil percentage (NP), lymphocyte percentage (LP), eosinophil percentage (EOP), haemoglobin (HB), packed cell volume (PCV), total proteins (TP), albumins (ALB), phosphorus (P), gamma glutamyl transferase (GGT), blood urea nitrogen (BUN), copper (Cu), vitamin B12 (B12), pepsinogen (PEPS), glutathione peroxidase (GHSPx)		
Calf faecal parasite markers recorded before the commencement of anthelmintic treatment		
FEC>0		Number of calves with positive faecal egg count (over 10 calves)
FLC	Larvae/g	Geometric mean lungworm larvae count multiplied by the number of calves with positive count (over 10 calves)

* D = Dichotomous variable Yes=1 , No=0
** Estimated from the dam blood lines and those of the sire when single sire mating and matching dam-offspring was performed, otherwise, mean calving mob values were estimated from the mean NZD in each calving mob and the sire blood lines
If multiple sire mating was performed, the sire with the highest foreign blood lines was taken arbitrarily as mating sire
Note Analyses were carried out at the individual level (outcome variable W4) except for farm mean biological characteristics (outcome variable MW4)

regression analyses (Kleinbaum et al , 1982) using Stastistica (Statsoft Inc , Tulsa, OK USA) with a 5% significance limit for inclusion or removal from the model

RESULTS

Means and standard deviations of stag and hind calf W4 at each level of categorical variables significantly associated with both weaner stag and hind W4 are presented in table 2 Mean, minimum, maximum, standard deviation, spearmann correlation coeficient and significance of association of continuous variables selected for multivariable analyses are presented in table 3

As an example, the null path model of hind-offspring risk factors and the final path diagram of associations between significant risk factors and weaner stag and hind bodyweights are presented in figures 1 and 2, respectively Unstandardised path coeficients (multivariable regression coeficients) are presented on each statistically significant path in the final diagrams ($p<0\ 05$) Putative and final path models for blocks 2 and 3 will be published elsewhere Statistically significant direct effects (regression coeficients) of the most important risk factors associated with weaner weight within each block are summarised in table 4 The most important dam-offspring risk factors identified in this analysis were AGE3, BCSS, WD6, ADVC, BIRTH and CHW9C in both stag and hind calves, explaining 33% and 29% of the weaner stag and hind bodyweight variability, respectively

DISCUSSION

Weaner stag and hind post-weaning bodyweight of individual deer corrected on April 1 (W4) can be used as one indicator of farm performance Weight of individual deer ranged from 19 9 to 64 5 kg for weaner hinds and from 29 6 to 67 0 kg for weaner stags over the two years of study Weaning weight is one of the key outcomes in the deer production process that can be targeted for improvement/efficiency in breeding and venison production units This paper focuses specifically on risk factors for individual weaner bodyweight (W4), and investigates mean biological markers in relation to mean weaner bodyweight (MW4) between farms The analysis of subsequent growth rates on weaners were being analysed at the time of writting, and will be reported elsewhere

Final path diagrams in Figure 2 show results to be relatively consistent between weaner stags and hind The complex interrelationships that exist in this set of variables can be visualised on these diagrams and they can help understand the plausible biological process involved

Main dam factors affecting individual weaner variables are, to some respect, consistent with pre-existing factual or anecdotal evidence For instance, adult hinds are known to raise bigger calves than yearling hinds through better milking ability Increased dam bodyweight has also been associated with heavier calves at birth, and was identified as having a positive impact on calf growth during lactation (Moore et al , 1988) Imported blood lines may produce heavier calves at birth which may be reflected through the associations between the percentage of New Zealand blood lines in the dam (NZD), her weight in June(WD6) and the change of her weight between September and calving (CHW9C) The direct positive effect of NZD on CHW9C may be because pure New Zealand origin hinds conceived earlier than other hinds in this study (Audigé et al , 1994)

Birth date had a significant positive impact on calf post-weaning bodyweight with more than

Table 2 Mean and standard deviation of weaner stag and hind bodyweight on April 1 for each level of dichotomous risk factors and T-test P values

	WEANER HINDS							WEANER STAGS						
	No = 0			Yes = 1				No = 0			Yes = 1			
Risk factor code*	Number of deer	Mean	SD	Number of deer	Mean	SD	P value	Number of deer	Mean	SD	Number of deer	Mean	SD	P value
1st BLOCK Individual animal characteristics														
AGE3	90	43.08	5.12	428	48.51	5.89	0.000	85	47.06	6.00	373	53.50	6.55	0.000
ADVC	54	43.23	7.57	453	47.94	5.55	0.000	36	45.30	7.42	415	52.74	6.44	0.000
2nd BLOCK Calving, lactation and weaning management														
RSWH10	651	46.81	6.67	746	46.22	7.01	0.108	660	52.14	7.78	695	50.54	7.48	0.000
STAGS	1184	46.87	6.74	264	44.25	7.14	0.000	1183	51.42	7.64	263	49.51	7.88	0.000
YARDBW	381	45.09	7.29	1067	46.85	6.68	0.000	414	49.68	8.13	1032	51.63	7.48	0.000
VCLOST	1045	45.55	6.89	403	48.55	6.39	0.000	1066	50.44	7.94	380	52.86	6.76	0.000
VYERS	1072	45.63	6.84	376	48.57	6.56	0.000	1036	50.13	7.7	410	53.44	7.26	0.000
3rd BLOCK Post-weaning grazing management (weaning- April 1)														
RSWH10	331	48.02	6.28	844	46.6	7.07	0.001	319	52.66	6.78	878	51.52	8.08	0.015
ODEER	840	46.47	6.96	347	48.32	6.45	0.000	779	50.73	7.65	429	53.8	7.57	0.000
OTHERST	1061	46.9	6.77	126	47.96	7.53	0.132	982	51.42	8.01	226	53.55	6.32	0.000
FSUP	955	46.57	7.15	232	48.89	5.09	0.000	986	51.54	7.99	222	53.08	6.54	0.007

* Codes are described in table 1

Table 3 Mean, range, standard deviation of continuous risk factors selected for multivariable analysis of stag and hind calf bodyweight on April 1 using the Spearman correlation coeficient (p<0.20)

	STAG CALVES							HIND CALVES						
Risk factor code*	Number of deer	Mean	Min	Max	SD	Spearman Corr Coef	P value	Number of deer	Mean	Min	Max	SD	Spearman Corr Coef	P value
1st BLOCK Animal individual characteristics														
W4	461	52.34	28.79	71.91	6.90			523	47.61	19.93	67.91	6.11		
NZC	449	70.86	6.25	100.00	24.12	0.07	0.142	511	71.85	6.40	100.00	22.78	0.07	0.099
NZD	461	85.06	12.50	100.00	23.11	0.13	0.005	521	86.35	12.50	100.00	22.17	0.20	0.000
BCSS	455	3.49	1.00	5.00	0.71	0.22	0.000	514	3.55	1.00	5.00	0.67	0.28	0.000
WD6	398	99.98	72.86	127.90	10.07	0.46	0.000	454	100.42	75.58	140.32	10.25	0.41	0.000
CHW9C	266	12.47	1.50	34.00	4.58	0.22	0.000	291	12.16	-2.50	30.00	4.66	0.24	0.000
BIRTHD	155	31.34	3.00	82.00	10.03	-0.48	0.000	173	31.52	16.00	60.00	9.33	-0.51	0.000
2nd BLOCK Calving, lactation and weaning management														
W4	1446	51.07	25.67	73.80	7.72			1448	46.39	19.93	69.78	6.89		
NZC	1446	79.27	6.25	100.00	18.81	-0.23	0.000	1448	79.93	6.40	100.00	18.37	-0.18	0.000
WAPC	1446	2.94	0.00	25.00	7.25	0.16	0.000	1448	2.90	0.00	25.00	7.24	0.23	0.000
SHIFT	1446	4.47	1.00	18.00	4.31	0.23	0.000	1448	4.54	1.00	23.00	4.35	0.30	0.000
M%AH	1446	81.86	0.00	100.00	28.93	0.21	0.000	1448	84.39	0.00	100.00	28.77	0.19	0.000
MJME/Ha	1446	549.23	16.08	1550.07	346.43	0.06	0.026	1448	570.17	16.08	1870.60	342.00	0.15	0.000
FAREA	1446	7.33	0.93	24.30	6.07	-0.05	0.040	1448	6.95	0.93	24.30	6.07	-0.12	0.000
PASTT	1446	1.92	1.00	3.00	0.56	-0.11	0.000	1448	1.93	1.00	3.00	0.56	-0.11	0.000
SUR	1446	26.16	0.00	100.00	35.79	0.12	0.000	1448	24.87	0.00	100.00	34.65	0.22	0.000
AVMMT	1446	12.02	7.92	15.37	1.85	-0.05	0.074	1448	12.04	7.87	15.37	1.90	-0.04	0.152
RAIND	1446	3.15	1.63	6.01	1.20	-0.22	0.000	1448	3.22	1.63	6.01	1.22	-0.19	0.000
SUN	1446	0.55	0.26	0.87	0.14	0.21	0.000	1448	0.55	0.26	0.87	0.15	0.21	0.000
WEAND	1446	70.27	54.00	95.00	10.37	-0.22	0.000	1448	70.30	54.00	95.00	10.85	-0.20	0.000
SIPC	1446	67.33	27.00	95.00	14.38	-0.23	0.000	1448	67.12	27.00	95.00	15.16	-0.22	0.000
ANTH	1446	1.12	0.00	3.00	0.62	0.27	0.000	1448	1.14	0.00	3.00	0.66	0.29	0.000
3rd BLOCK Post-weaning grazing management (from weaning to April 1)														
W4	1208	51.82	25.67	73.80	7.76			1187	47.01	19.93	69.78	6.86		
NZC	1208	77.86	6.25	100.00	19.46	-0.19	0.000	1187	78.89	6.40	100.00	19.10	-0.14	0.000
WAPC	1208	3.37	0.00	25.00	7.64	0.13	0.000	1187	3.31	0.00	25.00	7.59	0.21	0.000
ISWH	1197	16.24	7.00	21.75	4.37	-0.21	0.000	1175	16.08	7.00	21.75	4.38	-0.26	0.000
CLOVER	1197	1.72	1.00	2.44	0.48	0.15	0.000	1175	1.71	1.00	2.00	0.42	0.09	0.002
MSWH	1197	13.74	6.00	18.88	3.59	-0.24	0.000	1175	13.73	6.00	18.88	3.67	-0.25	0.000
TDEER	1208	125.49	25.00	225.00	48.74	-0.28	0.000	1187	123.47	24.43	225.00	49.00	-0.34	0.000
MJME/Ha	1208	592.02	86.64	1168.99	287.73	-0.14	0.000	1187	608.02	86.64	1168.99	298.91	-0.06	0.058
DEER/Ha	1208	37.75	5.10	75.35	18.85	-0.12	0.000	1187	38.98	5.10	75.35	19.48	-0.04	0.191
FAREA	1208	4.72	1.03	17.44	3.84	0.07	0.017	1187	4.60	1.03	17.44	4.02	-0.15	0.000
TOPO	1208	1.40	1.00	2.50	0.54	-0.08	0.004	1187	1.41	1.00	2.50	0.57	-0.15	0.000
RAG	1208	0.57	0.00	2.50	0.83	0.07	0.023	1187	0.55	0.00	2.50	0.83	0.09	0.002
SUR	1208	39.31	0.00	100.00	39.81	0.14	0.000	1187	36.24	0.00	100.00	38.75	0.13	0.000
TREES	1208	0.84	0.00	3.00	0.88	0.07	0.022	1187	0.82	0.00	3.00	0.88	0.09	0.002
AVWIND	1135	1.32	0.27	3.21	0.92	-0.14	0.000	1107	1.42	0.27	3.21	0.91	-0.05	0.078
AVMIT	1208	8.24	5.95	11.29	1.28	-0.14	0.000	1187	8.17	5.95	11.29	1.30	-0.15	0.000
AVMAT	1208	19.56	17.36	23.64	1.69	-0.05	0.109	1187	19.54	17.36	23.64	1.58	0.04	0.132
RAIND	1208	2.73	0.50	5.07	1.30	-0.22	0.000	1187	2.73	0.50	5.07	1.29	-0.24	0.000
SUN	1208	0.53	0.07	0.75	0.15	0.18	0.000	1187	0.54	0.07	0.75	0.15	0.21	0.000
5th block Individual calf blood biological markers (calf crops 1992 and 1993)														
W4	110	51.24	34.08	66.54	7.35			115	47.70	32.76	59.67	6.02		
TP	110	63.24	50.50	72.60	3.82	0.31	0.001	115	63.17	52.50	82.90	4.35	0.34	0.000
ALB	110	35.56	22.50	43.20	3.76	0.25	0.009	115	35.76	26.30	43.40	3.43	0.29	0.001
Farm mean calf blood biological and faecal parasite markers (calf crops 1992 and 1993)														
MW4	23†	49.87	43.02	55.53	3.53			22	45.82	38.35	51.81	3.75		
ALB	23†	35.62	29.96	39.11	2.81	0.43	0.042	22	35.85	29.96	39.11	2.66	0.51	0.015
Farm mean calf faecal parasite markers (calf crops 1992, 1993 and 1994)														
MW4	27†	50.94	41.94	59.03	4.16			27	46.34	39.27	51.32	3.50		
FLC	27†	285.55	3.60	1654.00	303.77	-0.29	0.146	27	285.55	3.60	1654.00	303.77	-0.46	0.016

Min = Minimum, Max = Maximum, SD = Standard deviation
* Variable descriptions are presented in table 1
** In the analysis of grazing management, estimated blood line percentages were included in all models to account for genetic variation between farms so NZC and WAPC are included in this table
† Number of farms

Figure 1 An example of null hypothesis path model individual dam-offspring risk factors for weaner bodyweight on April 1

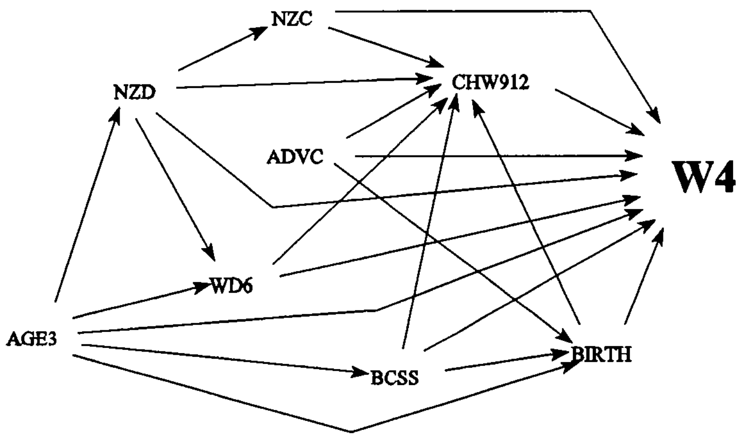
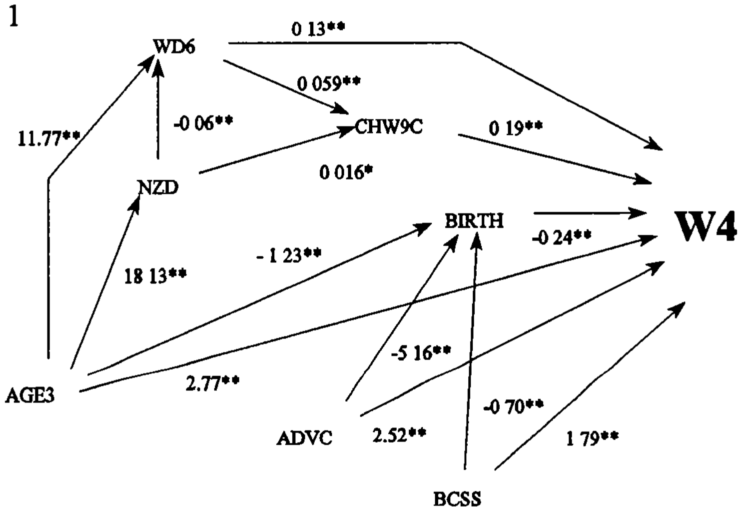
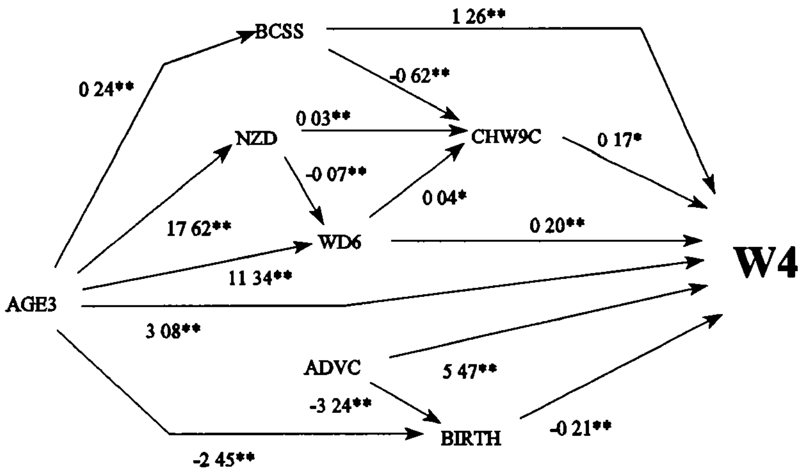


Figure 2 Final path models of individual dam-offspring risk factors for weaner hind and stag bodyweight on April 1

1 Weaner hind



2 Weaner stag



Note Risk factor codes are described in table 1

Unstandardised regression coeficients are presented on significant (*p<0 05, **p<0 01) paths

Table 4 Summary of major direct effects of risk factors for weaner stag and hind bodyweight within each block of explanatory variables

Main risk factors	Units*	WEANER STAGS Regr coef **	SE	P value		WEANER HINDS Regr coef **	SE	P value	
1st BLOCK Dam-offspring individual characteristics									
Model R square					0 33				0 29
Intercept		24 624	3 604	0 000		29 345	3 089	0 000	
Weight of the dam (on June 1)	kg	0 203	0 033	0 000		0 125	0 028	0 000	
Conception before May 1	D	5 472	1 005	0 000		2 515	0 797	0 002	
Birth date	day	-0 210	0 047	0 000		-0 238	0 045	0 000	
Dam 3 years old at calving	D	3 076	0 763	0 000		2 769	0 675	0 000	
Dam body condition score in September	1 to 5	1 256	0 396	0 002		1 785	0 360	0 000	
Dam weight change between September and November	kg	0 165	0 077	0 033		0 193	0 066	0 004	
2nd BLOCK Lactation and weaning management									
Model R square					0 27				0 29
Intercept		41 360	2 428	0 000		34 715	1 701	0 000	
Estimated percentage of New Zealand Blood lines	%	-0 109	0 011	0 000		-0 069	0 009	0 000	
Estimated percentage of Wapiti or Elk blood lines	%	0 133	0 027	0 000		0 148	0 023	0 000	
Mean percentage of adult hind in the mob		0 074	0 007	0 000		0 062	0 006	0 000	
Average pasture type score	1-3					-1 455	0 297	0 000	
Residual sward height over 10 cm at end of grazing period	D	-1 385	0 411	0 001					
Mean grazed paddock area	Ha	0 301	0 037	0 000					
Average of daily temperature ranges (maximum-minimum)	C	1 530	0 143	0 000		0 609	0 119	0 000	
Number of days between January 1 and weaning	day	-0 193	0 027	0 000					
Calves handled in yards before weaning		3 135	0 519	0 000					
Number of anthelmintic treatments before April 1		2 341	0 422	0 000		3 349	0 318	0 000	
Weaners were injected one dose of "Yersiniavax" before April 1	D	1 590	0 415	0 000					
Average daily sunshine	0-1					7 301	1 219	0 000	
Number of times deer were shifted between paddocks						0 571	0 094	0 000	
Mean daily total energy requirements by the mob per hectare	MJME/Ha					-0 006	0 001	0 000	
3rd BLOCK Post-weaning grazing management									
Model R square					0 23				0 23
Intercept		55 892	3 185	0 000		68 873	2 089	0 000	
Estimated percentage of New Zealand Blood lines	%	-0 024	0 011	0 035		-0 027	0 010	0 006	
Estimated percentage of Wapiti or Elk blood lines	%	0 168	0 040	0 000		0 244	0 025	0 000	
Number of days between Januray 1 and weaning	day	-0 136	0 021	0 000		-0 132	0 016	0 000	
Residual sward height over 10 cm at end of grazing period	D	3 879	0 965	0 000		4 923	0 701	0 000	
Mean pasture clover score	1-3	2 407	0 707	0 001					
Mean pasture sward height at start of grazing period	cm					-0 368	0 076	0 000	
Food supplementation of deer	D					2 169	0 526	0 000	
Average number of deer in the mob		-0 072	0 010	0 000		-0 022	0 004	0 000	
Mean daily total energy requirements by the mob per hectare	MJME/Ha	0 004	0 002	0 011					
Mean grazed paddock area	Ha	1 124	0 192	0 000					
Average daily rainfall	mm	-0 985	0 234	0 000		-1 020	0 163	0 000	
Paddock average wind exposure index		1 714	0 396	0 000					
Average tree score	0-3	-3 145	0 485	0 000					
Percentage of time spent in paddocks close to road, buildings or houses	%	0 049	0 009	0 000					
Paddocks shared with cattle, sheep or goats	D	2 329	0 896	0 009					
Weaners grazing with yearling or adult deer	D	3 095	0 947	0 001					
Average of minimum temperatures	C					-0 515	0 148	0 000	
4th BLOCK Biological markers									
Individual calf blood characteristics (calf crop 1992 and 1993)									
Model R square					0 11				0 10
Intercept		10 215	11 058	0 358		19 529	7 804	0 014	
Total proteins	g/l	0 649	0 175	0 000		0 446	0 123	0 000	
Farm mean calf blood and faecal parasite markers (calf crop 1992 and 1993)									
Model R square					0 23				0 27
Intercept		28 541	8 612	0 003		19 487	9 682	0 058	
Mean albumin concentration over 10 calves	g/l	0 599	0 241	0 021		0 735	0 269	0 013	
Farm mean calf blood and faecal parasite markers (calf crop 1992 and 1993)									
Model R square					0 18				0 21
Intercept		52 307	0 948	0 000		47 591	0 784	0 000	
Mean farm calf lungworm larvae index		-0 005	0 002	0 029		-0 004	0 002	0 017	

* D = Dichotomous variable (Yes=1/No=0)

** Kilogram calf bodyweight increase per unit increase of each continuous risk factor, or if dichotomous variables equal to 1, all other factors maintained constant

200 g increase bodyweight for each day earlier that the animal was born, after correcting for conception status (early or late) which produced 2 5 kg and 5 5 kg heavier weaner hinds and stags, respectively There is evidence that precalving hind body condition score be a major factor influencing weaner bodyweight This effect may be due to various factors such as the ability of fat hinds to produce heavier calves at birth (as shown by the negative effect of BCSS on CHW9C in the stag final model), to calve earlier (as shown by the positive effect of BCSS on BIRTH in the hind final model) and to have higher milk production The influence of hind body condition in September on birth date may actually be due to earlier conception as observed in hinds in good pre-mating body condition (Audigé et al , 1994) Thin hinds in March were more likely to be thin in September (Unpublished data)

Final diagrams also show indirect positive effects of AGE3 as adult hinds were heavier in June, in better body condition in September, and calved earlier than yearling hinds A negative effect of AGE3 was identified through NZD as imported blood lines were more prevalent in yearling hinds than adult hinds

The analyses of grazing management during lactation, weaning and post-weaning grazing management are more difficult to interpret because there is no pre-existing evidence of association or certain biological explaination for many factors Some factors in these blocks were chosen based on logical thought without back-up from the literature, so this discussion is only suggestive of plausible explainations It is beleived the most important factors would be significantly associated with both stag and hind weaner weight, while the significance of the other factors identified in only one of the two models (ie stag or hind) may be marginal although informative

These analyses support the beleived beneficial effect of introducing imported blood lines or using cross-bred with wapiti type deer in producing heavy weaners The more adult hinds in the calving mob, the heavier were the weaners, which is consistent with the previous analysis of dam characteristics The positive effect of high temperature ranges during lactation and low daily rainfall after weaning, may actually indicate the positive influence of sunny weather patterns (providing it is not too dry for adequate pasture growth)

An approx 2-3 5 kg weaner weight increase was associated with each anthelmintic treatment administered before April 1 The effect however is likely to be confounded with that of weaning date (WEAND) which was significant in the model of post-weaning management practices The later the weaning date, the lighter were the weaners on April 1 This warrants further evaluation of weaning practices to identify the specific effect, if any, of each of these risk factors This study however suggests high parasite burdens (measured through faecal lungworm larvae counts before the commencement of anthelmintic treatment) may have a detrimental effect on calf performance In this study some weaners were drenched as early as late January

Residual pasture sward height (RSWH10) should be maintained over 10 cm to produce heavy weaners as shown by the 4-5 kg increase of weaner bodyweight associated with this grazing practice Although the magnitude of effects may only be indicative, it strongly supports previous experimental evidence (Ataja et al , 1989), so this relationship is likely to be causal This is further supported by the finding that calf total protein or albumin concentrations were positively associated with weaner weights These biological markers in young ruminants can be used to monitor adequacy of nutritional intake

That large mobs of weaners were associated with low weaner weight is intriguing and needs further evaluation

In this study, blocks of explanatory variables were investigated separately because individual dam-offspring pair identifications were carried out on 6 farms only, while the analysis of post-weaning grazing management could not include farms that weaned calves on or after April 1

Estimated calf blood line percentages were included in all analyses as potential confounding factors It also enabled the identification of important factors within each block Results presented in table 4 show only estimated direct effects of significant variables on calf bodyweight More understanding of the whole production processs may arise from the analysis of final path diagrams, which will be described elsewhere

It must be remembered that path diagrams are built on the basis of current knowledge of deer production, and theoretical considerations, biologically sound, determined by research in other domestic species and field experience Statistical tests are carried out to test whether the putative theory in statistically sound, but it does not mean the theory is right Thus it is necessary to validate these findings through more research before any conclusion on causal relationships could be formulated

However, this statistical approach is a very efficient tool to explore plausible causal pathways between a set of risk factors This approach is also a first step in building models that can be used to help predict animal performance given a set of deer or farm characteristics For instance, using the model defined from dam-offspring individual characteristics (for which risk factors are likely to be causal), it is possible, given all reservations previously mentioned, to predict post-weaning weaner individual bodyweights on April 1 This is illustrated in table 5

Table 5 Application of modeling technique to the prediction of weaner bodyweight on April 1 (W4) with two deer conforming to a different set of characteristics

Dam characteristics						**Predicted W4**	
AGE3 Adult=1 Yearling=0	WD6 kg	ADVC Yes=1 No=0	BCSS score 1 to 5	CHW9C kg	BIRTH day after Nov 1	Stag calf kg	Hind calf kg
0	86	0	2	16	50 (Dec 20)	36 8	34 9
1	100	1	4	24	20 (Nov 20)	58 3	54 1

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