



BEEF CATTLE on TUSSOCK COUNTRY

J.G.Hughes

D.McClatchy

J.A.Hayward



TGMLI

LINCOLN PAPERS IN RESOURCE MANAGEMENT No 1 — 1971
PUBLISHED FOR THE TUSSOCK GRASSLANDS AND MOUNTAIN
LANDS INSTITUTE BY THE LINCOLN COLLEGE PRESS

BEEF CATTLE
ON
TUSSOCK COUNTRY

by

J. G. Hughes, D. McClatchy, J. A. Hayward

Lincoln Papers in Resource Management. No. 1 — 1971
(J. Runga, ed.)

Published for the
Tussock Grasslands and Mountain Lands Institute
by
Lincoln College Press

Copyright © 1971. All rights reserved.

Requests to reproduce material from this publication should be made to the Director of the Institute.

Tussock Grasslands and Mountain Lands Institute.

P.O. Box 56.

Lincoln College,

Canterbury.

New Zealand.



Showing the spirit of cattle raising in the high country.
Mt Albert Station, Wanaka. Photo: P. Gazzard

"This business of converting grass into beef is a wonderful occupation in the years when blizzards don't hit you at calving time and when it rains just when you need it for grass or wheat pasture. Those are the years when the extra pounds cover up mistakes in management and even cattle which were bought too high can show a small profit. Those are the years when bankers are friendly people and everybody on Main Street buys a pair of boots and gets into the cattle business.

"But there are also the years that we don't talk about except to brag that we lived through them ..."

A. P. Atkins (1964)

Cover: Printed by Bascands Ltd, photo B. Pinney
Typing: Miss H. R. Faulls
Diagrams: Mrs M. Rutherford and J. R. Barton

PREFACE

In 1968 the Soil Conservation and Rivers Control Council commissioned a report from the Institute on the feasibility and economics of cattle in the hill and high country of the South Island. That report was prepared by J. G. Hughes and J. A. Hayward of the Tussock Grasslands and Mountain Lands Institute and D. McClatchy, then of the Agricultural Economics Research Unit, Lincoln College and now Purdue University. Following its completion the report was submitted for comment to several authorities.

On behalf of the Institute the authors thank most sincerely the following who supplied information or commented on the original report: Messrs J. O. Acland, J. C. Aspinall, A. Bain, S. J. S. Barker, R. A. Barton, W. C. Boughton, Professor J. R. Burton, Messrs A. G. Campbell, L. P. Chapman, M. M. Chisholm, H. E. Connor, Professor I. E. Coop, Mr N. A. Cullen, Dr D. C. Dalton, Messrs B. Douglass, P. C. Ensor, Dr G. C. Everitt, Messrs J. Fitzharris, A. F. Greenall, G. K. Hight, Dr K. Hungerford, Dr K. T. Jagusch, Messrs B. E. Jessep, A. D. H. Joblin, I. G. C. Kerr, Dr D. R. Lang, Dr W. A. Laycock, Messrs R. S. Macarthur, R. V. Maxwell, G. A. Mead, A. M. Nicol, J. W. Ramsay, R. M. Robertson, A. Rowell, G. H. Scales, W. O. Sly, J. L. Thompson, J. M. Wardell, A. R. Watson, J. P. C. Watt, D. R. Wilkie, R. W. Wilson. While appreciating this help, the authors share with me alone the responsibility for the conclusions expressed in the present book.

During the last 18 months Messrs Hughes and Hayward have revised and recast the material of the original report. They have brought up to date the economic data originally collated by Mr McClatchy. The original unpublished report was intended solely for the use of the Soil Conservation and Rivers Control Council in the consideration of resource conservation policy as it affected cattle. It has been the intention of the Institute staff in preparing the present volume for publication to make available to all those concerned with beef cattle in the tussock country a practical but thorough compendium of all relevant information on beef cattle production in such environments.

In presenting this information, the authors have attempted to develop and maintain an integrated ecologic view of cattle in the tussock country - animals that affect and are being affected by their mountain environment. At the same time they have given constant attention to the practical business of cattle management for profit. I confidently hope therefore that this volume will be welcomed both as the first publication in a new series on Resource Management and as a useful guide to one of the fastest growing and potentially most significant enterprises in New Zealand.

K. F. O'Connor,
Director,
Tussock Grasslands and Mountain Lands Institute,
Lincoln College,
Canterbury

15th September, 1971

CONTENTS

	page
Frontispiece — P. Gazzard	ii
Quote — A. P. Atkins	iii
Preface — K. F. O'Connor	iv
Contents	v
List of Tables	vii
List of Figures	viii
List of Appendices	viii
 INTRODUCTION	 I
 CHAPTER 1 BEEF PRODUCTION FROM SOUTH ISLAND TUSSOCK GRASSLANDS	
1.1 Present Production	4
1.2 Beef Cattle	10
1.21 Theoretical limits on the rate of increase	10
1.22 Rates of increase of beef cattle numbers in recent years	14
1.3 Summary	18
 CHAPTER 2 MARKET PROSPECTS	
2.1 Present disposal of South Island output	20
2.2 Recent past, and probable future growth of the local beef market	20
2.3 Beef export prospects	22
2.4 Freezing works beef-handling capacities	25
2.5 Summary	29
 CHAPTER 3 BEEF CATTLE AND THEIR ENVIRONMENT	
3.1 Topography	30
3.11 Grazing site preference	30
3.12 Factors affecting steeland use	33
3.2 Climate	34
3.21 Adaptation	34
3.22 The effect of heat and humidity	34
3.23 The effect of cold	37
3.24 Rainfall and drought	43
3.3 Water for Stock	47
3.31 The need for water	47
3.32 Water intake and its relation to grazing	47
3.33 Water supply cost	50
3.4 Vegetation	53
3.41 Quantity and quality	53
3.42 Plants poisonous to cattle	63
3.5 Summary	66
3.51 Topography	66
3.52 Climate	67
3.53 Water	67
3.54 Vegetation	67
 CHAPTER 4 FACILITIES FOR CATTLE	
4.1 Boundaries	69
4.11 Natural boundaries	69
4.12 Fencing	70
4.2 Yards	73
 CHAPTER 5 THE INFLUENCE OF CATTLE ON VEGETATION, SOIL, AND WATER CONDITIONS	
5.1 Cattle Influence on Vegetation	75
5.11 Anatomical considerations	75
5.12 Cattle for vegetation control	77
5.13 Dispersal of seed by stock	83
5.14 Cattle, erosion, and depletion	83
5.15 Effect of trampling on plants	86
5.2 Cattle Influence on Soil	87
5.21 Anatomical considerations in treading	88
5.22 The effect of treading	88
5.23 Effect of treading on soil compaction	89
5.24 Effect of treading on soil stability	93

5.3	Influence on Water	94
5.31	Cattle influence on water	94
5.32	Canopy interception	95
5.34	Evaporation and evapotranspiration	96
5.35	Infiltration and percolation	96
5.36	Channel storage	99
5.37	Water quality	99
5.38	Presence of ponds and bogs	99
5.4	Summary	100
5.41	Cattle influence on vegetation	100
5.42	Cattle influence on soil	101
5.43	Cattle influence on water	101
CHAPTER 6	CONTROL OF REPRODUCTION	
6.1	Mating — Present Practice	103
6.2	Alternative Breeding Policies	104
6.21	What to aim for	104
6.22	Bull selection	107
6.23	The heritability of characteristics	108
6.24	Crossbreeding	110
6.25	Inbreeding	113
6.3	Mating Heifers at 1½ or 2¼ Years Old	114
6.4	Artificial Breeding	116
6.5	Autumn or Spring Calving	117
6.6	Summary	120
CHAPTER 7	WINTER FEEDING	
7.1	Present Practice	122
7.11	Calves	122
7.12	Cows	122
7.13	Steers	123
7.14	General practice	123
7.2	Supplementary Feeds	125
7.21	Hay	125
7.22	Silage	127
7.23	Brassicas	127
7.24	Autumn-saved pasture	128
7.25	Grain and concentrates	129
7.3	Results from some Winter Feeding Investigations	133
7.31	The effects of plane of nutrition	133
7.32	Compensatory growth	135
7.33	Pen feeding	136
7.34	Frequency of feeding	137
7.35	Efficiency of supplementary feeding	137
7.4	Summary	138
CHAPTER 8	MANAGEMENT OF YOUNG STOCK	
8.1	Calving	140
8.11	Present practice	140
8.12	Experimental studies	141
8.13	Nurse cow rearing	142
8.14	Calf marking	143
8.2	Factors Affecting the Growth of Calves	144
8.21	The effect of cow liveweight	144
8.22	The effect of the cow's milk yield	147
8.23	The effect of the age of the cow	148
8.24	The effect of crossbreeding	149
8.25	The effect of cow nutrition before and after calving	149
8.3	Weaning	150
8.31	Present practice	150
8.4	Growth Rates	154
8.41	The importance of a high rate of growth in young cattle	154
8.42	The importance of rate of growth to the runholder	155
8.43	Growth and food conversion efficiency	161
8.44	Growing muscle, fat or bone	161
8.5	Culling	163
8.51	Selling all calves	163
8.52	Keeping replacements	163
8.53	Culling cows	164
8.54	Cattle sales	165
8.55	Performance recording	167
8.6	Summary	169

CHAPTER 9	BREEDS AND BREED SUITABILITY	
9.1	Beef Breeds and Market Requirements	171
9.11	Meat yield and dressing percentage	171
9.12	Carcass quality	172
9.13	Early maturing or late maturing—which is best?	173
9.14	Producing beef from runs	175
9.2	Opinions on Breed Suitability for Hill and High Country Conditions	177
9.21	Hereford	179
9.22	Angus	183
9.23	Shorthorn	184
9.24	Galloways	185
9.25	Friesians	185
9.26	Charolais	188
9.27	Other Breeds	189
9.28	Crossbreds	189
9.3	Summary	191
CHAPTER 10	STOCK HEALTH	
10.1	Reproductive Disorders and Diseases	194
10.11	Infertility due to poor nutrition	194
10.12	Abortion	194
10.2	Parasites	195
10.21	Lice	195
10.22	Internal worms	196
10.3	Foot Troubles in Bulls	198
10.4	Cancer Eye	198
10.5	Nutritional Disorders Associated with Pasture	199
10.51	Grass staggers	199
10.52	Milk fever	199
10.53	Bloat	199
10.6	Mineral Deficiency	202
10.61	General	202
10.62	Salt supplementation	202
CHAPTER 11	CATTLE OR SHEEP	
11.1	Cattle sheep ratios	205
11.2	The interrelation of cattle and sheep grazing	205
11.3	Plant preferences of sheep and cattle	206
11.4	Experimental comparisons of productivity	207
CHAPTER 12	THE RELATIVE PROFITABILITY OF BEEF TO THE FARMER	
12.1	Introduction	212
12.2	Choice of enterprise; age at sale of surplus livestock	212
12.3	Summary of gross margins calculations	223
12.4	Interpretation and application of the derived gross margins	231
12.5	Some qualifications of the gross margins approach	239
12.6	General conclusions	242
References	244
Appendices	258

LIST OF TABLES

Table		page
1	New Zealand and South Island Beef Cattle Populations, January 1969	4
2	Distribution of South Island Beef Cattle by Regions, January 1970	5
3	Selected counties of South Island and their 1970 breeding cow/total-beef cattle percentages	6
4	Estimates of South Island beef cattle population by sheep farm category as per N.Z. Meat and Wool Boards' Economic Service Classification	7
5	Average total stock units (S.U.) and beef-cattle stock units carried per acre in 1958/59 and 1968/69 on four sheep farm categories	9
6	Cattle income as a percentage of gross farm income in some sheep farm categories: 1958/59 and 1968/69	10
7	Average annual percentage increases 1959-69 in total beef cattle and beef cows used for breeding: South Island and New Zealand compared	15
8	Ten-year increases (1960-70) in total beef cattle, and in beef cows used for breeding, for South Island statistical areas	15
9	Ten-year increases (1960-70) in total beef cattle for selected predominantly hill/high country counties	16
10	Beef-cattle per-acre increases 1959-69 on farms in the Meat and Wool Boards' Economic Service Sheep Farm Survey categories "S.I. High Country" and "S.I. Foothills"	17
11	Average annual unweighted increases in beef cattle stock units and total stock units carried on Otago hill/high country farms operating on Otago Catchment Board run plans	18
12	Critical temperatures in still air	37
13	Annual beef cattle food requirements	54
14	Dry matter production of some tussock grassland zones	57
15	Percentage of crude protein in dry matter samples from four unimproved tussock grassland sites	59
16	Sheep and cattle as treading agents	88
17	Heritability of some characteristics of beef cattle	108
18	Approximate food values of common New Zealand foodstuffs	131
19	Effect of age of cow on adjusted weaning weight of calves	149
20	Proportion of cattle breeds in New Zealand and on high-country runs	178
21	Meat production per acre	208
22	Average liveweights of ewes grazed with and without cattle for a three-year period	209
23	Summary of South Island hill/high country breeding ewe and breeding cow gross margins per stock unit under different price and performance assumptions	224
24	High country breeding ewe and breeding cow gross margins	234
25	High country breeding ewe and breeding cow gross margins	237

LIST OF FIGURES

Fig.		page
1	Land slope classes in the South Island	31
2	Climatic districts of the South Island	38
3	Frequency of snowfall in the South Island	40
4	Average annual water deficit	44
5	Seasonal occurrence of droughts in the South Island with frequency of days falling within a partial drought	45
6	Soils of the South Island	56
7	Seasonal production of digestible dry matter from pasture, and energy requirements of fattening cattle	156
8	The curve of liveweight growth of animals	156
9	Growth rates of steers from Whatawhata	157
10	Cow liveweight relative to calving date	157
11	Value of ox under certain assumptions re grade changes with carcass weight	218
12	Value for age graph based on Fig. 11 and assumptions re seasonal growth rates, seasonal grading (body condition) changes, and seasonal price premium above schedule rates in the spring	219
13	Ewe flock (fat lamb production, breeding own replacements) versus weaner fattening gross margins	222

LIST OF APPENDICES

Appendix		page
A	Map: Cattle numbers per property in the high country 1967	258
B	Map: Cattle breeds in the high country	259
C	Map: Sheep to cattle ratio on high country runs	260
D	Maximum sustained rate of increase of beef breeding herd: method of calculation	261
E	Growth, grading, and spring premium assumptions adopted for figs. 11 and 12	262
F	Cattle wintering costs as at October 1971 — A. R. McIvor	263
G	Comparison of capital margins as at March 1971 — J. D. Currie	267

INTRODUCTION

In general, high country and hard hill country properties share a number of common characteristics. They have long severe winters, and often steep slopes, high average altitude, small ploughable area, and high proportions of unimproved grasslands. Their soils are usually of low fertility.

These factors have produced a farming system based on extensive grazing of native vegetation. Surplus stock are usually cast-for-age and sold in store condition. In general the lowest-rainfall runs carry only sheep (usually Merinos). The maps in the appendix show that cattle tend to be found more in the higher-rainfall areas. The biggest herds are mostly on the high-rainfall "gorge" runs.

The reasons why runholders carry cattle are:

1. To make use of swamps and rough grazing unsuitable for sheep.
2. To decrease the dependence on wool prices as the main source of income.
3. To graze areas near to, but not fenced off from eroded areas where sheep may do more damage than cattle.
4. To graze areas where the snow risk is so high that sheep grazing would be hazardous.
5. To graze high-rainfall areas where sheep production is low and losses are high.
6. To reduce "roughage" and open up scrub for better sheep grazing.
7. To give more even use of labour between peaks of sheep-handling activity.

In short, cattle in these situations are reckoned to be more profitable than an equivalent number of sheep.

On the other hand, many runholders do not carry cattle.
Some of their reasons are:

1. They are not interested in cattle.
2. Their fences are inadequate.
3. Their yards are inadequate.
4. They have inadequate stock water.
5. Cattle can cause bad relations with neighbours.
6. The risk of death from tutu poisoning or bloat is unacceptable.
7. Cattle can be a liability in drought or dry summers.
8. A high capital outlay is needed.

The above reasons for and against carrying cattle are discussed in the appropriate sections of this report.

Cattle management on high country runs is fairly simple and uniform. It aims, in general, at carrying cows through on unimproved pasture to calve in the spring. Runholders usually keep their own replacement calves and sell the remainder in store condition at calf sales in the autumn. In general, hard-high-country runs also carry a high proportion of steers for grazing remote blocks. These grow steadily for sale at either 2½ years or 3½ years of age in store condition. Hill country runs also either produce weaner calves for sale or, if on 30 inches or more rainfall country with good pastures, aim to sell prime 18-24-month-old steers or heifers.

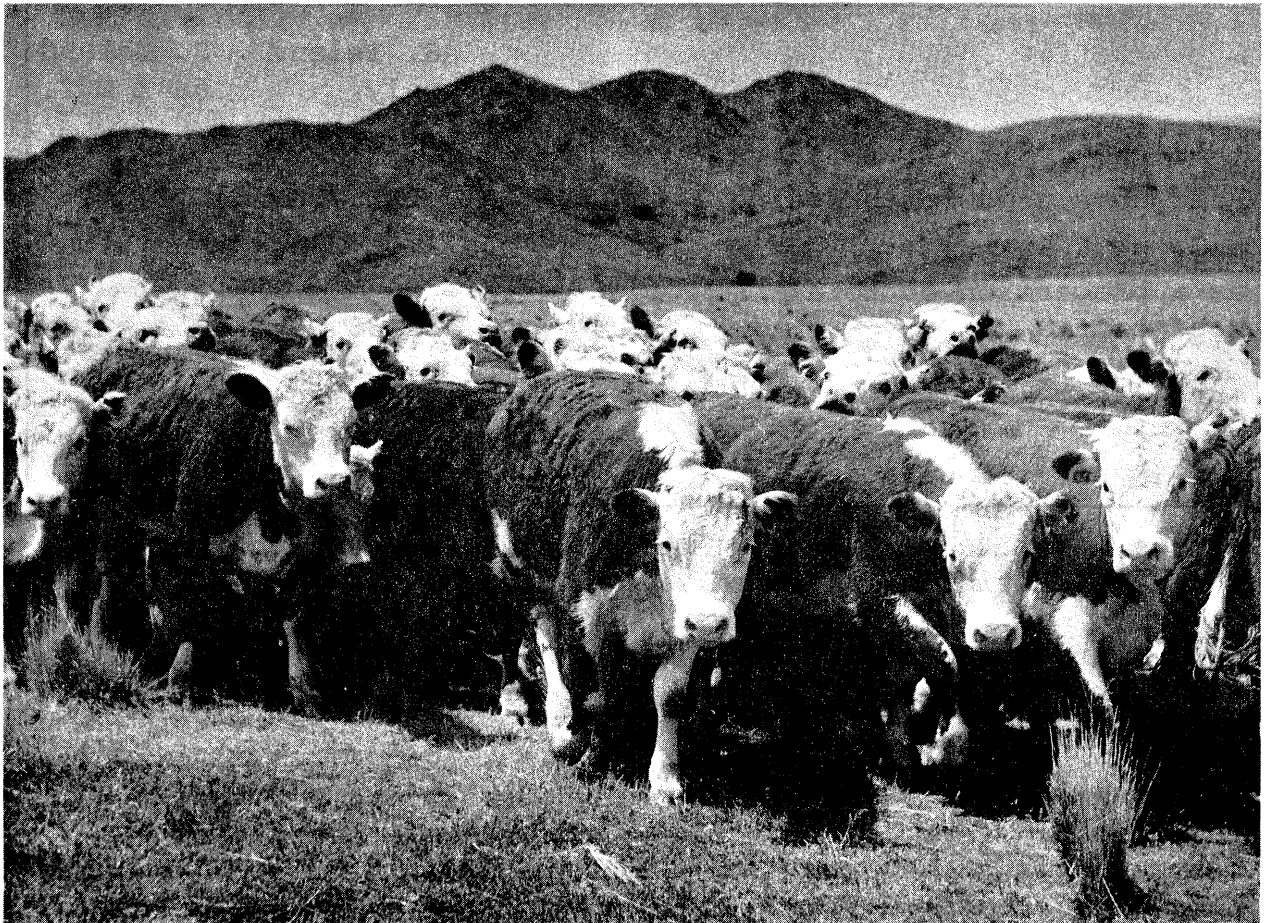
The high proportion of cows on most runs means that they have a high potential to increase the herd size.

The grazing management of cattle herds in this region is, however, relatively unplanned on most properties and until now they have more often than not been accepted as a sideline which has to fit in wherever it can into a mainly sheep-orientated management system. Supplementary feeding is the exception rather than the rule.

In some circumstances cattle control rough grassland well because of their different grazing preference to sheep but their

effect on the soil stability of steep hill country will need to be watched.

We believe that there is a good future market for beef cattle for breeding and for meat, that there are many opportunities for increasing the productivity of back-country cattle, and that there is already much research knowledge on which to base it. However, runholders will need to identify the characteristics they are looking for in their cattle. They will then have to take steps to measure the improvement in these characteristics. Finally, they should continually monitor by performance recording whether the extra management needed to secure production gains will pay.



- To decrease the dependence on wool prices as the main source of income. Heifers on Haldon Station in the Mackenzie Country.

Photo: B. Pinney

CHAPTER 1

BEEF PRODUCTION FROM SOUTH ISLAND TUSSOCK GRASSLANDS

1.1 PRESENT PRODUCTION

In January 1970 only 20% of New Zealand's beef cattle were in South Island (see Table 1).

TABLE 1			
New Zealand and South Island Beef Cattle Populations, January 1969			
	N.Z.	S. Island only	S. Island as % N.Z.
Total beef cattle	4,811,791	914,685	19
Beef cows used for breeding	1,486,324	298,720	21
Beef cows used for breeding as a proportion of total beef cattle	31%	33%	
1970 Total beef cattle	5,062,000*	1,013,150	20
* provisional total			

Source: N.Z. Department of Statistics - Farm Production Statistics and unpublished data.

Average annual cattle kill in South Island from 1964-70 was approximately 233,000 head or about one-quarter of the total population*.

Beef cattle in the South Island are spread throughout the farming areas of the island, but are relatively more concentrated in the coastal and south Otago and Southland regions. These two regions carried almost 40% of the total South Island

* This includes Meat Export Works and Abattoir slaughterings. Source: South Island Freezing Coys Assn and R. G. Pilling (pers. comm.) Farm killings for cattle are very low, making up less than 1% of total annual kill for New Zealand as a whole.

beef cattle in 1970. With Nelson-Westland and South Canterbury they carried more than two-thirds of total South Island beef cattle (Table 2).

TABLE 2			
Distribution of South Island Beef Cattle by Regions, January 1970			
Region	Counties Included	No. of cattle	% of S.Is. Total
Nelson-Westland	Waimea, Golden Bay, Buller Inangahua, Grey, Westland	132,954	13.1
Marlborough	Marlborough, Awatere, Kaikoura	88,577	8.8
North Canterbury	Amuri, Waipara, Cheviot	78,074	7.7
Cent. Canterbury and Plains	Ashley, Rangiora, Eyre, Oxford, Malvern, Paparua Waimairi, Heathcote, Ellesmere	63,153	6.2
Banks Peninsula	Mt Herbert, Akaroa, Waiarewa	32,218	3.2
South Canterbury (incl. Ashburton and Waitaki)	Ashburton, Geraldine, Levels, Mackenzie, Waimate, Waitaki	150,543	14.9
Central Otago	Vincent, Lake, Maniototo	67,272	6.6
Coastal/South Otago	Waihemo, Waikouaiti, Peninsula, Taieri, Bruce, Coutha, Tuapeka	168,385	16.6
Southland	Southland, Wallace	225,953	22.3
	Stewart Island and Chatham Is.	6,022	0.6
		<u>1,013,151</u>	<u>100.0</u>

Source: N.Z. Department of Statistics - Farm Production Statistics (in prep, adapted)

Traditionally, less fertile and steeper country has been used more for breeding or store-producing enterprises. More fertile and flatter areas have been mainly used for cattle fattening. Many counties and statistical regions include land of several different classes. However, although the variation

between counties in type of cattle farming is decreasing, some counties clearly have more breeding cattle, and others mainly fattening cattle. An indication of this is given by the ratio of beef cows used for breeding to total cattle. South Island counties with breeding cows accounting for over 40% of total beef cattle (breeding areas) and under 20% of total beef cattle (fattening areas) respectively are listed in Table 3.

TABLE 3	
Selected counties of South Island and their 1970 breeding cow/total-beef-cattle percentages. (All counties where this percentage is greater than 40% or less than 20% are included.)	
County	Beef Cows Used for Breeding as % Total Beef Cattle
(a) Breeding counties:	(>40%)
Cheviot	44.0
Mackenzie	40.5
Waihemo	40.5
(b) Fattening counties:	(<20%)
Rangiora	9.9
Eyre	11.36
Oxford	20.0
Waimairi	2.0
Ellesmere	18.31
Heathcote	15.1

Source: N.Z. Department of Statistics - Farm Production Statistics (in prep, adapted)

It is noteworthy that all counties where the proportion of breeding cows exceeds 40% are predominantly hill and high country in terrain and are characterised by the abundance of modified tussock grassland. All the fattening counties listed are on the Canterbury Plains wholly or largely. The Southland-South Otago basin also has important fattening areas, but here county boundaries do not coincide with topography changes.

Most beef cattle at present carried on South Island hill- and high-country farms can be described therefore as breeding and store cattle. Furthermore the present main outlet for surplus sale cattle from this general region is the store live-

stock market. Only aged and culled breeding stock are, in the main, sold direct from this region for slaughter.

Absolute numbers of beef cattle in the South Island hill- and high-country region cannot be deduced from County statistics. The N.Z. Meat and Wool Boards' Economic Service Sheep Farm Survey covers most South Island farms on which cattle are run. Sheep-farming regions of the South Island are divided into five categories, two of which roughly coincide with our loosely defined hill- and high-country region. These are their "1,2S - High Country" and "3S - Foothills" categories. In addition, their category "4Se - Fattening/Breeding" includes some easier hill-country properties which might qualify for inclusion in the hill-high-country region.

If the above survey's sample farms are taken as representative of the whole population, then average beef cattle numbers per farm multiplied by the estimated number of farms per category would give estimated beef cattle population per category. This calculation was done for beef cattle wintered in 1969 (see Table 4).

TABLE 4				
Estimates of South Island beef cattle population by sheep farm category as per N.Z. Meat and Wool Boards' Economic Service Classification				
Category	Av. total cattle wintered per sample farm 1969	Estimated no. of farms	Estimated total cattle	Est. % of total cattle on sheep farms
1,2S High Country	216	350	75,600	11.2
3S Foothills	199	1,000	199,000	29.4
4Se Fattening/Breeding	71	2,900	205,900	30.5
4Si Intensive fattening	33	4,700	155,100	23.0
5S Mixed crop/fattening	16	2,500	40,000	5.9
Total			<u>675,600</u>	<u>100.0</u>

Source: N.Z. Meat and Wool Boards' Economic Service, Publ. 1508 (adapted)

The Economic Service estimates that 15% of total beef cattle in New Zealand are carried on non-sheep farms. Survey figures are total cattle wintered and therefore do not include many of the previous season's slaughter stock which are in January figures. These two factors explain the discrepancy between estimated total cattle (Table 4) and the actual total cattle recorded by the Department of Statistics (Table 1). Taking into account the basis of classification of the Economic Service's categories, it appears that approximately 40-50% of South Island beef cattle are carried on hill- and high-country properties. Appendix A shows that for the high country, most cattle are found in the higher-rainfall areas, with the biggest herds on high-rainfall "gorge" runs.

Numbers of cattle as a proportion of total livestock are relatively low when compared to North Island hill country farms (Table 5). The average stocking rate of South Island hill- and high-country properties is also much lower than on North Island hill country. This reflects the differences in the physical environment. Increases in the significance of cattle on sample farms in South Island have been more marked in the first half of the last decade than on sample farms in North Island hill country (Table 5).



TABLE 5

Average total stock units (S.U.) and beef-cattle stock units carried per acre in 1958/59 and 1968/69 on four sheep farm categories.

Region		1958/59	1968/69	10-year change as % of 1958/ 59 figures	10-year change as % of av. of 1958/59 and 1968/69 x 0.1 = approx. annual change
1,2S (S.Is.High Country)	Total S.U./acre	.201	.247	+ 22.9	+ 2.1
	Cattle S.U./acre	.0129	.0261	+102.3	6.8
	% Cattle S.U.	6.4	10.57		
3S (S.Is. Foothills)	Total S.U./acre	.977	1.016	+ 4.0	+ 0.4
	Cattle S.U./acre	0.109	0.178	+63.3	+ 4.8
	% Cattle S.U.	11.2	17.52		
2N (N. Is. Hard Hill Country)	Total S.U./acre	1.928	2.455	+27.3	+ 1.6
	Cattle S.U./acre	0.772	0.777	+ 0.6	+ 0.07
	% Cattle S.U.	40.0	31.6		
3N (N.Is.Hill Country)	Total S.U./acre	2.961	3.383	+14.3	+ 1.3
	Cattle S.U./acre	.854	1.026	+19.6	+ 1.8
	% Cattle S.U.	28.8	30.2		

Source: N.Z. Meat and Wool Boards' Economic Service. Bull.12 (Keen & Gow) and publ. 1508 (adapted)

The smaller proportion of cattle in total livestock in the South Island hill and high country categories is reflected in the smaller proportion of gross income contributed by the beef cattle enterprise (Table 6).

Opposite - In the high country most cattle are found in the higher-rainfall areas, with the biggest herds on gorge runs. Upper Wilkin River on Mt Albert Station, with Mt Ragan in the background. Rainfall averages 110 inches per annum.

Photo: P. Gazzard

TABLE 6

Cattle income as a percentage of gross farm income in some sheep farm categories: 1958/59 and 1968/69

Class	Region	Cattle Income as % Gross Farm Income	
		1958/59	1968/69
1,2S	(S.Is. High Country)	6.1	7.8
3S	(S.Is. Foothills	6.3	16.2
2N	(N.Is. Hard Hill Country)	27.6	36.5
3N	(N.Is. Hill Country)	22.6	27.8

Source: N.Z. Meat and Wool Boards' Economic Service, Bull. 12 and Publ. 1508 (adapted)

Caution must be exercised in interpreting Table 6. Short-run price fluctuations can confuse the comparison of incomes between single years. Differences of a few percent may not be significant nor accurately represent longer-run trends.

1.2 BEEF CATTLE

1.21 THEORETICAL LIMITS ON THE RATE OF INCREASE

Under existing legislation which prevents the importation of livestock, increases in the national beef herd may be achieved only by:

- (a) Expansion of the beef breeding herd -
 - i. from existing beef breeding stock (retention of females for breeding purposes), and
 - ii. from surplus female dairy animals.
- (b) Expansion of the dairy herd, and consequently of the size of its by-product, surplus and culled animals for beef.
- (c) Increasing the average age of slaughter of beef animals.

Increases in beef cattle numbers in any one region of the country may be achieved by the above methods, and also by:

(d) Purchases from another region.

The possibilities of each of these methods, with particular reference to the South Island high/hill country region, are discussed briefly below.

Increases from existing beef breeding stock:

The potential rate of increase of breeding cow numbers by self-generation will depend on death rates, birth (calf survival) rates, the age at which heifers are first calved down, herd replacement rates, and the proportion of female animals born which are retained for breeding purposes. Indications are that average values for these critical parameters in South Island hill/high country at present would be approximately as follows:

Age at first calving	3 years
Breeding cow replacement rate (culls and deaths)	20% per year
Calving (survival to weaning)	80%
Death rate in young female replacement stock (weaner and yearling heifers)	3% per year
Proportion of females weaned which <u>could</u> be retained for breeding purposes	90%

Under these assumptions it can be shown mathematically that the maximum possible sustained rate of increase of the breeding herd by this method is 8.7% per year (see Appendix D)

Purchases of surplus females from the dairy herd for beef breeding purposes:

Recent work at Whatawhata (Hight, 1968c) shows that the Friesian may be as good as, if not better than, traditional beef breeds, as a purely beef breeding animal on hill country. This suggests the possibility that some open-minded farmers in this region may in the future purchase surplus dairy animals for beef-breeding purposes. This practice has not yet been adopted to any significant extent.

What potential for expansion exists here? Of the 330,000 beef breeding cows in the South Island let us assume that 200,000 are in the high- or hill-country region.

There are approximately 160,000 dairy cows in the South Island of which possibly more than 60% (M. G. Hollard, pers. comm.), say 100,000, are Friesians. The average replacement rate of the New Zealand dairy herds is about 17% per year. Female calves born per year, as a percentage of total cows, would be about 47%. Allowing for deaths in young replacement breeding stock, a slow expansion of the South Island dairy herd, and a proportion of these female calves being unsuitable for breeding purposes, it would appear that surplus female dairy calves per year would number about 20% of total dairy cows. This represents roughly 20,000 Friesians per year in the South Island. It is unrealistic to suggest that, even given the demand, these could all be channelled into the South Island high/hill country. Many surplus Friesian females are currently being used as replacements in previously non-Friesian dairy herds. Nevertheless, if 10,000 Friesian heifers per year could be added to hill country breeding herds, this would represent an annual increase of the order of 15% on present beef breeding cow numbers in this region. This suggests that the rate of increase of the beef breeding herd in the region could be nearly doubled if this source of breeding stock were tapped.

Purchases of breeding cattle from other regions:

In theory, it is unlikely that one region would increase its breeding cattle numbers to any appreciable degree at the expense of another. It is apparent that different regions have increased their beef cattle numbers at different rates in the past (see section 1.22). However, at no stage, in recent years at least, has a marked increase in one area been accompanied by a marked decrease in another area, and indications are that very little net transfer of mature breeding stock or female replacements occurs between regions.

Significant purchases of beef-breeding cattle by one region from another, apart from short-term shifts because of localised drought conditions, might only be expected if the relative profitability of beef cattle in one region rose well above that in another region. Under the existing free-market system, store prices tend to move with schedule prices so as to equate the general level of profitability of beef cattle between the breeding and fattening regions, which could continue as long as there is a reasonable price margin in favour of fine wools compared to coarse wools. While this situation exists there would appear to

be more incentive for crossbred wool producers to substitute cattle for sheep. The prices they offer may, in some cases, be sufficient for some fine wool producers to sell some of their breeding cattle. Any subsidisation, either directly or indirectly, of cattle in the high/hill country only, would tend to have the opposite effect, i.e. to stimulate net purchases of breeding cattle by high-hill country farmers from other regions.

It would appear that, from the point of view of the high/hill country as a whole, appreciable net inflows of breeding stock from other beef-breeding regions are unlikely.

Increases obtained by retaining surplus store stock to a greater average age of sale:

The three methods discussed above all pertained to increases in the beef-breeding herd, and assumed that there was both a fixed ratio of breeding stock to dry stock, and that dry-stock numbers would rise in the same proportions as breeding-cow numbers. However, if the proportions of dry stock should rise, then the factors limiting the rate of increase of beef-breeding cows may have a less limiting influence on increases in total beef numbers.

Dry store-stock numbers in the region may be lifted by net purchases, either from another beef-breeding region, or from the dairy herd, of animals to be raised primarily for meat. However, net purchases of such store stock by a basically store-producing region such as this seem very unlikely. Recent general rises in beef prices, together with changes in the structure of the beef export schedule in favour of leaner carcasses, have stimulated considerable interest in the raising of surplus dairy animals for beef at greater than "bobby" weights. Nevertheless, to date transfers of such animals away from dairy farms for these purposes have been mainly direct to fattening farms. It has been suggested that hill-country farmers with high milk-producing breeds (e.g. Friesians) could mother an extra dairy calf on to each breeding cow, so as to raise two weaners per breeding cow instead of one. At present, however, we know of few farmers doing this. There would be many practical difficulties involved in such a system, especially on the harder hill- and high-country properties. Consequently this must be regarded merely as a long term possibility. The purchase of reared and weaned dairy animals for later sale would probably prove profitable only for farmers on better class hill country who could grow such animals to slaughter condition. Furthermore, farmers in this region are less likely than those in others to be in close contact with potential sources of such animals.

An alternative way of increasing the proportion of dry cattle in the herd is by raising the average age at slaughter, or, in this case, at sale. Increases obtained by this method are not continuous. That is, the increases, though potentially large, will occur only for as long as the average age of slaughter is rising. In fact in recent years the trend has been for the average age at slaughter of prime animals, and age at sale by store breeders, to be younger rather than older. This has largely been due to a more positive market demand for younger leaner beef, particularly on our export markets. We expect that such trends may continue into the future. If they do, then this will tend to depress the potential rate of increase in beef cattle numbers in the region.

It could be suggested that the breeding-cow replacement rate is much higher than it need be, and that if breeding cows were culled later in their life, the replacement rate would be lowered, and more young females would be available for increasing herd numbers. However, while this could occur, a higher death rate and lower calving rate could be expected. While culling policies at present may be largely based on the age of the animal, in an older breeding herd the comparative profitability per unit of beef-breeding activity (at the present relatively high boner-beef prices) appears to slightly favour a policy of pregnancy diagnosis, followed by culling before winter of all cows not in calf. For this reason a decrease in the average herd replacement rate, or an increase in the average age of breeding cows slaughtered, is likely to be very slow in future years.

1.22 RATES OF INCREASE OF BEEF CATTLE NUMBERS IN RECENT YEARS

The average annual rates of increase of both total beef cattle and beef-breeding cows in the South Island have been considerably greater than in the whole country in recent years (see Table 7).

TABLE 7		
Average annual percentage increases 1959-69 in total beef cattle and beef cows used for breeding: South Island and New Zealand compared.		
	Average Annual % Increase 1959-69	
	South Island	New Zealand
Total beef cattle	5.9	4.7
Beef cows used for breeding	6.8	4.7

Source: N.Z. Department of Statistics - Annual Farm Production Statistics (adapted)

Rates of increase have varied over different regions of the South Island. Relative increases by statistical areas are shown in Table 8, and in selected counties with large areas of hill-high country in Table 9. Division of overall percentage increases by the number of years offers a rough method of estimating average annual percentage increases, but results in a certain over-estimation of the true figure, especially at higher rates of increase.

TABLE 8				
Ten-year increases (1960-70) in total beef cattle, and in beef cows used for breeding, for South Island statistical areas.				
	Increase from 1960-70 as % of average of 1960 and 1970 figures		1960-70 % increase x 1/10 = approx. annual % increase	
	All beef cattle %	Beef breeding cows %	All beef cattle %	Beef breeding cows %
Marlborough	65.5	66.6	6.6	6.7
Nelson	75.1	80.6	7.5	8.1
West Coast	60.0	66.7	6.0	6.7
Canterbury	68.8	73.1	6.9	7.3
Otago	85.8	90.9	8.6	9.1
Southland	75.8	69.9	7.6	7.0
South Island	74.0	76.6	7.4	7.7

TABLE 9		
Ten-year increases (1960-70) in total beef cattle for selected predominantly hill/high country counties.		
County	Total	Average
Amuri	67.7	6.8
Cheviot	79.5	7.9
Waipara	56.8	5.7
Mt Herbert)		
Akaroa)	60.9	6.1
Wairewa)		
*Mackenzie	79.0	7.9
Waikouaiti	98.2	9.8
Otago Peninsula	85.1	8.5
Bruce	82.9	8.3
Tuapeka	97.9	9.8
Maniototo	103.5	10.3
*Lake	98.4	9.8
Vincent	95.6	9.6
* Predominantly <u>high</u> -country counties		

Source: (for both) N.Z. Department of Statistics Annual Farm Production Statistics (adapted) and unpublished data.

It will be seen from Tables 8 and 9 that the rates of increase in hill/high country areas have been generally high in recent years, remembering the theoretical upper limit to the rate of increase possible by breeding from existing stock, discussed in the previous section. In the Otago area, particularly, rates of increase would appear to be close to the maximum level attainable by self-generation. Most females born in this period have apparently been put into the breeding herd.

In the South Island in general, rates of increase in hill/high country counties would appear to have been as high or higher than in the whole Island. The higher rate of increase in beef-breeding cows than in total cattle shown in all statistical areas, would also tend to indicate that proportionately more heifers have been put into the breeding herd in recent years.

Further evidence for the rates of beef cattle increases obtained in recent years in the South Island hill- and high-country region, comes from the Meat and Wool Boards' Economic

Service's survey data. Table 5 (Section 1.1) indicated that the proportionate increases in beef cattle stock units on sample farms in their high country and foothills categories, have been considerably more than the proportionate increases in total stock units carried on these properties. The increases in actual cattle numbers for the same farms over the ten-year period 1959/69 are shown in Table 10.

Table 10 indicates a rather lower rate of increase on hill- and high-country farms than appears to be suggested by the county statistics. Part of this discrepancy may arise from the Economic Service's sample being not fully representative of the whole farm population in this region in cattle numbers carried.

TABLE 10				
Beef-cattle-per-acre increases 1959-69 on farms in the Meat and Wool Boards' Economic Service Sheep Farm Survey categories "S.I. High Country" and "S.I. Foothills".				
Region	Beef cattle wintered per 1,000 acres		Increase 1959-69 as % of av. of 1959 and 1960 figures	Ten-year increase (%) x 1/10 = approx. annual % increase
	1959	1969	%	%
1,2S (S.I. High Country)	3.07	7.46	83.3	8.3
3S (S.I. Foothills)	29.63	51.60	54.0	5.4

Source: N.Z. Meat and Wool Boards' Economic Service Bull. No.12 and Publ. 1508.

Otago hill-country farms operating on Otago Catchment Board farm and run plans have shown a similar pattern of relative increases in beef cattle compared with total stock. Table 11 shows the unweighted average annual increases in beef cattle stock units (ewe equivalents) and total stock units from time of commencement with the farm plan up to 1968, and expressed as a percentage of 1968 levels. Farms which have been operating on a farm plan for less than two years have been excluded. Note that absolute rates of increase here are not directly comparable with those shown in previous tables, the base year being 1968 in this case, as opposed to the average of 1959/60 and 1968/69 in previous tables. Emphasis on increasing the proportion of cattle

appears to have been greater on sheep stations than on hill country farms.

TABLE 11

Average annual unweighted increases in beef cattle stock units and total stock units carried on Otago hill/high country farms which have been operating on Otago Catchment Board run plans for two years or more. (Increases expressed as % of 1968 levels.)

Farm Category	Av. % cattle S.U. increase /yr	Av. % total S.U. increase /yr	Av. cattle S.U. increase as % av. total S.U. increase
1. Extensive sheep stations (mainly wool production)	15.6	4.6	74
2. Wool & surplus-stock- producing sheep stations	13.2	5.0	37
3. Renewable farm lease areas (wool and surplus stock)	12.2	4.1	34
4. Predominantly fattening hill farms	6.3	5.2	24
Total (unweighted average)	11.8	4.7	39 (weighted)

Source: Calculated from data provided by A. J. Warrington (pers. comm.)

1.3 SUMMARY

(a) Roughly 20% of New Zealand's beef cattle are in the South Island, and roughly one-half of these (10% of New Zealand's total) in the South Island hill/high country region, dominated by tussock grasslands.

(2) This region is primarily a breeding and store-stock producing one as far as beef cattle are concerned.

(3) Beef cattle in this region constitute a much lower proportion of total stock units carried and of total farm gross income than they do in North Island hill-country areas. Never-

theless, in recent years rates of increase in beef cattle in the South Island high/hill country have well exceeded rates of increase in total stock carried, so that cattle have assumed a growing relative importance to the farmer. The same trend is not evident in the corresponding North Island area, where, if anything, the beef cattle/sheep ratio has tended to decline.

(4) Increases in beef-cattle numbers in the South Island hill/high country are likely to be achieved mainly by self-generation of existing breeding herds. Significant net buying, by this region, of breeding stock from other regions or of surplus dairy animals for beef-growing purposes appears unlikely in the near future.

(5) The maximum sustained rate of increase obtainable by self-generation in this region would appear to be about 8-9% per year. Since farmers as a body are unlikely to exploit all the possibilities for increase, a maximum upper limit, depending on the strength of the incentive, may be about 6-7% sustained rate of increase. This rate will be less for all cattle (c.f. breeding cows) if the average age of sale of surplus store stock continues to fall slowly. Purchases of surplus female Friesians from town-supply dairy farms for breeding purposes, offers an opportunity for this rate of increase to be augmented by up to, say, another 5% per year. However, it can be expected that such a new practice would be adopted only slowly.

(6) A reasonable conclusion would appear to be that beef numbers in the region cannot be expected to grow at an average rate of increase of greater than 8-10% per year in the next 5-10 years, without direct encouragement and aid from outside.

(7) In recent years (i.e. over the present decade) in the South Island hill/high country region, expansion of beef cattle numbers, and particularly beef breeding cows, has been at a much faster rate than expansion in sheep numbers.

(8) Nevertheless absolute increases in total stock units carried over this period have been largely contributed by sheep, due to the fact that beef cattle at present make up only a small proportion of total stock carried in this region.

(9) The recent past rates of increase of breeding cattle in the region would appear to have been near the maximum attainable without transfers of breeding stock from other regions.

CHAPTER 2

MARKET PROSPECTS

2.1 PRESENT DISPOSAL OF SOUTH ISLAND OUTPUT

On the basis of 1969 beef and dairy cattle populations, and assuming similar slaughter rates between the two islands, it seems that approximately 16% of New Zealand's beef production is in the South Island at present.

Approximately 64% of total production of beef and veal is exported and 36% is consumed locally (N.Z. Meat and Wool Boards' Economic Service Annual Review of the Sheep Industry 1969/70, p 116).

Approximately 29% of New Zealand's population is in the South Island (N.Z. Official Year Book, 1970).

Assuming that there is negligible net transfer of meat between islands and that consumption of beef and veal per head is similar in both islands, then the proportion of New Zealand's total beef and veal production consumed in the South Island is $0.29 \times 36 =$ about 10%.

Therefore roughly 10/16 or 63% of South Island beef production is at present consumed on the local market, and 37% exported.

Of the South Island total cattle kill roughly 46% (by numbers) is slaughtered in abattoirs and 54% in meat export works (Williyams, Sth Is. Freezing Co. Assn, pers. comm.). However, much of the freezing works kill is also for the local trade.

2.2 RECENT PAST, AND PROBABLE FUTURE GROWTH OF THE LOCAL BEEF MARKET

According to the New Zealand Meat and Wool Boards' Economic Service Annual Review of the Sheep Industry for 1959/60 and 1969/70, this country's consumption of beef and veal rose from 102.4 thousand tons (bone-in basis) in 1958/59 to 132.4 thousand tons in 1968/69. This is an increase of 29.39% over the 1958/59 figure in 10 years, or a growth of just over 2% compound per year.

Over the same period, again according to the Year Book, the average annual population growth was about 2% per year.

Consumption per head has been increasing. The figures of consumption of beef and veal per head of population bear this out. (N.Z. Meat and Wool Boards' Economic Service Annual Review of the Sheep Industry 1959/60 and 1969/70).

1958/59	99 lbs per head
1968/69	107 lbs per head

It appears therefore that although beef prices rose relative to mutton in recent years, consumption per head in this country has increased with increases in income per head.

In the South Island, population growth has been slower than for New Zealand as a whole, rising from 1961 to 1969 by only 10.8%, or roughly 1.4% per year (N.Z. Official Year Book 1970). It therefore seems reasonable to assume that South Island consumption of beef and veal has grown more slowly than that for the rest of New Zealand in recent years.

If it be assumed that recent trends continue, then to satisfy increases in local consumption with no change in the quantity exported, an increase over present South Island production of about 2% per year will be needed. Beef production increases above this figure would have to be exported.

If increases in average annual beef production follow increases in beef cattle numbers, then it would appear that increases of about 8% per year on average could be reasonably expected in coming years. In fact, much beef production is derived from the dairy herd, which may not grow at the same rate. However, the growing of more dairy beef animals to greater-than-bobby weights would result in an increase in the average beef slaughter weight overall, and a rise in beef production greater than the rise in beef cattle numbers and numbers slaughtered.

While it is very difficult to estimate what the future rate of increase of South Island beef production will be, it is evident that increases are likely to be well above the absolute increases in local consumption. Therefore it may be concluded that most increases in South Island beef production will be exported.

2.3 BEEF EXPORT PROSPECTS

A shallow analysis of the world beef situation would indicate that future prospects are good for beef exporting countries.

The F.A.O. World Commodity Review (1967) indicates that New Zealand beef production is only about 1% of total world production. The same source says that 5-7% of world production is traded annually between countries. "The Beef Situation" (Australian Bureau of Ag. Economics, 1968, Table 14) indicates that in recent years New Zealand has had about 10% of this trade. It may be argued that because of this country's small share of the world market, variations in the rate of increase of New Zealand's exports will have little effect on world beef prices unless the world market price elasticity of demand for beef tends towards zero. In fact estimates of this elasticity in various importing countries have varied, but have all been closer to 1.0 (where, say, 1% price rise causes 1% demand fall) than to zero.

F.A.O. (1966) has also projected future trends in world beef consumption and production, taking into consideration past trends and likely future trends in production, income per head growth, population growth, dairy industry changes, legislative trade restrictions, and so on, country by country. They predict a world beef deficiency of 200 to 300 thousand tons in 1975 (excess of demand over supply), and conclude that for world supply and demand to be reconciled, world prices must rise. As a proportion of beef traded, 200-300 thousand tons represents roughly 10% of projected world trade in 1975.

Thus, looking at beef in very broad terms, future export prospects appear good, with rising world prices and New Zealand not having to worry about increases in her beef exports significantly depressing world prices. This would probably be completely true if world trade was unrestricted, and if "beef" was just a single homogeneous product. But in fact neither of these conditions hold.

There seems little evidence to suggest that the future problem will be one of finding market outlets which could take increased beef exports, despite statements to the contrary which are sometimes heard. In spite of quantitative restrictions on many markets, many other unrestricted markets, which will expand in size as price falls, are still available to New Zealand. The problem is better expressed not as "what quantity of beef can be sold in total to export?", but rather as "what average price can be obtained for any given quantity of beef exported?"

In the F.A.O. 1966 projections quoted above, by far the largest increases in imports of beef over present levels were estimated for western European countries, both inside and outside the E.E.C. The projected increase of North American imports was relatively small (though recent developments may put this prediction in question). Much of the import demand in Europe will be for frozen processing quality beef, as it is in the U.S.A. at present. For instance in the Supplement to the Official E.E.C. Bulletin (No. 4, 1966) appears the following comment:

"In view of the constant need of processing industries for lean meat, commercial imports of frozen veal and beef are in the years to come likely to reach at least 100,000 to 220,000 metric tons per annum."

This is probably a conservative estimate as frozen beef and veal imports by the E.E.C. in 1964 and 1965 were 240,000 tons and 207,000 tons respectively. Recently New Zealand has lost her relatively small share of the E.E.C. trade*. This is probably a direct result of price increases in the two main markets of U.S.A. and U.K., which put them in a more attractive position to exporters than the tariff-protected (20% tariff) E.E.C. market. If future import licences within the E.E.C. for frozen beef were to be allocated to produce from exporting countries on the basis of recent past share of the E.E.C. market, then the recent loss of trade with E.E.C. could have serious consequences.

It is apparent that wholesalers in many countries would import more beef now at world prices if trade barriers were removed (e.g. E.E.C., Japan). While such barriers continue to exist the problem of access of New Zealand beef to these high-price markets is a political one. It is in New Zealand's interests that world trade barriers on agricultural products be reduced.

Other trends which appear to be working in New Zealand's favour, at least in U.S.A., Europe, and Japan, are:

(a) A greater acceptance of frozen meat at the retail level, which is probably due largely to its ease of handling, and to the rise of the supermarket as a retail outlet.

(b) A greater demand for "convenience" foods, and hence processed meat forms (New Zealand's beef exports are largely of processing quality at present).

* See, for instance, - Great Britain: Commonwealth Secretariat Commodities Division; Meat and Dairy Produce Bulletin May 1968, pp 49, 50, 51.

(c) A demand for higher standards of hygiene at slaughter, and for disease-free sources. In this respect New Zealand has a major advantage over her South American competitors on the world beef market in particular.

The outlook for processing-quality meat in the future appears to be good. In recent seasons large increases in the export of manufacturing beef to the U.S.A.* have had little or no depressive effect on prices, although fears that a U.S. quota may be invoked have led to a self-imposed quota by Australia and New Zealand at the present time. Representatives of the meat-exporting companies have varying views on the future potential expansion, at least to New Zealand exporters, of the U.S. manufacturing beef market. Because recent production increases are likely to be well above the annual average rates of increase which can be expected in future years from this country, and were achieved with little effect on the U.S. market price, we are inclined to be optimistic.

What may be a more critical question with respect to exports is whether New Zealand can continue to achieve a premium above manufacturing or "boner" beef prices for her better-quality prime cuts and quarter beef. At present most of her prime beef production is consumed locally. In future, expansion of beef production at up to 10% per year on average, will result in most increases being exported. This, in turn, will mean a much greater proportionate increase in the quantity of prime beef exports, than in the quantity of "boner" beef exports, particularly if the expansion of the dairy herd is only slow by comparison. The marketing of such prime beef export increases may well pose more of a problem than that of boner export increases. In recent years a programme of increased cutting of prime beef, with consequent product differentiation, has allowed the exploitation of many specialised markets overseas. Many of these markets are small, and their foreseeable expansion only slow.

Large increases in the export of prime beef in future years will probably be mainly as cuts. This may necessitate the development of new markets for such better-quality beef, or the acceptance of lower premiums for prime beef over manufacturing-quality beef.

* See "Meat" (publication of Market Inf. Service of N.Z. Meat Producers Board) No. 163, Sept. 30, 1968. From the figures quoted it would appear that in the period January-August, New Zealand beef and veal exports to the U.S. mainland were that year 14% higher than for the same period the previous year. In subsequent months increases may have been higher.

It has been argued that most of the future increases in South Island beef production must go to export. It may reasonably be expected, therefore, that if beef cattle increases in the South Island continue at about 5-10% per year, then beef exports from the South Island may grow at an average rate of 25% per year in the next few years. As, at present, only about 6% of total New Zealand beef exports come from the South Island, this will not represent a large increase in New Zealand's total beef exports. However, if North Island beef production were to increase at 5-7% per year, then North Island beef exports might be expected to rise at about 7-9% per year. The average rate of increase of New Zealand's total beef exports could therefore well be in the range of 8-12% per year on average in coming years.

When all things are taken into account, it appears to us that the present level of the beef export price schedule can be expected to be maintained, if not increased gradually, in the future. Also, there appears to be no good reason to believe that boner beef prices are relatively too high at present, i.e. that the premium for prime beef is too low. If anything this premium may tend to decline in the future with more world demand for both leaner meat, and processed meats. However, there is no sign in the beef export schedule for 1970/71 of such a relative decline for prime beef yet.

The importance of this discussion of export price prospects is based on the assumption that local beef price depends on prices received for exports. In the South Island, local butchers must offer farmers at least the export schedule value of their animals to buy them. A graphical comparison of export schedule price movements with weighted retail and wholesale New Zealand beef price series (from Yandle, 1968, pp 172, 173) would seem to indicate that local prices have tended to follow export prices in past years. Similarly store beef prices can be said to mainly follow the export beef schedule in the long run.

2.4 FREEZING WORKS BEEF-HANDLING CAPACITIES

As has been indicated (Section 2.1), approximately 54% of the annual South Island cattle slaughter at present takes place in the meat-export freezing works, including much beef which later is consumed locally. It appears unlikely that local abattoir facilities will be increased, in general, at a greater rate than the growth of local demand. Consequently it may be concluded that the bulk of projected beef production increases will have to be handled by the export freezing works. A rise of 10% in beef

production per year will presumably mean an increase of nearly 20% in meat-export freezing works' kill for the next few years, if they are to absorb all or most of the increase.

It is conceivable that rapidly rising beef cattle numbers in future years could result in available killing space being inadequate, at least at certain times of the year. This prospect has caused a certain amount of concern about the desirable rate of beef cattle increase. Such a situation would greatly decrease the economic attractiveness of the beef enterprise to the farmer, and greatly increase its uncertainty. South Island hill/high country farmers would be affected by such difficulties both directly, in attempting to dispose of their old cull cows, and indirectly, through a consequent depressive effect on the store market. Everitt, G. C. (1969, pers. comm.) claims that present slaughter outlet limitations in the North Island are an active deterrent to producers in increasing beef production.

Some freezing company representatives were approached on this particular problem. Mr M. B. Willyams, Secretary of the South Island Freezing Coys Assn, provided a summary of the present and planned beef handling capacities in each South Island freezing works. In general, taking into account:

- (1) existing excess capacities in some freezing works,
- (2) expansions of beef houses in progress, and
- (3) expansions being planned for the near future,

it appears that available capacities for handling cattle slaughter and processing will be sufficient to cope with the maximum average rate of increase of beef cattle offered for slaughter in coming years. Since increases of the kill in any one year may be well above the maximum sustainable or average rate of increase, then it appears desirable to plan for some excess capacity, over and above expected average increases.

In certain areas, particularly Nelson and Marlborough, there appears to be very little choice of outlet for most farmers. In such areas a short-term bottleneck at the freezing works concerned will have more serious consequences than in those areas where supply can be relatively easily diverted to another freezing works which has excess capacity at the time. Here it is in the farmers' interests more than in other areas that provision should be made to keep freezing works' beef handling capacities ahead of supply increases.

Any one of several main factors may, at any one time, cause a freezing works to be unable to slaughter all stock offering. These fall into three main categories:

(1) Labour union quotas - These quotas are set by the relevant union for each works on a maximum-per-day basis. Their object is to ensure that the total annual kill of the works is spread over a reasonable length of season, so that the period of employment is acceptably long. Such a spread of the killing season is also in the companies' interests from the point of view of efficient use of their overhead capital investment in plant.

It appears to be the unions' attitude to allow the quota to rise in proportion to the supply as long as the length of the killing season is not shortened. Unfortunately short-term problems may occur due to the unions being unwilling to increase quotas until concrete evidence is available that the general, all-year-round level of supply has risen. This would result in a time lag between supply rising and quota rising, during which time some offered animals may have to be refused.

This limitation, therefore, in any one freezing works, is unlikely to continue at any time for longer than one full season, and probably less. It is possible that better systems of negotiation and payment will in future largely remove such difficulties.

(2) Limitations in plant capacity - such limitations may occur in the space or capacity for slaughtering, cutting, chilling and/or freezing. In the recent past many works have been rectifying inadequacies in cutting and chilling facilities brought about by the trend towards greater and greater boning-out of beef, rather than exporting it as quarters. By and large it appears that freezing works are now getting to a stage of again having balanced proportions of each of the above facilities, and that future capacity increases will necessitate expansion in all directions.

Concern has been expressed at the length of time involved in setting up new plant. Such concern assumes that freezing companies will not act to expand until existing facilities are actually being used to the limit, and also assumes that if and when the latter situation does arise then the companies will be prepared to expand.

The latter assumption above appears to be correct - i.e. that in general the companies are prepared to expand their beef facilities, given reasonable evidence that farmers are increasing cattle numbers. As a body they can ensure that the slaughter charges which they set are sufficient to cover expenses, by relating schedule price paid to market prices received. The slaughter and processing margin can thus be

kept independent of market price.

If farmers are increasing beef cattle numbers, they must slaughter them at some stage. If in future there is better planning, and more precise fore-knowledge of later seasons' offering for slaughter, then the former assumption above may not be true, in that capacity increases may take place before a bottleneck occurs. However, past experience has been contrary to this, and hence the time taken to rectify plant capacity shortage is a cause for concern.

In some cases expansion of capacity will be able to be carried out by the freezing work's own permanent engineering staff in the off-season, so that restrictions are only short-term in nature. When major new construction is involved, rather than relatively minor modification of existing plant, then the restriction will be of longer duration and more serious. Chilling space shortages may occur more often and fall into the former category of being more easily rectified than, say slaughter capacity. However, it seems that the situation is different for every particular works, and generalisations cannot be made about the ease or speed of rectification of the various types of plant capacity shortages.

The available evidence indicates that the freezing works as a whole are planning for large increases in beef throughput. The 1969 capacities of all South Island freezing works in total, with minor modifications in one or two cases, were, on the basis of data provided by Mr Williams, about 25% above 1968 peak daily killings. Projected increases over the next five years, in many cases already well on the way to completion, would allow a peak kill of nearly double the 1968 kill by 1973-74. It is possible, though unlikely, that this degree of expansion in slaughter offerings of cattle to the meat export works will take place in this time.

(3) Changes in hygiene requirements - such changes bring the necessity for re-design, and, until the required modifications can be made, will act to constrain the numbers of beef animals which can be accepted for slaughter.

Overall, the position with respect to the beef handling capacities of freezing works would appear to be satisfactory. In individual areas, particularly those served primarily by only one freezing works, some problems may be expected from time to time.

2.5 SUMMARY

(1) Increases in South Island beef production will mainly have to be channelled to export.

(2) A relatively low proportion of South Island beef production is at present exported.

(3) There appears to be evidence that local market price is related to export price schedule level.

(4) The profitability of the beef enterprise to a South Island high/hill country farmer will depend largely on the level of the beef export price schedule, both directly through his sales of cull cows, and indirectly through its major influence on the store stock market.

(5) The present beef schedule price level does not appear to be unjustifiably high, taking world trends into consideration, and could reasonably be expected to be maintained or even increased gradually in the long run.

(6) The present relative levels of prime beef and boner beef prices within the schedule similarly do not appear to unduly favour boner beef. However, the present premium in favour of top-quality beef may be eroded somewhat in the future.

(7) Freezing-works beef-handling capacities, both existing and planned, appear to be sufficient to cope with likely levels of increased beef numbers to be offered for slaughter in the next five years.

CHAPTER 3

BEEF CATTLE AND THEIR ENVIRONMENT

3.1 TOPOGRAPHY

Nearly three-quarters of the South Island is classed as steep-land. The proportion of steep-land can be even higher within the high country region itself as illustrated from the Upper Waimakariri:

	<u>South Island</u> (Long, 1966)	<u>Upper Waimakariri</u> (Hayward, 1967)
Steep-land	70 %	83 %
Rolling land	11 %	10 %
Flat land	19 %	7 %

This table shows the importance of considering whether cattle graze steep-land effectively.

3.11 GRAZING SITE PREFERENCE

Chisholm (1968) suggests that cattle will climb to over 6,000 ft and graze almost anywhere on Molesworth. Some run-holders on similar country confirm this observation, particularly when their cattle have been bred on the property for some years and are encouraged to spread their grazing.

But other owners complain that cattle will not leave the river flats or fans; or that they hang around the gate where they entered the block. This seems to be especially true of cows and calves, even more so if they have not been bred on the country they graze. Some owners regularly return their cattle to grazing areas distant from these favoured spots. Others give up after two or three attempts. But persistence seems to work. In time cattle get to know the country and are happy to live out on their blocks; often to follow the seasonal growth as it progressively attracts them to higher and higher altitudes. Perhaps, as Stoddart (1960) suggests, cattle tend to climb to less accessible areas only when they have grazed out the easier country. Certainly Hight (1966b) found that cattle at a high stocking rate on a lower level of nutrition, were more adventurous than well-fed beasts.

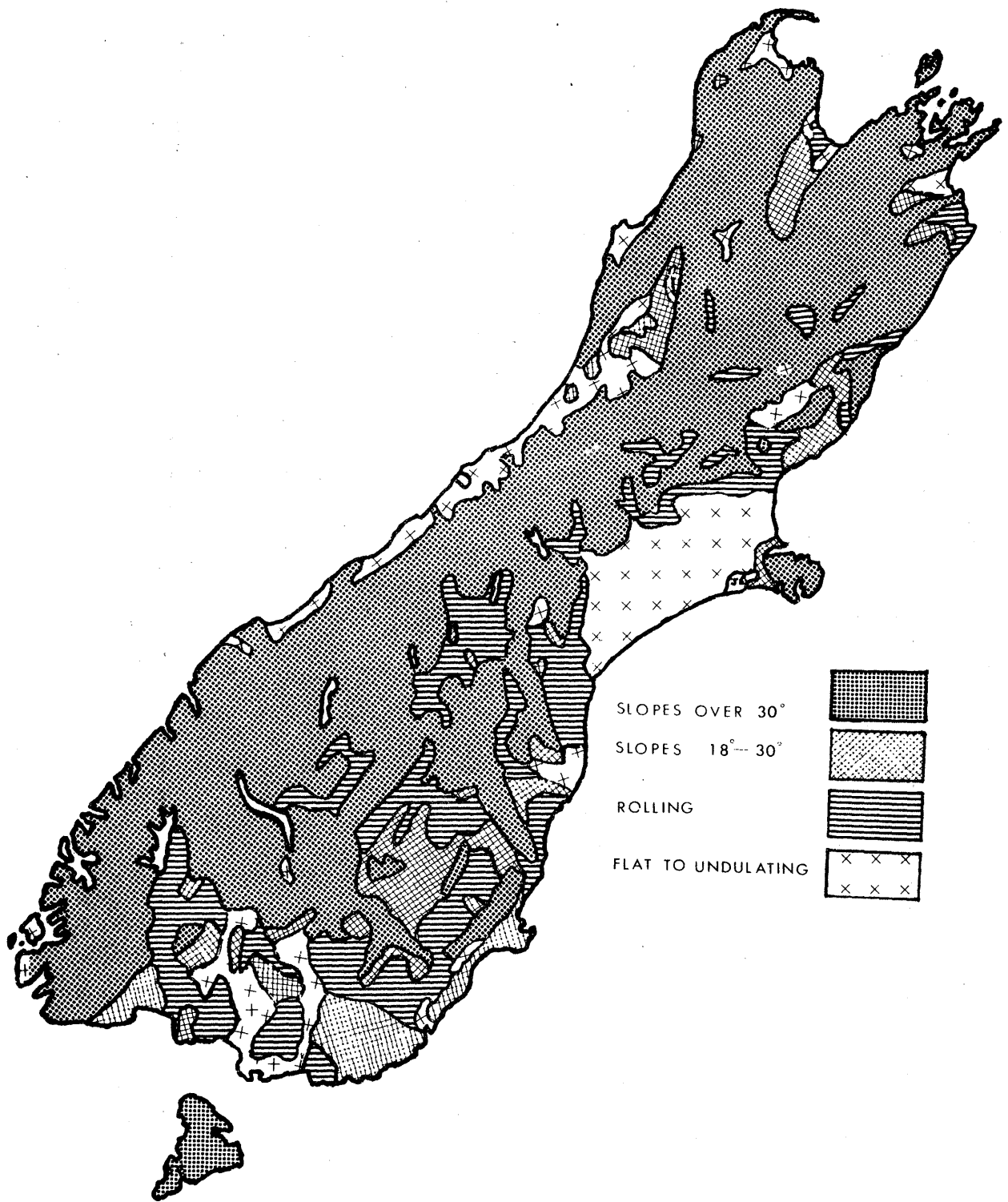


Fig. 1
Land slope classes in the South Island
(after Pohlen 1967)



Upper - Cows and calves on Wilkin Point, Mt Albert Station, Wanaka. After weaning, the cows are wintered on the higher country where they graze to 4,000ft-4,500ft. Salt is put out to attract them to selected wintering blocks.
Lower - Crossing the Wilkin River.

Photos: J. E. N. Quaife.

Relief is a factor, however. The low hills common in the North Island, perhaps 500 ft from valley floor to ridge top, confine cattle less than the often-2,000-ft-high faces of the South Island back country.

However, quality of grazing is probably more important than steepness of slope to the wandering beast. Cattle will quite happily poke their way into rough, broken and bluffy country searching for succulent grass, although they seem to prefer to graze out from some nearby resting site.

Johnstone-Wallace and Kennedy (1944) showed that cattle on good pasture may spend 12 hours out of 24 lying down and both Peterson and Woolfolk (1955) and Reppert (1960) recorded only slightly shorter periods of rest when the cattle were grazing much poorer quality rangeland forage. This may explain why large plain steep faces tend to be unpopular with cattle but smaller faces, which are dimpled or handy to natural benches where they can rest, are more likely to be grazed, particularly if water is not far away.

Although cattle prefer easy slopes to steep ones, sheep on the other hand seem to find the steeper country more to their liking. This is especially true of Merinos. Other less adventurous breeds appear to lack their compelling urge to climb to the top of the hill. Whatever the reason for this, sheep are accepted as more willing grazers of steep country than cattle. But every year the tally of deaths and broken limbs suffered by cattle falling off narrow, perhaps icy, tracks or over bluffs (particularly on the steep rock country at the heads of the southern lakes) show that cattle traverse and probably utilise the forage of such terrain. Unfortunately, too, it is such steep dangerous country which clears first from snow in winter. In colder months cattle show a similar preference for sunny slopes to sheep but common opinion is that this preference is more clearly shown by sheep than by cattle at other times of the year.

3.12 FACTORS AFFECTING STEEPLAND USE

Mueggler (1965) suggested that the use of mountain slopes depended on their steepness and the distance from water. Cook (1966) agreed but added other factors such as the percentage of palatable plants on the site and the thickness of the scrub around it. Although he found that use decreased as slope angle increased, he decided that none of the factors was on its own a

reliable guide to how much use cattle would make of rough ground. He concluded that animal psychology was probably very important, with young stock tending to be more adventurous.

In a study with Hereford cattle in North America lasting several years, Hickey and Garcia (1964) found that younger cattle, especially yearling heifers, grazed rough country more evenly than older cattle. They observed that their yearling steers seemed to find the rocky faces something of a challenge.

However, New Zealand experience does not confirm that young stock graze more widely than old. Here mature cows bred on the country seem to be the most wide-ranging class of cattle, especially once their calves have been weaned. The American experiment may not have been a true age comparison in that the older cattle were cows with calves at foot and would tend to stay closer to water.

3.2 CLIMATE

3.21 ADAPTATION

Climate affects an animal's productivity by its influence on the vegetation and on the animal's physiology. Some animals are better able to cope with, or adapt to climate stress than others. Both management and physiological factors may determine how much an animal is able to adapt to the environment. Dowling (1965), however, does not consider any one factor to be of singular importance. There are also variations in the adaptive ability between breeds (Rollins, Carroll and Ittner, 1964).

3.22 THE EFFECT OF HEAT AND HUMIDITY

Regional Data

The highest temperature recorded in New Zealand is 38.3°C at Ashburton. Although 32.2°C temperatures have been recorded at almost all meteorological stations east of the Main Divide, these are likely to occur on only one day a year (De Lisle and Brown, 1967). Longer-term average rather than extreme temperatures are likely to affect the performance of cattle.

The mean daily maximum temperature at Cromwell in January is 24.4°C and the 24-hour mean for the same month is 17.8°C . These are the highest figures for the South Island but those of several North Island areas are higher. For instance, Kawerau has a mean daily maximum temperature of 25.6°C in January (19.4°C daily average) and Auckland a mean daily average of 20.6°C in February.



Cattle can tolerate cold better than heat. Those with access to shade during periods of high temperature or humidity are likely to have a better productive performance than those suffering heat stress.

Photos: Upper - J. E. N. Quaife, Lower - G.A.Dunbar

Effect on Production

These New Zealand figures must be compared to the results of overseas research on the effect of temperature on cattle.

Hafez (1967) and Guilbert and Hart (1951) (quoted by American Society of Agricultural Engineers, 1967) state that the growth of European breeds of cattle is depressed when temperatures above 24° are maintained constantly (at a steady 29° - 32° C it ceases entirely). Milk yield is also responsive to temperature. Hafez (op. cit) reports that in cattle the yield is scarcely affected by temperatures between 4° - 21° C but beyond these limits it decreases slowly as temperatures get colder at one end of the scale or hotter at the other. The rate of decrease is more noticeable at high humidities.

There is a breed difference in milk production response to heat. According to Yeck and Stewart (1959), as temperatures rose above 21° C, Friesian milk production was the first to decline, then Jersey, then Brahman.

Bianca (1959a, 1959b, 1966) has shown that although cattle can gradually adapt to heat by reducing their metabolic rate and increasing their respiratory rate, their tolerance is less if they are deprived of water. Adaptation to humid heat is poorer than to dry heat. Dukes (1955) notes that calves do not tolerate heat as well as cows.

From the above results we can conclude that even in the warmest months daily average temperature figures in the hill and high country are unlikely to be high enough to have a significant effect on cattle production. Furthermore mean temperatures drop about 1.6° C with each 1,000ft rise in altitude (Kidson, 1931) and even more rapidly at high altitudes in Otago (Mark, 1965a).

Shade

Experiments to show whether providing shade increases the rate of growth of beef cattle have given conflicting results. Some scientists report significant increases with shade in both arid climates (Ittner and Kelly, 1951) and hot humid climates (McDaniel and Roark, 1956). Others seem to find no advantage at all (McCormick, Givens and Southwell, 1963), at least in a humid climate.

An animal standing in the open is exposed to radiant heat from the sun whereas the beast in the shade endures only the

heat of the air about it. Therefore if shade helps an animal to keep a comfortable body temperature, it seems logical that its productive performance should be better than one which suffers heat stress.

3.23 THE EFFECT OF COLD

Regional Data

The lowest temperature recorded at an official station in New Zealand is -19.7°C at Ophir.

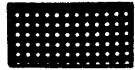
Mean temperatures at sea level decrease from 15°C in the northern North Island to 9.4°C in the south, and as we have noted, there is also a decrease in temperature with increasing altitude. Furthermore, inland average winter temperatures are lower than coastal ones. The mean temperature at Alexandra in July is 2.2°C and at Molesworth 1.7°C . These are two of the coldest recording sites in New Zealand.

Cold Tolerance

Although Barton (1968b) suggests that cattle can adapt to cold after a period of adjustment, Joyce (1968) has pointed out that cold stress can cause an insidious drain on production even if it does not cause death.

Table 12 lists the critical temperature of animals at different levels of feeding. Critical temperature is the temperature below which an animal must produce more than normal body heat. Until this temperature is reached, protective reactions such as raising the coat hairs to entrap air can maintain body temperature. But below this, heat production must increase regardless of food supply if the animal is to survive.

TABLE 12		
Critical temperatures in still air (from Joyce, 1968)		
	Maintenance Feed	Full Feed
(Fully fleeced sheep)	(-6.1°C)	(-4.4°C)
Short-coated steer	10°C	-9°C
Fully-coated steer	-10°C	-20°C
3 day calf 1 gal. milk/day		12.8°C
20 day calf $1\frac{1}{2}$ gal. milk/day		7.8°C



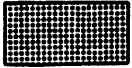
M

High rainfall; mountain climate



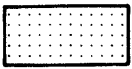
E

Mild temperatures, high rainfall increasing rapidly inland with height; minimum rainfall in winter especially in the South. Prevailing winds S.W. but gales not frequent at low levels in spite of exposed coastline.



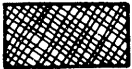
F₂

Cooler and wetter hill climates; rainfall 30"-60". N.W. winds prevail with occasional very strong gales, especially along river courses. Snow may lie for weeks in winter.



F₀

Semi arid areas; rainfall 13"-20". Very warm dry summers; cold winters



G

Warm summers, cool winters. Rainfall 25"-35", evenly distributed except for slight falling off in winter.



G₂

Wetter and slightly cooler than G climate; rainfall 35"-50"; in coastal districts cloudy windy conditions and frequent showers.



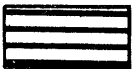
F

Low rainfall; 23"-30"; in the south slightly more in summer than in other seasons. Warm summers with occasional hot Foehn north-westerlies giving temperatures above 32°C. Cool winters with frequent frosts and occasional light snowfalls. Prevailing winds N.E. near the coast; N.W. inland.



B

Sunny rather sheltered areas which receive rains of very high intensity at times from N.E. and N. Very warm summers and mild winters. Annual rainfall 40"-60" with winter maximum.



D₂

Wetter than type D; rainfall 50"-80".



C₀

Drier than type C; rainfall 25"-35". Very sunny.



C

Very warm summers; day temperatures occasionally rise above 32°C with dry Foehn N.W. wind blowing. Rainfall 40"-60" per annum; marked decrease in amount and reliability of rain in spring and summer; moderate winter temperatures with maximum rainfall in this season.

NOTE:

SUFFIX O : DRIER
2 : WETTER

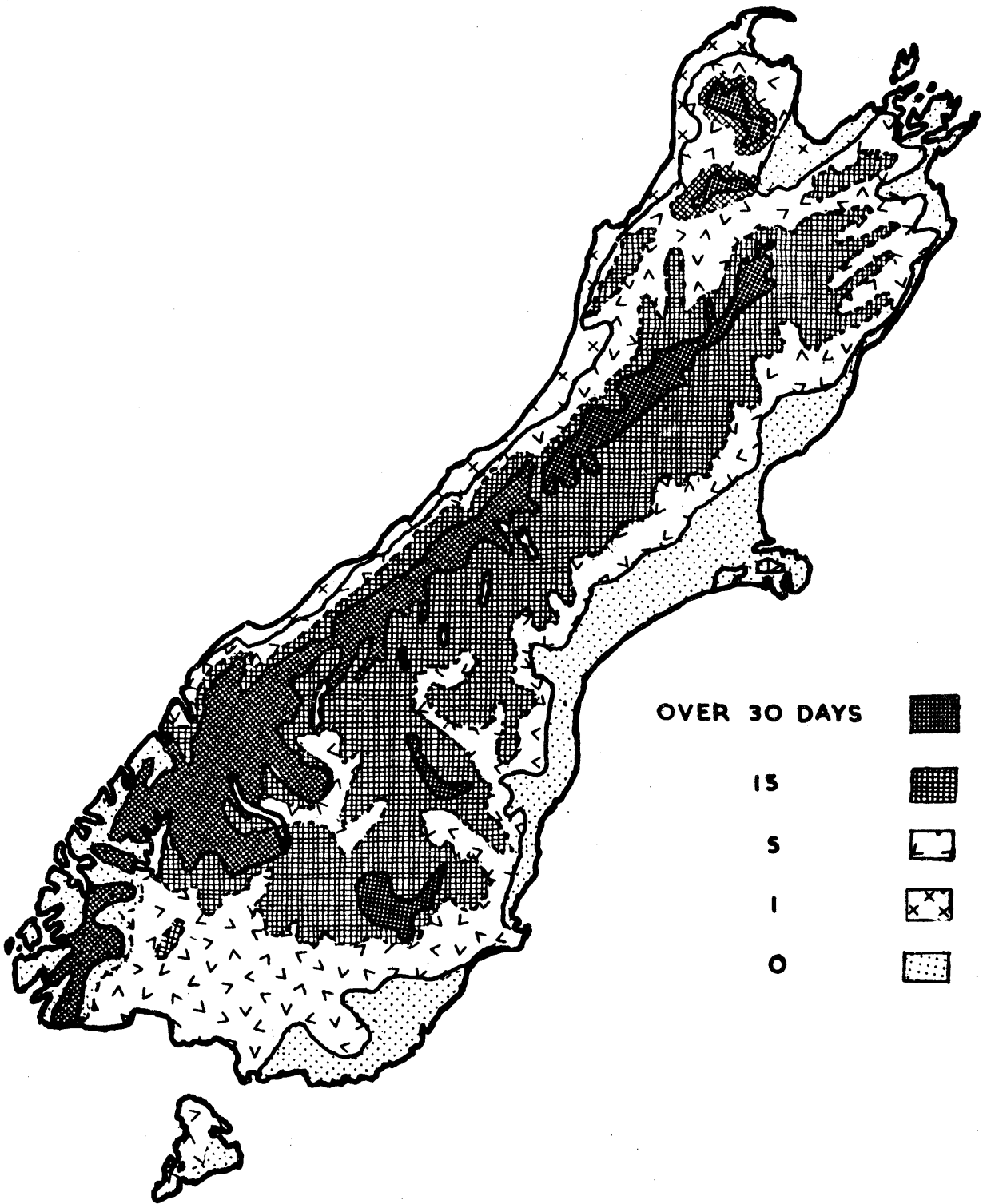


Fig. 3
Frequency of snowfall in the South Island
(after Kidson 1950)

Table 12 clearly shows that full-fed animals can stand more cold than animals fed only a maintenance diet. At low temperatures extra food is needed by animals to cope with the cold conditions (Winchester, 1964). This was demonstrated by Blaxter and Wainman (1961) who found that an 1100 lb steer gaining at the rate of 1 lb a day needed an extra 6 lb oats per day to maintain this rate when the temperature fell only two degrees from its critical temperature of 3.3°C.

Hafez (1967) states that the growth of well-fed cattle with dry hair and hide is not reduced until temperatures well below freezing point are reached. In fact the American Society of Agricultural Engineers (1967) reports that most studies show that beef cattle fatten well in a cold environment, high temperatures being more harmful than cold.

Breed Differences

Different breeds of cattle, even within the European breeds, have different tolerance to cold.

For instance, on a Westland dairy farm Clark (1967) changed from Jerseys to Friesians when he found that the latter were less affected by bad weather. On one occasion, of 30 calves he lost in a storm, 29 were Jerseys and one was Friesian. He noted that on a rough day Friesians would be out grazing while Jerseys huddled in a corner.

Yeck and Stewart (1959) found that the milk production of Jersey cows dropped sharply below 1.7°C but Friesians remained unaffected even at -12°C.

Shelter

Table 12 suggests that in New Zealand hill and high country, well-fed cattle are unlikely to need shelter. This opinion would agree with that of Diggins and Bundy (1962) who believe that cattle are not particularly sensitive to changes in weather conditions. When they are on full feed they will seldom go inside open sheds even in the coldest weather. They state that beef herds can be successfully wintered without shelter even in the cold winters of northern North America. They concede, however, that good windbreaks such as trees or a high board fence, or natural shelter such as cross-wind hills and gullies will reduce the amount of feed necessary to winter the herd.

Box, Brown and Liles (1965) observed that their Hereford

cattle grazed normally in winter and spring in winds up to 25-30 m.p.h. but took shelter at higher velocities or in strong gusty conditions.

Joyce (1968) agrees that shelter reduces wind velocity and prevents exposure to driving rain but doubts whether adequately-fed cattle need more protection than that given by hill topography.

Cold and Calves

In the South Island high country, southerly storms with heavy rain or snow, strong winds and low temperatures, can cause distress to stock, particularly to calves. On some exposed properties calves die shortly after birth in these conditions. Most run-holders try to reduce this risk by holding cows on sheltered blocks for calving but many others take no precautions at all. If Alexander's (1962, 1964) work with Merino sheep can be taken as a guide, calves born in bad weather will be more likely to survive if the cows have been reasonably well fed - at least in the later stages of pregnancy.

Plantation windbreaks or even close-boarded shelters on exposed calf-wintering areas can help the calf to use more of the food it gets for growth rather than for extra heat production.

At Mt Possession Station (Chaffey, pers. comm.), open plantations with dense shelter on the windward side are favoured. He has observed that even on cold but fine winter nights, calves shelter under the trees and come out more vigorous in the morning than others bedding down on open paddocks. Cattle are not incompatible with tree plantations according to Barr (1968) if there is good grazing control - in fact their manure may help the trees.

Snow

Cattle are less affected by snow than sheep. In November 1967 when up to four feet of snow fell in the Canterbury high country, cattle deaths were proportionately very much lower than those of sheep. Dead adult cattle were mainly cows at or near calving. Many calves died too from drowning or starvation. Cows, particularly Herefords, were reported to have suffered badly-sunburned teats by reflection from the snow and for up to three weeks refused to let calves suckle. Fortunately the snow cleared within a week (Hughes, 1969). On other occasions snow can lie for many weeks in late winter and cause calf deaths by exposure and starvation.

3.24 RAINFALL AND DROUGHT

Rainfall

In general, cattle farming is well suited to high rainfall areas; it is much more difficult in very dry regions.

In the driest parts of New Zealand - the inland basins of Central Otago, the southeastern portion of the Mackenzie Country and the mid-Waitaki valley - average annual rainfall varies from 13 inches to about 20 inches (N.Z. Meteorological Service 1966a). In 1964 only 8.3 inches fell at Alexandra, probably the lowest rainfall recorded in this country (N.Z. Met. Serv. 1966b).

In such semi-arid zones, soil temperature and moisture may be sufficient for unrestricted plant growth in only three months of the year (O'Connor, 1959). Besides this, Coulter (1966) has shown that annual rainfall is usually below the annual water requirement of vegetation in all the South Island except Southland, the West Coast and the western high country. The amount of rainfall in the spring is especially important in determining how much herbage is produced in sub-humid back-country areas where the bulk of production occurs in the spring and summer according to O'Connor, Vartha, Belcher and Coulter (1968). It can alone account for 69% of the variation in annual pasture yield.

Apart from rainfall, certain soil physical factors also limit soil moisture storage and availability (Cutler, 1966). Broadly speaking, the brown-grey earths and the yellow-grey earths which dry out in summer are less suited to cattle farming than the yellow-grey/yellow-brown earths which do not. Only on the latter is there adequate moisture for good plant growth (Cutler, 1966).

Drought

Drought is one of the greatest enemies of the cattle farmer. It is not simply low annual rainfall - the farmer can adapt his management for this. The cardinal point about drought is that it is as yet unpredictable. Bondy (1950) has studied the incidence of drought in New Zealand. With the general exception of Southland, the West Coast and the western high country, (the high annual rainfall areas) all other South Island districts have a seasonal risk of drought when the soil moisture in the root zone is at wilting point or below.

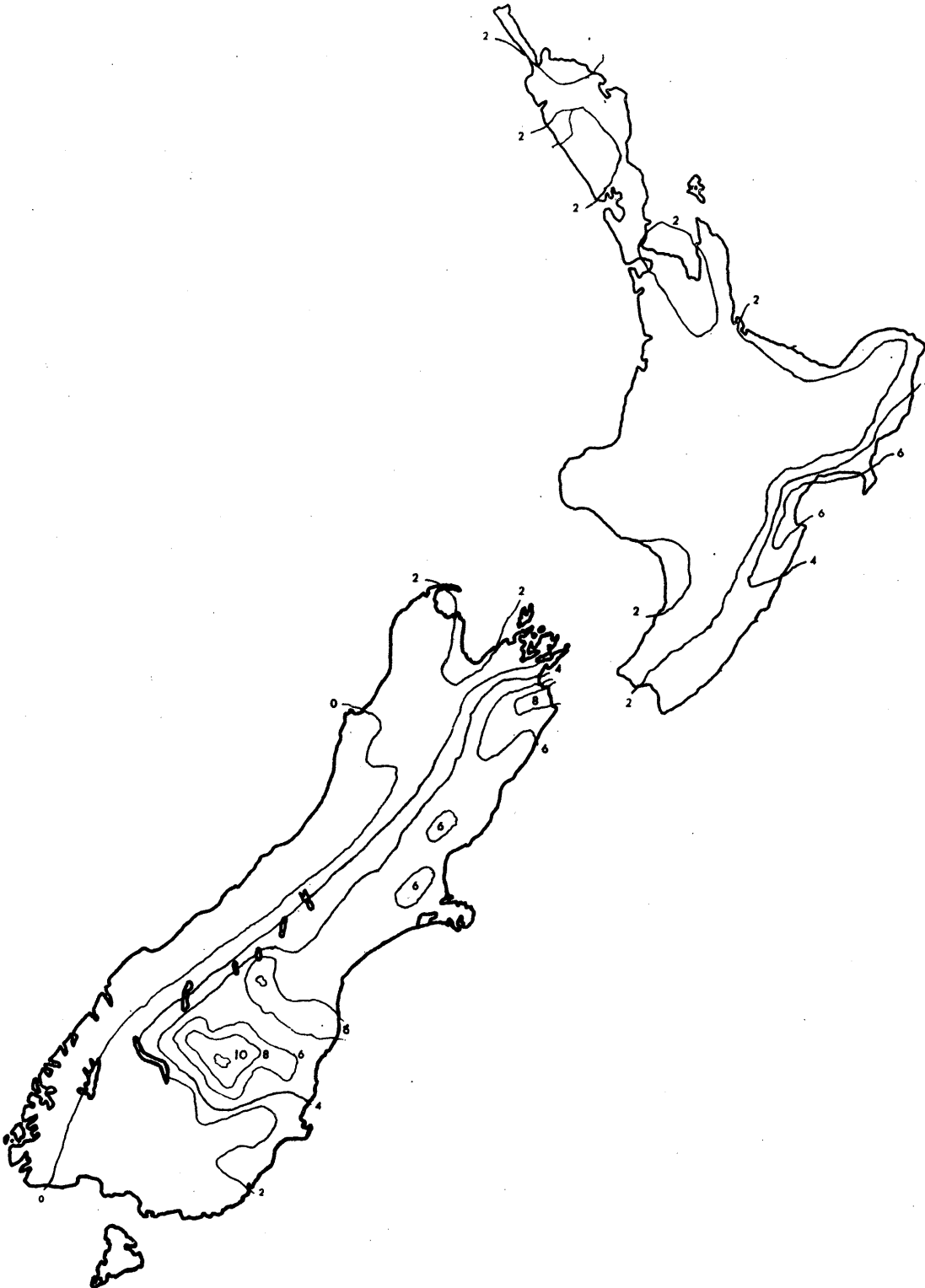


Fig. 4

Average annual water deficit (inches)

(after Coulter 1966)

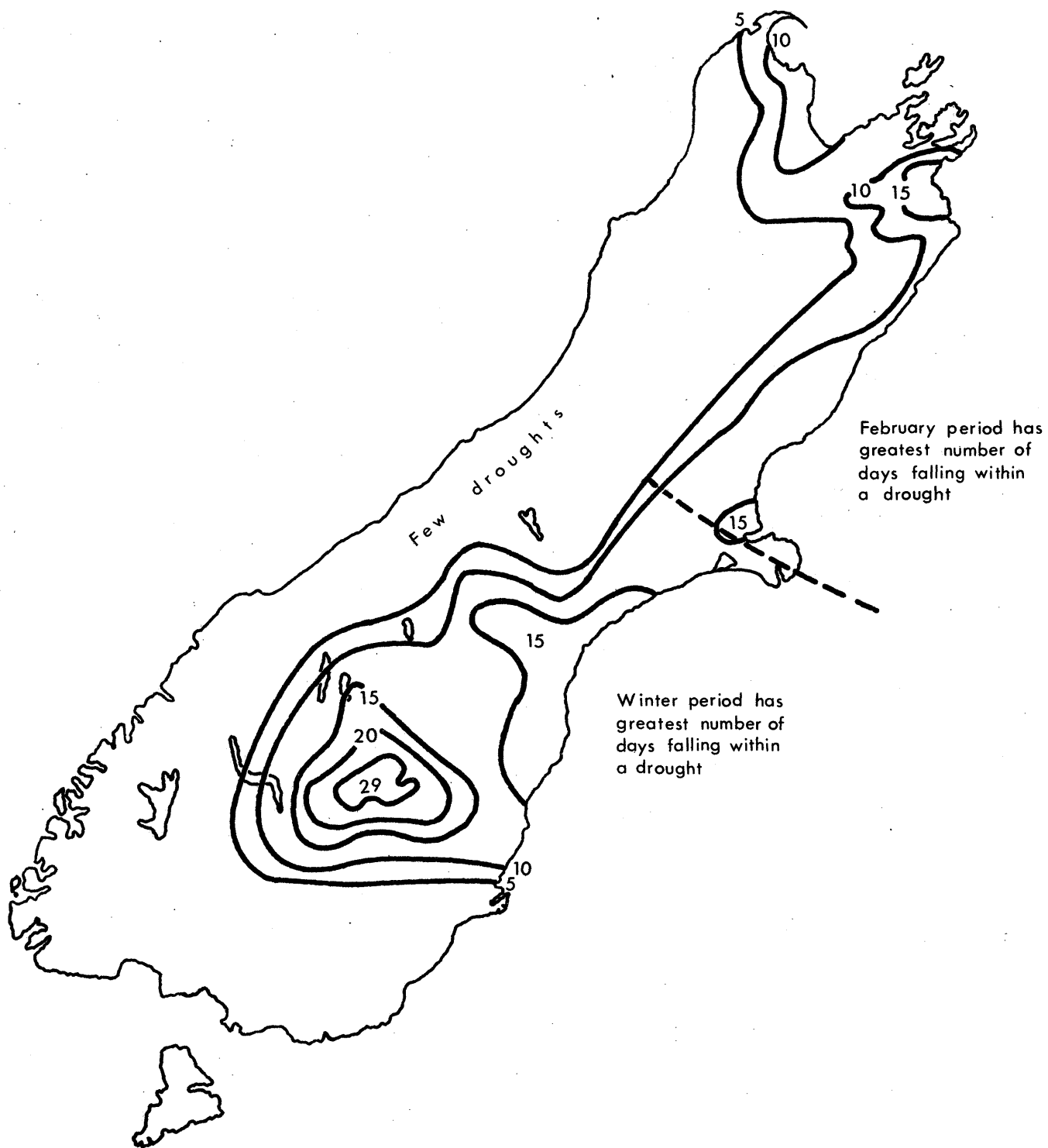


Fig. 5

Seasonal occurrence of droughts in the South Island with frequency of days falling within a partial drought. (After Bondy, 1950)

Short-term droughts usually mean a temporary animal food shortage, especially on shallower and lighter soils and consequent lower animal production. Longer droughts can cause expensive management changes.

Runholders faced with the risk of feed shortage in a drought can either:

- (a) sell stock before the normal dry season;
- (b) sell only when actually caught by a drought;
- (c) keep saved or supplementary feed ready for use;
- (d) select a combination of these practices.

These several policies are reviewed in turn:

(a) At present the run country is geared to selling calves in the autumn after weaning. This means that runs carry the maximum number of cattle through the dry late summer period. Only a change to autumn calving and early summer sale would avoid this.

(b) Droughts do not affect all areas of the island at the same time. Nevertheless cattle sold because of drought have to be sold well outside the dry district (at high cartage cost) to get a good price. Since one never knows when a drought is starting nor when it will break, the tendency is to carry cattle on and hope for rain. If no rain comes and the cattle are eventually sold they may well have dropped in condition and command only low prices, perhaps leaving little if any profit for a year's grazing. Of great importance is the relative severity of any drought to the runholder with stock to sell and to the fattening farmer, normally a potential buyer. If cattle fattening grows in attractiveness for irrigation-farmers their steady demand will give buoyancy and stability to the breeding side of the industry.

(c) The future of the cattle industry depends to great degree on the cheap growing, storage or management of food supplies to carry cattle over deficiency periods including partial droughts and dry spells.

Part of the answer may lie in growing the right plants. Mitchell (1963) has suggested that perhaps we should be growing tall plants with better light interception and deeper rooting systems (such as maize) to provide more food during the dry

season, although the opportunities for doing this in the tussock grassland environment may be different from those of North Island lowlands.

In the meantime, the breeder caught by a drought must selectively cull his least-productive animals such as old, dry and poor cows (which are currently in good demand by freezing works for boner beef) and save feed in good seasons to carry over the rest.

The problem of droughts and dry spells will become more acute for many runholders when their rising cattle numbers exceed the carrying capacity of swamps, stream margins and other localised damp areas.

3.3 WATER FOR STOCK

3.31 THE NEED FOR WATER

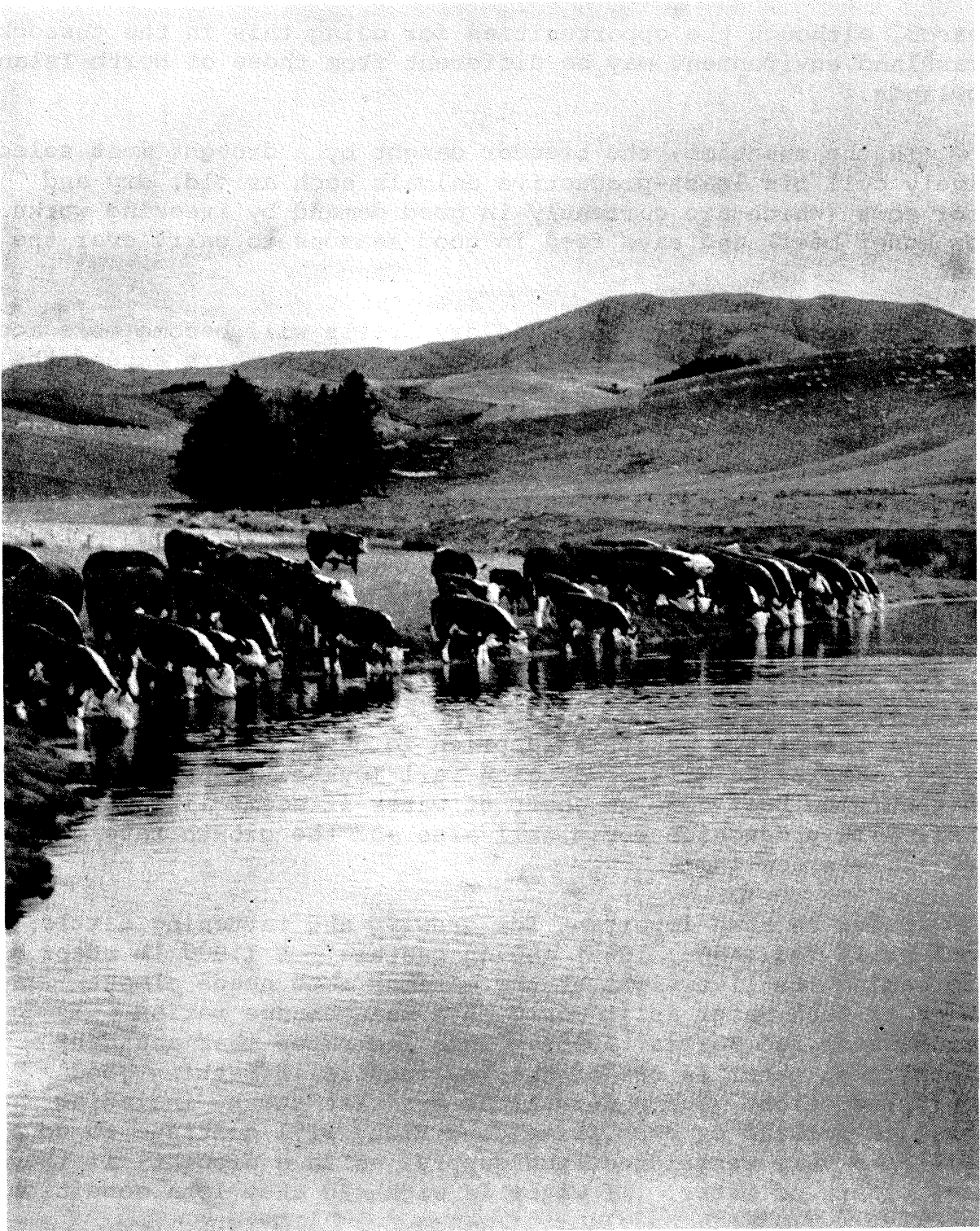
Greenfield (1967) notes that, "generally, water consumption is regarded as the greatest limiting factor in cattle feed intake and animal gain."

If too little water is supplied to dairy cows their dry matter intake and milk production fall (Sykes, 1955). Therefore when nursing beef cows go short of water it seems likely that their milk production would fall also and the growth rate of their calves decline.

Water is also important for growing and fattening cattle; both stall fed (Anon, 1965) and on pasture. A 1,000 lb steer increasing its liveweight at the maximum rate needs almost twice as much water as it would on a maintenance ration (Winchester and Morris, 1956). This indicates that abundant clean fresh water is one of the key factors in getting good beef production. Our observations are that stock, including those in forward or even prime condition, will continue to do well on a very restricted feed supply, as in a drought, if they have plenty of water. If water is withheld they lose condition quickly.

3.32 WATER INTAKE AND ITS RELATION TO GRAZING

Water intake and frequency of drinking varies with the class of beast, the temperature, the season and the kind of



If water is withheld, cattle lose condition quickly. Herefords at a dam on Mr A. Gillespie's property, Edievale, West Otago.

Photo: J. W. Sim

feed (Sampson, 1952). Nursing cows have the greatest demand. On open country, cattle prefer to drink at least once every day in the hot summer months and young stock even more frequently (Reppert, 1960). In winter when they need less, or in spring when the moisture content of forage is high, cattle may drink only once every two or three days.

McIvor (1967) suggests that stock get adequate water from vegetation alone when they are grazing green leafy pasture with only 15-25% dry matter. However, in a New Zealand summer, tussock country may be 60-80% dry matter, and supplementary water is therefore essential.

Winchester and Morris (1956) found that the amount of water consumed was related directly to the air temperature.

In Britain it has been found that stock need 4-6 lb of water per pound of dry matter with suitable extra allowances for pregnancy and lactation (A. M. Nicol, pers. comm.).

Although the water intake of cattle averages 10-12 gallons per day, (Riddolls, 1958; Sampson, 1952; Patterson, 1967) it varies from about 2-3 gallons per day for yearlings in cool weather to about 20 gallons per day for nursing cows grazing forage in a hot summer season (Greenfield, 1967; Skovlin, 1965).

Clearly, if other things be equal, it is commonsense to graze areas with abundant water in summer and those blocks with less water when the stock need it less.

Water supply is usually adequate on the gorge runs, but elsewhere in the hill and high country of South Island, New Zealand, the problem of supply usually increases as the annual rainfall decreases. In addition, topography may limit the usefulness of a water supply. For example, in Otago many streams are deeply entrenched in steep-sided gorges while the main grazing areas are on raised downs and tablelands between them. The gorges may be inaccessible to cattle; at best, access into them can be difficult, especially in winter.

Distance from water is one of the factors which determine where cattle will spread (Mueggler, 1965; Cook, 1966). They may, however, readily move out a distance from water to get a certain preferred species of plant (Herbel, Ares and Nelson, 1967).

Hickey and Garcia (1964) detected a class difference in movement from water. While cows and calves stayed close to

it until forced out by a shortage of feed, dry stock roamed widely. Clearly the distance cattle will travel from water sets a limit to the area they will graze. Hence well-distributed watering points are important to secure well-distributed grazing. An added disadvantage of too few watering points is that "an excess amount of walking to water uses up feed that would otherwise be utilised for growth and fattening" (Diggins and Bundy, 1956).

The acceptable distance apart of watering points varies with the terrain. The few published opinions suggest that cattle should not have to walk more than two miles to water on easy terrain and not more than half a mile on rough rocky mountain country.

The distance between watering points should depend on the number of cattle the vegetation can carry. Too few points, or too many cattle per point, can result in pasture damage and soil displacement on land closest to the waterhole. Sampson (1952) recommends one permanent watering place for each 50-100 cattle on flat country or 15-30 cattle on steep country.

An interesting Australian point of view is given by Beattie (1966). He states that there should not be too many waterholes or "animals which are naturally lazy will tend to survive and if hard times come mortality may be very heavy, as these, without the same dogged determination to live, will give up hope and die quickly. The will to live, the spirit of doggedness is important to animals in a drought."

In spite of this, we agree with Goebel (1956) that by increasing the number of watering points, cattle can be encouraged to spread their grazing and make better use of the available forage. He also noted that with more water points, there was much less "trailing" and cattle did not have to interrupt their normal grazing habits to seek water.

Also with smaller mobs gathering at more points the potential problems caused by dominance within herds and by territorial jealousy between herds could be expected to be less.

3.33 WATER SUPPLY COST

The availability of water is the overriding factor deciding whether or when an area can be grazed by cattle. Greenfield (1967) reports the opinion of "some range operators" that half a pasture's value lies in its water supply. Fortunately, most

of the back country has large enough water supplies for the type of extensive grazing practiced now but as blocks are subdivided and stock numbers increase extra water will be needed in many cases.

The cost of water development can be justified only if it will lead to increased returns from the area or to better pasture use from a soil conservation point of view.

In our tussock country it is difficult to sort out the facts on which to base a decision. Several values would have to be found; for instance the value of:

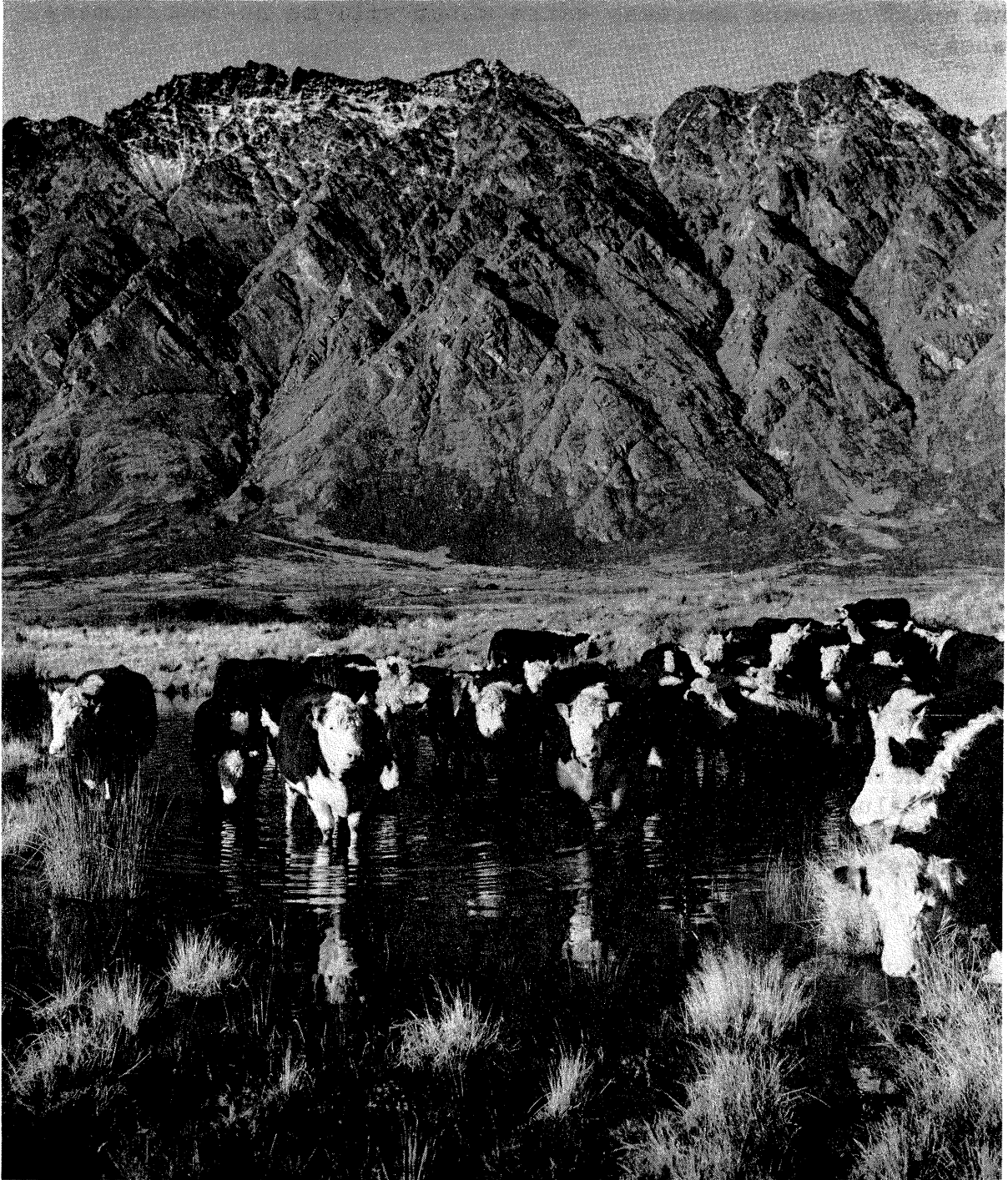
- (a) a higher rate of growth of sale-stock from a better spread of grazing;
- (b) a higher rate of calf growth due to ample water close to feed for its mother;
- (c) using previously unused pasture;
- (d) less soil erosion by more even pasture use or less trampling;
- (e) controlling rank growth by grazing rather than burning.

There is little evidence to give cash backing to any of these values. In the meantime it seems that the worth of extra water supplies has to be a matter of personal judgement. The popular criteria are:

- Will they increase the number of cattle a block can carry?
- Will they spread the cattle better over the block?
- How cheaply can they be constructed?

If the runholder is satisfied that "Yes" answers the first two questions and the last can be done out of income without undue strain he will go ahead. Water can be supplied to a block by:

- i. natural streams;
- ii. natural lakes, tarns and ponds;



Cattle prefer to drink at least once every day in the hot summer months and young stock even more frequently. Herefords at a pond on Remarkables Station, Queenstown.

Photo: D. G. Jardine

- iii. natural or developed springs;
- iv. artificial ponds whether dugouts (in Australia, "tanks" or turkey nests") or impounded behind embankments;
- v. troughs linked by piped reticulation systems to a source of supply. This may be a well, or any of (i), (ii), (iii) or (iv) above. The system may be gravity fed or pumped, usually by an electric motor. Windmills and hydraulic rams are rare.

Riddolls (1958) has given a full description of water supply systems but at present, stock water ponds are the most common and usually the cheapest to develop.

The flow of water required to supply livestock is relatively small. Greenfield (1967) suggests that a flow of three-quarters of a gallon per minute will supply 100 cattle. Waller, Gold and Sinclair (1958) stated that even a trickle of not more than half a gallon per minute could be stored to supply the needs of 35 head of cattle.

In the Hakataramea Valley, in 1961, small wet areas in inaccessible sites were successfully and cheaply opened up by explosives. Although these "ponds" are now mis-shapen, cattle still use them and continue to be better spread over the block than before.

However, in our opinion, as pastures improve and stock density increases, there will be a more than proportional increase in the popularity of piped water supply. Its two great virtues are the efficiency of water reticulation and its guaranteed flow. Freezing problems can usually be overcome if flow can be maintained. Too often farm ponds dry up in a drought when they are most needed. The extra expense of piped supply could show real long-term benefits to the runholder whose cattle numbers are restricted by the risk of drought. As stock numbers increase so will the importance of dependable supplies of drinking water.

3.4 VEGETATION

3.41 QUANTITY AND QUALITY

The capacity of a pasture to support livestock depends not only on the quantity of forage it produces but also on the quality or nutritional value of the forage - its energy and protein con-

tent, its digestibility, and the amount and proportion of various minerals and vitamins it contains. The soil type and the fertility of the soil in which plants grow has a strong bearing on their nutritional value. This can also vary between species of plants and seasons. Plants may have a high nutritive value at one season of the year but very little in another. For instance, young growth of grass in spring may be high in crude protein, whereas mature grasses or grasses grown on low-fertility soils tend to be high in cellulose and lignin and thus may be of low digestibility, less nutritive value, and of low acceptability to stock.

Food Intake

Coop (1965) noted that there were then no New Zealand data on the food intake of beef cattle. To estimate it he assumed that their daily requirements were the same as dairy cattle, and used the prediction equations developed for them by Hutton (1962) and Jones, Drake-Brockman and Holmes (1965). Coop calculated that a 1000 lb beef cow raising a calf would have a Digestible Organic Matter requirement for a year as follows:

Maintenance	185 days @ 7.4 lb DOM/day	=	3060 lb
Lactation	180 days @ 17.0 lb DOM/day	=	1370 lb
Pregnancy requirement			120 lb
Calf requirement for 6 months to weaning			<u>600 lb</u>
			5150 lb DOM

From this he constructed the data on which Table 13 is based.

TABLE 13						
Annual Beef Cattle Food Requirements (after Coop 1965)						
Class	Liveweight (lbs)	Dig.Org. Matter Requirement (lbs)		Dry Matter (lbs)		
				Good Pasture (DM has 62% DOM)	or	Bad Pasture (DM has 40% DOM)
Cows	1000	5,150	from	8,300	or	12,900
Two-year-olds	800-1,000	3,800	from	6,200	or	9,500
Yearlings	600-800	3,200	from	5,200	or	8,000
Weaner calves	300-600	2,830	from	4,600	or	7,100

The "good pasture" in the above table has dry matter consisting of 88% organic matter and 12% minerals. If 70% of this organic matter is digestible, the pasture dry matter contains $88 \times 70 = 62\%$ of Digestible Organic Matter.

However, in unimproved tussock grassland, only about 40% of the dry matter may be Digestible Organic Matter (Scales, Pers.comm.). Therefore, as shown above, an animal on such poor pasture would have to eat much more dry matter than on a good pasture to get the Digestible Organic Matter it needed. It may not be able to do so.

As we have seen, Coop (op. cit.) estimated that a 1000 lb cow on a maintenance diet needed 7.4 lb of Digestible Organic Matter per day. If the dry matter of a high-country pasture contained only 40% DOM then the animal would need to eat 18.5 lb of dry matter per day to maintain liveweight alone. However, Van Dyne and Meyer (1964) and Van Dyne and Lofgreen (1964) in California found that steers grazed dry summer range at the rate of only 15.4 lb of forage dry matter per 1000 lb liveweight. Although Pieper (1969) comments that the few studies of cattle intake on rangeland show very variable results, clearly a cow is able to eat barely enough rough forage for maintenance and must rely on selective grazing for calf production or growth.

Certainly dry matter intakes of 15-19 lb per 1000 lb liveweight (or 1.5-1.9% liveweight) are well below the figure of $2\frac{1}{2}$ -3% liveweight which Joyce and Maclean (1970) suggest is the maximum dry matter intake of cattle grazing highly digestible forage.

Because of the seasonally severe climate of the high country the food requirements of cattle could well be even greater than those given in the last column of Table 13 and their physical ability to eat enough low-quality herbage may be even more severely taxed. The inevitable wastage associated with grazing, treading and fouling could mean that the dry matter allowance for each beast could exceed the intake requirement by up to another 50%.

Dry Matter Production of Pastures

From work done by O'Connor (1959, 1960, 1967) and others, it is possible to estimate the dry-matter production of the more common grassland communities and soil groups. These together with estimates of potential production (assuming adequate nutrients, plant introduction and grazing control) are shown in Table 14.

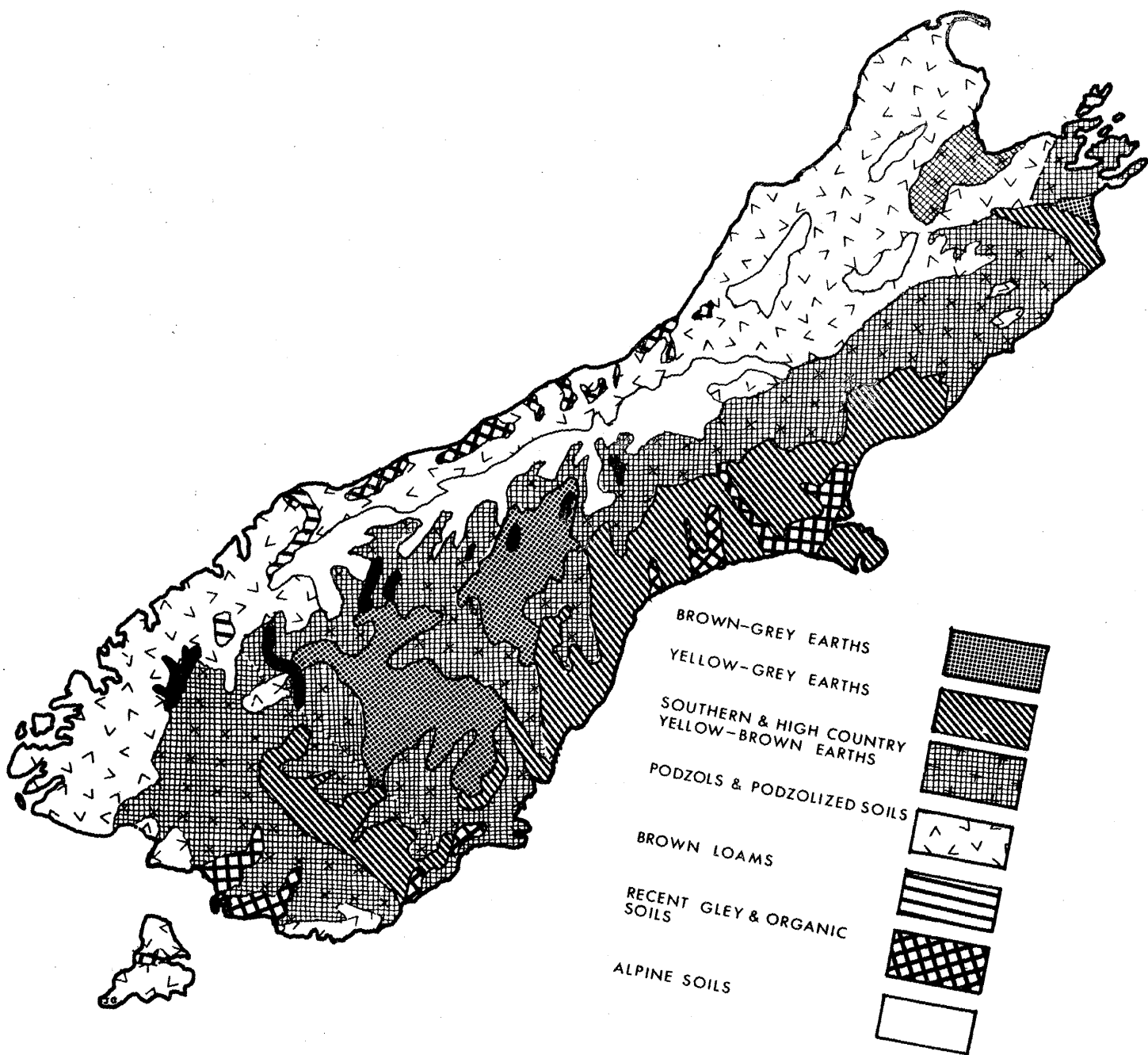


Fig. 6
Soils of the South Island
(after McLintock 1960)

TABLE 14

Dry Matter Production of Some Tussock Grassland Zones*

Tussock Grassland Zone	Soil Group	Dry Matter Production lb Actual	Potential
Scabweed and depleted short tussock grasslands (semi-arid (Central Otago)	B.G.E.	50-1000	3000-4000 unirrigated 6000-11000 irrigated
Montane short tussock grasslands, <u>Festuca/Poa</u> (sub-humid and humid)	Y.B.E.	500-3000	5000-15000
Montane/sub-alpine tall tussock grasslands <u>Festuca/Chionochloa</u> (humid Southland-Otago)	Y.B.E.	500-2000	3000-10000
Sub-alpine tall tussock grasslands <u>Chionochloa</u> (humid)	Y.B.E.	100-1500	2000-6000

* Compiled from estimates presented by O'Connor 1959, 1960, 1967.

The Relationship between Pasture Quality and Animal Use

Johnston-Wallace and Kennedy (1944) working with succulent pasture noted that for a mature lactating dairy cow to have a dry matter intake of 32 lb per day (equal to a rate of 11,700 lb per year) she had to consume 150 lbs of green herbage (at 21% dry matter). This represented a heap nearly 6 ft diameter, 3 ft high in the centre. The mechanical operation of gathering this amount of herbage with a 2½ in. "mower" requires considerable time and effort on the part of the animal. (Hancock 1949, reported cows taking nearly 24,000 grazing bites in a day or 15.3 per minute.) They concluded that deficiencies in pasture could not be compensated for by increasing the area available for grazing, and inferred that a cow's physical ability to eat was the factor limiting its dry matter intake.

Coop (1961) stated that the appetite of cows is roughly proportional to 2½-2¾% of their liveweight.

However, as he pointed out, food intake naturally depends a great deal on the digestibility of the plants. That is, the low digestibility of poor pasture probably limits intake more than the ability of the cow to gather it. Later Coop (1967) stated that feed of high digestibility can be rapidly processed by the animal and this in itself leads to greater intake. Also, the higher the digestibility of the food the greater will be the efficiency with which the animal body uses it for various functions. On the other hand, food of low digestibility (irrespective of how much moisture it contains) is inefficient for growth, fattening or lactation although acceptable for "maintenance" purposes.

The question is, how much forage of a given food value will an animal eat in a day? That is, what is its daily intake of nutrients?

The Food Value of Plants and its Effect on Animal Growth

The animal's food supplies it with varying proportions of carbohydrates, fats or oils, proteins, minerals and vitamins.

Broadly speaking, carbohydrates (such as plant sugars, starches and cellulose) and plant oils are broken down in the animal's body and used for heat production and energy. Surplus supplies are stored as deposits of fat.

On the other hand, the break-down products of plant protein are used for forming tissue and the active living matter of the body. The amount of protein a cattle beast needs depends on its state and age - whether it is merely existing or whether it is pregnant, lactating or growing. The non-nitrogenous part of the protein can also be used for energy or fat formation. Unfortunately protein, unlike the breakdown products of carbohydrates, cannot be stored in quantity in the body for later use.

In short, growth is an increase in the size of the organs and in the muscle and bone or structural tissues. Its rate mainly depends on the proteins, minerals and water in the food. At the same time, the process of growth also needs more of the energy-producing substances and more vitamins to support it. An increase in body size due to growth must not be confused with an increase in body size due solely to fat deposition.

Obviously plants vary in the digestibility of their constituents and in their proportion of proteins, carbohydrate, minerals and vitamins. Thus an animal can have a poor protein intake either because the plants it eats are indigestible, or because they are low in protein, or both.

In fact, protein demand depends on whether an animal is growing, fattening, pregnant, lactating, or merely maintaining itself. It also depends on the energy content of the diet.

A high level of protein in pasture is especially important for young growing animals (Wilhite and Grable, 1966). For instance, Baker (1968b) suggests that intensively-fed steers up to 550 lbs liveweight need 14-15% protein in the dry matter of their food.

In contrast, low nitrogen levels depress food intake and body tissue formation, or growth. Reproduction also suffers. U.K. Agric. Research Council (1965) tables show that 820 lb beef cattle can exist on food with only 3-4% protein in its dry matter. In general, if food contains over about 6% protein, energy supply instead of extra protein becomes the limiting factor to better animal performance (Caffrey, 1970). Roughages with low digestibility usually have low proportions of available protein nitrogen (Corbett, 1969), e.g. barley straw 3%. Since the bacteria in the rumen need nitrogen to function and multiply, low nitrogen intake means poor rumen activity, slow digestion of roughage coming into it, and lack of appetite for more. An animal's food intake can be depressed if protein in the food is less than about 10% (Elliot, 1967) or even below 14% (Lyons, Caffrey, O'Connell, 1970).

The percentage of protein in a food is merely a guide to its suitability - it is the minimum daily intake of protein (or of energy) which is important (Andik, Donhopper, Farkas, Schmidt, 1963) That is, the quantity of food eaten, due to factors regulating it, is at least as important as the composition of the food in deciding whether an animal's needs are being met by the forage it gets.

The Nutritive Value of Unimproved Tussock Grassland

Coop (1952) described the nutritive value of unimproved grasslands in the hill and high country as extremely low. Table 15 shows why.

Site	Altitude	% Crude Protein		
		Spring	Summer	Winter
Jollies Pass	2,800	8.3	10.0	-
Lake Lyndon	2,500	6.5	5.7	-
Grasmere Station	2,000	5.4	6.5	4.6
Grampians Station	1,500	10.5	4.6	-

Samples are of inter-tussock plants considered edible.

Darling found that the material collected at Grasmere Station had very low digestibility co-efficients of dry matter - 44.5, 41.6 and 42.7. MacRae and O'Connor (1970) found slightly better values of 43-57 for four species of tall tussock fed to sheep, the higher figure being similar to the digestibility values for medium to poor quality hay. They too found the nitrogen level of tall tussock feeds to be very low (2.7-4.6% crude protein) as had Connor, Bailey and O'Connor (1970), (2.3-6.4%). MacRae and O'Connor found that adding protein-rich and mineral-rich lucerne meal to a tall tussock diet resulted in higher intakes, but even with these supplements, the nutritive value of the tall tussock remained so low that it failed to meet all the maintenance requirements of the Romney sheep used as test animals. Connor et al (1970) found not only differences in organic and mineral composition among species of tall tussock and between seasons of collection, but also wide differences between plants.

In general, unimproved South Island tussock grasslands provide such forage to cattle pastured on them that the combined effect of low protein, low mineral and low digestibility levels makes them at best scarcely a maintenance diet. The low digestibility, in particular, causes not only a low carbohydrate and therefore low energy intake, but also a low intake of pasture already very low in protein and minerals.

The abundant plants of unimproved tussock grasslands appear to be especially unsuitable for young growing stock. That stock do in fact live and grow and even occasionally fatten on them can be due only to the selective grazing of the few more palatable and more nutritious plants in the sward. This is possible under a lightly-stocked extensive grazing system. Alternatively the presence of relatively more fertile areas in a grazing block may provide a better-than maintenance diet.

We suggest that while unimproved grasslands usefully fit into a grazing programme for breeding cows (where a maintenance diet is satisfactory for half of the year), they are generally unsuitable for the efficient growing of stock for meat production.

Possibilities for Use of Tussock Grasslands

Unimproved subalpine zone* grasslands can be used occasionally as a runoff. Greater use can be made of them if they are improved by introducing grasses and clovers at the lower margin of the zone. The higher rainfall of this zone may make it valuable in an otherwise semi-arid climate.

* lowland - 1500 ft, montane 1500-3000 ft, subalpine 3000-4500 ft.

Unimproved montane zone grassland can be improved in food value with introduced grasses and clovers. However, if grazed in its unimproved state, and if there are few localised damp, favoured sites, then it will probably be at the cost of making poor use of the animal's productive capacity and of its value as an expensive capital investment. Raising store steers, especially, can be an inefficient investment on improvable country. Cattle are too valuable to "put out the back and forget". Consigning them to such country should be for some good reason. Breeding cows for instance can effectively use unimproved montane grassland as long as they are only lightly stocked before and after calving.

It is impossible for cattle to exert grazing control over unimproved tussock grasslands and at the same time make the rapid growth needed for high-quality beef. Despite this, we realise that there is often justification for producing slowly-grown lower-grade beef in the interests of making some use of otherwise ungrazed country. This beef if finished on better pasture finds a good local, and an increasing overseas market.

Tussock Grassland Improvement

A discussion on the improvement of tussock grasslands is beyond the scope of this study. The methods, materials, economics and utilization of improvement have been discussed by many authors, including Cullen (1966), Dingwall (1955), Fitzharris (1966), Lobb (1959), Ludecke (1962), O'Connor (1963, 1965, 1966a, b), O'Connor and Clifford (1966).

Especially valuable has been the work done by O'Connor and colleagues on the importance of grazing management in achieving and maintaining high levels of pasture productivity. For example, O'Connor and Clifford (1966) reported that periodic hard grazing produced higher herbage yields than periodic lax grazing at all their experimental sites in the Mackenzie Country. The benefits from hard grazing were small where there was little clover, but high where there was a good clover-rich sward. They emphasise, "Eat grass to grow grass". However, fast-growing animals need tall succulent lax-grazed pasture (Taylor, 1966, 1968). That is, grazing management for maximum herbage production and maximum total meat output, or for newly-improved hill blocks, is rarely compatible with maximum per animal growth rates. The successful manager decides his priorities for each particular pasture and class of livestock.

The value of tussock grassland herbage as cattle food probably will approach or equal that of lowland high-fertility pastures as plant quality and soil fertility are improved. However, it is conceivable that the mineral composition of herbage from improved tussock grasslands may need supplementing for it to fully satisfy the needs of growing animals.



Tall tussock pasture modified by grazing and occasional topdressing, Hakatere block, Mt Possession Station. With improved soil fertility and plant quality these downlands, for cattle, have a potential stocking rate equal to the lowlands. This has been estimated at one breeding cow to two acres in the summer months.

Photo: T.G.M.L.I.

3.42 PLANTS POISONOUS TO CATTLE

Tutu

Species of the Coriaria genus are found throughout New Zealand up to an altitude of 3,500 ft. Species range in size from the few inches of a juvenile plant up to a tree 25 ft high. (Connor 1951). Coriaria occurs throughout the South Island run country but it is particularly common on properties around the southern lakes, where tutu poisoning is probably the most frequent cause of death to all stock.

Some runholders expect annual animal losses of up to 5-10% from tutu. It is feared more than any other cause of cattle deaths. One of the big problems of developing bracken-fern country, quite apart from getting rid of the fern itself, is that when superphosphate is applied a dense stand of tutu almost invariably appears.

All parts of the tutu plant except the soft black petals are poisonous to sheep and cattle although goats seem to be able to eat it without ill-effect (Connor, 1951).

Opinions vary amongst runholders about when it is safe to graze blocks containing tutu. Deaths can be quite unpredictable. Cattle born and raised on country where tutu is growing seem either to tolerate it or avoid eating the plant. However, there are still deaths amongst such stock, although they are less than among bought-in beasts. Most runholders would support J. C. Aspinall's (1968) opinion that it is very dangerous in the first flush of spring growth when hungry cattle will eat almost anything (particularly after a late cold spring when grass is slow to appear and tutu is the first green plant to show). It is also dangerous when first frosted in the autumn. However, others can point to stock lost at various times through the spring, summer and autumn. It is also said to be more dangerous when wet. Often, undisturbed stock seem to be able to eat it without ill-effect but when they are excited the symptoms quickly appear. The greatest losses from tutu happen when hungry beasts driven along a road or turned into a block find stands of this plant.

Within a few hours to two days of eating a critical amount of tutu, the beast becomes excited, salivates, perhaps bloats, throws convulsions and lapses into a coma. Death is then probable. No antidotes are available although stockmen believe that beasts can be saved by cutting their ears, facial veins or nose to make



Lake Hawea country where bracken fern is common. This weed suppresses pasture growth and may cause poisoning in cattle. Control entails plant introduction, subdivision fencing and heavy initial stocking rates of sheep and cattle.

Photo: R. Kerr

them bleed. While this can be done quite easily with sheep, it is often not possible to get near affected cattle until too late.

Careful management is needed to prevent tutu poisoning. Where tutu is widespread the task is very difficult, but the principles are:

1. Never turn hungry stock into a badly infested block.
2. Take stock off bad tutu blocks or paddocks when it first comes away in the spring. Restock when enough other plants have grown to provide alternative feed.
3. Avoid grazing these blocks when the plants are blackened by frost.
4. Do not let topdressed blocks become rank, particularly for the first few years. Keep them well grazed, especially in the high rainfall areas where tutu grows best. J. K. Rowley (pers. comm.) successfully controls tutu on oversown and topdressed bracken-fern country at Lake Hawea by periodically stocking small blocks with wethers at 40-50 per acre. However, the wethers must be well filled with other food before being turned onto the tutu-infested pasture.

Tutu can be controlled by herbicides. For isolated plants 2-4 ozs of Tordon pellets per square yard or 8-16 grains of active ingredient 2, 3, 6 TBA pellets could be used. Stock should be kept away from treated plants until all the foliage has dropped off. (Matthews and Allen, 1970; Ivon Watkins-Dow 1966).

Extensive areas can be sprayed with 245T or Tordon 75T. The total cost for 245T sprayed with a helicopter (spray subsidy deducted) would be \$13 per acre. A repeat application would probably be necessary. On smaller areas, high-concentration, high-pressure spraying by motorised mist blowers has proved very successful in January/February.

The total cost for Tordon 75T sprayed with a helicopter would be \$19 per acre (spray subsidy deducted). No retreatment should be necessary.

The operating cost of a fixed-wing plane at a basic \$5 per 40 gallons could be more expensive than the operating cost of a helicopter on the awkward sites where tutu is often found in the high country.

Obviously these costs are scarcely justified unless there is only a small area of tutu on a property and spraying would remove the risk of stock losses altogether. It must be remembered, however, that the value of one beast saved could pay for the spraying of 5-6 acres.

It has been recently observed (R. Plummer, pers. comm.) that the weedicide component of 2.4D superphosphate has effectively dealt with tutu in the Roxburgh district of Otago when applied at the rate of 7-8 cwt per acre.

Bracken Fern

This plant (Pteridium aquilinum var esculentum) can cause deaths in both cattle and horses. The plant is common in high country, particularly in the southern lakes region where it often forms a dense zone on hillsides from lake water level to about 3,000 ft. Although fern poisonings are rare they can occur when stock have little else to eat for two to eight weeks. Calves are as susceptible as older cattle. There are many symptoms, but dysentery, bleeding from the nose, eyes and vagina, and swellings under the skin are present (Connor, 1951). Cattle may continue to become ill for up to six weeks when taken off the fern. Only some of the animals in a mob may show symptoms but those that do usually die.

There is no specific treatment but 600 mg of Nicotinamide daily may help, with calcium and vitamin K to increase the rate of blood clotting.

Poisoning is a risk when cattle are mob stocked on fern to crush it. It may be prevented by sowing clover or grasses into the fern, or by feeding out hay.

Ngaio

The tree "Ngaio" (Myoporum laetum) can also be poisonous to cattle, but is found on the sea coast, not inland.

3.5 SUMMARY

3.51 TOPOGRAPHY

Cattle, particularly young stock, are capable of grazing steep country. However, in general they prefer easier land and are attracted on to steep slopes only by the presence of

good forage or by hunger from grazing pressure elsewhere. Cattle are not as agile as sheep and if grazed on country with rocky bluffs, particularly where the ground is frozen or wet, deaths from falls must be expected. Cattle graze level land to best advantage although they can also use rolling country fully. Where country is rough they tend to congregate on more level areas such as valley bottoms or ridge tops, leaving the steep positions unused or only partly used.

3.52 CLIMATE

Nowhere in the South Island pastoral country are temperatures either too low or too high for successful cattle farming. It is fortunate that cattle can tolerate cold more easily than heat for South Island temperatures are generally at the cool end of the temperature range. Climatically the region is well suited to cattle.

The problems of wintering cattle are more likely to be the problems of feed supply than climate. However, special measures to shelter weaned calves in winter are desirable on country exposed to the south.

3.53 WATER

Cattle need an assured supply of clean water close to the pasture they are grazing if a high rate of food intake and weight gain are to be kept up. They need between five and twenty gallons a day each. Well-distributed watering points are necessary if cattle are to make even grazing use of an area.

Surface water sources will continue to be the cheapest and most popular supply of stock water but in our opinion, piped water systems will increase in importance.

It is difficult to put a cash value on improving the supply of water to a block and the decision will continue to be made on a personal judgement of its benefit.

Much more attention will have to be paid to providing clean, reliable water supplies for cattle on tussock blocks than has been the case in the past.

3.54 VEGETATION

At least 13,000 lb of dry matter per annum would be needed to satisfy the requirements of a beef cow on unimproved pasture

in the region, with proportionately less for younger stock. This approaches the upper limit of a beef cow's ability to harvest enough for its needs for maintenance, pregnancy and lactation.

The general low digestibility of the unimproved vegetation reduces the intake of forage, common species being very low in protein and often in minerals. The amount of energy retained for growth and lactation is usually also low.

Only the animal's selective grazing of the better quality plants on sites with better soil fertility allow these grasslands to support a cattle industry now. On unimproved pastures liveweight gains will be slow.

For both efficient pasture and livestock production, grazing should be based on improved tussock grassland, leaving unimproved tussock grassland for those periods of the year when a maintenance diet is acceptable for cows.

There are few plants which are poisonous to cattle but tutu is the most important and tutu poisoning is one of the most common causes of death. Careful management is the most practicable means of avoiding stock loss.

CHAPTER 4

FACILITIES FOR CATTLE

4.1 BOUNDARIES

4.11 NATURAL BOUNDARIES

Most of the gorge runs and some others have unfenced natural boundaries. These may be high mountain ridges above the limit of vegetation, lake margins, or rivers. High-altitude boundary fences (where they exist) often suffer severe snow damage and fences between some runs are not maintained. Although cattle could stray across such open country, the general lack of vegetation provides little temptation for large mobs. Short strategic fences across saddles can solve the problem of practical stock-proof boundaries. Although lake boundaries offer few chances for cattle to stray, river boundaries can be a real worry. Where a gorge station occupies all of an upper catchment and has the divide for its boundary, stocking it is easy. However, when a boundary lies along a river, confining cattle is difficult. This is particularly so if the valley is narrow with one attractive sunny face and the other shaded and rank. The flow of most mountain rivers varies. Thus, adequate water boundaries through much of the year can dwindle to no barrier at all in winter. Cattle are tempted to cross a river to graze a sweet sunny face, no matter who owns it. This often leads to one man giving free grazing to his neighbour's cattle for at least part of the year. This sort of situation has caused strained relations between neighbours. We know of one case, where, to avoid potential dispute, no cattle are run in a valley. In another case the Crown awarded all the grazing in an unfenced valley to one lessee, and the neighbours ceased to be friends. Cases such as these are the exception rather than the rule but the situation may worsen as cattle numbers and grazing pressure increase.

Although boundary fences could solve these problems, there are many places where fencing watercourses merely to keep cattle apart is either not economic or impracticable, particularly when the river is already a satisfactory barrier to sheep. Valley fences also deny stock ready access to water. There are three remedies:

- (a) Joint ownership of a herd with each owner's share in agreed proportion to the grazing his property provides. This is not often a satisfactory solution but there are examples of such a partnership or syndicate.

- (b) Redistribution of land to give both sides of a valley to one lessee. Despite the difficulties of a "just" settlement more rearrangements of this type may have to be sought, particularly if cattle are substituted for sheep in an area because the upper hill slopes are badly eroded. However, river-valley grazing is precious to runholders and negotiation for transfer can be expected to be difficult.
- (c) Fencing of station boundaries is the obvious if expensive answer. One or more electric wires are a satisfactory barrier to cattle trained to respect electricity. The advantages of electric fencing boundaries are:
- i. Long distances can be fenced cheaply;
 - ii. Few posts or standards are needed and the risk of riverbank washout is thus reduced;
 - iii. An electrified wire suspended from bank to bank across a stream is an effective and flood-free barrier;
 - iv. If a section of fence does wash out, the material cost is light and the section can be relatively easily remounted.

The cost of a fence built of two 12½ gauge high tensile steel wires fixed to two 3-4 inch treated-wood posts per chain with insulated staples is about \$150 per mile for materials only (charger and controller excluded).

4.12 FENCING

Principles and Practices

Hughes (1963) has described the principles and advantages of subdividing native tussock grassland into blocks, preferably based on land capability classes and units. The aim should be to improve the grazing value through better sward management, to simplify the management of various classes of stock, and to ensure that they have a feed supply appropriate to the season.

However, on Mt Aspiring Station, J. Aspinall (pers. comm.) has observed that cattle bred on particular native grassland areas with reasonable feed available and not overcrowded, regard those areas as "home". He states that they do not stray

far from them even without fences. On the other hand young stock, or stock on strange country, will wander freely.

Herding is occasionally used in this country to achieve the same purpose as fencing. For instance, on the 450,000 acre Molesworth Station where no sheep are grazed, it is clearly simpler to supervise the 9,000 cattle with stockmen than to erect and maintain the hundreds of miles of snow-prone fences otherwise needed for grazing management. Drift fences are, however, used on Molesworth to assist control of herds.

Nevertheless, fencing will continue to be the preferred method of grazing control even on cattle-only properties. On these places it may be that less fencing will be needed than with sheep. But since most runs graze both, we have to assume that a fencing pattern planned for good pasture management with sheep will be equally satisfactory for cattle. The results of O'Connor (1966) and O'Connor and Clifford (1966) have indicated the potential value of close fencing to get periodic hard grazing of and high production from country topdressed with fertilisers.

Types of Fence

Good strong fences are essential for cattle. Many high-country fences are still the "Merino" five-wire fences, 2 ft 6 in. to 3 ft high. Others are higher but good sheep fences are not necessarily adequate for cattle.

There are at least two schools of thought about fences for cattle. One holds that fences must be physical barriers at least 3 ft 6 in. high, and preferably higher, which cattle will not try to jump over. Another school prefers "six-wire" fences about 3 ft high. Their argument is that well-handled, quiet cattle will not want to jump, but if they do then the low fence will not be caught by their hooves and damaged.

Our opinion is that the lower fences, which are cheaper and stronger, (with fewer wires there is less strain on tie-downs and strainer posts) are quite satisfactory in remote areas on sparse grazing or on steep, broken slopes. In neither of these places are cattle likely to congregate. Elsewhere (between paddocks, near gateways, along stock tracks and wherever cattle may be in mobs, or tempted to cross) a strong fence at least 3 ft 6 in. high is needed. Although fences are important, teaching cattle to respect them is even more important. Once cattle have learned disrespect for fences they will jump them almost at will.

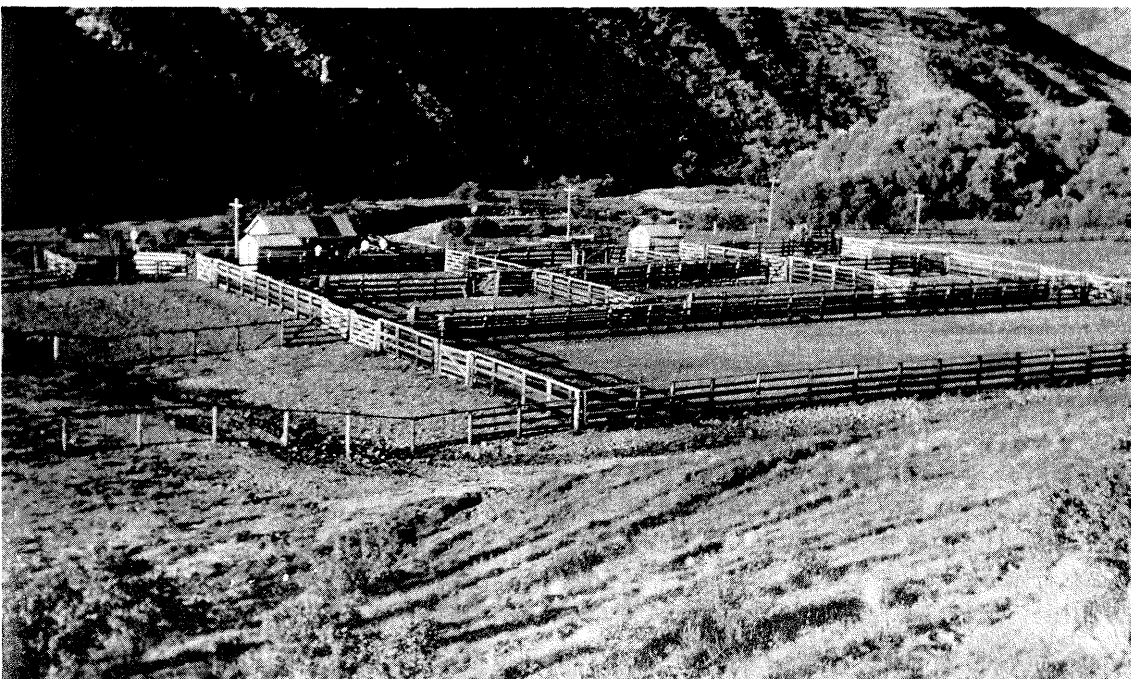


On a land capability basis, land with improved pastures will normally have priority for fencing. Grasmere Station.

Photo: R.D. Dick

The Bush Gully yards on Molesworth Station.

Photo: D. A. Manson



Cattle-proof fences are costly to build. Good quality hill fences cost \$800 to \$1,000 per mile, the price paid varying with type of materials, labour cost and site (Hughes, 1962). Lower-cost "flexible" or suspension fences with posts 1-2 chains apart have proven satisfactory on flat and rolling country.

Although electric fences have a chequered reputation in the back country, there is no doubt that cattle remember and respect an electric shock. We recommend that where accessible country is being developed electric fences should be considered for their cheapness, especially if they can be connected to a mains-operated controller. A full six-wire electric fence on difficult hill country could cost \$500 - \$800 per mile erected (Weston, 1968). In fact, on cattle-only country, two electric wires are a reasonable barrier to trained cattle. Even a single electric wire on top of a normal fence (\$25 - \$50 per mile, depending on type of insulator) is a worthwhile insurance against damage. It can be a better deterrent to cattle than barbed wire which, by tradition, is considered essential on top of cattle fences but which may actually induce damage by encouraging rubbing. More important, barbed wire is gaining in notoriety because it scars, and therefore devalues, hides. Several properties now hold cattle successfully without it, relying on an electrified top wire instead.

4.2 YARDS

At least one set of cattle yards is required on a property. They need not be elaborate but strength and good design are essential. Anything less causes loss of time and temper - both of which are needed in drafting.

The construction of yards is well covered by Montgomery (1968). The full capacity of cattle yards should be based on an allowance of 20 sq. ft per beast (Anon, 1966c). The working capacity, on the other hand, is about half the full capacity.

Depending on quality, cattle yards cost up to \$8 per beast, at working capacity, for materials alone. The labour cost would be about another \$8, making a total cost of about \$16 per beast, at working capacity, for materials alone. That is, the full cost of good yards is about 30 c. - 40 c. per square foot.

The Department of Lands and Survey basic yards, with rail-iron posts and wooden rails, designed to draft a mob of 50-60 cattle cost about \$700-\$800 excluding ramp. A patent head-bail

would cost at least another \$100. The total area of these yards is 2,400 sq. ft (R. W. Wilson, pers. comm.).

The capacity of a set of yards can be increased by enclosing small adjacent holding paddocks with post and wire fences as high as the yard walls but costing a good deal less. Cheap yards can of course be built for little more than the cost of labour where there are suitable trees for posts and rails on the property.

In New Zealand, distance to yards from any point on a property is rarely great. Even with small mobs we do not recommend camp drafting unless unavoidable and then only by particularly experienced men and horses. Although strong on visual appeal to lovers of "horse opera", it is generally slow, uncertain, and wearing on man, horse and cattle beast. The precision, speed and efficiency achieved by good men drafting in good yards whether with or without a drafting race has more to commend it.

When drafting, all dogs should be tied up well away and noise and excitement kept to a minimum. Both in yards and on the muster cattle should be moved quietly and firmly. It is surprising what can be done with cattle if they are handled properly and see a rider often. Quiet cattle spend their time grazing and growing, not watching the skyline and running for cover. Truly, "The eye of the master fattens his cattle".

"The eye of the master ..."
Braemar Station Herefords.
Photo: T. Donaldson



CHAPTER 5

THE INFLUENCE OF BEEF CATTLE ON VEGETATION, SOIL, AND WATER CONDITIONS

Grazing, treading, resting, dunging and urinating by cattle can affect:

- plant vigour and abundance,
- soil compaction and stability
- water yield and quality

Sometimes these activities are beneficial, sometimes they are harmful. The degree to which they are one or the other can vary widely depending on the condition of the vegetation and soil beforehand, their vulnerability to grazing use, the stocking rate, and the degree to which the cattle are allowed to graze the available herbage.

The careful manager, of course, aims to maximise the special advantages of cattle in herbage utilisation while minimising the damage they can cause.

In this chapter we will discuss how cattle eat, and the effect of their grazing behaviour on vegetation, soil, and water in the tussock grasslands.

5.1 CATTLE INFLUENCE ON VEGETATION

5.1.1 ANATOMICAL CONSIDERATIONS

Cattle differ from sheep in their method of prehension, that is in their manner of seizing food and conveying it to their mouths. Sheep have a cleft upper lip which, with their incisor teeth working against the pad, permits very close grazing. On the other hand cattle protrude the tongue, curve it around herbage, draw it between incisor teeth and the dental pad and cut it off. It is therefore physically easier for sheep to close graze a sward than it is for cattle. Indeed Voisin (1959) has observed that it is impossible for cattle to graze vegetation shorter than $\frac{1}{2}$ inch but sheep can graze to soil level. However, the greater stature of cattle makes it easier for cattle than for sheep to graze tall grasses such as snow tussock.

There is also a marked difference in the preference of cattle for different types of vegetation, where they have a choice. For instance, Johnstone-Wallace and Kennedy (1944) found that cattle in a cultivated pasture searched for and grazed young plant tissue and left older material. Similarly, Reppert (1960) found that grazing heifers showed a preference for leaves before stems and for green forage before old forage. Again, from New Zealand observations (Chapman, 1954; Suckling, 1962) we infer that cattle show a preference for the younger more digestible herbage in grasslands containing tussocks and other fibrous plants. However, where the more digestible plants are very short or sparse, cattle are likely to exert higher grazing pressure than sheep on the taller, rougher components such as the sedges, tall tussocks (snow tussock, toi toi) or even species of flax. In such circumstances, cattle will graze widely whereas sheep will tend to restrict themselves to small areas of short vegetation which they can keep to an acceptable height.

When there is little choice, as at high grazing pressure (ref. Mott, 1960; Campbell, 1966a) cattle will graze herbage of otherwise low acceptability, although again there is often a preference ranking. For example, Connor et al (1970) have observed broad-leaved snow tussock (Chionochloa flavescens) grazed to the butts in some Canterbury tall-tussock grasslands but C. macra nearby ignored until there was little C. flavescens left. On other sites, they noted C. macra grazed. The widespread narrow-leaved C. rigida was seen to be sometimes heavily grazed. Indeed only red tussock (C. rubra) seemed unattractive to livestock on all unimproved sites.

There are plenty of similar observations of intermittent grazing of tall tussocks. Unfortunately, there are no experimental reports which would help us define the soil, plant and animal conditions under which snow tussock is grazed or ignored.

The fact remains that, as Connor et al themselves state, "runholders have in front of them abundant evidence of non-use of tall tussock by livestock". Clearly there are local circumstances of either fertile soil, high grazing pressure, favoured site, specific chemical composition, or better digestibility which cause some small areas of tall tussock to be eaten.

Often individual plants are close grazed while their neighbours are ignored or merely sampled. The reason for this preference for different plants of the same species is at yet unknown, although the variation in chemical composition between tall-tussock plants reported by O'Connor (1971) may be a clue. Individual tussock plants are more likely to be grazed if they

are growing close to preferred plants of other species, or if the sward has been burned or topdressed. It is understandable why snow tussock is usually ignored by cattle. Unfortunately we have no measured evidence of why it is sometimes eaten.

Stoddart and Smith (1955) noted that because cattle graze with a pulling motion whereas sheep merely nibble, cattle may pull more plants from the soil. Johnson (1953) has suggested that tussocks will be pulled if cattle are left on one area for too long. Pulling of even such a deep-rooted plant as snow tussock by cattle has on occasions been observed on Molesworth.

5.12 CATTLE FOR VEGETATION CONTROL

In most areas of the South Island hill and high country there has been a marked reduction in burning since the passing of the Soil Conservation and Rivers Control Act in 1941. However, tussock grasslands are still burnt, usually under permit from catchment authorities, for several reasons:

- (a) To improve access through tall tussocks and scrub for sheep, and
- (b) As a pre-treatment of swards before the introduction of grasses and legumes.

Although these are acceptable reasons they do not include the traditional practice of burning to stimulate new tussock growth of higher digestibility than mature foliage.

There is little doubt that periodic burning was a cheap and effective way of controlling rank vegetation and improving forage quality. Further, there is substantial evidence (O'Connor, 1963; O'Connor and Lambrechtsen, 1964; O'Connor and Powell, 1963; Mark, 1965a, 1966; Rowley, 1970a) that spring burning may stimulate leaf elongation, new leaf production, flowering and, in certain circumstances, dormant seed germination in leaf litter. This activity is probably due to higher temperature in the burnt plants after defoliation. The results of these authors' work casts doubt on whether spring burning alone permanently damages tall tussock plants. However, there is also strong evidence that not only can post-December burning cause widespread tiller death (Rowley, 1970a) but also that frequent defoliation of snow-tussock plants, especially of new regrowth after burning, can quite rapidly kill them (O'Connor, 1963; Mark, 1966). As Mark points out, even severe annual clipping of unburnt plants can cause a high mortality rate within three years.

On the other hand an ungrazed community may return to its former botanical composition within a similar time on favourable sites (O'Connor and Powell, 1963; B. P. J. Molloy, Pers. comm.) although regrowth is slow at high altitudes (O'Connor, 1963).

The low dietary value of tall tussock (Chionochloa spp.) has already been shown in Chapter 3. Therefore there is little advantage in retaining a dense tall tussock grassland in the zone below 3000-3500 ft altitude. Here, except for its soil conservation value, a tall tussock grassland is often more a liability than an asset. But where improvement by oversowing and top-dressing is feasible and economic, retaining snow tussock plants in the sward has many advantages. These benefits are in:

- (a) supplying some shelter for livestock and for inter-tussock plants from wind;
- (b) promoting early break in snow cover by heat conduction along the leaves;
- (c) increasing the stability of the soil by their deep-rooting habit;
- (d) improving soil-moisture status where atmospheric moisture can be trapped,
- (e) providing an accessible forage source in deep snow.

On ground not suited for improvement by topdressing and oversowing, pastoral use decreases in importance with increasing altitude and slope. In the sub-alpine zone the primary objective should be conservation of the vegetative cover for soil stability and water-quality improvement - although late-summer/autumn grazing is still a valid secondary use if at low grazing pressure. This food reserve will become of yet greater importance for occasional relief in times of drought as stock numbers increase on the improved country below. In this secondary grazing zone, animals can be allowed to select a diet from the available herbage as long as their presence does not cause an increase in bare ground even on preferred grazing sites. If increasing density of vegetation restricts their grazing area, then the primary hydrological role of plant cover in this zone must be respected and animal numbers reduced accordingly. We do not condone burning of sub-alpine grasslands to maintain forage quality or access. Not only is the risk of spread of fire to eroded ground unacceptably high, but so also is the vulnerability of the burnt areas to frost lift or high-intensity rain damage

before the slow renewal of ground cover. However, we are not convinced that cattle grazing is a feasible substitute for burning for vegetation control in the high grasslands and scrublands above 3000 ft. In fact we are not convinced that vegetation control is yet needed in this zone anyway.

Undoubtedly cattle make better use of tall tussock than sheep. They are also less inclined than sheep to graze steep mountain sides. We know that a diet of tussock offers a sub-maintenance level of nutrition. Therefore we recommend that the sub-alpine zone be used primarily for breeding cows in autumn after weaning, or for older dry store cattle, especially of Angus or Hereford breeds. They can be stocked at a grazing pressure low enough to enable them to select an above-maintenance diet from the inter-tussock species while the plants have a reasonable nutritive value. Remember, breeding cows should put on weight in late autumn rather than lose it. It should be unnecessary to point out that if such cattle show signs of hunger their grazing pressure is much too high for the continued vigour of both animals and plants.

Below 3000-3500 ft the alternative pre-treatments of short- and tall-tussock grasslands for forage improvement are cultivation, grazing, or burning. In the unimproved state their herbage production may be 500-2000 lb dry matter per year. With adequate plant nutrition, fencing and stocking their production can rise to 6000-12,000 lb dry matter (O'Connor, 1960).

Cultivation is practicable only on slopes below 20°. It is expensive but usually allows quick production of a high-yielding grass-dominant sward. On high country yellow-brown and yellow-grey soils aerial oversowing and topdressing with adequate fencing for stock control can produce equal amounts of herbage for equal capital inputs to those of drilled swards (Bilborough, 1965). However, successful pasture establishment with introduced grass and clover from the air may require plant-canopy control beforehand. The standing crop of existing vegetation must be short enough to allow good light penetration to new plants near the ground (O'Connor and Lambrechtsen, 1964). The practicable alternative methods of defoliation before aerial improvement are grazing or burning.

Sheep, even wethers at high concentration, are ineffective at controlling rank unimproved tall tussock. Although better in short tussock they will lose condition unless there is ample inter-tussock growth of fair digestibility, such as the adventive exotics Yorkshire fog, browntop and sweet vernal, the native



Claimed from scrub. Some 6,000 acres on Bluff Station, Marlborough, was burnt, and oversown with 26½ tons of grass seed. The response was pictured 2½ years later.

Photo: Marlborough Express

grasses such as Agropyron scabrum, or catsear. Cattle would seem to be a better alternative. Certainly experience at Mt Peel Station (J. O. Acland, Pers. comm.) has been that on easy slopes cattle can successfully reduce the abundance and vigour of one species of snow tussock (Chionochloa rigida) and produce a site suitable for aerial seed introduction. Indeed frequent grazing by cattle caused a high mortality among these tussocks within three years.

It is uncommon to find evidence of cattle successfully controlling unimproved tall-tussock grassland, particularly on steep slopes, although in time they tend to open it up around preferred grazing sites. Cattle are more successful at controlling short-tussock grassland than are sheep. In its often-partially-depleted state, such a sward provides no better diet for growing, late-pregnant or lactating stock than does tall-tussock grassland, unless low numbers allow cattle a generous opportunity to select a nutritious diet.

Cattle are run for profit and a practice which restricts profitable growth must have its cost justified by some benefit. In other words, if steers are forced to eat snow tussock instead of other available food and cease to grow, the real cost of substituting vegetation control for meat production has to be recognised. However, breeding cows are available in early winter for roughage control and can afford to lose up to 10% of their autumn liveweight at this time. Unfortunately with the onset of winter the dark-lying blocks which most need hard grazing become increasingly unattractive to stock and later too cold or frozen to use. Besides, few farmers have large enough dry herds or small enough blocks to keep tussocks grazed down, even if conditions are suitable. Therefore if fire is the only alternative and can be confined to uneroding ground, if a thorough programme of pasture improvement will be carried out afterwards and if there is likely to be quick re-establishment of ground cover, a single burn before treatment seems better practice than fasting cattle. If this is unacceptable, partial control of roughage by cattle and spreading of fertiliser and clover seed will be a less-hazardous but less-efficient alternative in terms of extra herbage produced for money spent. Once clovers are introduced there is no trouble controlling roughage with cattle, or sheep and cattle. In fact cattle at high grazing pressure have been seen to almost completely clear an improved block of red tussock (Chionochloa rubra) and fescue tussock (Festuca novae-zelandiae) in three years on rolling country. By our observations, only silver tussock (Poa caespitosa) seems capable of persisting under regular stocking.



Silver tussock seems capable of persisting under regular stocking.
Upper - A modified tussock pasture on Mesopotamia Station, mid
Canterbury. This is dominantly fescue tussock with some silver
tussock.

Photo: G. A. Dunbar

Lower - Silver and fescue tussock country, South Otago.

Photo: H. J. Taylor



On many properties there will be blocks of overgrown improvable tall-tussock-dominant country on which development cannot take place for several years. Here we recognise that a preliminary burn may be necessary to encourage cattle (and sheep) to make use of the herbage and maintain some vegetation control.

Some North Island farmers claim that in scrubland cattle alone can replace the need for burning. At high stocking rates they are said to be particularly effective against juvenile scrub plants (Madden, 1962).

Although we lack clear evidence of similar value for South Island conditions, it is widely known that cattle will track through scrub and make it more accessible for sheep - especially if tall legumes such as red clover or Lotus species have been sown to attract cattle into it.

The joint use of cattle and sheep can greatly reduce scrub species such as matagouri and scrub briar when heavy stocking follows heavy topdressing.

Cattle can also be used to crush young bracken fern fronds (Pteridium aquilinum var. esculentum) in spring. They are safest following mob-stocked wethers if there is a risk of bloat through strong clover growth (Rowley and Warrington, 1970). Here again an initial controlled burn will encourage vigorous clover production and make it possible to carry sufficient stock for effective trampling of fern fronds.

5.13 DISPERSAL OF SEED BY STOCK

Heady (1964) studied seed spread in faeces and reviewed the work of others. He concluded that seed survival varied widely between species but that small hard seed survived best. At Te Awa, Suckling (1965) noted that about 10-11 lb of viable clover seed per acre passed through cattle when they were grazed on pastures which had been allowed to seed. However, J. C. Aspinall (Pers. comm.) has observed that clover seedlings growing in cow pats do not survive without topdressing. We have found no information about the relative efficiencies of cattle and sheep in the dispersal of seed.

5.14 CATTLE, EROSION, AND DEPLETION

There is a widely held view that a shift to cattle grazing from sheep will reduce rates of erosion. On a few properties, changing from sheep to cattle has proved to be sound for economic



Because of the effects of water and slope on cattle distribution, cattle will normally spend more of their time on the lower slopes than sheep. Lake Luna Basin, Mt Creighton Station, Wakatipu. The lake lies at 2,600 ft, Mt Larkin, left background, is 6,185 ft. Photo: G. Anderson

reasons and has reduced seasonal labour and new capital investment in fencing, besides markedly decreasing the risk of stock loss by snow. These reasons alone are enough to recommend cattle. However, we further consider that when cattle alone are carefully managed, less erosion is likely to occur than with sheep alone of equivalent total bodyweight. But we cannot emphasise too strongly that many factors must be taken into account when impartially comparing the relative merits of cattle or sheep. Too often the issue is prejudged and based on unproven hearsay evidence, not fact.

Apart from the question of whether or not cattle cause less erosion than sheep, it can be argued that cattle may create conditions under which there is less opportunity for erosion. For example,

(a) If cattle will control vegetation by grazing and thus avoid the need for burning, some surface litter can be retained and the soil better protected from raindrop splash. Canopy reduction by grazing or burning will also improve light conditions near the ground and favour living ground cover. Thus Greenall (n.d.) reported large increases in herbs and sward grass after burning had reduced canopy and litter in mid-altitude snow-tussock associations.

(b) Again, from the earlier discussions on the water requirements of cattle and the effect of slope on cattle distribution, we can infer that cattle will spend more of their time on the lower slopes than sheep. In general it is the high altitude land which is usually most eroded. If this land will respond to relief from grazing, and if cattle are less likely to graze this country, then they could indirectly help the revegetation of eroded land. This could well be a significant factor in favour of cattle grazing as an alternative to sheep.

(c) Because cattle and sheep prefer to graze different sites relative to aspect, slope and water supply, we can expect differences in the way that grazing pressure is distributed over a hill-country block. If cattle are substituted for sheep, for instance, we could expect a lower grazing pressure on the sites and plants preferred by sheep but not by cattle. In contrast, if cattle and sheep are grazed together, sheep may extend their grazing to areas which cattle have cleared of roughage - such as on the lower slopes. On the other hand, if sheep are forced to compete with cattle for scarce feed they may extend their grazing from safe ground at lower altitude into higher areas more subject to erosion and depletion.

Where cattle (or sheep) are heavily grazed for several years on natural vegetation growing on drier soils, not only will forage yields decrease but the soil may well adopt the characteristics of one with even lower soil moisture status, e.g. less organic matter, higher temperature and smaller root systems. An artificial "droughty" soil and sward can be created with all its disadvantages (Johnston, Dormarr, Smoliak, 1971).

In short, although it may be true that cattle are associated with less erosion than sheep, it would be most difficult to prove or disprove such a proposition with so many complex facets. Indeed there may well be little difference in the comparative influence on erosion of similar total weights of beef cattle or sheep on areas with similar soil and vegetation characteristics. We are convinced that grazing pressure is more critical to soil erosion than class of stock.

We are further convinced that the principle contributions of cattle to reducing high-country erosion lie in their different grazing-site preferences compared to sheep. Except where this benefit applies, we are reluctant to advocate changing to cattle primarily to reduce the rate of soil erosion. We prefer to recommend them as an excellent complement to sheep on hill country or as a class of livestock able to justify their presence on economic grounds alone if necessary.

5.15 EFFECT OF TRAMPLING ON PLANTS

Treading affects pastures as well as soil. The influence can be direct as with trampling damage, or indirect by compaction of the soil in which the plant is growing, thus reducing its supply of air and water.

Seedling trees and shrubs can be damaged by trampling stock, particularly where they concentrate, and by cattle more than sheep (Stoddart and Smith, 1955). Adult plants may also die, for example, tussocks uprooted by cattle hooves. However, there must be a high level of grazing pressure before there is significant damage. On unimproved native pasture, cattle will be fasting well before widespread trampling damage is possible, and thus the risk is low. On improved pasture, although the risk of trampling is higher, the denser and more-actively-growing vegetation is better able to bind the soil and replace plant losses with new tillers on surviving plants (Edmond, 1957).

Plant cover can reduce the effect of treading on soil condition and on subsequent pasture yield (O'Connor, 1956a, 1968,

Brown, 1968a). Taller swards are likely to suffer less damage than short swards.

Compaction causes a variable effect on the rate of growth of vegetation. It may actually increase growth if by consolidating soil around a seed or plant it makes it easier for the plant to draw moisture from deeper in the soil (Hyder and Sneva, 1956). Indeed some compaction is necessary for good grass growth (Edmond 1958b) but excessive compaction, or puddling, or both will restrict root development and reduce yield. Puddling, with its restriction on the diffusion of air to the plant and on later soil moisture recharge appears to cause the greater reduction in plant yield (Domby and Kohnke, 1956).

If grazing pressure is high, treading can alter the botanical composition of a pasture (Edmond, 1958a; Brown, 1968a). Plants which tolerate treading damage such as perennial ryegrass and timothy will persist where more susceptible plants such as browntop and white clover will fall in yield and density.

The influence of treading on pastures has been thoroughly studied in recent years in lowland situations in New Zealand (Brown, 1968a, b; Campbell, 1966b; Edmond, 1958a, b, 1962, 1964; Gradwell, 1956, 1960, 1965, 1966). These studies indicate that stock density and grazing duration have to be much higher than the average treading load on high-country pastures (other than on winter feeding paddocks) before harmful soil compaction is caused, or total pasture production is much reduced.

We have no evidence comparing sheep and cattle treading influences on plants. Treading can occasionally be beneficial to vegetation. Not only may seedling scrub weeds be reduced in density but Chisholm (Pers. comm.) has observed that consolidation of scree by cattle improved the establishment of seed previously sown into it.

5.2 CATTLE INFLUENCE ON SOIL

Many people voice concern about the influence of cattle treading on hill and high country grasslands. We will look at the reasons for this concern.

5.21 ANATOMICAL CONSIDERATIONS IN TREADING

Cattle differ from sheep in the magnitude and character of their treading loads. The following table for mature sheep and cattle of various breeds is derived from O'Connor (1956a). The values of Lull (1959) for hoof area and static ground pressure are within the ranges given.

TABLE 16			
Sheep and Cattle as Treading Agents			
	Total Bearing Area per Hoof (sq. in.)	Static Ground Pressure (lbs per sq.in.)	Estimated Walking Ground Pressure (lbs per sq.in.)
Sheep (80-120lb)	2½-4	9-12	18-24
Cattle (800-1400lb)	12-18	15-30	30-60

This table shows that total bearing area and static ground pressure for sheep are much lower than for cattle. The estimates of walking ground pressure for sheep and for cattle are based on the observation that, at a fast walk, the animal's weight may be borne almost entirely on only two feet at a time. Of course, in the action of treading with thrust for forward movement, the actual pressure of a hoof or part of a hoof on the soil may be very much greater momentarily than the values given above. How long the pressure is applied for also has an important effect on soil compression. Obviously hoof pressure will vary not only with the weight of the animal and the size of its hooves but also with its gait and the steepness of slope. Suffice to say that while actual point load on the soil may vary widely from the values given above, a cattle beast has about twice the hoof pressure of a sheep at a similar stage of development.

5.22 THE EFFECT OF TREADING

The amount of treading which cattle do in a day depends on the distance they walk. This in turn depends on the shape of the country; where the preferred grazing and bed grounds lie in relation to water and salt; the size of the paddock; the amount and quality of the available forage; the weather; the age, sex and breed of the animals, and their familiarity with the grazing

area (Shepperd, 1921; Valentine, 1947; Wagnon, 1963; Cook, 1966).

Therefore, the distance walked will vary widely between different classes of cattle on different sites. Reported values for unherded cattle in large paddocks or on open range vary between 1-5½ miles per day (Shepperd, 1921; Peterson and Woolfolk, 1955; Hafez and Schwein, 1962; Wagnon, 1963; Box, Brown and Liles, 1965).

In walking trials with cattle on level ground Murray and Yeates (1967) found that steers made 842 ± 2 and heifers 948 ± 11 steps in one-third mile at 1 2/3 m.p.h. or about one step every 2 ft. Thus beef cattle could make 2600-14,500 steps per day when walking on a range. However, as O'Connor (1956a) points out, the paces taken when walking may bear little relation to those taken when grazing (grazing steps are usually shorter). When this is added to the variation in length of step caused by differences in slope angle, the impossibility of deriving meaningful estimates of the amount of treading done by cattle in a day can be easily seen.

In general, sheep walk much further than cattle in a day, although the two species have not been compared on the same site. Reported average sheep values on rangeland vary between 2-11 miles per day (Cory, 1927; Louw, Havenga, Hamersma, 1948; Hafez and Scott, 1962; Squires and Wilson, 1971).

O'Connor (1956a) estimates that cattle tread on about twice the area of ground per day compared to sheep in similar grazing conditions. Therefore, in the broadest terms, at a grazing substitution rate of one cattle beast equals five sheep, although the five sheep may tread on about twice as much land per day as the single cattle beast, they do so with only about half the pressure.

5.23 EFFECT OF TREADING ON SOIL COMPACTION

Compaction of the soil surface can be caused by raindrop impact or stock treading. Many studies of soil deformation by treading of grazing animals have been carried out in North America.

The central theme in most of the results has been that heavy grazing increased runoff and decreased the infiltration capacity of soils compared to light or no grazing. However, there are obvious inconsistencies in the reported bulk densities of soils under grazed and ungrazed sites where this was being measured (Lodge, 1954). Laycock and Conrad (1967) identified the reason

for the difference. They pointed out that the reaction of soil to animal treading was largely dependent on its moisture status, that is, that treading on moist soils often caused soil compaction but that treading on dry soils did not necessarily do so. But the case is not that simple, that is, that moist soils compact, dry do not.

For instance, on very wet soils of poor structure and low cohesion, treading can cause puddling rather than compaction, even of only the top few millimetres. This is because water and air trapped in the soil cannot be compressed when an animal treads on it and consequently the unconfined soil deforms and flows away from the hoof (Gradwell, 1956, 1960; O'Connor, 1956b). In fact puddling can occur without true compaction in very wet soils (Edmond, 1958; Scott, 1963).

On the other hand, in some porous sandy soils treading may actually cause a greater increase in bulk density (but to a lower final value) than similar treading on clayey soils (O'Connor, 1956b). This may lead to a higher water storage capacity (Rosenberg and Willits, 1962). These examples show that animal treading is not always a disadvantage.

The effect of animal treading on North Island, New Zealand lowland soils and pastures has been studied by several workers such as Edmond (1957, 1958a, b, c, d, 1960, 1962, 1963a, 1964, 1966), Campbell (1966b), and Gradwell, 1956, 1960, 1965, 1966). These studies appear to have been all made on soils with a moisture status close to field capacity. In general, the results showed that treading compaction caused increased bulk density, reduced infiltration and reduced pasture growth on these soils. According to Gradwell (1956) compaction of moist soil by treading caused air voids between the particles to close up and thus the amount of compaction possible was limited by the available air space. The depth to which compaction occurs depends mainly on the degree of cohesion among the soil particles (O'Connor, 1956b). However, even though treading may compact only the top few inches of soil this can be enough to reduce infiltration and the recharge of soil moisture down the rest of the profile. Compaction also can restrict root penetration (Trowse and Baver, 1956).

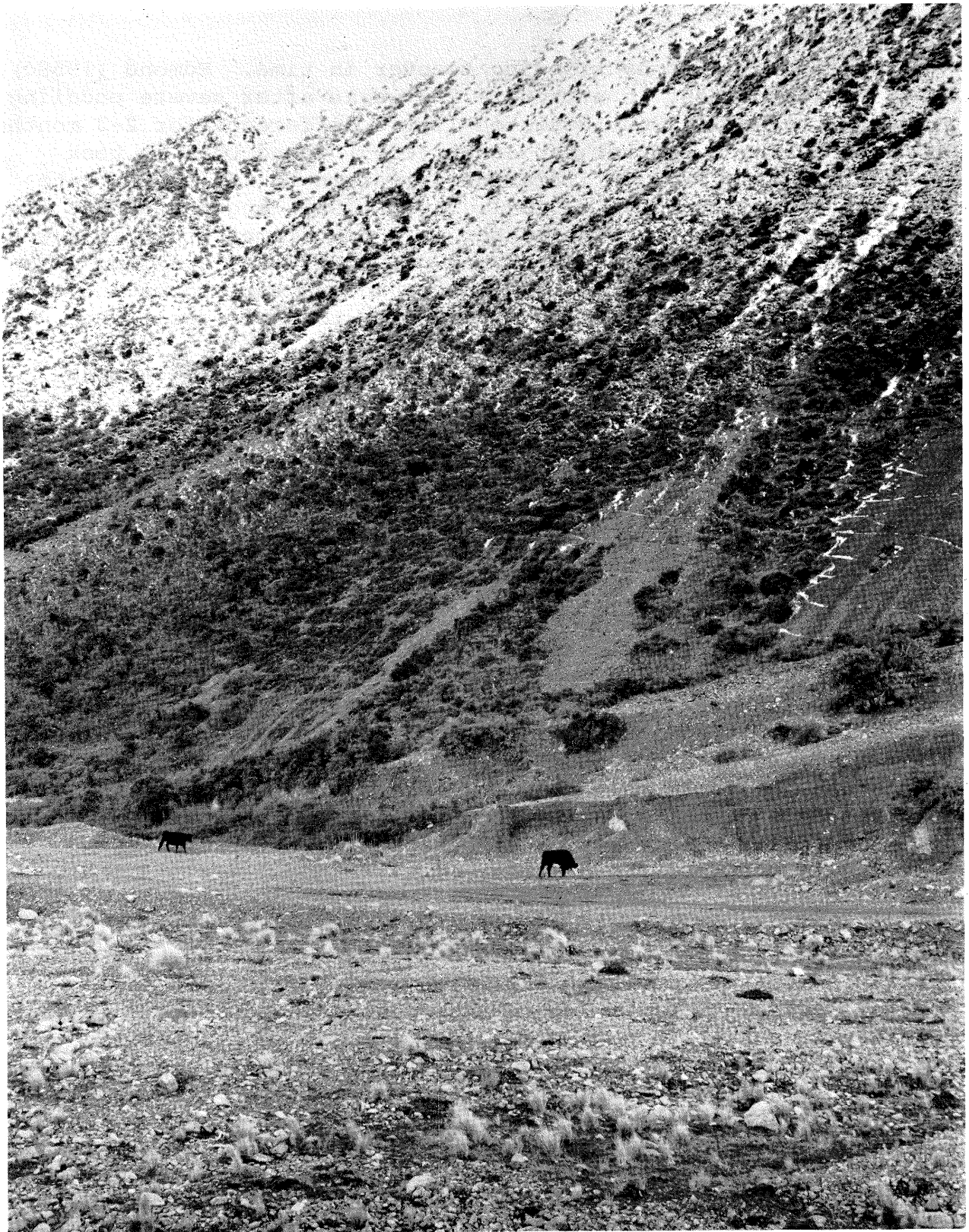
In short, treading can alter not only the bulk density of a soil but also its structure, the amount and distribution of pore space, and hence the capacity for infiltration or soil moisture storage.

Soils compacted by treading recover in time. Edmond (1958c) found an improvement in structure 2-3 weeks after severe puddling, although Gradwell (1960) detected little difference for 2-3 months. On the other hand, Parker and Jenny (1945) found that it took almost five years for infiltration to return to its former rate on a compacted then spelled soil. Lull (1959) suggested that the effects would last for much longer in a dry climate than in a wet one because in the former there was no wetting and swelling which could reduce soil density. The more abundant earthworms and other microfauna in damp soils also contribute to their resilience.

For a parallel reason, D. W. Ives (Pers. comm.) suggests that South Island upland and high country yellow-brown earths are unlikely to suffer badly from compaction. He considers that their structure in general is such that compression would cause the weakly-formed aggregates to break down to plate-like clay-sized minerals. Water entering the micropores between the clay particles and absorbed by the fine humus fragments which are usually present would cause these soils to puff up and resist compaction.

Gillingham's (1964) study of infiltration on a Tekoa soil under tall tussock grassland in the Rakaia catchment tends to confirm that these soils do not have an irreversible compaction problem. Comparing infiltration under (a) ungrazed, (b) depleted after previous grazing, and (c) regenerated snow-tussock vegetation, he found only a slight decrease in macroporosity and no difference in bulk density from ungrazed to regenerated to depleted sites. There was no significant deterioration in infiltration between these sites.

Clearly intensive stocking can cause at least temporary compaction and puddling with decreased infiltration, aeration and available moisture on moist strongly-weathered lowland and downland soils. However, we can reasonably conclude that it is unlikely to result in more than minor changes to the infiltration rate and water storage of soils in the upper catchments of South Island, New Zealand, other than in local areas of high stock concentration or movement. Unfortunately, there is little evidence available about the effect of treading on other hill and high country soils - except that of Nordbye and Campbell (1951) who reported higher infiltration rates under ungrazed tussock cover in yellow-grey soils on the Wither Hills, than under grazed Notodanthonia.



When there is little feed on lower country, cattle will venture onto steep slopes to graze. Here soil displacement by treading can accelerate erosion.

Photo: T.G.M.L.I.

While the overall effect of treading on infiltration may be quite small, it can exert considerable local influence.

Differences in the grazing distribution of cattle and sheep have already been pointed out. From these it can be inferred that cattle treading influences may be found more associated with lower slopes, streams and bogs whereas sheep treading influences are seen higher on the slope range and near camp sites.

5.24 EFFECT OF TREADING ON SOIL STABILITY

There are other ways that treading affects the soil. Ellison, Croft and Bailey (1951) noted that soil displacement on slopes took different forms. Under intensive use, near-level terracettes or stock tracks may be formed, as described so well for New Zealand by Guthrie Smith (1969) at "Tutira". Where displacement is not concentrated in tracks it may be marked by soil accumulation on the up-slope side of perennial plants. Ellison et al suggested that this type of displacement might be much more serious than tracking. Although stock tracks are more obvious, they suggest a measure of stability in that the land has adapted, at least temporarily, to intensive use. But displacement over a wide area can indicate continuing instability.

During and Radcliffe (1962) and Radcliffe (1968) have made studies of animal tracking on New Zealand hill country. They give values to some of the phenomena described by Guthrie Smith. Apparently no New Zealand studies on hill country have carefully examined the significance of the "widespread displacement" described by Ellison et al. It is probable that such movement by stock has contributed to the total downslope erosion in tussock grasslands.

Not only may animals cause downslope soil movement by walking, which is mainly a compression load on the soil, but their emergency braking can also damage the sward and displace soil by applying shear stress along its surface layers. Slick marks are often obvious where animals have slipped when negotiating steep slopes but they may also be found on level ground where surfaces have become greasy. Large numbers of cattle moving down driving spurs or jostling along tracks around the heads of gullies can cause extensive and serious erosion since the downslope line of their skid marks can act as channels for overland runoff flow.

Trolove (1953) formed the opinion that cattle "increased the spread of slides" on steep hill country and found it necessary to run only young cattle on such country. In the Rangitata Gorge,

Acland (Pers. comm.) has considered substituting sheep for cattle on steep hygrous soils because of the damage done by cattle. And of western United States rangeland, Stoddart and Smith (1955) wrote: "Sheep, being smaller than cattle, probably cause less damage to the range by trampling than do cattle, provided they are not bunched. Certainly cattle cause more disturbance on wet hillsides than an equivalent number of sheep, provided the sheep are properly handled."

5.3 INFLUENCE ON WATER

5.31 CATTLE INFLUENCE ON WATER

The rainfall-runoff process is a most complex physical phenomenon. While there are many factors which influence the timing and availability of water from any one catchment, some of the important ones are listed below. Those which could conceivably be influenced by grazing have been marked with an asterisk(*) .

- | | |
|-------------------------------|---|
| Precipitation | - form, type, intensity, duration, time distribution, aerial distribution, direction of storm |
| Interception and infiltration | - vegetation species*, composition*, age and density*, season of year, precipitation characteristics, infiltration characteristics*, percolation* |
| Evaporation and transpiration | - temperature, solar radiation, wind, humidity, soil moisture level, type of vegetation* |
| Catchment geomorphology | - size, shape, slope, orientation, stream density, channel storage* |
| Physical characteristics | - size and shape of cross section*, slope length, roughness, presence or absence of lakes or ponds*, backwater effects, tributary effects. |

This list shows that at the outset there are few opportunities for cattle use or any other land management practice, to influence the rainfall-runoff process. Those features which could be influenced by cattle management are discussed.

5.32 CANOPY INTERCEPTION

When rain, fog, and snow are intercepted by the plant canopy water from them can be lost by evaporation before it reaches the ground. The proportion of annual rainfall which is intercepted and evaporated back to the atmosphere may vary from 10-20 percent (Lull, 1964) to 50 percent (Fahey, 1964), although these figures are really a reflection of the frequency of non-runoff-producing fog and light rain.

On the other hand, on foggy or cloudy sites interception can result in more moisture being trapped and reaching the ground than would have fallen on it directly from the atmosphere if the plants were not there. The absolute values of interception storage have been estimated by Reynolds and Leyton (1963) at about 0.05 inches and calculated by Lull (1964) at 0.06 inches of rain. Burgy and Pomeroy (1958) found values of 0.04 to 0.05 inches in grass.

However, Mark and Rowley (1969) found that defoliation of snow tussock by burning resulted in much less surplus soil moisture below the sward than that below undisturbed snow tussock (short tussock grassland had an even lower surplus than burnt tussock). This indicated that the tall tussock canopy intercepted extra moisture from the atmosphere. Again, Rowley (1970) reported an interception increase of 26% in surplus moisture below the same tall tussock on Rock and Pillar Range, Otago, and an extraordinary 500% gain on foggy Mt Cargill.

Obviously a drastic change in canopy such as that caused by burning would cause a correspondingly large decrease in interception. But it is doubtful if the relatively minor reduction in snow-tussock foliage density due to grazing with sheep or cattle would have significant effects on surface water runoff - particularly since high leaf and litter interception values would be most likely to occur where vegetation is growing on damp sites already having a low infiltration capacity.

Dry plant residues will absorb 250-300% moisture (Soil Survey Staff, 1951). Again, litter interception of precipitation may prevent water reaching the soil and lead to its loss by evaporation (Clarke, 1937). On the other hand it may also trap extra moisture from the atmosphere. Further, any water that is not evaporated and reaches the soil surface is likely to enter it more readily than if there was no litter (Weaver and Rowland, 1952). The soils of the tussock grasslands may carry up to 35,000 lb litter per acre, depending on their state of depletion

(G. T. Daly, Pers. comm.). If this is so, litter interception values could be of the order of up to 0.50 inches. It may therefore be assumed that in small catchments litter interception can be a significant factor in the rainfall-runoff process.

Litter also can play a useful role in dissipating the energy of raindrop impact where vegetation is sparse and thereby reducing the chance of soil particles becoming detached from the soil surface (Osborn, 1954).

Several factors (such as plant type, climate, aspect, degree of grazing, etc.) influence plant decay and net litter accumulation. For example, Johnson (1956) found that as the number of stock increased, the quantity of litter decreased. Some of this decrease is due to trampling and displacement. But, in addition, more light at the base of grazed plants reduces leaf death by shading and hence the supply of litter. (Brougham, 1956; Hunt, 1970). Of course, on the other hand, cattle at high stocking rates can tend to increase leaf and tiller death by increased trampling losses, damage to, and detachment of herbage, as Quinn and Hervey (1970) recorded. However, we have found nothing to suggest that class of livestock influences the rate of litter accumulation. If there are differences between the effects of cattle and sheep, we think that these will be slight, and almost certainly masked by other more important variables.

5.34 EVAPORATION AND EVAPOTRANSPIRATION

Drastic changes in plant type (e.g. from broad-leaved shrubland to a grassland sward) have been shown to influence evapotranspiration losses and hence water yield (e.g. Lewis and Burgy, 1967; Goodell, 1966; Hibbert, 1967, 1969, 1971). However, within a grassland sward there is no reason to believe minor defoliation differences between cattle and sheep will have enough effect on evapotranspiration to alter streamflow significantly.

5.35 INFILTRATION AND PERCOLATION

Soil structure and texture, and the related characteristics of porosity, directly influence the movement of water into and through the soil. The presence of vegetation and especially the characteristics of the root system also have a pronounced effect on porosity. A number of comparative studies have been made of the influence of vegetation on infiltration. Most of these have concentrated on the relative effects of forest, scrub, and grassland on infiltration. Rather less is known about the effect of

different systems of grassland management, although several workers have studied the influence of grazing intensity on ground cover and infiltration rates (Alderfer and Robinson, 1947; Dortignac and Love, 1960; Johnston, 1962; Rauzi, 1963; Rauzi and Hanson, 1966). In general they have shown that the higher the grazing intensity, the less the ground cover and the lower the infiltration rate. However, they did not show how much the reduced infiltration rate was due to the change in density of vegetation or to the degree of soil compaction, at any given grazing intensity.

As we have already seen, compressive or shearing forces can break down soil aggregates and lead to reduced porosity. But this does not necessarily mean that increases in treading load on pasture are always associated with reduced soil permeability.

For example, the improvement of pasture by oversowing and topdressing may improve soil water storage and conductivity. Barratt (1968) has observed that untopdressed soils in New Zealand tend to have weakly-granular structure, supporting swards with shallow, thinly-branched rooting systems. On the other hand, she found that a range of topdressed New Zealand soils had (amongst other attributes) stronger development of granular structure, increased interpedal porosity, more prolific grass-rooting systems, and more abundant earthworms.

In addition, besides more complete cover by the plant canopy, the greater organic matter in the soil is likely to improve its waterholding capacity (Sears and Evans, 1953), plant roots living or decayed may open up soil channels thereby improving infiltration, and the denser sward may reduce soil compaction by animal treading.

The effects of hill pasture improvement were reflected in the results of an experiment at Makara, Wellington (Toebe, Scarf and Yates, 1968; Yates and Scarf, 1969). Here, although sheep production rose with aerial oversowing, topdressing, and subsequent hard grazing from 2.5 to 7.9 ewe equivalents per acre over five years, runoff decreased, porosity and infiltration probably increased, the number of flow days increased and stream flow became more steady with a lower peak discharge.

Obviously a three-fold increase in the amount of treading had less effect on the runoff from the catchment than the changes in soil condition due to pasture improvement. Such an assumed increase in infiltration does not necessarily happen with every



Cattle may often be observed wading around the margins of ponds,
Dunrobin Station, Southland.

Photo: B. Pinney

case of pasture improvement. The amount, type and vigour of vegetation, and soil condition before improvement would determine this. However, the example does show that increased treading does not necessarily have harmful effects on infiltration if it is a consequence of more vigorous pasture growth. There is no obvious reason why this should not hold also in the high country.

We have no evidence that class of livestock is important, that is that cattle will lead to differences in the infiltration capacity of a catchment compared to sheep.

5.36 CHANNEL STORAGE

Channel storage has an important role in modifying flood flows. In a number of small catchments in Otago, cattle have been observed trampling and pugging the beds of ephemeral streams and those with very low base flows (J. P. C. Watt, Pers. comm.; Tripp, 1953). While treading can cause an increase in channel storage capacity, it is doubtful if the change will be large enough to have a measurable effect on flood flows.

5.37 WATER QUALITY

Treading of the stream bed may, however, produce two important side effects. Disturbance of the bed may increase sediment production. This and animal voiding may be detrimental to water quality. These effects will be important where the water is used for household supply or significant for recreational, agricultural and industrial use.

Drainage water from a catchment can of course be contaminated by faecal matter deposited well away from the channel. Organic pollution leads to nitrogen and phosphorus enrichment and the risk of spread of disease-causing organisms.

5.38 PRESENCE OF PONDS AND BOGS

Bogs and ponds within a drainage system generally reduce flood peaks and help to sustain base flow. In the Snowy Mountains of Australia, Costin, Wimbush, Kerr and Gay (1959) noted that the movement of stock into a bog led to a breakdown of the internal bog-drainage system. As water began to flow over the bog surface, drainage channels were formed. In consequence the water table was lowered and the peat began to dry out, and erode, or humify. In New Zealand, Mark (1960) has reported that some of the alpine bogs in the Benger district (Otago), "are in excellent cover condition, but where cattle have had access, trampling has

resulted in the exposure of the peat to erosive forces and thus caused moderate to severe deterioration in their condition and also in their ability to regulate water yield."

Whereas sheep tend to remain on the bog margins, cattle are frequently observed wading up to their hocks through a bog. Similarly cattle may often be observed wading around the margins of small ponds.

Where swamps, bogs or ponds are important in regulating stream flow, or where water quality is important, cattle may be a disadvantage unless their access to these areas is strictly controlled.

Cattle make little grazing use of red tussock except on highly fertile soils. Cattle treading, however, may cause consolidation of organic soils at seasonally-wet places where this tussock persists in montane areas. While this will give sheep access to more palatable herbage, it may be harmful to the hydrologic behaviour of the catchment.

5.4 SUMMARY

5.41 CATTLE INFLUENCE ON VEGETATION

Cattle differ in their manner of eating, in their plant preference and in their grazing distribution to sheep. These factors can be manipulated for better herbage utilisation in a block or for reduced depletion of vegetation in areas subject to erosion.

For nutritional and managerial reasons cattle control of rank unimproved tussock grassland is rarely practicable. At high altitudes the alternative, burning, is too hazardous but below 3000-3500 ft if the risk of accelerated soil erosion can be kept low, burning can be either an acceptable pre-treatment for areas intended for intensive aerial improvement, or a way to encourage cattle to eat snow tussock.

After burning or improvement, cattle and sheep can exert reasonable control at high enough grazing pressure over tussock, scrub and fern.

Cattle trampling can have both beneficial and harmful effects on the sward, firming ground around seeds and plants but also capable of reducing plant vigour and changing composition.

Cattle are often associated with reduced erosion but we find their principal advantage compared to sheep is that they do not prefer to graze steep slopes or high eroded country. On any particular area of land we consider that equal liveweights of grazing animals could well have equal total effects on soil and vegetation regardless of whether they are sheep or cattle.

5.42 CATTLE INFLUENCE ON SOIL

Cattle exert perhaps twice the pressure in pounds per square inch on the soil but may tread on only half the area of soil each day compared to sheep.

In general treading causes compaction of soils, particularly damp but not saturated soils, often leading to reduced infiltration of water, decreased soil water recharge, and increased runoff. However, the effect is temporary, although some soils take longer than others to recover. In very wet soils, cattle can cause soil deformation and puddling and restricted plant growth by reduced aeration. Shear stress by sliding cattle can result in stripping of the sward surface.

The risk of harmful compaction of high country soils by cattle is low - except in small areas near tracks, water holes, and preferred sites.

Treading can cause soil deformation as terracettes. On the other hand, it is more likely that the harmful effects of cattle on soil will be in widespread displacement on steep slopes and in poaching of areas of concentration close to streams and watering points. On steep slopes with damp soils the potential damage cattle can cause may make it wise to consider their replacement by sheep.

5.43 CATTLE INFLUENCE ON WATER

Plant canopies, especially of tall tussock, can have a significant effect on soil moisture by fog interception. However, the effect of cattle grazing on them would be small compared with the drastic reduction in canopy by fire.

Litter also can intercept precipitation leading often to its evaporation back into the atmosphere rather than throughfall to

the soil. On the other hand, infiltration conditions for water which does reach the ground are normally better under litter than without it.

Cattle (or sheep) grazing reduces the accumulation of litter above the soil. By improving light conditions for growth in the sward cattle may reduce the rate of leaf death and hence rate of litter deposition.

Defoliation of a sward by cattle is unlikely to affect significantly the amount of soil moisture lost by evapotranspiration.

While increased grazing is usually related in experimental results with reduced infiltration of water in the soil, the relative importance of soil compaction or vegetation removal has seldom been separated. Pasture improvement can lead to less runoff in spite of higher stock numbers carried.

Cattle treading can lead to stream channel changes, decreased water quality and decreased drainage regulation by ponds and bogs.

The risk of harmful compaction of high country soil is low - except in small areas near tracks, water holes, and preferred sites. Grasmere Station, mid Canterbury - Baldy Hill 5,687 ft in the background. Photo: R. D. Dick



CHAPTER 6

CONTROL OF REPRODUCTION

According to Gregory (1964), the calving percentage has a greater bearing on production cost in commercial breeding operations than any other factor.

6.1 MATING - PRESENT PRACTICE

On only one or two properties with a rather haphazard cattle policy are bulls left with cows all the year round. Normally bulls are kept away from the cow herd for 8-9 months of the year. The date of joining of course depends on when calving is planned for. In the high country it is rare for bulls to be turned out before mid November except on the most favoured properties. December is the popular month. A few higher properties with late pasture growth (including Molesworth) mate their herds even after mid January. Their owners insist that this later mating gives cows the opportunity to be in good condition when put to the bull and hence leads to better calving percentages. Although the late-born calves will look small in saleyards alongside earlier born ones, they should suffer no discount if the property has a reputation for good quality stock. Private sale would, of course, avoid a comparison.

Most runholders like to keep cows and bulls on relatively small blocks at this time, preferably on flats or areas of easy slope to help the bulls' mobility. Usually they mate on the block with the best summer feed for lactating cows. If there are enough paddocks or small blocks, or if the cattle numbers are small, runholders frequently sort their cows up into mobs of about 40, each with one bull. This stops fighting between bulls and means they will give more attention to the cows. However, a lot of paddocks are needed for such small mobs and many runholders compromise by running mobs of 90-120 cows with 3-4 bulls. On steep country where bulls have to work harder to find cows, rates as low as one bull to 25 cows are sometimes used.

It is common practice to check on the cattle every few days during mating and turn the cows down to the bull if they have strayed away.

Bulls are sometimes exchanged between mobs after about three weeks to reduce the risk of dry cows from temporarily or permanently infertile bulls (Acland, 1967).

Identification

Whatawhata Hill Country Research Station has developed a marker harness for bulls to show when or whether cows have taken them (Lang, Hight, Uljee, Young, 1968). This, however, while useful for sorting out late or infertile cows, does not identify infertile bulls.

Stockmen are realising the importance of knowing the individual performance of beef cows and bulls. Unfortunately the difficulty of identifying each animal is a real one which is only now being solved. Several brands of readily visible neck or ear tags are available. One ear tag, in particular, of soft plastic is very good. Freeze branding, too, is good but slow. (This method still carries risks of hide damage, although these are low by comparison with fire branding, Anon, 1969a.) Although American range scientists found human hair dye a satisfactory marker for periods of 60-180 days depending on the season, the practice has not been used here yet (Currie, 1966).

Only when the number of each cow in a mating group is recorded and its breeding performance checked, will it be possible to sort out infertile bulls and cows. At present changing over bulls merely reduces the risk of dry cows. The alternative, leaving bulls each with their own mob of cows, courts the risk of an infertile bull failing to impregnate its mob.

The semen of bulls can be tested during the mating season for sperm vigour. This is difficult for the average runholder to organise but at least one property believes it to be worthwhile (Acland, 1967). Apart from the fact that most runs pay \$200-\$600 for bulls, the cost of keeping a cow for a year is rising. Thus, failure to get a cow in calf is becoming such a significant loss of income that measures like this will no doubt rapidly become more common - as will performance recording for individual cows.

6.2 ALTERNATIVE BREEDING POLICIES

6.21 WHAT TO AIM FOR

The cattleman's aim should be to breed an animal of high fertility that has trouble-free calving with low calf mortality, good foraging ability under hill country conditions, structurally sound in foot and jaw and with the ability to reach

slaughter weights as consumer-pleasing beef quickly and efficiently. (Hight, 1968e; Everitt, 1968; Warwick, 1968a)

The N.Z. Hereford Cattle Breeders Association (1968) list the characteristics which increase the value of a beef animal. They state that a breeder must emphasise all of them to make real improvement:

1. Better conformation, quality or grade for the live animal. This should mean a superior carcass at the works.
2. Increased fertility or percentage of calf crop.
3. Heavy weaning weights or improved mothering ability.
4. Increased weight gain and better feed efficiency under all conditions.
5. More muscling and less wasteful fat in the carcass with sufficient marbling to ensure eating quality.
6. Longer productive life span in the herd.

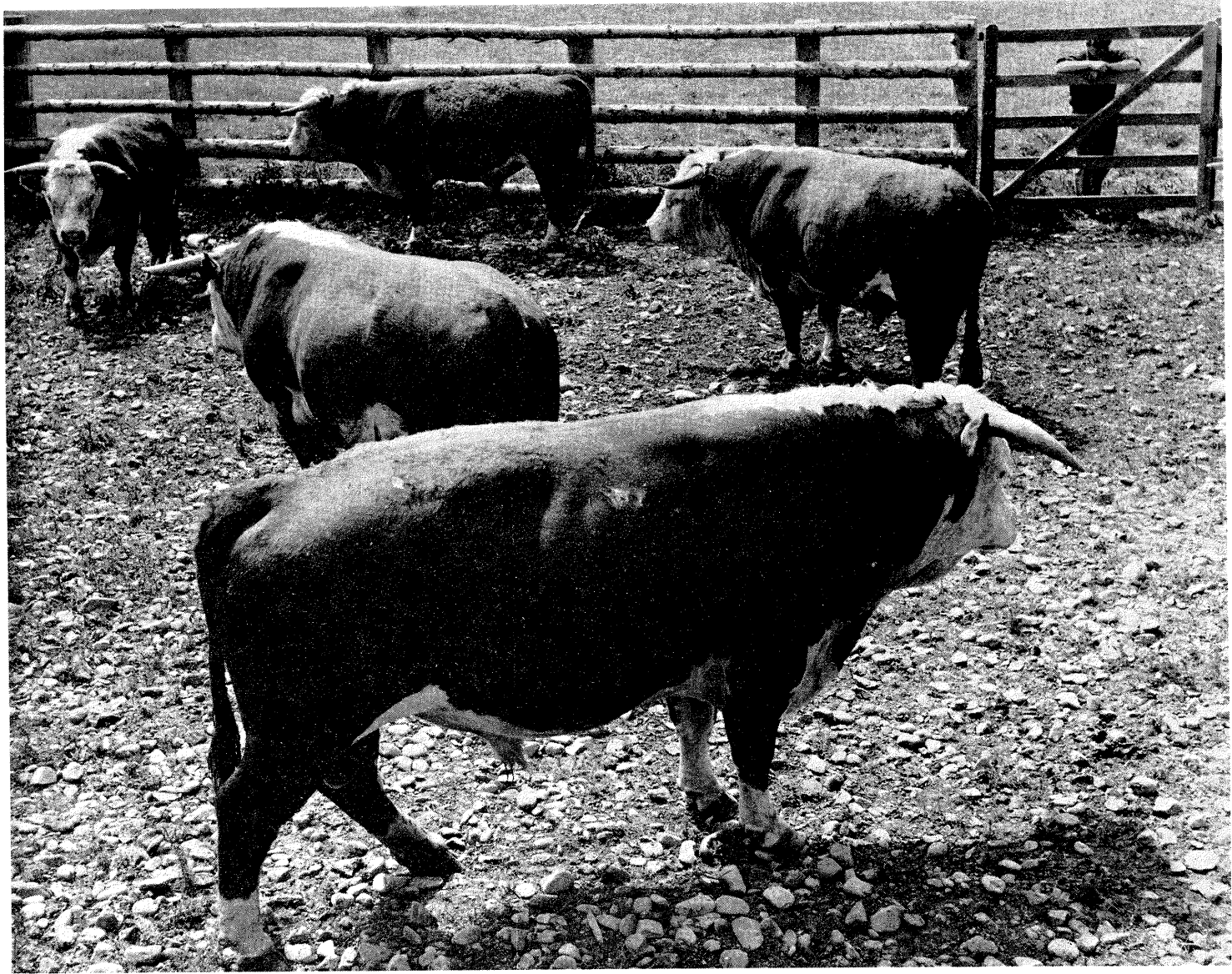
These are praiseworthy objectives. In addition, Chapman (1965) has given the characteristics he seeks in hill country cattle as:

- (a) constitution or ability to thrive under hard conditions;
- (b) foraging ability;
- (c) milking qualities;
- (d) early maturity;
- (e) conformation.

Although not included in this list, "good bone" is a characteristic keenly sought after by most breeders.

Let us briefly discuss these requirements in relation to the region.

Constitution (or adaptation to cold, and often to low quality feed) and foraging ability are essential for cattle



Run bulls prior to going out with the cows. Dunrobin Station, Mossburn, Southland
Photo: B. Pinney

expected to survive and grow in a severe climate on extensive range country.

Good milk yield permits fast calf growth rate before weaning and the winter.

Early physical maturity, a characteristic of the British beef breeds, is desirable where winter conditions are harsh and pasture growth indifferent in all seasons except spring.

"Good bone" in itself has little virtue - the size of bone being partly a characteristic of the breed and stage of growth. But if "good bone" is used to mean large size of animal at a given age then this is greatly to be sought after.

Conformation, however, is a characteristic difficult to define. Its importance is often overrated except in so far as it is a productive feature related to physical soundness and hence productivity.

6.22 BULL SELECTION

Gallagher (1960) makes five salient points about choosing a bull capable of leaving highly-productive progeny:

1. Select from a stud with weight-for-age records.
2. Select from a stud where the cows are run on cattle country as a commercial herd.
3. Select from the six bulls with the best weight-for-age records.
4. Examine them for bad feet or jaws, temperament (which is quite highly inherited → it is believed that the more docile the animal the quicker the fattening and the better the carcass quality) and lastly conformation.
5. Be ready to give time to selection and be willing to pay more for the good bull.

These points are quoted because of their importance in future run productivity. The word "herd" could in each case be used instead of "stud" for studs do not have sole right to high-producing cattle. Selection in most cases has been on points (2) and (4), although feet have often received less than

due attention. The importance of (1) and (3) is only slowly being realised. Not all high-gaining bulls leave high-gaining offspring but selection of bulls for this characteristic is well worthwhile (Barton, 1962).

For instance, the heritability of weight gain on pasture is about 30%. That is, (ignoring the effect of the cow), if a bull has a weight-gain rate of 1 lb a day above average, his progeny could be expected to have weight-gain rates of 30% of 1 lb or 0.3 lb per day (9 lb per month) above average.

Many breeders have growth-rate figures available but they are useful for comparison only within each herd. In time the seller of calves, or of store stock, will trade not only on the appearance of his products but also on their genetic inheritance.

Clearly, whether one buys from a registered stud or selects a bull from an unregistered herd is a matter of choice. The potential for leaving plenty of top-quality progeny should be the deciding factor - not the bull's name.

6.23 THE HERITABILITY OF CHARACTERISTICS

Heritability is the amount of variation between animals that is transmitted to their offspring. The heritability of characteristics of cattle has been listed by Gregory (1964) and by Warwick (1966, 1969). Two extracts are presented below. Warwick (1969) notes that his data are "summarised from many published sources". Wider ranges indicate characteristics for which fewer estimates have been made and for which probable average heritability is less widely known.

TABLE 17

Heritability of Some Characteristics of Beef Cattle

Characteristics	Level	Approx. av. heritability (%)	
		Warwick (1969)	Gregory (1964)
Calving interval (fertility)	Low	0-15	10
Birth weight	Medium	35-40	40
Weaning weight	Medium	25-30	30
Weaning conformation score	Medium	25-30	25
Maternal ability of cows (including milk production)	Medium	20-40	40
Steers or bulls fed in feedlot from weaning to final age of 12-15 months			
Feedlot rate of gain	High	45-60	45

Character	Level	Approx. average heritability (%)	
		Warwick (1969)	Warwick Gregory (1964)
Efficiency of feedlot gain	High	40-50	40
Final weight off feed	High	50-60	60
Slaughter grade	Med. to high	35-40	40
Carcass grade	Med. to high	35-45	30
Av. rib eye area per cwt. carcass weight	Med. to high	30-50	70
Fat thickness over rib per cwt carcass weight	Med. to high	25-45	-
Tenderness of meat	High	40-70	60
Summer pasture rate of gain of yearling cattle	Medium	25-30	30
18-month weight pastured cattle	High	45-55	-
Cancer eye susceptibility	Medium	20-40	30
Mature cow weight	High	50-70	-

This table shows that some characteristics such as mothering ability of the cow and hence growth rate of the calf are strongly inherited. The farmer can expect to get good results by selecting for them. Also, Brumby, Walker and Gallagher (1962) found that the progeny of fast-growing bulls have passed on to them about 25% of the superiority in growth rate which the bull had compared to his herd mates. On the other hand, fertility is poorly inherited and selection or culling for this will show only slow improvement.

How to Estimate the Performance of Progeny from Their Parents

How does one calculate the combined effect of the inherited performance level of a cow and of a bull on their calf? Suppose, for example, that the average weaning weight of calves from a herd is 500 lb. Now again suppose that only those heifer calves are kept for replacements which weighed at least 550 lb at weaning (or 50 lb above the average) and that these are mated with a bull which weighed 600 lb (or 100 lb above the average). Since both the heifers and the bull influence their offspring, their calves would theoretically have an advantage over the herd average of half their parents' combined advantage or half of 50 lb + half of 100 lb = 25 + 50 = 75 lb if weaning weight was 100% inherited. But weaning weight has been found to have a heritability of about 30%, not 100%. Therefore the actual advantage which the new calves should have in weaning weight

over the rest of the herd is not 75 lb but 30% of 75 lb or 22½ lb and they should therefore weigh on average about 522½ lb. Now the new average is 522½ lb and when these calves in turn are mated to an above-average bull, their offspring will be even heavier.

Repeatability

Some tests refer to "repeatability" in breeding. This is a calculation of how much variation there is in a particular factor measured several times - for instance in the weaning weights of calves from a certain cow.

6.24 CROSSBREEDING

Crossbreeding has been found to increase the performance of young beef cattle (Mason, 1966; Warwick, 1966, 1968; Veterinarian, 1967c, 1969). However, some characteristics are affected more than others. Warwick (1966b) pointed out that the greatest increases from controlled crossbreeding were in factors that were of low heritability. For example, the rate of weight gain of progeny is not improved nearly as much by a crossbreeding programme as are poorly-inherited factors such as fertility and will-to-live. Mason (1966) after reviewing all the principal crossbreeding experiments agreed with this but added that there was a significant increase in the performance of crossbred progeny over their straightbred parents when the progeny themselves had calves. The phenomenon of increased performance in first-cross cattle is called hybrid vigour or heterosis.

Warwick (1968b) has reviewed the results of American crossbreeding experiments between Herefords, Shorthorns and Angus cattle. When crossbred calves from straightbred parents were compared to straightbred calves, the crossbreds, on weighted average, had 1-3% higher calf drop, 3% higher weaning weight (over 12/13 experiments) and 2-4% higher post-weaning rate of gain. There was only a slight advantage (0.7% in feed efficiency to the crossbreds since their larger size would tend to cancel out the advantage of faster rate of growth. Crossbreeding showed no significant advantage in carcass grade, composition, palatability or conformation. Crossbred heifers tended to have earlier first heats.

When crossbred cows were compared with straightbred cows the results tended to show that the crossbreds raised 4.3% more calves whose weaning weight was 5.6% higher. Indeed, Turner, Farthing and Robertson (1968) achieved an average 9.6% greater

calf crop with crossbreds than with purebreds.

Ocasionaly in the experiments reviewed by Warwick a top straightbred animal would exceed the crossbreds for some particular characteristic but in general, taking calf crop, weaning weight, post-weaning gain and carcass value together, the crossbreds were ahead and the top crossbreds well ahead of the top straightbreds.

Barron (1967) also confirmed the higher performance of cross-bred (Hereford x Angus) cows and noted that they had better mothering ability, were healthier and had more vigour in periods of stress or under adverse conditions than the straightbreds in the experiment.

As far as the different breeds are concerned, Warwick (1968b) found that none of the straightbred cattle of the British beef breeds - Angus, Hereford or Shorthorn - involved in the experiments covering over 5,000 cattle, showed consistent advantage in the different tests. In fact Mason (1966) found greater variability between trial results than between breeds. There did, however, seem to be real hybrid vigour between some crosses (such as Brahman x British breeds) but little between others (such as dairy breeds x British breeds). The superiority in reproductive performance of crosses in which one parent was a Brahman was confirmed by Turner et al (1968), (i.e. Indian species x British breeds).

Obviously the extra advantage to be got from crossbreeding depends on the particular virtues of the parents. For instance, the weaning weight of calves from good-milking Friesian cows is similar whether they are sired by a Friesian or an Angus bull. However, if the cross is reversed and the cow is Angus, even if the bull is Friesian the weaning weight of the calf is lower (G. K. Hight, pers. comm.).

Similarly, Warwick (1968b) reported that young cattle out of cows mated to Charolais bulls had superior growth rate and leaner- but lower-grading carcasses than cattle out of cows of similar breeds not crossed with Charolais bulls.

It must be remembered that the greatest effect of hybrid vigour is shown by first-cross animals. But if these crossbred animals are then mated with similar crossbred animals the advantages become more dispersed with each successive cross. In fact first-cross x first-cross breeding reduces the progeny-performance levels to only half the increase the original first cross had when compared to the straightbred. Thus crossbred animals are not necessarily any better than straightbred



The extra advantage to be got from crossbreeding depends on the particular virtues of parents. The first generation cross usually have more hybrid vigour than subsequent generations.

Photo: J. E. N. Quaife

animals. It depends not only on the characteristic under discussion but also on whether the crossbred is a first cross or later or just the product of haphazard mixed breeding.

A crossbreeding policy in a herd poses organisational problems. Either straightbred replacement heifers must be bought in to maintain the purity of the breeding herd or two or more separate herds must be kept with crossbred cows mated to bulls of a different breed.

Mason (1966) believed that backcrossing or crisscrossing was needed to lift performance above that of the straightbred. Warwick (1966) was sure that a systematic rotational type of breeding programme in larger herds could effectively raise the level of production of poorly-inherited characteristics. In fact, he suggested that crossing among the British beef breeds could lead to 12-15% higher weight of calf weaned per cow over the herd.

Crossbreeding obviously has advantages, particularly if the sire or dam is chosen for some special ability, such as the Friesian for milk production. The resulting gains are worthwhile even if there is no obvious extra advantage due to hybrid vigour. Crossbreeding is therefore useful as a means of getting more and faster-growing sale stock. However, one important point must be emphasised. Regardless of a crossbred animal's inherited potential for fast growth or any other characteristic, unless it has sufficient feed available to allow it to satisfy its appetite and express that potential it will have no advantage at all compared to the straightbred. It may even perform worse. The same rule applies to superior straightbred meat-producing animals such as the Charolais compared to their slower-growing rivals.

Clearly the parents in the high-country breeding herd may well play their most useful role by remaining the source pool of straightbred cattle.

The straightbred parents of a cross must be of high quality if any crossbred progeny are to be of high quality also. This is especially important for highly-heritable factors such as weight gain.

6.25 INBREEDING

Several studies have reported that inbreeding has had adverse effects on a number of performance characteristics.

Burgess, Landblom and Stonaker (1954) found that it depressed gain before weaning and weight for age. This was confirmed by Swiger, Gregory, Koch and Arthaud (1961) who also observed that inbreeding depressed birth weight weaning weight, post-weaning gain and feed intake.

6.3 MATING HEIFERS AT 1½ OR 2½ YEARS OLD

Most runholders are strongly opposed to mating yearling heifers and the harder the country the stronger the opposition (Johnson, 1953, Bain, 1965). They hold the opinion that even if the cow and calf survive parturition, the calf will be small, both will need more feed and attention, and the cow's growth will probably be permanently stunted. Occasionally runs which have tried the practice have ceased it. One of these had successfully mated young heifers for several years, then in a particularly long and cold winter lost over one-third of them at and near calving.

However, a handful of easier runs do mate heifers without unusual trouble. These runholders realise the advantages of a cow not only having an extra calf in her lifetime but also of reducing the time she spends as a non-paying passenger on the property. In fact one runholder went so far as to suggest that normal 2½ year mating could be detrimental to a cow's milking ability and breeding life (Early, 1968).

Barton (1961), Bellows (1968) and Donaldson (1968) each emphasise that cows calving first as two-year-olds have an average lifetime production greater than those calving as three year olds. That is, they wean more than just one extra calf.

Barton (1966a) reported two-year-old first calvers having a subsequent lifetime production of 9.1 calves weaned compared to three-year-old calvers with only 7.9 calves weaned.

Although there may in practice be some difficulty getting young heifers in calf, Bellows (1968) showed that heifers mated but failing to conceive in their first breeding season were potentially poor producers anyway.

However, there appear to be a number of conditions for successful heifer mating:

(a) Feed heifer calves well to get them to an acceptable size for mating

An Australian property with cattle scales for weight-gain selection also uses them for checking whether heifers are heavy enough for mating. It puts to the bull only those which are over 600 lbs liveweight at 15 months of age (Vine, 1966). This minimum weight has been endorsed by Barton (1964) and Warwick (1966) although Diggins and Bundy (1962) suggest not less than 850 lbs! This last figure is patently too high and 500 lb may well be big enough for heifers of small breeds such as the Angus. There is obviously no one minimum weight for all cattle. Young (1967) found that the bodyweight of a heifer at first joining seemed to bear no relation to its ability to become pregnant. Clearly, however, it must have reached puberty first and there are several factors which influence when it does. Bellows (1968) has emphasised the importance of good feeding so that heifers reach puberty quickly and can thus conceive early in the breeding season. If the heifer conceives and calves late, her next and later conceptions may also be delayed. He has shown that heifers which conceive early continue to do so.

Bellows reported a breed difference in the age at which heifers reach puberty. In a comparison between three breeds he found that Angus reached it first, Charolais next and Herefords last, although Charolais were the heaviest when they reached it. The Angus would therefore appear to be the best suited to early mating of these three straight breeds. However, Bellows also stated that in general crossbreeds reach puberty earlier than straightbreeds. For example, J. Acland (Pers. comm.) found that Angus/Charolais-cross heifers took the bull at 500 lbs liveweight whereas straight Angus heifers did not.

(b) Use a younger or lighter bull, such as an Angus or even a Jersey

This is commonsense practice for smaller calves and less calving trouble. Young (1970), however, found no tendency for different bulls of the one breed (Angus) to leave different sized calves.

(c) Mate early

Mate early so that the heifers give birth to lighter calves in the early spring. Young (1970) found that with Angus heifers as the season advanced, the mean calf birth weight increased by 1.4 lb every 10 days. With three-year-old Devon cows, calf birth weight increased by 2.0-2.4 lb every 10 days (Young, 1968)!

- (d) Feed the pregnant heifer well through the summer and autumn

Warwick (1966) states that after mating, pregnant heifers should be fed to gain enough weight so that they go into the winter at 835-850 lbs (a 250 lbs increase in weight over the summer and autumn). (The figures probably refer to Herefords.) They should be held at this and not allowed to gain or lose too much weight from then on through the winter. Such careful feeding will keep the heifers in good condition and the calves reasonably small at birth. Poor feeding may also restrict the growth of the pelvic brim (Young 1970) and pelvic girdle size is important for easy calving. And, as with all pregnant stock, so too with first-calving heifers prenatal exercise is most important.

- (e) Keep the calving heifers near the homestead so that they can be given help if necessary
- (f) Feed the newly-calved heifer very well while she is suckling

Poorly-fed heifers may not come in heat and therefore fail to calve next year. This is a big risk where feed supplies are less than adequate (Young 1965). Good feeding also produces good calf growth. Two-year-old Friesians at Whatawhata Hill Country Research Station have reared calves weighing 350 lbs at 4½ months of age (G. Hight, pers. comm.).

Warwick (1966) observed that heifers mated as two-year-olds often did not catch up in size to those mated as three-year-olds until they were six years of age, but as already reported, the former's lifetime performance was greater.

All the above conditions, except the choice of bull breed, are easier to achieve on a hill-country than on a high-country property. But we believe the practice of early mating has many inherent advantages and will become much more popular as the pasture on hill and high country runs improves.

6.4 ARTIFICIAL BREEDING

It could be reasoned that the beef industry would do well to follow the lead of the dairy industry and use top sires to improve the standard of progeny by artificial breeding. Struthers (1968) pointed out that this was, at the time, impractical for at least two reasons:

- (1) It was difficult to know when hill-country cows were on heat;

- (2) Even if this was known, much labour would be involved in the daily rounding up and inseminating of the few cows found to be ready.

He suggested that the technique of synchronising heat periods by using hormones did, however, give some promise of future developments (although there has been some doubt about the conception rate achieved with it at present).

It is a reflection of the surge of interest in artificial breeding that these limitations to its practice are being overcome. For instance, the Whatawhata mating harness marks cows in heat when used on a teaser bull (Lang and Hight 1969). By culling cows which are slow to conceive, the mating and thus inseminating period can be shortened. Mating in paddocks makes it easier to check and pen cows ripe for insemination, and farmers can become proficient themselves in implanting the freezer-stored semen capsules. Two men can cope with an artificial breeding programme for a maximum of about 350 cows ("Norwester" 1970). Nevertheless, artificial breeding poses many problems in beef herds. If marked cows are drafted out from the mob every day not only does the daily drafting upset the cows and calves but also particularly the calf of an oestrus cow kept apart from the rest of the herd for 24 hours so as not to interfere with the work of the vasectomised marker bull running with it. Cutting out of oestrus cows and their calves from the herd by stockmen on horseback is much sounder practice but needs skilled and careful riders. For all its advantages, the organisational problems with artificial breeding on hill or high country properties are such that it is unlikely to become common practice for many years, except on a few intensive beef-raising properties or in nucleus bull-breeding herds. However, artificial breeding over the top 10% of a herd may be worthwhile.

6.5 AUTUMN OR SPRING CALVING

Advantages and Disadvantages

No high-country runholders in the South Island have yet adopted an autumn-calving policy. Occasionally, by accident, a runholder has to put one or more bulls out so late that some of his cows calve in late summer but the practice is uncommon. There is, however, a fair amount of discussion on its feasibility.

The advantages and disadvantages of autumn calving have been set out by Skyrme (1965) and by Longwill (1966) as:

- (a) less metabolic disorders, (this is now found to be unproven);
- (b) cows are calving at a slack time for labour;
- (c) cows are more ready to mate;
- (d) they have higher calving percentages;
- (e) cows are more mobile to clean up winter roughage than when heavily pregnant;
- (f) suckling calves winter well and can then be weaned on to good spring and summer grass growth;
- (g) there are more cattle to graze spring growth;
- (h) well-grazed pastures grow better after autumn rains;
- (i) larger calves top sales;
- (j) calves can take full advantage of two maximum-pasture-growth seasons before slaughter.

The disadvantages include:

- i. the cow's nutritional requirements do not coincide with the pasture growth pattern;
- ii. calves may be difficult to keep going over the summer period and may even have to be sold in severe drought;
- iii. a maintenance ration may be needed in the late winter.

Although it is unlikely that the need for very early weaning would arise with our present spring calving, it could have a place if autumn or out-of-season calving became necessary.

Thomas and Durham (1964) found that calves could be weaned from cows at five weeks of age and self-fed on an all-concentrate ration. They had very good feed conversion rates of 4 lbs feed per pound of liveweight gain up to 400 lb liveweight.

Mueller and Harris (1967) pointed out that with autumn calving the pregnant cow could be turned out to rough grazing during the summer, thus sparing better feed supplies for other stock. However, the authors noted that cows suckling calves tended to be poor travellers and needed to stay close to water.

Work by Joblin at Ruakura (Anon, 1968a) compared the growth rates of autumn-born to spring-born weaners on good pasture. That author found a slight advantage to the spring-born cattle by 18 months of age at slaughter. He observed that cows with autumn calves needed more feed in the first winter and the yearlings suffered a check due to feed shortage in their second winter. He found no features of autumn calving which recommended its widespread adoption.

Alternative Systems

There are several possible alternatives to spring calving.

- (a) Calving in the November-January period. This would bring problems of holding back the pregnant cows' condition while feeding on good spring/early-summer pasture.
- (b) As cattle numbers rise to tax labour resources, it could be feasible to calve part of the herd in the spring and part at another time of the year. Bull costs would be halved by using them twice, and labour and killing spread (Anon, 1968b). But the harder the winter the earlier the autumn calving should be.
- (c) Calving in mid/late winter instead of in spring. Willhite and Grable (1966) point out the advantages of the calf being big enough to eat grass when it comes away in the spring, and also to make full use of the dam's milking capacity at the height of the spring flush. More shelter (they recommend moveable pole-type structures) and labour would be needed.

The Place of Autumn Calving on Run Country

The more attractive features of the autumn-calving policy would appear to be, first, having both cows and calves to graze on spring/early-summer pasture growth and, second, the opportunity to sell 20-24 month old beasts after two good pasture-growth seasons.

However, we are of the opinion that while this practice may

bear testing on foothill runs normally selling fat-stock and having good summer rainfall and winter-feed supplies, it has less place here than in the North Island because of the lower and less reliable autumn pasture flush. In particular we do not consider it has any place yet on runs which produce calves for sale as weaners. It is cheaper to fit requirements and numbers to seasonal pasture growth.

Calf losses, also, could be high in a long hard winter unless there was especially good feed for the cows.

This extra-early calving would be possible only where extra winter feed can be grown. It would appeal to the breeder/fattener rather than to the breeder of calves or store cattle for sale. Although larger calves do fetch higher sale prices, fluctuating calf prices and the uncertain premium per extra pound, carry little incentive to invest in extra facilities and extra feed to market bigger calves. When, in time, the calf breeder is paid on sale weight and can calculate the economics of selling calves of different weights (as we believe will happen) the points for and against will be clearer.

6.6 SUMMARY

Bulls are usually joined with cow herds about December to give calving in September/October. Although autumn calving has proved satisfactory on some North Island farms, there do not seem to be enough advantages to recommend its adoption in the South Island run country. There could be a case on some properties for its partial introduction, however, or variation from present calving dates.

Heifers are normally mated at 2½ years of age but there are many advantages with mating at 1½ years if the heifers can be fed well enough to be 600 lb or more when put to the bull.

The breeder's aim should be to produce an animal of high fertility that has trouble-free calving, with low calf mortality, good foraging ability under hill country conditions, structurally sound in foot and jaw, and with the ability to reach slaughter weights as consumer-pleasing beef quickly and efficiently. Good constitution is also needed by hill-country cattle. The main misunderstanding between breeders and scientists seems to be on the importance of external conformation. It is agreed that it is important for breed improvement and physical soundness but there seems to be little relationship

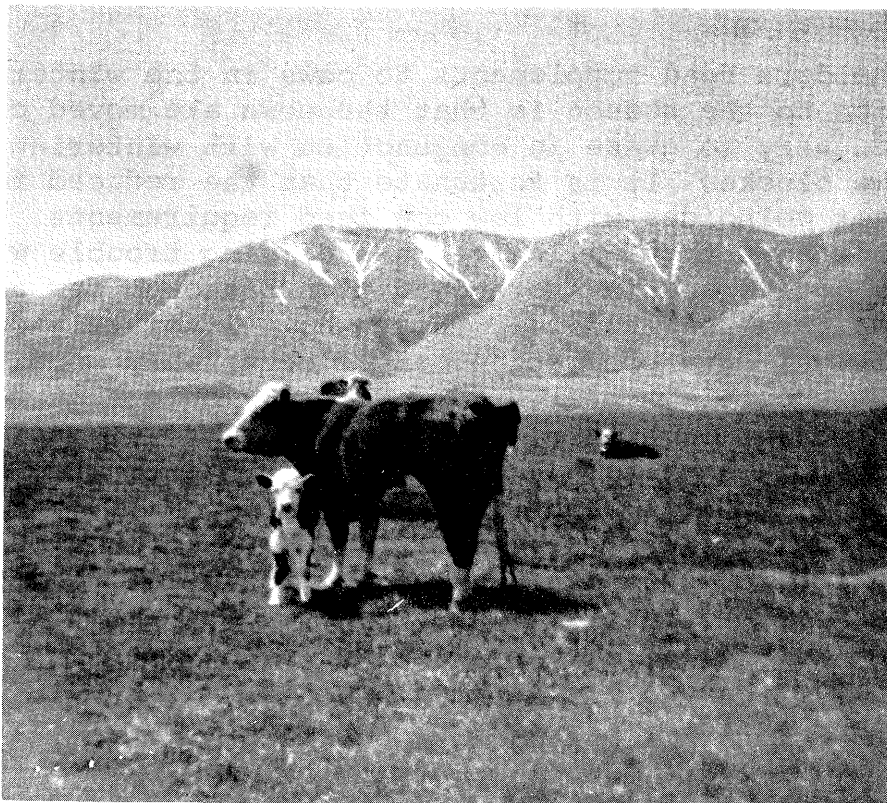
between live appearance and meat quality or performance.

Achieving characteristics in young stock which are important to meat producers, such as high growth rate and fertility, can be helped by choosing good bulls but they are at present chosen on appearance rather than performance. Many difficulties will have to be overcome before artificial breeding is feasible in the run country.

The characteristics of cattle vary in their heritability. Meat tenderness is very high, mothering ability and weight gain rate moderately high and fertility low. However, crossbreeding is a proven way of increasing factors which are only poorly heritable by straight breeding. Hybrid vigour has been found to give significant increases in the production of progeny compared to their purebred dams and sires, but the quality of the latter must be high to start with.

Good milk yield permits fast calf growth rate before weaning.

"Glenrowan", Kyeburn, Central Otago.
Kakanui mountains in the background. Photo: Annette Greer



CHAPTER 7

WINTER FEEDING

7.1 PRESENT PRACTICE

7.11 CALVES

In brief, calves are usually weaned in late autumn, and wintered as a separate mob either on paddocks or more often on a warm hill block (probably one sown and topdressed). Whether the calves will also get supplementary feed depends on the quality of the pasture, the access to the block, and whether such feed is grown.

Calves are usually started on supplementary feed right after weaning in April-May unless there are good grass paddocks available. If there are, supplementary feeding is often delayed until late May-June. Feeding continues until pasture growth is well away from mid-September onwards, depending on the location of the property. That is, calf feeding can last for up to 150 days and is frequently of 120 days duration.

7.12 COWS

Few runholders feed supplements to cows in the winter. The main concession to the season is that the cows are moved on to lower sunny country to graze in conjunction with wintering sheep - usually on ewe blocks. It is fortunate that the reduced forage supply of winter coincides with low cow feed requirements. Most runholders know that they will have less calving trouble with cows that are active and in store condition although few are prepared to do them really hard. Those who deliberately do so find that survival and production can be remarkably good. Runholders whose cattle winter hard, generally hold that their cows must be brought back into good condition through the summer and kept that way into the early part of the winter. They can then be turned out on hill country even up to 4,000 ft to winter. (Chapman, 1954; Bain, 1965) Runholders who successfully calve their heifers at two-years-old, instead of the normal three-years-old, are certain that calving troubles with immature cows are much less if they are left to fend for themselves "on the hill" for at least the latter part of the winter. But in the opinion of one runholder, if, through a particularly late, cold, early spring, cows are really starving in the last 2-3 weeks of pregnancy they may then slip their calves (I. Ivey, pers. comm.).

Therefore it seems that there is a limit to how hard cows can be done at this time. Also, cows which are in good condition during the winter may be able to forage more actively than those which are not (P. Ensor, pers. comm.).

Overfeeding of beef cows in the winter is more often a management fault of those who are new to cattle. We know of several cases where this has been followed by troublesome calving with losses of both cows and calves at birth. This is particularly so with heifers at first calving, especially if they are two-year-olds. One runholder said he, "literally calved his too-well-fed heifers with a Landrover and a rope" - not all successfully.

7.13 STEERS

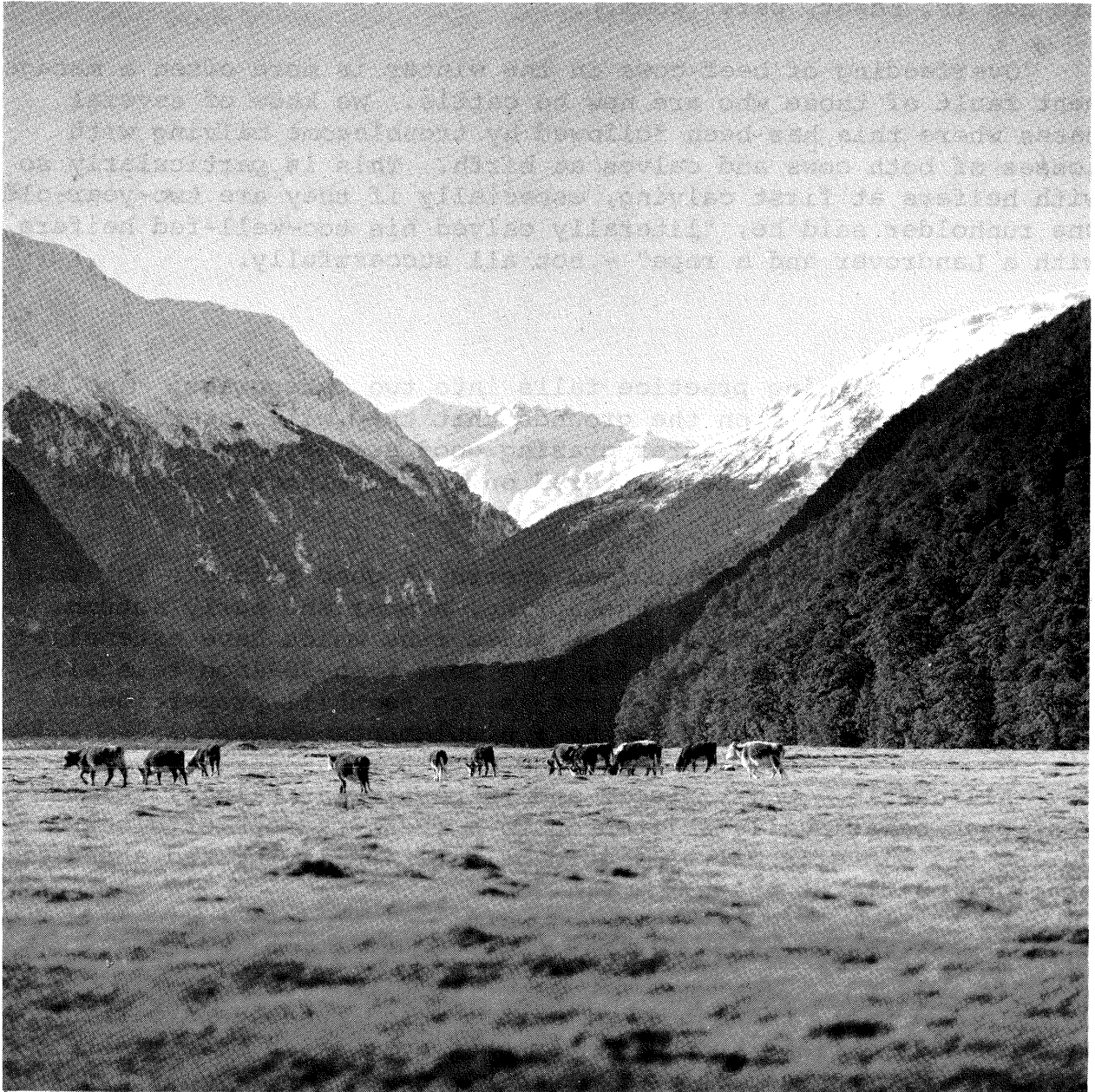
Steer wintering practice falls into two categories. One is to forget about them on the grounds that they will later be sold store or forward store after grazing good summer pasture. In this case steers are then wintered on poorer winter blocks than cows.

The other system is to feed steers on good paddocks for sale in prime condition through the spring, summer and early autumn. This policy is limited mainly to those runs which have extensive grassed flats or downs, usually in a more-than-30-inch rainfall at up to 1,500 ft altitude - that is, to foothill properties. Some hay is then normally fed as a supplement.

All cattle - cows, steers and in particular calves, seem to do best when occasionally shifted on to a fresh paddock or block during the winter. Calves should be rotationally grazed ahead of older cattle or sheep.

7.14 GENERAL PRACTICE

In the past, the number of cattle which runholders carried was often determined by the number that could find sufficient rough grazing to keep themselves in reasonably good condition through the winter without supplementary feeding. It has not been usual even to shift them to a new block near calving. In fact, as at other times of the year, on most runs they have been left to make their own arrangements for food. The runholder became aware of them again when the first calves showed up in the spring. This reflects the fact that on all but a handful of runs with big herds, cattle until the last year or two have been an often-irritating sideline for runholders.



Cows which are in good condition during the winter may forage more actively than those which are not. West branch of the Matukituki River, Mt Aspiring Station. Photo: J. G. Hughes

But it is in the field of wintering cattle that the most interesting and useful research for runholders has been done in this country. On the feed requirements at this time of the year and their cost will depend the feasibility of running enough cattle to exploit summer pasture growth. Profits can be made or lost on the cost of winter feeding.

If cattle numbers increase, the limit of natural winter grazing resources will soon be reached on most runs. Then runholders will have to pay much more attention to cattle nutrition and the provision of winter forage or supplements.

7.2 SUPPLEMENTARY FEEDS

7.21 HAY

Although hay varies widely in quality, its digestibility is usually low because of its fibrous nature. Intake therefore may be restricted and unless there is a high proportion of leaf it provides merely a maintenance ration.

Good hay is the most common fodder for calves and is usually fed at the rate of 1-1½ bales (60-90 lb) per week per calf, with pasture runoff (cost 1c lb; 10c per day). Daily feeding is usual although feeding every two days or even weekly may not be harmful.

Tara Hills Research Station (N.Z. Dep. Agric. 1968, pers. comm.) found that one group of Galloway x Angus calves gained 73 lbs of liveweight when fed 15 lbs of lucerne hay daily over the winter. But another group lost 21 lb when fed only 8 lb hay daily. However, compensatory growth by the poorer-wintered calves after hay feeding finished reduced the difference from 94 lbs to 52 lbs 11 weeks later and to only 44 lbs by the following May. In fact the steer calves recovered better than the heifer calves to be only 24 lb less than their well-wintered colleagues by May (G. Scales, pers. comm.).

The above experiment shows that 10-12 lbs of good hay a day with runoff may be adequate for a maintenance ration with a little gain for beef calves in a high-country winter. Indeed Tara Hills have recently wintered 450-lb calves satisfactorily on 10 lbs lucerne hay per day alone.

However, since heifer calves appear to show less compensatory growth in spring and summer than steer calves it may be better

to feed them 15-16 lbs of hay per day in winter if they are to be put to the bull at 1½ years old (G. Scales, pers. comm.).

Hay is usually fed out on the ground but a few properties use open or covered racks for hay. This is more often the case if it is being fed with turnips. One North Canterbury runholder has an excellent self-feeding rack installed under a high-floor hay barn. Forty calves eat 10 bales of hay a day from it (Grigg, 1965). Another feeds from covered racks and finds calves thrive on 16 lbs lucerne hay a day or 12 lbs hay plus saved grass (Anon, 1968d).

Cows need at least half a bale of hay per day each if there is little other feed. However, A. Bain (pers. comm.) holds the opinion that since hay would cost up to \$25 per cow for a 100 day winter it places a heavy charge against receipts for calf sales. He considers that every effort should be made to winter cows without expensive supplementary feed.

Some runs feed out hay or silage to adult cattle in the winter on rough or fern-covered blocks to let the stock trample and open up unwanted vegetation. If the hay was cut after seeding, feeding out is a good way to spread grass and clover seed. However, feeding out hay to run cows on lower hill slopes near the home-~~stead~~, although saving time, tends to bring them off the hills where there may be some grass, on to the flats where there may be little and they merely wait for hay.

Hay varies widely in quality, depending on the stage of growth at which it was cut, the proportion of clover leaf or lucerne leaf in it, and the weather conditions while it was curing.

Calves are normally fed good-quality hay but second-grade meadow hay or even ryegrass, oat or barley straw (with grain or other supplement) is satisfactory for older cattle. When cattle have only straw to eat, a nitrogen supplement and energy supplement may be needed.

Will Calves go out After Hay?

Runholders often argue against holding calves in and feeding them supplements through the winter. They say they will not afterwards go out willingly to fossick for themselves on the blocks. They also say that even if the calves do go out after the winter, they may return again as yearlings to be fed in the following winter.

This may be true where the tussock country is unimproved. But if clover and grass are successfully established on the hills, it is our observation that young stock are much less inclined to hang down near the home paddocks. Good forage soon erases their memories of hay. We accept that paddock-wintered calves are more likely than hill-wintered calves to return for feed in the second winter but we hear of many cases where this does not happen. The problem of stock hanging down near paddocks should be less severe when cattle are bred on a place and have inherited an awareness of the seasonal grazing rotation.

7.22 SILAGE

Silage has a slightly better food value than hay made from the same pasture (Mackintosh, 1970) but less of it may be eaten (Campling, 1966). It provides solely a maintenance diet. Calves are wintered on silage on a few runs.

Opinions on self-feeding calves differ (Pennycook, 1968; "Cantuar", 1967). The idea seems good but some users find calves have difficulty tearing silage out of the stack face unless it was ensiled in the short, chopped form. At Tara Hills, calves maintained weight during the winter on 30-40 lbs of fed-out grass/lucerne vacuum silage but did not gain on this ration, whereas those fed 15-16 lb of lucerne gained about 1 lb per day (G. Scales, pers. comm.). Nicol (Anon, 1968f) found that weaners wintered on lucerne silage had only half the growth rate of weaners fed on swedes and hay or autumn-saved pasture and hay.

Silage seems a more satisfactory feed for older cattle than for calves. A number of runs winter feed their yearlings or cows on silage, particularly in the higher-rainfall zone where hay-making is difficult. Self-feeding adult cattle is practicable, especially where a runoff area such as a hill block is adjacent to the clamp. Yearlings at Lincoln College ate 60 lb of 20% dry matter silage per day in the winter of 1968 (A. Nicol, pers. comm.). Older cattle will eat 70-90 lb or more of good-quality silage per day.

Cattle allowed 24-hour access to a silage clamp do not necessarily stay there all day. One runholder has found that they feed for an hour or two then move well out on to adjacent hill country for the rest of the day (Hughes, 1966).

7.23 BRASSICAS

Brassicas have a high moisture content and therefore low proportion of dry matter. They are best fed with hay. Choumoellier

has a good balance of protein, carbohydrate and minerals but swedes and especially turnips are low in protein.

Brassica crops are not often grown as supplementary feed for adult run cattle. But on some properties a special area is grown for calves (Tripp, 1953; Mackenzie, 1957; Acland, 1957, 1966). Although choumoellier leaves are good for calves, most, but not all, farmers find that they lose condition on stalks alone. One farmer found the weight gain of weaner calves on choumoellier very much better than on hay and grass fed to capacity. They were stocked at 10 beasts to the acre for eight weeks with three bales of hay each over that period (Hall, 1967).

Choumoellier has the advantage that it is fairly resistant to pests and weeds, grows reasonably well under drier and poor conditions than many other crops, and stands up above snow. However, cattle feeding on it, especially if it is immature, can get a sometimes-fatal nutritional disorder known as redwater unless enough good hay is also fed out. The condition is most common late in the season, particularly if the choumoellier exhibits second growth high in nitrate.

Swedes are a popular alternative to choumoellier for wintering calves on farmland. Reeves (1967) found one-sixth of an acre per calf of swedes alone to be a generous three-months winter ration for weaners kept for fattening near Ashburton. Acland (Pers. comm.) obtained $1\frac{1}{2}$ lb of liveweight gain per day on swedes compared to only $\frac{1}{2}$ lb per day on silage, and Nicol (Anon, 1968f) at Lincoln College also achieved $1\frac{1}{2}$ lbs of gain per day with weaners wintered on either swedes and hay or autumn-saved pasture and hay.

7.24 AUTUMN-MAINTAINED PASTURE

As grass matures, its protein content, mineral content and digestibility decrease. Saved pasture for winter use, if green and leafy, is a highly nutritious ration.

Joblin (1968) found in his trials at Ruakura that autumn-saved pasture and early grass regrowth gave better, more regular growth-rate responses in winter than either grass silage, maize silage or hay. The difference between these last three fodders was small although hay gave the highest digestible protein intake. Joblin suggested that while these fodders were useful for maintenance feeds, the maximum possible use should be made of grass. This has been confirmed by Nott (1969) who reported that $1\frac{1}{2}$ weaners per acre on saved grass and 3-4 lbs hay per day gained

1.2-1.9 lb liveweight per day in Hawkes Bay.

Certainly, farmers over-wintering bought-in calves for sale prime in the summer favour it as food. At Mayfield, Sewell (1968) allowed calves to graze for 4-6 hours a day on autumn-saved pasture. He also fed a bale of good hay to every 10-12 calves.

In the high country, saving grass for late winter use is not generally a success due to the low winter temperatures and low fertility of most pastures. Fertiliser nitrogen may well prove to be an economical aid to saving grass in the future. Also, where soil fertility is being deliberately improved, better grass storage will follow.

Some cattlemen in more climatically-favoured areas like prairie grass for calf feed. At Amberley, Gould (1968) grazed 100 calves on 30 acres of prairie grass and turnips (plus one bale of hay to 10 calves per day in the winter) for 10 months. He got three return grazings from the prairie grass through the winter.

7.25 GRAIN AND CONCENTRATES

These feeds have a high-energy value but the protein level of grain is relatively low. Their principle advantage is their low moisture content and hence ease of transport.

We do not know of any high-country properties on which cattle are fed high-protein supplement through the winter and only one where a crushed-grain supplement is used.

But grain is a good winter food for cattle when fed with some roughage and calcium supplement, although it can be expensive as a sole diet. Young cattle should be started on 1 lb grain plus 4 lb of good hay a day. Trotter (1968) reported feeding 18-month-old cattle through a winter at 3 lb mixed grain per day each and one bale of ryegrass straw to 20 beasts at a cost of \$2 per head per month. Nicol (1960) maintained the weight of 480 lb weaners on 2 lbs barley and 9.2 lbs of barley straw. Double the barley (4 lb) and only slightly more barley straw (9.5 lbs) allowed a gain of $\frac{1}{2}$ lb of liveweight per day.

In fact, wheat has a higher food value than barley which in turn has a higher food value than oats.

But wheat is a safe feed for cattle only if they are introduced to it gradually and the amount available is strictly controlled. Otherwise it can cause digestive upsets or even death.

Crushing grain has always been considered essential for cattle. However, in Australia whole wheat has been gradually fed to cattle after a week or so with good utilisation (L. Corah, Pers. comm.).

Cattle on a high grain diet need a crushed lime supplement. All cattle on grain, concentrates, straw and hays need plenty of water. Although Thomas and Durham (1964) suggest that beef cattle can winter satisfactorily on concentrates alone without roughage, barley, oat and ryegrass straws are useful roughage supplements fed in small amounts to bulk out a diet of grain. However, cattle cannot maintain their weight on straw alone. Urea will increase the digestibility of straw when cattle are on low-protein diets (Nicol, 1969) and may stimulate animals to eat more roughage. It may give no response, however, if a green pick is available from pasture (Jagusch, 1970).

A North Island farmer uses crushed linseed plus roughage. In spite of its high cost per ton (\$150) it is the cheapest protein available on a protein unit basis. Pregnant Angus cows just maintained their condition on 1 lb each a day of this (7.5c) plus molasses carrier (2c) plus up to half a bale of barley straw (5-10c) (Firth, 1969). The linseed had the advantage of a laxative effect to compensate for the tendency to compaction with the relatively indigestible straw.

If adult cattle need supplementary feeding in winter it seems that diets similar to those given above, that is, feeding as much cheap straw as possible, and a small amount of grain, or a high protein supplement, will prove to be the most economical.

Joblin (1968) referring to the barley-beef industry in Britain, suggests that high quality grain-only feeding for wintering cattle would probably be uneconomic in New Zealand. He quoted feed conversion efficiencies of the order of 10 lb of dry matter to 1 lb of liveweight gain and suggested the price per pound of carcass weight would need to be about 16 times the price of grain to make its use worthwhile. He believed that grass was a much cheaper alternative. Nevertheless, he and others (Joblin, Reardon, Phipps, 1970) were later able to show that a summer supplement of maize meal not only increased the digestibility of dry summer pasture as might be expected, but was economic to feed as a supplement at the rate of 0.25% of the animal's liveweight each day. No supplement, or higher amounts daily (0.5%-1.0% liveweight) depressed the cash surplus over meal cost with 18-month-old Friesian steers kept for killing after the summer. This suggests that even small amounts of supplement may be worthwhile.

TABLE 18

Approximate Food Values of Common New Zealand Foodstuffs
(I. E. Coop, Pers. comm.)

		% Dry Matter	Pounds of Digestible Organic Matter (DOM) in 100lbs of feed	% Digestible Crude Protein (dig. CP)
Pasture Hay	Poor	85	44	3
	Average	85	48	6
	Good	85	50	8
		(84-90)		
Lucerne Hay	Poor	85	44	9
	Average	85	48	11
	Good	85	50	14
Wheat Straw		90	30	1
Oat Straw		90	40	1
Barley Straw		90	42	1
Pea Straw		90	40	4
Ryegrass Straw	(Perennial)	90	41	2
	(Hl or Italian)	90	43	2
		(89-92)		
Silage	Poor	25	12	2
	Average	25	14	2
	Good	25	15	3
Pasture	Leafy, spring and autumn pasture	20	14	4
	Green pasture running to stalk	20	12	2
	Brown, summer pasture with some green bottom	66	33	4
	Brown, summer pasture with no green bottom	80	40	5
	Dry unimproved pasture	80	35	2
	Autumn saved pasture	20	13	3
Lucerne grazing, aftermath		25	16	5
Cereal Greenfeed		20	14	2
Kale and Choumoellier		15	11	2
Green maize		25	13	1
Rape		14	12	2
Swedes		12	9	1
Turnips		10	7	1
Fodder Beet		15	10	1
Barley		87	75	7
Oats		87	63	6
Maize		87	78	7
Wheat		87	79	10
Peas		87	74	20
Pollard		87	64	10
Bran		87	60	9
Linseed cake		87	70	25
Meat meal (meat and bone meal)		90	70*	40
Meat meal (pure meat meal)		90	90*	60
Sheep nuts (various brands)		89	65-75	7-15
"Molactrate"		85	75	16
Molasses		75	60	1

* Value adjusted to allow for high fat content



Good hay is the most common supplementary fodder for calves. Here heifer calves are being introduced to hay on Dunrobin Station, Southland.

Photo: B. Pinney

Table 18 shows approximate energy and protein values of some common New Zealand animal foodstuffs. For a good, practical book on foods and feeding see Coop (1961) "The Principles and Practice of Animal Nutrition". Joyce and Maclean (1970) also compare food values for production. Mackintosh (1970) gives a short review of the supplementary feeding of beef cattle. Note:

1. Food contains moisture and dry matter. The dry matter contains minerals, and organic matter - but only the organic matter supplies energy (and protein).
2. Not all the organic matter is digestible or usable. The indigestible part passes out as faeces. The digestible part is retained as a source of nutrients.
3. The "digestible organic matter" value for a food is the percentage of usable organic matter in the food. Thus in 100lbs of hay there could be 15lb of water, 10lb of minerals, 25lb of indigestible organic matter and 50lb of Digestible Organic Matter. The DOM value of this feedstuff could now be compared with that of another.
4. DOM values for green forages vary according to their stage of growth when eaten. Values for roughages vary according to the stage of maturity of the plants when cut.
5. For most foods the single values given represent averages of a range of values. Values for grains, their by-products, and milk foods are much less variable than for other feedstuffs.
6. This table can be used to calculate the comparative cost of different feeds based on their energy and protein value. For instance, the cost of 1 lb of digestible organic matter in good hay can be compared with the cost of 1 lb of digestible organic matter in barley to find the most economical way of feeding cattle.
7. Some tables use "Digestible Dry Matter" instead of "Digestible Organic Matter". DDM includes minerals and organic matter and is roughly equal to 1.1 x the DOM value.

7.3 RESULTS FROM SOME WINTER FEEDING INVESTIGATIONS

7.31 THE EFFECTS OF PLANE OF NUTRITION

Barton (1961, 1966) has summarised the results of a number of studies on wintering beef cattle.

1. Too-liberal winter feeding costs more than low-plane feeding and shortens the useful productive life of cows. Also a cow fed on a low plane of winter feeding will give more calves in her lifetime.

2. Heifers fed too well during the winter have more calving difficulty, and calf and cow losses are higher than among poorly-fed heifers. Low-plane-wintered heifers also produce more milk after calving.
3. Calves from poorly-wintered heifers are smaller at birth - but not calves from adult cows.
4. For good frame development in heifers, a medium level of feeding seems best. However, although poorly-fed heifers mature more slowly, their skeletal growth is largely unaffected and normal size is reached by about 3½ years of age.
5. If a heifer calf is fed poorly and gains no weight during the winter, is then mated and goes into the winters of her first two pregnancies losing 20% or more of her weight each time, then her calf drop will be less, the weaning weight of her calves will be lower and her maturity and conception will be delayed.
6. The mature size of beef cows is little reduced if post-calving feed is good enough to permit recovery after low winter-feed levels.
7. A high winter-feeding level increases the chance of a cow developing cancer eye (Barton 1961, 1966; "Veterinarian", 1968e).

In a comprehensive series of experiments at Whatawhata, Hight (1966, 1968a, b, c, d) came to the conclusion that mature cows could be wintered quite safely on a low level of nutrition but should be better fed for several weeks before calving and especially from calving to weaning. This ensured not only high calf weaning weights but greatly reduced the number of dry cows in the following season.

Therefore, to summarise, while a medium plane of nutrition is desirable for wintering heifers (or at least they should go into the winter in good condition), cows produce best if kept on a low but later-rising plane of nutrition during winter pregnancy. Everitt (1961) considers that it is more profitable to carry cows on the hill in winter to clean up roughage than old heavy uneconomic steers. This class of cattle are poor converters of pasture into maintenance energy or meat (Joblin, 1966a, b).

7.32 COMPENSATORY GROWTH

This phenomenon is best illustrated by an example. Obviously, if we take two animals and feed one well and the other poorly the first will grow faster than the second. But if we then put the second on the same good ration as the first, it is quite likely that the once-slowly-growing animal will surpass the weight gain rate of the always-well-fed one on the same type of feed and will approach or even catch up to the liveweight of the latter.

This compensatory growth can be used to significantly reduce the cost of winter feeding. For instance, in trials at the Winchmore Irrigation Research Station it was found that steer calves wintered in sheltered paddocks on concentrates (barley meal, barley and linseed-based nuts) put on twice as much weight over the winter as those fed out in an open paddock on swedes and hay (Walker, 1966; Walker and Lobb, 1968). However, after grazing on irrigated pasture the cattle were slaughtered in March. Those which had made the poorest winter gains were at least as heavy as the other cattle (Lobb, 1968). This result was confirmed by Bellows (1968) who found that cows in particular had a high ability to adapt to the feed supply. If they were grazed on good feed after calving they caught up over the spring and summer (five months in the experiment) to cows well fed right through the previous winter. Harte (1968) points out that if cattle are intended for slaughter they should be held back from sale long enough to get the full benefit of compensatory recovery.

Joblin (1968) has reported, however, that these compensatory growth responses are affected by a number of factors including the age of the animal, the length and severity of the feed restriction and the amount and quality of the feed supplied after the restriction ends. His opinion is that, at least for fattening cattle, compensatory growth cannot be relied upon to make up for deficiencies in winter management. He found that yearlings poorly fed in winter did, by increased food intake and efficiency of feed conversion, make up for some (38%) of the large (175 lb) end-of-winter difference in liveweight compared to well-wintered beasts. But at neither equal nor free intakes could they catch the others even by the next autumn. He emphasised that a low level of winter feeding followed by a compensatory growth system will usually give lighter cattle at 20 months than could be obtained through management systems where cattle gained weight throughout the winter. Nicol and Coop (1970) in a review of New Zealand experience with this phenomenon indeed point out that in the experiments the poorly-wintered group rarely recovered over the next 5 months more

than 45% of the difference between them and well-wintered cattle. In general, too, over the whole period, restricting feed intake in the winter to produce growth rates below 1 lb per day and making up the deficiency later, reduces overall efficiency of conversion of feed to meat and should be avoided (Watson, 1943).

Young cattle seem less able to recover after poor feeding than older ones. For example, Winchester and Howe (1955) and Winchester and Ellis (1956) found that calves over three months of age reduced to a maintenance ration for two to six months showed compensatory growth when well fed afterwards. But Wardrop (1966) found that calves reared from birth to three months of age on a low plane of nutrition then fed well had not shown compensatory growth up to 12 months of age.

As Joblin (1968) pointed out, the length of the food restriction can have its effect too. Thus, Pearson Hughes, Alder and Redford (1959) found that prolonged under-nutrition in the first 8-12 months caused permanent stunting in cattle.

It seems reasonable to us that young growing animals would be less able to compensate for restricted winter feed than adults. If this is so, it means that runs cannot afford to do their young stock too hard in winter whether they are pregnant or not. At some stage there is a critical level below, and time-length of underfeeding beyond which calves cannot recover their lost growth.

But significant economies in the winter feeding of older stock can be made by taking advantage of their proven ability to make reasonable compensatory growth later on good spring-summer pasture.

7.33 PEN FEEDING

Schuster and Albin (1966) experimented with range Hereford cows to see how they adapted to winter feeding with concentrates or silage in yards. Cattle on both feeds took up to two weeks to adjust with some loss of weight in the first few days, but soon regained their original condition. A few failed to adjust and had to be removed.

Silage-fed cows kept their weight better than those fed on concentrates. But liveweight changes from concentrates and range feeding were about the same and from their study Schuster and Albin concluded that range cattle could adjust to penfeeding and re-adjust back to native pasture afterwards.

These experiments are interesting. It is quite possible that even with the established ability of cows to live on a restricted diet through cold winters without harm, winter feeding in yards or small paddocks for at least some of the herd may become necessary as numbers increase in the back country, even if only for four to six weeks before calving at the end of the winter. Split herds, with old cows and first calving heifers kept in while the rest stay out on the hill, will be one way of increasing the winter-carrying capacity.

7.34 FREQUENCY OF FEEDING

One of the greatest disadvantages of supplementary feeding of cattle in winter, apart from its cost, is the labour it needs if done on any scale. Less-frequent feeding would reduce the cost. Weekly feeding of hay was better than daily feeding with adult Merino sheep (Lewis, 1968), perhaps because even shy feeders were able to satisfy their appetite. With cattle, McIlvain and Shoop (1962) reported that there was only a slight difference, between the gains of weaner steers fed a protein-rich supplement daily, three-daily or weekly, in favour of daily feeding - particularly in winter. However, Melton, Jones and Riggs (1960) found that weekly-fed animals spent much more time away from the troughs than daily-fed ones. Although feeding hay to beef calves every 2-3 days may do no harm if they also have pasture pickings it seems to us to be quite feasible for adult cows to be left longer between supplementary feeding times if they have rough grazing too.

7.35 EFFICIENCY OF SUPPLEMENTARY FEEDING

Feeding supplements does not necessarily increase animal production from a property. Animals fed energy supplements may simply reduce their intake of standing forage proportionately. If the protein content of the forage or fodder is very low, however, a protein supplement is likely to increase roughage consumption by supplying body protein for rumen microflora.

Fodder conservation (i.e. hay, silage) may be false economy if stock intake has to be restricted during the important early-lactation and mating period in order to shut up paddocks for hay. According to Hutchinson (1971) more use should be made of the animal's own conservation mechanism. This is a normal response of animals to a fluctuating feed supply. Indeed it could well be more efficient to allow adult animals to store surplus energy from herbage as fat in the summer and autumn and to later break it down for metabolizable energy, than for man to store the same amount of herbage as hay and feed it out in winter when the

available forage is less than the animal's maintenance requirement. Hutchinson (op. cit.) points out that there is a limit to the rate at which an animal can use its stored reserves for maintenance. With Merinos the maximum is about 60% of total requirement. Standing forage or supplements must make up at least the remainder. Therefore supplementary feeding may be most effectively used to slow down the rate of liveweight loss to a safe level of under-nutrition.

For a comparison of wintering costs see Appendix F.

7.4 SUMMARY

Supplementary feeding of older breeding stock is rare but when it is convenient, calves are often fed hay or silage, or less commonly, roots. Grain or concentrates are sometimes used for fattening stock but not supplementing breeding stock yet. Good-quality pasture has been proved to be excellent winter food. Autumn-saved pasture is popular with farmers fattening bought-in calves for later sale at 18-20 months of age but its preservation for late-winter use is difficult in the high country.

Many runholders avoid winter feeding calves on the grounds that they will not be good fossickers on hill blocks later. However, we are certain that the problem is greatly reduced if good improved pasture is established on the blocks.

Most runholders let older stock fend for themselves in winter and the shortage of feed then means that cows will be in good store condition for spring calving. Over-feeding has been found to cause calving troubles, particularly with first-calving heifers. Also, a fit cattle beast is a far more useful animal on run country than an overfat one.

There is experimental evidence to show that young stock need a good start in life but they have some ability to compensate for moderate levels of winter feeding by increased growth rates in periods of strong pasture growth. This phenomenon is much more pronounced with mature cows and should be used to economise on winter feed. However, better nutrition is needed for several weeks before calving and cows must be allowed a high plane of feed afterwards. Cows fed in this way have better lifetime production.

Cows should be allowed to store energy as fat during the summer and autumn then use it for maintenance during the winter. This can be at least as efficient as making and feeding hay, and

considerably cheaper.

Although there is at present little supplementary feeding of cows in the winter, it will become more common in future, both to control the rate of body weight loss as fat is used up, and to supplement intake before calving. Pen feeding for breeding cows is possible, but paddock feeding for the young or old of the herd is more likely to be used. Pen, pad or shed wintering could become of increasing importance for calf rearing in the severe climate of the back country. However, even more common will be the wintering of calves down-country on agistment.



Cows should be allowed to store energy as fat during the autumn then use it for maintenance during winter. Cows on Remarkables Station - the country across Lake Wakatipu is Cecil Peak Station, rising to 6,477 ft. Photo: G. D. Jardine

CHAPTER 8

MANAGEMENT OF YOUNG STOCK

8.1 CALVING

8.11 PRESENT PRACTICE

Most run cows calve on their hill-wintering blocks. It is not usual for them to be moved for calving on to specially saved hill blocks, although a few runholders do bring the cows down into the paddocks a week or two before calving starts. Others let into the paddocks only cattle which have come down to the homestead end of their winter blocks and are hanging about by fences or gateways. If cows are allowed to camp in such places for too long they eat out the nearby forage and drop in condition just when they should be improving.

Before calving, cows in paddocks or handy blocks may be given hay or silage. Stockmen find that cattle readily eat these supplements if they have been used to them as calves. But late pregnancy is too late to be teaching cows to eat strange foods. In general cows will not eat high-roughage and concentrate feeds if there is plenty of grass in the paddocks. Unfortunately, if grass is scarce, the cows may well drop critically in condition before learning to eat enough hay, silage or other supplementary food to satisfy their needs.

There are real advantages in having cows in rising store condition at calving. Good stockmen also know that if a cow is fit and active she will calve more freely. Therefore calving on well-grassed hill blocks is preferable to calving in paddocks. This is particularly the case if the hill blocks have reasonable natural shelter (one occasion when scrub is an advantage). Too few runs have good tree shelter in paddocks.

On most runs the cows are left to calve without supervision. It is not uncommon, however, for first-calving heifers to be kept separate from the rest of the herd in a handy paddock for help if needed.

Calving is usually timed to start either as the first spring growth of grass comes away or slightly before, that is, from mid-September onwards through mid-October. Most calves are dropped in October.

The lower and warmer properties calve earlier, but the higher properties such as Molesworth Station calve even as late as mid-October onwards because of their delayed spring growth.

Those runholders who time their calving to start at or just before the onset of spring growth do so in the belief that a single calf cannot drink all the milk from a high-producing cow (Acland, 1957; Barton, 1962; Walker, 1963; Willhite and Grable, 1966). If the cow has more milk than her calf needs, she may partially dry off. On the other hand, if her milk production is retarded at first by a lack of feed, then the peak of the cow's supply will be more likely to coincide with pasture growth and a much greater demand by the calf.

One inducement to early calving is that when runholders are selling calves in saleyards, larger, earlier-born calves tend to fetch higher prices. (Of course on a value-per-day-grazed or per-pound-liveweight basis the higher-priced calf might have cost more to produce, but this has not been tested.)

However, early calving can be very risky in the high country if extra feed is not provided. Snowfalls and the start of spring growth are unpredictable events. The hungry cow with hungry calf at foot is a pitiable sight and it can be a costly error if the calf dies.

8.12 EXPERIMENTAL STUDIES

Bellows (1968) discussed the reasons for calf losses and reported that 11% of deaths were due to calves dying shortly after birth. From another study he reported that 53% of calves which died were the progeny of first-calving three-year-old heifers. Most deaths were from injuries resulting from slow or difficult delivery. Over half of the calves could have been saved by attention at calving.

The size of the pelvic opening in the heifers was found to be important (a fact confirmed by Young, 1970). This increased by 25% from two-year-old to three-year-old, and was always bigger in well-fed stock. There was no difference in the range of calving difficulties between the Angus and Hereford breeds but difficulty varied widely between the progeny of different sires within the same breed. The loss from calving difficulties was second in number only to the loss due to cows failing to conceive.

Surprisingly, Young (1970) found no difference in calving difficulty (dystocia) between two-year-heifers either well-fed

or poorly-fed between pregnancy diagnosis and calving (to a weight difference of 168 lbs).

There is conflicting opinion about the effect of level of winter nutrition on the birth weight of calves. For instance, neither Jordan, Lister and Rowlands (1968) nor Hironaka and Peters (1969) found a significant difference in the birth weight of calves due to the level of winter feeding of the dam. But Wiltbank, Rowden, Ingalls, Gregory and Koch (1962) on the other hand found that calves were heavier at birth when cows were well-fed before calving. Fear of this happening, whether well founded or not, is one of the principal reasons why runholders who are aware of the risks of large calf size at birth try to keep cows from putting on too much condition during pregnancy. In fact the finding by Young (1968) that calf birth weight increased as the calving season advanced and hence the need to calve early to limit birth weight may well be wiser than deliberately restricting the feed level of cows in the winter in hopes of getting the same result. In other words, underfeeding cows in late pregnancy should be avoided. Hight (1966b) found that more calves died from cows kept on a very low level of feed right up to calving than from those fed better towards the end of pregnancy. There are other disadvantages with starvation during late pregnancy which we will discuss later. The practical difficulty is to strike a satisfactory balance between too much and too little food when pasture growth and climate varies so much from year to year. Here the judgement of the stockman is really tested and forage or fodder reserves become a necessity rather than a luxury.

8.13 NURSE COW REARING

This practice is becoming quite common for raising dairy-beef bobby calves and is attracting interest for rearing beef calves too.

Everitt (1968) and Everitt, Phillips and Whiteman (1968) have shown that nurse-cow rearing can be cheaper and less labour demanding than bucket rearing when dairy calves are being kept for beef production. Indeed the latter found that calves suckled three to a dairy cow compared favourable in liveweight at 7-10 weeks old to single-suckled calves on beef cows at 7-8 months old.

Candy (1967) found that calves raised three to a foster cow were on average 120 lb heavier at weaning than bucket reared calves. He also found that dairy-breed calves multiple-fed by foster mothers each had a weaning weight 85 lbs heavier than single-suckled Angus calves and that each foster cow weaned a

total of 1,391lb of calves compared to an average 413 lbs of calves by each single-suckled Angus cow. The extra pasture consumption of the three fostered calves and their foster mother compared to the single natural calf was unstated but at least the foster mother cow as an economic unit was being efficiently used.

However, the system is of real interest only where surplus calves from milking dairy cows can be bought very young for rearing on foster-mother cows on runs. The calves, of course, could have been sired by beef bulls (preferably by artificial breeding). And they could be nursed by beef cows along with their own young. But the lower milk supply of the cows of beef breeds common on the hill country (Walker, 1963) compared to such dairy-type cows as Friesians means that one calf is often enough and sometimes more than enough for the former. In short, because of its practical difficulties, nurse-cow rearing is unlikely to become popular in the South Island hill country, much less in the high country.

8.14 CALF MARKING

The date of marking calves varies widely. Two to three months old is a popular age. That is, calves are usually marked from the end of November to the end of January. But some runs are later than this. Molesworth must be about the last - marking in late March when the calves are over five months old (Chisholm, 1960). Since the timing is not critical, on most runs it is a job which is fitted in between sheep work.

Besides castrating males and earmarking, heifer calves must be injected for brucellosis at from three to six months old, all dehorned if necessary, and perhaps drenched with selenium and/or an anthelmintic drench. They may be given age tags in their ears as well as punched or cut ownership marks. Unfortunately no ear tags suitable for hill country are visible at long distance, although new soft plastic tags are a great step forward. But permanent branding by applying very cold "irons" to the hide with consequent later growth of white hairs on the site has been developed in the United States, has been found practicable here, and is becoming popular (Hooven, 1968; Anon, 1967f). If calves are freeze branded when in the calf crush for marking, the brand grows with the calf and becomes very easily seen.

The rate of calf castrating, earmarking, and vaccination is up to 120 per hour, depending on the facilities, the number of men and what is done. Freeze branding, however, can be carried out at a rate of only about 20 beasts an hour by two men with single "irons" (Crawford, 1969). Multiple iron holders (Ely and

Launchbaugh, 1969) and constant-temperature brands (A. McIvor, pers. comm.) can increase the rate.

There may be an advantage in delaying castration. Ruakura have found that bull calves castrated at seven months of age later grew faster as steers than those castrated at three-and-a-half months of age and the slowest-growing steers of all were those castrated at birth (Anon, 1966b).

8.2 FACTORS AFFECTING THE GROWTH OF CALVES

8.21 THE EFFECT OF COW LIVEWEIGHT

The birth weight of a calf may be related not only to the nutrition of the cow during pregnancy and to date of calving (see section 8.12), but also to the liveweight of the cow.

For instance, Alexander, Sutherland, Davey, and Burns (1960) showed that about 6% of the birth weight of the calf was due to the body weight of the dam. The birth weight of calves also varies between breeds. Everitt (1967) at Ruakura, reported straightbred Friesian calves weighing an average 85 lbs, while straightbred Angus weighed 68 lbs and Jersey 56 lbs. He showed, too, that crossbred calves have birth weights somewhere between those of the straightbred calves of two parent breeds. Pani (1968) in reviewing experiments on birth weight, also reported that crossbred calves were heavier than straightbred calves when the dams were from a breed of larger size than the breed of the sires. That is, calves out of Friesian cows by Jersey bulls (72lbs) were heavier than calves out of Jersey cows by Friesian bulls (64 lbs).

Everitt (1967) found a sex difference too. Bull calves were consistently heavier than heifer calves although the difference was less with straightbreds (1-2 lbs) than with crossbreds.

However, Pani (1968) also noted that several experiments showed that the influence of the dam's body weight on the calf's body weight decreased as the calf grew older. This could well be due to the overriding but gradually decreasing influence of the cow's milk-producing ability on the calf's growth.

Barton (1967b) reported that large cows within a breed, besides probably producing more milk than smaller cows were also more fertile and (1962) better adapted to rigorous grazing conditions.

But Purdy (1967) pointed out that big cows do not always produce big calves. He was more interested in the efficiency of the cow, that is the relationship between its size and the size of calf it weaned. Although Warwick (1966) tends to deprecate the difference in food consumption between a cow weaning a large calf and one weaning a small calf, it is true that larger cows eat more food. A 1,400 lb cow could need about 63 lbs of grass a day or 25% more than the possible 50 lb of grass a day needed by a 1,000 lb cow for maintenance.

Therefore, the more calf liveweight which can be weaned per 1,000 lb of cow liveweight the more efficient is the conversion of pasture by way of the cow's milk to calf meat.

For example, Warwick (1966) has pointed out that a 1,400 lb cow weaning a 700 lb calf is not necessarily any more efficient than a 1,000 lb cow weaning a 500 lb calf. In trials he found wide variations in efficiency between cows even within breeds. In four lines of cattle he found differences up to an average 54 lbs of calf weaned per 1,000 lbs of cow.

Bratcher (1968), late secretary of the American Angus Society, in support of his breed has claimed that, "smaller cows wean a higher percentage of their bodyweight in calf, particularly if they are good milkers like the Angus. It is not uncommon for a 1,000 lb Angus cow to wean a 500 lb calf in 205 days. In fact Angus cows that wean 60% of their weight in calf are not rare."

The inference we draw from this statement is that smaller cows (or at least Angus cows) are more efficient in calf production than larger cows. This may or may not be correct. There is some evidence from Argentinian work to support this (Molinuevo, 1967) but in this particular experiment, although the Angus produced more calf liveweight from a set area than Charolais, the latter gave more total beef if dams were considered too.

Our opinion is that there is probably little if any difference between breeds in efficiency of grass use for beef production but there can be large difference between individuals within breeds. However, if the Argentinian evidence is correct, the small Angus cows in this case were able to wean more calf per unit area of ground than the larger breed. Calf-producing efficiency is a most desirable trait on all breeding properties. We would, however, prefer to see the experiment repeated with bigger numbers of calves (than seven in each treatment) against several different breeds before accepting it unequivocally.



8.22 THE EFFECT OF THE COW'S MILK YIELD

The rate of growth of the suckling calf largely depends on the cow's milk supply which (along with inherited productivity) in turn depends on the food available to her.

Renbarger, Smithson, Stephens and Pope (1964) working with Hereford cows, found that by feeding different daily rations to them they could vary their levels of milk production. These in turn gave different calf-growth rates. Better-fed cows gave more milk and their calves grew faster. (Also the better fed cows took the bull again sooner.) Brumby, Walker and Gallagher (1962) found similar results at Ruakura up to a calf age of 12-16 weeks and further stated that the more milk the calf got the faster it grew. There was no case of diminishing returns up to that age.

A three-weeks-old calf will consume its own weight in milk each week. At eight weeks it will consume about 70% of its weight in milk each week and at 12 weeks old the equivalent of about half of its bodyweight in milk (Barton, 1962; Walker, 1963). The growth rate stays almost the same during this time but the difference is made up in pasture consumption.

Milk yield varies between breeds and crosses of beef cows. As far as straightbreds are concerned, American research found that the milk yield of the Charolais was more than that of the Aberdeen Angus which in turn was more than that of the Hereford. (Also cows five years old and over exceeded younger cows in milk production and cows nursing bull calves gave more milk than those nursing heifer calves (Melton, Riggs, Nelson and Cartwright, 1967)). Comparing crossbreds with straightbreds for milk production, Brumby et al (1962) found that the Angus/Hereford cross gave 25 gallons more, the Angus x Friesian cross 47 gallons more (est.) and the Angus x Jersey cross 106 gallons more milk in a lactation than the average straightbred Angus cow. The Angus, and Hereford x Angus lactation curves were very similar but the crossbreds showed a slight advantage over the straightbreds (Walker, 1963). Both reached their peak of production about eight weeks after calving.

The variation in milk yield between various breeds and

Opposite: At three weeks old a calf will consume its own weight in milk each week and at 12 weeks old about half its weight. Growth rate is about the same, the difference made up in pasture consumption. Sunnyside Station, west Southland. Photo: D. O'Brien.

crosses can be clearly seen. The importance of the milk yield of the dam to calf growth has already been shown. In fact, Neville (1962) attributed 68% of the variations in the eight-months weight of calves to differences in the milk production of the dam. The weight of the calf at weaning really depends more on the milk supply of the cow than on any inherited ability of the calf to grow fast.

Fortunately, Warwick (1966) has pointed out that the feed requirements of a cow are not greatly different whether it weans a heavy or a light calf.

Therefore the stockman has much to gain by selecting cows on milk yield as reflected in the weaning weights of their first calves.

Unfortunately milk yield is weakly inherited and improving the milk yield of a herd by keeping the female progeny of good-milking beef cows leads to only a slow improvement. Crossbreeding is a more rapid way to improve the milk yield of cows and hence growth of calves (Walker, 1963).

8.23 THE EFFECT OF THE AGE OF THE COW

While almost 70% of a calf's weaning weight is due to the milk supply of the dam, the age of dam also has a significant effect on weaning weight.

Gallagher (1960) has stated that cows between five and nine years old should produce the heaviest weaners and a three-year-old cow's weaner calf would be about 30 lb lighter than average. This trend has been confirmed by Baker (1968) who reports that generally the performance of calves increases as the age of the dam rises from two to seven years.

Beaty, Powell, Fortson and Saunders (1963) produced the following table of the effect of age of range cows on the weaning weight of calves. The average age of weaning was 233 days (or 7½ months).

TABLE 19			
Effect of Age of Cow on Adjusted Weaning Weight of Calves (from Beaty et al 1963)			
Age of cow (years)	Average Weaning Weight (lb)	Percentage of Average	Observations (numbers)
2	328.95	83.90	17
3	395.40	86.63	17
4	420.02	92.02	10
5	481.85	105.57	19
6	479.82	105.51	21
7	483.86	106.01	25
8	478.25	104.78	23
9	470.83	103.15	20
10	484.93	106.24	16
11	482.19	106.08	11
12	458.60	100.48	4

This table largely agreed with Gallagher's findings by showing that calves from young cows were lighter than those from older cows at weaning but there was little change in the average weaning weight of calves from cows between 5 and 11 years old following a first calving at two years of age. (From the same records it was noted that steer calves average slightly over 10% heavier than heifer calves at weaning.)

8.24 THE EFFECT OF CROSSBREEDING

The section on crossbreeding showed that hybrid vigour gave a first-cross beef calf only a slight weight-gain advantage to weaning over a straightbred calf. The milking ability of its dam was a more important factor.

8.25 THE EFFECT OF COW NUTRITION BEFORE AND AFTER CALVING

Hight (1968b) found that calf weight at weaning depended almost equally on the level of nutrition of the cow both before and after calving and its consequent effect on her milk production.

Calves from cows on a low plane over the winter were 13 lbs or 22% lighter than calves on a high plane over the winter.

By weaning, calves from cows poorly fed right through were 74 lbs lighter than calves from cows well fed right through. Of that 74 lb difference, half was due to the level of feeding of

the cow before calving and half to her level of feeding from calving to weaning.

Hight later (1968d) found that even if low-level cow nutrition in the winter was improved over the last 3-8 weeks of pregnancy, there was no real improvement in calf weight at weaning. However, fewer calves died near birth and their birth weight was higher.

Obviously, for high calf liveweights at weaning, cows must be well fed both before and after calving. A high level of feeding ~~both~~ after calving is also important to ensure a good conception rate.

It is essential to get calves to a high liveweight at weaning even though Joblin (1966b) showed that the level of nutrition of the cow before weaning had almost no effect on the growth rate of its calf afterwards (see Fig. 9, p.157).

8.3 WEANING

8.31 PRESENT PRACTICE

On a handful of the hardest runs, usually growing no supplementary winter feed crop, calves born in one spring are carried through to the following spring before weaning. For instance, this is the policy on Molesworth Station where the minimum altitude is 2,000 ft and most of the valley floors are at 3,000 ft. Here the reasons given for late weaning are:

- (a) Because of the altitude and climate there is no area where weaned calves can be safely run on their own in winter.
- (b) The growing season is too short and the climate too unpredictable for winter-feed crops to be grown.
- (c) The expense and complication of making and carting out winter feed is avoided.
- (d) Cows educate their calves to seek shelter (much of the winter country faces into the south) and the calves, when two seasons later returning to this same country as cows with their own calves, will know instinctively where best to avoid snow and storm (Chisholm, Pers. comm.).

This practice, of course, also has some obvious disadvantages. The success or failure of it depends on whether the calves are better or worse off in the winter than they would be weaned. This depends on whether the cow continues to feed the calf but even more on the amount and quality of pasture available to them both. Calves would be competing with cows for winter pasture and a calf, still drawing what milk it could from its mother, would tend to pull down the cow's physical condition. When winter pasture is limited, this can lay the cow herd open to trouble in a cold snowy winter. And since the grazing area has to be large enough to feed both cows and calves it must include more (probably poorer) country than would be needed for the cows alone.

Here, calves overwintered on the cows are usually weaned four to six weeks before the next calves are born to give the cows some chance to recover in condition. The practice of spring weaning may be unavoidable at present on a few properties, but we believe that its disadvantages outweigh its advantages. The provision of shelter, improved pasture and winter feed supplies for autumn-weaned calves should be aimed for in the future wherever possible.

Most of the runs selling all surplus calves other than replacements for the herd, wean in the autumn just before the April calf sales. Replacement calves are usually drenched before being turned on to the best available pasture for a month or so, preferably with good hay to get them used to it before the winter (Tripp, 1953). Turton (1953) believed that steer and heifer calves intended for fattening should be separated after weaning and the heifer calves spayed. But spaying heifer calves for fattening is not common now because of the demand for them as breeding stock. Heifer calves must now be vaccinated against contagious abortion.

Proper and intelligent handling of the newly-weaned calf to get it quietly used to dogs and fences pays good dividends to the owner who will give time to it.

Date of Weaning

The date of weaning of calves should depend on the feed supply. (It now usually depends on labour convenience.) If there is ample feed, little is gained by early weaning except the opportunity to use the cows in a mob for pasture control.

However, if hill-country pastures dry out badly in summer, calves should be weaned and put onto fresh pasture and the



In the high country, weaning should be early enough to allow cows and calves time to settle down on their separate winter blocks before cold weather sets in. Weaning Glen Lyon and Huxley Gorge calves. Photo: A. G. Wigley

cows turned out to relieve grazing competition. Weaning in February-March does little harm to calves born early enough and leaves the cows free for use on hill blocks (Acland, 1966). At this time of the year the cows will climb and spread out well.

Brumby et al (1962) found at Ruakura that after 3-4 months of age the liveweight gain of the calf bore little relationship to the amount of milk it consumed from the cow. Most of its nourishment would by then be coming from pasture. They also showed that the weight of calves at weaning made no difference to rate of growth afterwards if both heavier and lighter calves were on the same quality feed. There is some doubt whether this is always the case - that is, there is some evidence that heavier weaners may grow faster (A. Nicol, pers. comm.). However, we can assume that calves could theoretically be weaned on to good food from 3-4 months after birth without much disadvantage.

But although calves are reported to have been successfully weaned at 200-250 lb liveweight at Ruakura (Anon, 1966e), Joblin (pers. comm.) and Hight (1968e) have stressed that unless ample high-quality weaner feed is available, early weaning can do considerable harm to the calf by restricting its subsequent rate of growth.

G. Scales of Tara Hills High-Country Research Station (pers. comm.) recommends a weaning weight for beef calves of 400-450 lb so that they can go into the winter at between 450-500 lb liveweight. Barton (1964b) prefers a slightly higher weaning weight of 450 lb for heifer calves and 500 lb for steer calves at seven months of age but this figure, which assumes a growth rate of 1.8-2.0 lbs per day to weaning, would rarely be achieved in the high country.

Nevertheless, heavy weaning weights have many advantages when slaughter at an early age is aimed for. The big animal at weaning will, on equal feed, reach slaughter weight before the small animal. Fortunately, weaning weight is quite strongly inherited and thus selection for it will give rapid improvement in the herd average performance (Hight, 1968e).

In the high country, weaning should always be early enough to allow cows and calves time to settle down on their separate winter blocks before cold weather sets in.

As has been pointed out already, the weaning weight of the calf is a good indication of the beef cow's milk-producing ability. Therefore weaning is the best time for selecting cows on the performance of their calves.

There are obvious difficulties in determining a beef calf's exact birth date - and hence age at weaning - so its rate of growth can be compared with that of other calves. But Acland (1969) believes that by selecting an average date of birth, (say nine months from the middle of the first breeding cycle in the herd) rather than trying to note the actual date of birth, the best calves from the early-conceiving cows can be found. Thus a single weaning day can be chosen for weaning-weight selection.

Even when the best calves are sorted out there are problems in matching them to their dams. Penning small numbers of selected calves and allowing their dams to drift back and join them is feasible if slow. Dye-marking guns are a help in marking the cows for drafting.

8.4 GROWTH RATES

8.41 THE IMPORTANCE OF A HIGH RATE OF GROWTH IN YOUNG CATTLE

(a) For Beef Production

Everitt (1966) has indicated that a calf born at 80 lb liveweight and growing at an average 1 lb per day would weigh only about 580 lbs liveweight or (at 55% dressing percentage) about 320 lb carcass weight at 21 months, before the second winter. It would be unfit for killing at this size and would need to be overwintered.

However, a calf which gained 2 lb liveweight per day would reach about 1090 lbs liveweight or 600 lbs carcass weight at 21 months and be fully ready for slaughter before the second winter.

This weight would agree with the 1,000-1100 lb liveweight range which Brumby et al (1962) recommend as the optimum stage for killing, from an energy conversion point of view. It would give carcasses of 550-610 lbs.

However, a regular rate of weight gain is unlikely to be achieved in practice even though it should be aimed for. Warwick (1968) notes that in beef production it is desirable to have rapid even growth from birth to slaughter.

Since beef cattle in this country live almost solely on grass, their rate of growth tends to fluctuate with the supply of pasture. Periods of reduced growth occur when feed is short of animal requirements or of poor nutritional quality (Joblin, 1966b).

Everitt (1967) showed that steers on restricted feed similar to that in a summer drought had to be taken well into the succeeding winter and even on to the following spring to reach slaughter weight. By then they had poor-quality carcasses. Obviously on pasture the fastest rate of growth is made in spring and early summer.

According again to Everitt (1967), the average liveweight increase of beef animals on grass in New Zealand was about 1 lb per day giving beasts of almost 675 lbs carcass weight at over two years of age. This is only half the rate of weight gain needed for producing top-quality young beef. In fact the growth rate of a calf from birth to weaning should be from 2-3 lbs per day (Hight, 1968e). Everitt (1967) emphasises that if cattle are carried on the hill too long at a slow rate of growth before reaching an economic slaughter weight, they will have excessive fatness in relation to weight and a poor yield of meat. Furthermore, after reaching somewhere between 850 and 1100 lbs liveweight they will become less efficient at converting feed energy into beef (Macdonald, 1957).

Carrol, Nelson, Wolf and Plange (1964) even recommend that calves intended for beef production should be fed supplements from weaning onwards if necessary to maintain continuous growth. For at this time of their lives they are at their most efficient in converting feed to liveweight gain.

(b) For Breeding

We have already shown in the section on mating heifers the advantages of feeding heifer calves well. It induces them to reach puberty at an early age and be big enough (preferably over 550 lbs liveweight at 15 months old) to take the bull at 1½ years of age instead of 2½ years of age. We have pointed out the production gains from mating good heifers as young as possible.

8.42 THE IMPORTANCE OF RATE OF CATTLE GROWTH TO THE RUNHOLDER

We are well aware that high rates of cattle growth, although practicable on good hill country, are not often possible on harder land. In fact, a valid reason for the high country continuing a policy of producing breeder stock rather than fattener stock is the real difficulty of achieving good rates of growth in calves and weaners grazing native or semi-improved vegetation.

Until now, growth rates have meant little to most runholders.

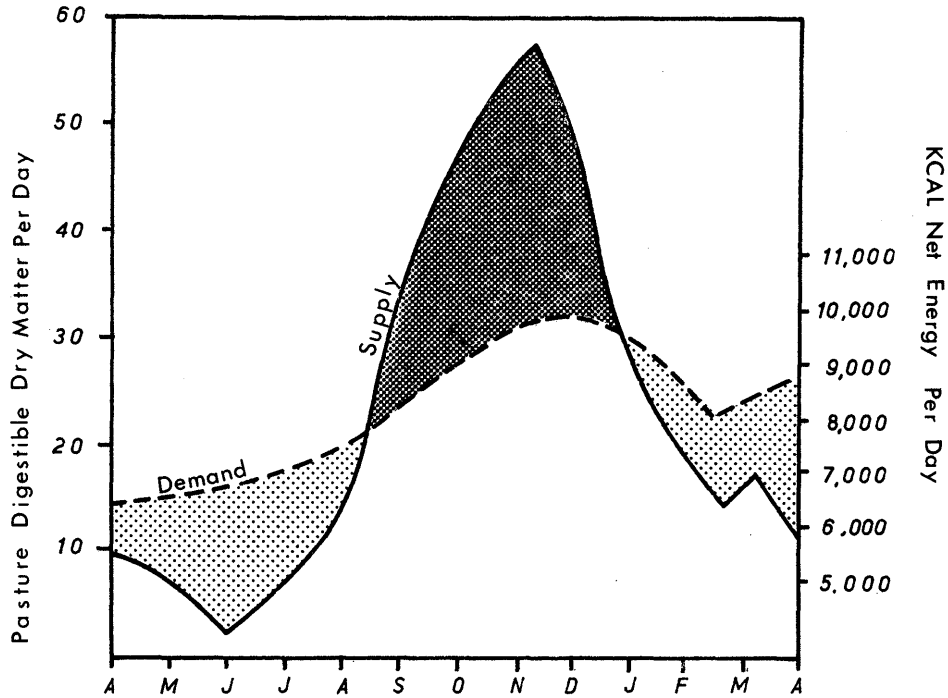


FIG. 7 SEASONAL PRODUCTION OF DIGESTIBLE DRY MATTER FROM PASTURE, AND ENERGY REQUIREMENTS OF FATTENING CATTLE (From Joblin 1968)

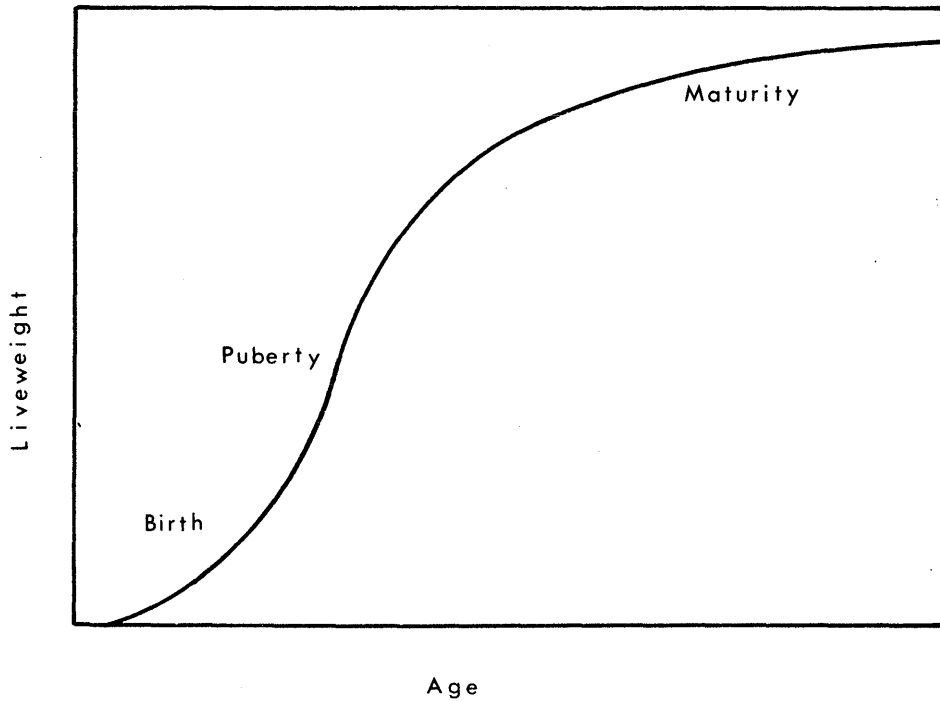


FIG. 8 THE CURVE OF LIVEWIGHT GROWTH OF ANIMALS (Mackintosh 1970)

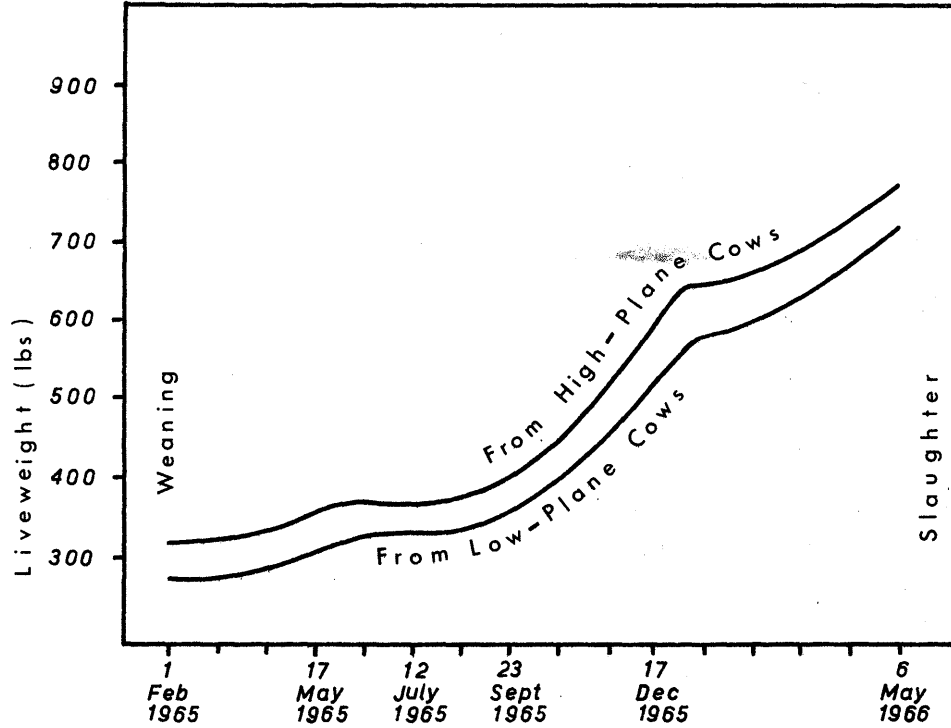


FIG. 9 GROWTH RATES OF STEERS FROM WHATAWHATA (From Joblin 1966)

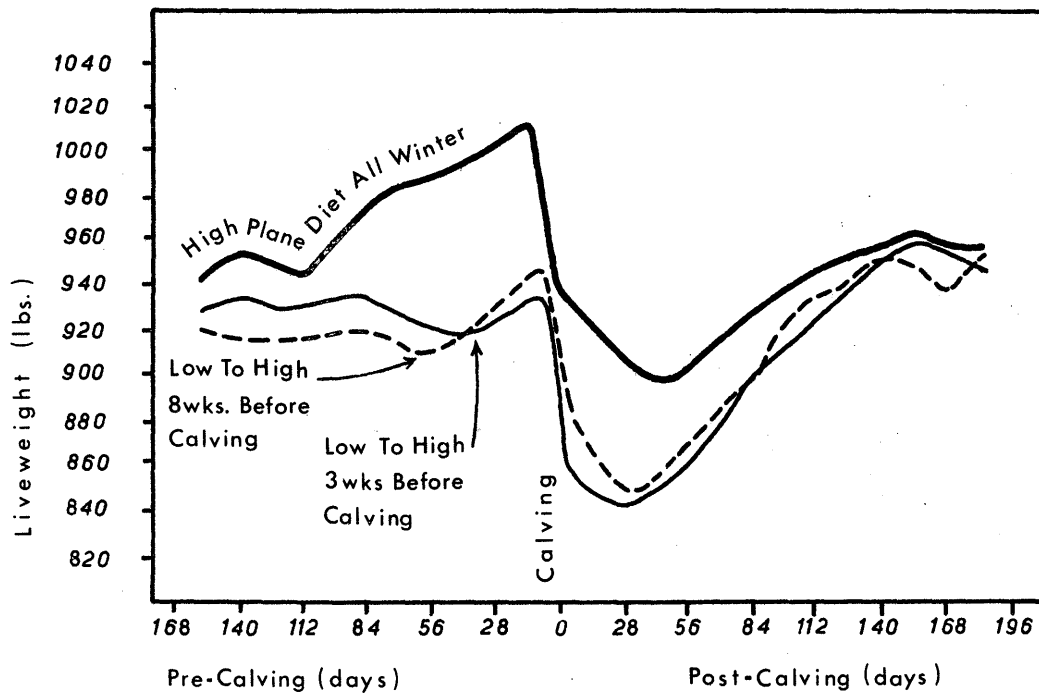


FIG. 10 COW LIVEWIGHT RELATIVE TO CALVING DATE (After Hight 1968)



On many hill properties fast calf growth rates can be achieved with reasonable feeding improvement. Heifer calves on improved pasture, Forest Range Station, Tarras.

Photo: R. Emerson



A valid reason for the harder country to produce breeding stock rather than fattening stock is the difficulty of achieving good rates of growth in calves and weaners grazing native or semi-improved vegetation. Hard hill country, mid Canterbury.

Photo: E. R. Mangin

In general they have been concerned with breeding calves of reasonable size for the autumn calf sales. Here the prices paid depend mainly on size and general appearance but also on coat colour, reputation of vendor and breed.

Without sale by weight it has been unimportant to the runholder how fast his calves have grown. Indeed, even if he had weighed them he would usually have felt there was not much he could easily do about improving their growth. They would likely be grazing unimproved blocks anyway where their growth rate, along with the cow's milk supply, depended on the response of the native plants to the season.

But times and profits are changing. As pasture improvement increases in area and cost, in future runholders will be forced to assess their return on investment. To do this they will have to know the price they get per pound of cattle liveweight at sale. This means weighing stock and thinking about the value and costs of efficiently converting pasture and supplements into beef or breeding stock. On improved pasture the higher the stocking rate the higher the apparent level of utilisation (Joyce and Rattray, 1969) but overgrazing can easily lead to declining pasture production (Joblin, 1969) and depressed animal growth.

On many hill properties, fast calf growth for early breeding or slaughter could be achieved with reasonable feeding improvement. And for the properties aiming to sell cattle in prime condition the rate of growth can make all the difference whether or not a beast can be sold prime at 18-20 months before the second winter. In our opinion, the advantages of producing more calves per cow, and good quality beef, make growing better pasture worth the extra effort where it is practicable. These objectives may, however, conflict with a policy of "maximum beef per acre". Here high total meat production is the aim. It implies high grazing pressure and less-than-maximum calving percentage and growth rate rather than high individual animal performance. We think that rational management policy should fall somewhere between very high and very low per animal production. Just how high or low will depend on individual taste and circumstances.

To get high per acre production needs reasonably even rainfall (or irrigation), reasonably even temperatures, and dedication. But high per animal performance, implying high calving percentage and high growth rates seem worthwhile objectives for the South Island hard-hill and high country farmer for several years yet.

8.43 GROWTH AND FOOD CONVERSION EFFICIENCY

Rapid growth is associated with the most efficient use of food. Warwick (1966) states that on average, for each increase in daily gain of one-quarter pound, there is a saving of about 7% in the pounds of feed required to produce a pound of live-weight gain. And Conniffe and Harte (1967b) showed that when animals of the same breed are fed as much as they want to eat, those with the highest liveweight gain will in general have the highest efficiency, measured either as liveweight gain, carcass weight, or weight of lean meat in the carcass.

Rapid growth and thus high food conversion efficiency is a feature of the late-maturing animal (Fraser, 1959). For instance, Jamieson and Scott (1966) report that Charolais-cross animals have a better feed conversion efficiency by 4-21% than the earlier-maturing British breeds.

However, Bratcher (1968) of the American Angus Society (a breed renowned for its early-maturity) claims that "current research in the United States is proving ... that medium size cows like the Angus are the most efficient converters of grass to beef. Maintenance requirements are lower per head and more animals can be run on a given area." We have found no evidence to support this statement. In fact Neumann and Snapp (1969) report experiments showing that the Angus, along with straight Brahman and Jersey cattle, were less efficient than Herefords, Santa Gertrudis and Friesian (most efficient) in a feed lot.

Harte and Conniffe (1967a) in Ireland found that there was no major difference between Friesians and the crosses, Hereford x Shorthorn or Angus x Shorthorn, in the efficiency of converting feed into lean meat, even though the Friesians yielded more lean meat per animal. This tends to indicate that while some straight breeds are more efficient food converters than others, the best animals in straight breeds are as good as the first-cross for efficiency.

8.44 GROWING MUSCLE, FAT OR BONE

It is probably hard to believe that the early maturing British beef breeds have a slower rate of liveweight growth than later-maturing breeds such as the Friesian, but it is true.

It can be explained in this way. The tissue growth of a body takes place in the following order: bone develops earlier than muscle which develops earlier than fat. Therefore, at a

similar age the early-maturing animal, whose tissues are nearer an adult ratio to one another, will have a higher proportion of fat in its body than the less-mature animal. Even the fat itself will be laid down in a certain order: First internal and kidney fat, then a layer over the muscles and thirdly fat within the muscles seen as "marbling" (Hammond, 1952). Heifers are earlier maturing than bulls and steers and thus have more fat at similar ages.

Now it takes about two to four times more food energy to make a pound of fat than a pound of muscle or "lean" (Joblin, 1966, "Veterinarian", 1968b). Therefore, on a constant food intake, liveweight gains decrease when food energy begins to be stored as fat. Thus the later-maturing animal, which is still putting food energy into muscle instead of fat, will continue to gain weight more rapidly. Gallagher (1963) has given a dramatic example of the wastefulness of letting a beast put on too much fat. He pointed out that in a line of steers with carcass weights of 750 lbs, about 112 lbs of waste fat would be trimmed off each carcass at packing. The feed energy wasted in this fat would have been enough to give a liveweight increase of 200-250 lbs in a young animal growing mostly meat and bone.

Small size in cattle must not be confused with early maturity. Small cattle fatten at lighter weights but not at younger ages than large cattle (Knox, quoted by Barton, 1962). Their small size may in fact be a disadvantage because at a given weight or age, animals of large mature size will gain weight more rapidly on less feed than animals of small mature size (Kidwell and McCormick, 1956). These larger, faster-growing animals will have carcasses which contain a higher proportion of muscle and lower proportion of fat (Everitt, 1966).

In general, the older the animal the more fat there is in its body. Twenty-one-months-old steers from Ruakura killed out with 12.8% fat. But those kept to 31 months had 18.9% fat and 2.9% less saleable meat (but 2.8% less bone in the total carcass weight) (Joblin, 1966b).

But on the other hand, if an animal is killed too young, the overhead costs of producing it, that is the cost of keeping its sire and dam, cannot be spread over as many pounds of carcass weight sold.

Nevertheless young animals make more efficient use of food for weight gain than older ones. A cattle beast's fastest rate of growth is somewhere in the first eight months. From then on it tapers off. Clearly it is commonsense to kill for beef

just when a beast is starting to become less efficient and before it converts food to too much wasteful or misplaced fat.

From a marketing point of view, Professor Butterfield (pers. comm.) recommends that the cattle breeder should aim for "maximum muscle, minimum bone, and whatever fat the market demands".

Double Muscling

A condition of cattle known as "double muscling" or muscular hypertrophy has excited some interest in recent years. It is a genetically controlled trait which can be selected for and appears as a varying degree of abnormal enlargement of all the muscles of a body rather than duplication of muscles. Obviously such animals not only have very high yield of meat from the carcass but a low proportion of bone. The growth rate of young cattle up to 12 months of age is also very high. However, there is a fairly high incidence of infertility in females with this characteristic, a 30-50% lower milk yield, and high mortality at calving in those cases where the condition develops before birth rather than after (Oliver and Cartwright, n.d., Sth Aust. Dep. Agric., 1968).

8.5 CULLING

8.51 SELLING ALL CALVES

Some runs keep none of their own calves for replacements, buying in sufficient heifers each year to maintain their herds. This practice is not uncommon amongst runholders with small herds practising crossbreeding - that is using, say, an Angus bull across Hereford cows (or vice versa) and selling all the progeny. Unless the herd is large enough, they do not consider it worthwhile to keep (in this case) both Hereford and Angus bulls. If they did, they would have to separate part of the herd of cows to produce purebred replacement calves (and some sale culls) from the remainder which breed crossbred sale calves. However, buying in is not common for most runholders hold the opinion that stock bred on the place are far better "doers" than stock bought in.

8.52 KEEPING REPLACEMENTS

Most runholders keep their own replacements. Calves and rising-two-year heifers (if any) are selected by eye appraisal of conformation, size, thrift and colour. Selecting new replace-

ments for the herd on recorded weight gains is being practised on only two runs to our knowledge, although keeping big calves is a form of weight-gain selection in itself. We expect weight-gain selection to increase significantly in the future amongst breeders selling calves (as well as amongst fatteners) if breeders find the price they receive depends on the measured quality of their stock. In the meantime, sellers getting good prices are inclined to be against tampering with the selling system.

Selection on weight gain can show significant practical increases in productivity, not always related to appearance. One Australian property culls all cows and calves if the calves do not exceed 450 lbs liveweight in 220 days, after finding that some of the best-looking cows produced some of the poorest calves (Vine, 1966).

8.53 CULLING COWS

In the high country, cows are culled on fertility, age, thrift and health.

Some runs carry as many heifer calves as possible through the winter so that later they have a better choice of replacements. The young cattle are also versatile controllers of roughage. Selection is made either at 18 months of age, or after the first calving on the appearance of their progeny ("Cantuar", 1967).

One or two runs pregnancy test their cows (not sooner than 60 days after joining) and sell barren cows to the works to reduce the strain on winter feed. There can, however, be a 10% difference between test results and calves marked, partly due to early calf losses (Young, 1967). Most cattlemen cull for fertility after the calving season. With the prevailing high price for export boner meat, most cows culled, including old but sound ones, go to the works. Some cows of good appearance may be sent to the saleyards or, if from a well-known property, sold to private buyers. Lameness, difficult calving and cancer eye are almost the only diseases for which cows are culled, other than barrenness.

Since few cows are as yet age marked, appearance is usually the only basis on which a cow is culled for age. Cows are often kept in the herd until 10-12 years old and occasionally, on the best country, until 14 or 15 years old. Most runholders aim to sell only when the risk of an old cow dying on the place gets too high. Hight (1966, 1968a) has recommended that cows should be culled at 8-9 years of age because of declining calving per-

centage if older than this and Young (1965) found a high proportion of inert ovaries in cows 8, 9 and 10 years old, especially if in poor condition, but the best criterion for retaining a cow is her ability to continue to produce calves.

Bulls are not kept for more than about 4-5 mating seasons. They are then also sold to the freezing works for boner meat.

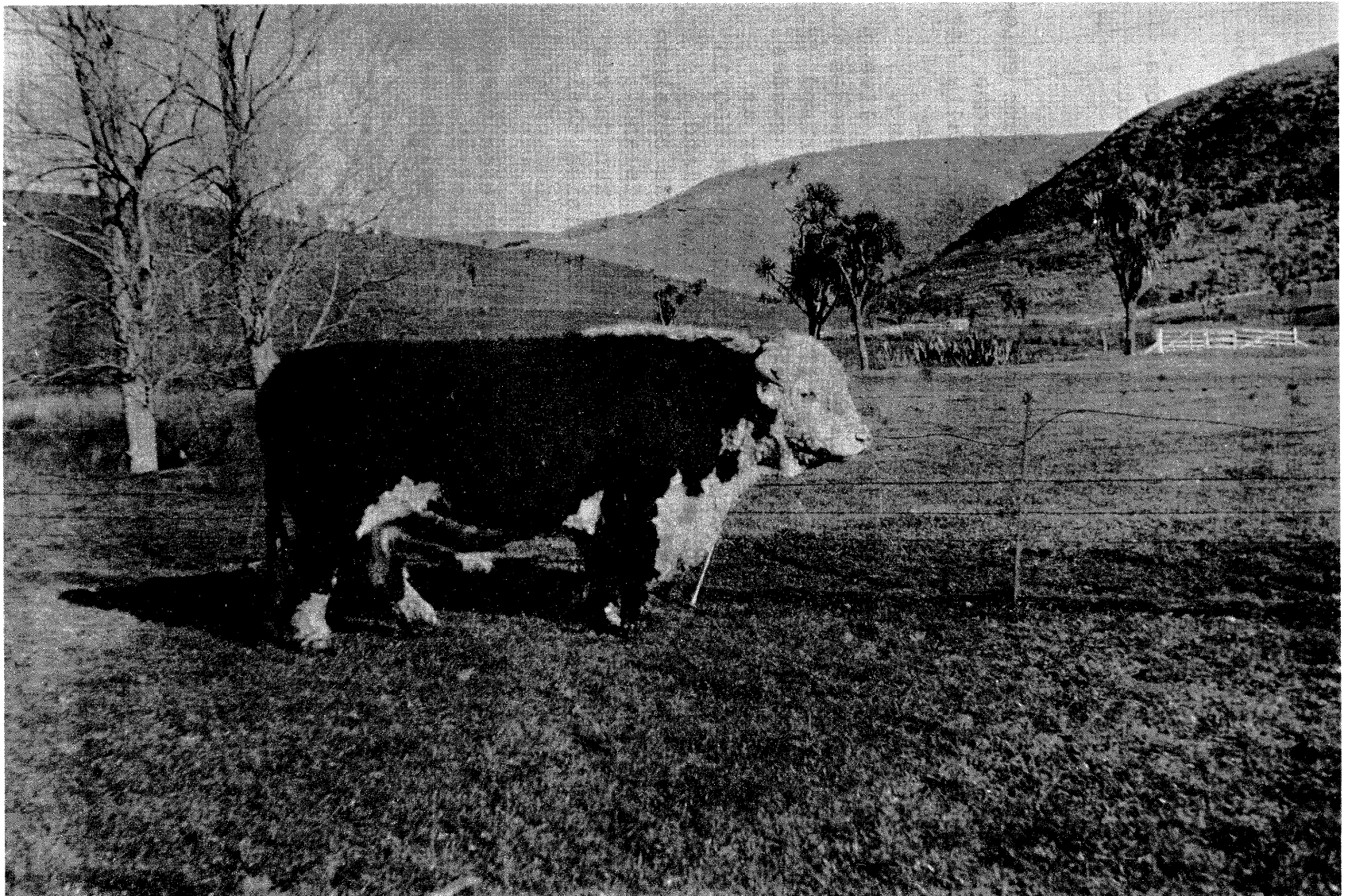
8.54 CATTLE SALES

A few of the more favoured runs buy in calves at autumn sales for winter feeding and intermittent sale as the beasts become prime in the following autumn. Otherwise, calves are usually bought by other runholders for breeding (if heifers), or by farmers in higher rainfall or irrigated areas for fattening. Winchmore Irrigation Research Station has reached 430 lbs live-weight gain for a year when the calves were wintered on swedes and hay (Walker and Lobb, 1968). Reeves (1967) has surprised many by his account of carrying $1\frac{1}{2}$ - $1\frac{3}{4}$ beasts per acre on swedes and pasture from purchase at five months old to slaughter as chiller beef 12 months later. He turned off about a net 500 lb beef per acre on irrigated but otherwise fairly light land. But Joyce (1968) reports that 700 lbs beef per acre was obtained from a self-contained management system in the North Island! Such results augur well for a good future demand for run calves and illustrate the potential for many farmers to finish their own stock.

If heifers are kept or bought in for beef production they are usually spayed at a cost of 70c - \$1. Unspayed heifers can be fatter and more wasteful if held to the same sale weight as steers ("Veterinarian", 1966b).

Hard and high runs often keep as many steer calves as possible and sell them as adult steers at $2\frac{1}{2}$ or $3\frac{1}{2}$ years of age as "stores" for final fattening by others on farmland. While on tussock, their main function is to graze rough blocks into better shape for sheep. At any time of the year they can expect to be on harder country than the cows. On some southern-lakes runs they are kept for fern crushing in the spring when cows are not available. Some runholders also find that store dry cattle are more flexible to carry since they can be sold at almost any time of the season if necessary (Scaife, 1963).

Many runs keep over a few steer calves (perhaps late calves not ready for autumn sale, or calves missed in a muster) for intermittent sale when the market seems right. Management of



Bulls are not kept for more than 4-5 mating seasons. Tregoyd Unesco in excellent condition photographed July 1968 as a five-year-old - Limestone Hills, Waimate.

Photo: A. G. Wigley

these few steers is generally fairly haphazard.

There is a very good market for 18-month heifers for breeding purposes and for in-calf heifers and cows, although these two latter classes can be a bad buy if purchased without guarantee. Bull beef production is unlikely to become policy on South Island hill country in the foreseeable future, even though bulls are more efficient meat producers than steers. The practice has been reviewed by Barton (1968).

8.56 PERFORMANCE RECORDING

In the opinion of Butterfield (1967), there are four reasons for weighing cattle:

- (a) To record the calf's birth and weaning weights and hence the milking ability of its mother and to a lesser extent the calf's own weight-gain ability to weaning. Thus fast growing calves and good-milking mothers can be identified. (Recording of calf's birth weight is not essential - authors' comment)
- (b) To record gain after weaning to show how well the animal can grow on the available feed.
- (c) To find marketing weight, which when compared with the time taken to reach it, is the most common indicator of cattle efficiency.
- (d) To record carcass weight, if necessary, for payment.

Besides these reasons, weighing stock can also be useful as an index of the adequacy of feeding level during critical periods, as a record of improvement in herd performance, as a comparison of supplementary feeds and for sire comparison (G. Falloon, pers. comm.).

According to Gregory (1964) a programme for performance recording should "include the systematic measurement of traits of economic value and the use of these records in selection". Its purpose is to help find animals which are genetically superior in these traits.

Thus, weighing or recording cattle has two principle objects: to monitor the performance of the herd as feed supplies change during the year, and to enable high-quality replacement stock or their parents to be chosen. The features of a good programme

should be that:

- (a) all animals are given equal opportunity;
- (b) systematic records are kept of all important economic characteristics on all animals;
- (c) records are adjusted for known sources of variation such as age of dam, age of calf, and sex;
- (d) records are used for selecting replacement stock and culling poor producers;
- (e) that nutrition and management are uniform for all the animals to be compared;
- (f) selection is made in an environment (e.g. on a type of grassland) similar to that in which the animals or their progeny are expected to live in future.

(Gregory, 1964) Black and Gregory, 1969

The same authors list the major performance traits influencing the efficiency of production as:

- Reproductive performance
- Mothering or nursing ability
- Rate of growth
- Conformation as it relates to structural soundness
- Efficiency of growth or conversion efficiency of food to body weight
- Carcass quality
- Longevity, or length of productive life of breeding animals.

Obviously a runholder starting recording should select at first those characters which are most important to him.

Simple hydraulic scales have been developed in New Zealand and cage scales (which are less subject to inaccuracy from cattle position) are available. An electronic scale for automatically weighing cattle on range country without disturbing them is being developed in the United States (Martin, et al, 1967).

When using scales to compare beasts, the stage of gut-fill

of the cattle should be remembered for a cow can lose up to 10 lbs an hour when standing in a yard.

While measurement for growth rate during an animal's life is commended by almost everybody (although few farmers have started to do it yet) some fat-stock sellers, agents and buyers consider weighing has little place in the saleyards (Anon, 1966a). However, cattle scales have now been installed at the Frankton saleyards and the liveweight of cattle is visible at the time of sale (Miller and George, 1969). "Dairy beef" sales in the North Island are now mostly made on a liveweight basis. At the Omarama cattle sale (1971), more than two-thirds of the animals presented for sale were weighed beforehand by the Department of Agriculture. Average weight (over two sales): steer calves 388 lbs, heifer calves 377 lbs, range 200-560 lbs. There was a close relationship between liveweight and price (J. D. Currie, Pers. comm.).

8.6 SUMMARY

Most runs leave cows to make their own feed and shelter arrangements at calving. Usually calving is timed to take place after spring pasture growth has started. This gives the cow a rising plane of nutrition from late pregnancy onwards. There is evidence that leaving cows unattended at calving can result in significant numbers of calf deaths at calving. There is a definite breed difference in birth weights. Nurse cow rearing of dairy-bred calves by beef cows can make full use of their milking capacity but it is at present impracticable on high and most hill country properties.

Weaning is usually carried out in the autumn before calf sales, although a few properties leave the calves on the cows all winter. There is strong evidence that a calf's weaning weight depends on the cow's milking ability, and that in turn on her feed supply. There are important reasons why a high weaning weight should be aimed for if sale or early slaughter is planned.

If growing cattle are intended for slaughter before their second winter they must grow at an average rate of at least 2 lb liveweight per day throughout their lives.

Large cows tend to wean high-liveweight calves but the efficiency of production, i.e. calf weaning weight compared to cow liveweight, is more important. There may be some breed difference. Calves from young cows are generally lighter at weaning. After weaning, calf liveweights fluctuate with pasture growth but an as even as possible growth rate should be aimed for. Rapid growth

is also desirable as it gives efficient use of feed.

Unfortunately there has been no premium paid for fast-growth characteristics of calves from runs and indeed these have not been measured.

But the fattener is most concerned to have beasts which will grow rapidly and kill out prime at an early age. They will then have only a small amount of fat compared to muscle in the carcass. Breeds differ in being early or late maturing and thus in rate of growth and efficiency of feed conversion to saleable meat. Beasts of large mature size gain weight more rapidly than those of small mature size. But the fattener must decide which to choose for his conditions - an early-maturing beast for killing prime at 18-20 months or a later-maturing beast for possibly killing FAQ at that age or carrying on to prime later.

In the past, runholders have mainly been divorced from the fattening side of the business and have sold their stock without being aware of how well it measured up for meat production. We suggest that sale by appearance will in time be largely supplanted by sale on growth performance.

Although most cull cows and bulls are sent to the freezing works, calves are sold to other breeders or to fatteners. Recent evidence of the high production of beef possible from irrigated pasture should ensure an increasing market for young store stock from the back country.

Weighing stock has many reasons to commend it, particularly as an indication of the productive performance of individual stock and as an aid to selection.

A high weaning weight should be aimed for especially if sale or slaughter is planned. Glen Lyon Station weaners - Huxley Gorge country in the background.

Photo: A. G. Wigley



CHAPTER 9

BREEDS AND BREED SUITABILITY

9.1 BEEF BREEDS AND MARKET REQUIREMENTS

9.11 MEAT YIELD AND DRESSING PERCENTAGE

The high prices received for boner bull reflect the export demand for high-yield, non-fat meat. For instance, boner bull could be expected to yield 72% meat after 1-2% of fat trimming and cull cow 65% after 5-6% of fat trimming. But ox beef, when perhaps 10-12% excess fat and tissue has been trimmed from it, could yield only about 64%, or 8-10 lbs less meat per 100 lb of carcass. Only about a quarter of this would go into premium cuts (Watson, 1967). As we have already pointed out, if the animal had grown older the proportion of fat could be expected to have increased and the percentage yield of lean meat decreased.

Dressing percentage, or the proportion of the carcass weight to the liveweight, is of less importance than lean meat yield. At one time a high dressing percentage was considered a virtue. Now it is apt to mean a higher carcass content of fat.

Coop (1968) found that although the beef breeds had the highest dressing percentage, the percentage yield of edible trimmed meat showed no difference among the breeds he tested - Angus, Hereford, Jersey, Friesian, Charolais x Friesian, Jersey x Friesian and Red Poll x Friesian. The Angus and Hereford cattle had less bone and more fat than the other breeds and crosses but these two body components cancelled each other out between the breeds. That is, if an animal had high bone, it would have low fat and vice versa. The price advantage would be to the high bone - low fat animals such as the Friesian because bone has to be removed in cutting anyway, regardless of whether or not there is any fat to cut off.

Barton (1966b, 1966c, 1967a) reported that the yield of trimmed cuts was almost identical from Angus, Hereford and Friesian carcasses. Although he reasoned that the Friesian's superior growth rate therefore gave them a clear advantage, the profit advantage he gained from the Friesians was due mainly to their lower purchase price as calves.

Zebu-cross steers (e.g. Brahman x) can have a higher muscle to bone ratio than British-breed steers of the same carcass weight

according to Hewetson (1970) although there was no difference between them at the same age.

9.12 CARCASS QUALITY

Carcass quality is concerned not only with proportions and amounts of bone, muscle, and fat in different parts of the carcass but also in the quality of the meat itself - its tenderness, flavour, and juiciness in relation to maturity. Unfortunately few of the characteristics of a cattle beast as potential beef can be measured on the live animal other than age and the development of muscling (Mason and Beilharz, 1970). At present, potential carcass quality is invariably judged by meat buyers on eye appraisal.

There are many claims made by the different breed societies and their supporters about the superior carcass properties and meat quality of their chosen breed.

However, Butterfield (1968, 1964) found when he dissected beef from British breeds, from Brahmans, and even from rangy scrub steers from the Northern Territory of Australia, that the proportion of red meat (muscle) in various parts of the body was similar between all three in spite of their very different body shape. He therefore concluded that improved breeding had not altered the proportions of muscle tissue in different parts of the body in cattle. (Nor had it therefore increased the yield of so called "high priced cuts" - in spite of often-expressed opinions to the contrary.)

Also Barton (1967c) found that the proportion of most-valued cuts differed by not more than 1-2% between beef-bred and dairy-bred animals. Neither did he find the eating quality of the beef-bred animal superior to that of the dairy bred run under similar conditions. He also stated (1967b) that he knew of no scientifically-documented evidence anywhere in the world which showed that the eating quality of Angus beef was invariably superior to the beef from other British breeds. Neumann and Snapp (1969), reporting exhaustive studies by Tennessee researchers, stated that although Angus steers dressed and graded highest of all the breeds studied (Angus, Hereford, Brahman, Santa Gertrudis, Friesian, Jersey) the higher grade did not result in greater tenderness or flavour.

Bryce-Jones (1968) and Jamieson and Scott (1966) found that meat from Charolais-cross animals (a breed not included in Neumann and Snapp's experiment) was less tender, less juicy

and less flavoursome than meat from Hereford-cross animals.

These results are reported not as criticism of the particular breeds but to indicate that claims of special meat quality for any breed are not often supported by experimental facts.

But even if differences in some important meat characteristics are sometimes less real than imagined, there can, however, be big differences between individual animals within a breed. Warwick (1966) says, "There are large hereditary differences among beef cattle in ability to produce tender, juicy, palatable beef with a minimum of waste fat. Past judging standards have failed to identify those animals with high lean content and indeed apparently have favoured those with ability to lay on fat smoothly at young ages regardless of lean content or muscling."

There are certain meat characteristics which do vary between breeds. One of these is fat colour. Experiments by Morgan, Pickering and Everitt, (1969) showed that the fat colour of the Jersey was more yellow than that of Friesian and Angus straight-breeds (which were about the same). Jersey crosses with these two breeds and with the Charolais were of intermediate yellowness. There were appreciable differences in fat colour between animals within all breeds and particularly within the Jersey breed. Neither age nor sex was closely related to colour intensity. The Charolais appeared to be the most effective crossing partner in reducing the yellowness of Jersey fat. The authors concluded that within-breed selection, crossbreeding and breed replacement could effectively reduce fat colour and largely eliminate the marketing problem of yellow fat in the Jersey and Jersey cross breeds.

9.13 EARLY MATURING OR LATE MATURING - WHICH IS BEST?

There is no such thing as one breed being better than another all round. Each may have advantages in some characteristics. For instance, early-maturing cattle are not necessarily better than late-maturing cattle. Each has a place for a purpose.

Some beasts being early maturing kill out with the proportion of bone, muscle and fat required by certain markets before others. But if an early-maturing beast is kept too long it will have put on too much late-deposited fat even on poor hill-country pasture. Conversely, a late-maturing beast killed young will still be at the muscle-growing stage and may have too little fat for some markets (Butterfield, 1967).



The quality of country and available markets are important factors in the choice of breed and type. Herefords on Lindis country.

Photo: T.G.M.L.I.

How should the choice of type be made? The answer lies in the quality of one's country and the markets there are for the type of beef one is able to produce.

The fattener, usually farming good country, selects early-maturing breeds or crosses. He aims to get his cattle away prime for local or choice-cut export markets before their second winter. If he fails, his profit will be less, for the more expensive winter food will mainly go into heat production and/or fat. Obviously when time of fattening is as critical as this, beasts which mature with the right balance of muscle and fat for his market at an early age are more likely to be ready for slaughter before the second winter than beasts which mature later and need a much faster weight-gain rate to finish in time.

Therefore, the traditional British breed may well succeed here where the faster-growing but later-maturing Friesian or Charolais may miss out unless feed conditions are right for maximum growth (Coop, 1968). If too much feed is needed to get those later-maturing breeds finished in time it may be wiser to carry them on for sale over the next summer and autumn when they will have reached, but still not exceeded, a desirable fat-muscle balance for prime-quality beef. If sold earlier, before reaching prime, the carcasses will still grade FAQ at the same, or not much less than GAQ price.

9.14 PRODUCING BEEF FROM RUNS

Few runholders on harder country are concerned with producing beef directly. If they were, the later-maturing breeds would seem to fit in better with the poorer pasture quality and end up killed for export as low-fat FAQ carcasses.

Instead, most concentrate on producing breeding stock whose rate of growth seems (erroneously) less important. Or they sell cattle of early-maturing breeds as young as possible in store or forward store condition for farmers on better country to finish off rapidly. But for the reasons we have explained above, the risks of holding on to early-maturing beasts too long should be obvious.

Unfortunately runholders producing calves for sale have in the past had little need to consider the meat-producing quality of the animals they were breeding. They have not been concerned about research findings on growth rate or breeding. In part this has been because there has been little information, but there have also been other reasons:



The show ring has tended to encourage selection of cattle on appearance rather than ability to grow beef profitably. Kelso Show.

Photo: D. G. Crawford

- (a) Most cow herds have been small and the owners considered them neither an important part of the business nor gave much thought to improving their productivity other than, perhaps, calving percentage.
- (b) Very few calf sellers have known where their calves ended up or how profitable the buyer found them to rear. In other words, the runholder often forgets that he is just one link in a chain producing beef for the table. Even when he is selling heifer calves for breeding they in turn have calves as cows, at least half of which - the steers - will be killing stock. Only the man who keeps his calves through and finishes them himself is really aware of how speed of growth and yield of meat affects his profits.
- (c) Most of the publicity about cattle has come from stud breeders each claiming his breed and type is the best for almost any kind of country and often basing his sales appeal on show-ring success. This has led runholders to judge their calves on how they look on the day of the sale. And in fact, until now, this is what they have been paid for. The buyers have paid for appearance, size and how well the cattle might "shift" to their farm. There has been no premium for potentially fast rate of growth or for fertility.

We suggest that this emphasis on sale by appearance will decrease as the fattening buyer pays a premium for well-grown stock which will give him the best profits.

In our opinion, truth in advertising should apply just as much to beef cattle as it should do to toothpaste. While every user is entitled to his opinion, sellers have a special onus of accuracy on them.

9.2 OPINIONS ON BREED SUITABILITY FOR HILL AND HIGH COUNTRY CONDITIONS

Table 20 shows the proportion of each breed on high-country runs.

TABLE 20		
Proportion of cattle breeds in New Zealand and on high-country runs		
	New Zealand (1963)	High Country (1965-67)
16.3	Hereford (polled and horned)	50%
74.5	Aberdeen Angus	15
4.6	Beef Shorthorn	2
-	Galloway (inc. belted Galloway)	2
-	Friesian	-
-	Crossbreds	31

Map 2 in the appendix shows the distribution of these breeds and indicates that:

- (a) Angus are more popular in the northern half of the island and Herefords in the southern;
- (b) There are few Beef Shorthorn and Galloway herds - the only high-country Shorthorn herds are in Otago;
- (c) Many properties run more than one breed. This is due more to breeding crossbred calves for sale or for inclusion as first-cross cattle in the herd to make use of hybrid vigour, than for different virtues of either of the two parent breeds.
- (d) There are no fully Friesian herds in the South Island high country.

There is, unfortunately, little real evidence to show that one beef breed is better than another for hardiness or productivity in a particular high-country area. The only controlled comparison made on hard North Island hill country indicated that Friesians surpassed Angus cattle in performance on this type of country (Hight, pers. comm.). Tara Hills are studying calf growth.

Breed preference is based mainly on personal opinion. An owner's choice of breed is usually influenced by:

- i. The breed already on the property when bought;
- ii. The success of other owners;
- iii. Observation of, or experience with other herds;

iv. Comparative prices received for sale stock of different breeds;

v. Aesthetic reasons, such as attractive coat colour.

Few runholders change their mainline breed once they have made their choice, except for special reasons. For instance, a few changed gradually to Galloway after that breed was imported in 1947. However, a decision to produce crossbred calves is more easily made. That is, sometimes a few Angus bulls are used in a Hereford herd (or vice versa) to get crossbred progeny for sale. Recently a few runholders have bought Friesian bulls for the same reason. Many of the smaller run herds have started from a few Shorthorn, Jersey, or Friesian house cows whose heifer calves have been kept until in time there were enough to warrant the purchase of a beef bull. The herd has then been gradually graded up to a beef breed.

The relative merits of the different breeds for back-country use are confused by the understandably conflicting claims of stud breeders and some runholders of set opinion. Unfortunately they have rarely had the chance to try other breeds in a fair trial on the same ground. Instead they generally counterclaim against any virtue other breeds might have.

Differences due to variations in environment (feeding, management, climate, and country) are often confused with differences claimed to be due to heredity.

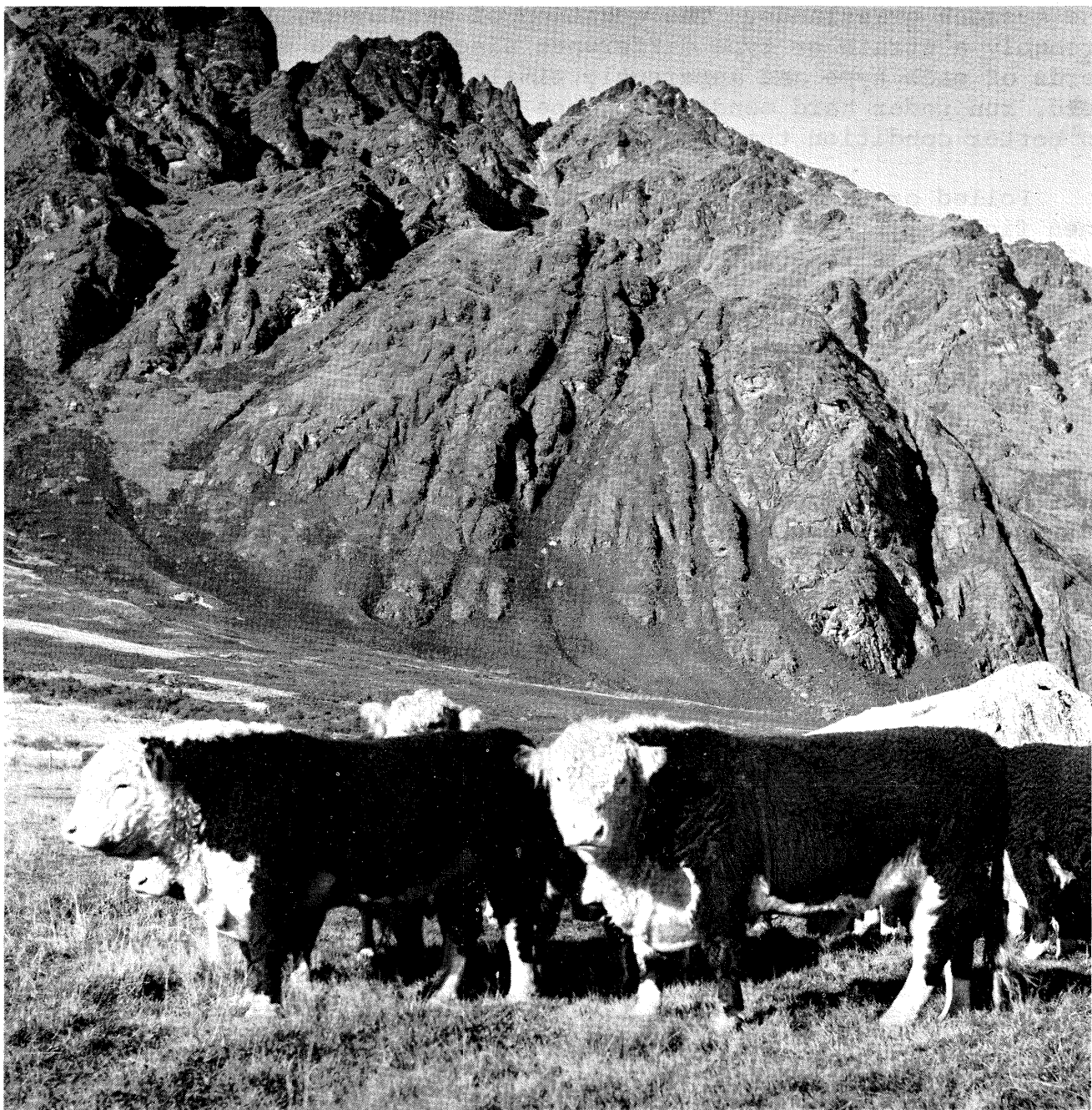
However, while it is wise to have an open mind, it could be true that stockmen get the best results from the breed they are convinced does best on their type of country.

The following opinions of breed characteristics are the summarised views of back-country cattlemen. They may or may not stand up to critical examination, and they may well conflict with breed-society views. Nevertheless they are impressions worth repeating as a distillation of popular opinion.

9.21. HEREFORD

Horned or polled? Those who prefer horned Herefords say polled Herefords are less hardy. Owners of the latter of course dispute this. Certainly horned Herefords are more common in the gorge country, but since they have been run on these properties for much longer the strains could be expected to have adapted to the environment. Polled Herefords are generally accepted as





Above: There is little evidence to support the view that horned Herefords are more hardy than polled. Polled bulls on Remarkables Station, Wanaka. Photo: D. G. Jardine

Opposite: Hereford stud bulls used on the property of J. B. Falconer, Kaiwera, Gore. Photo: T. Falconer

being better suited to good country. Their increase in popularity on runs is quite recent and has paralleled the improvement of the tussock grasslands. The question of hardiness, if true, is probably a strain or type difference since we have seen adjacent herds of each type and apparently similar vigour. In one mixed herd, run under hard conditions, the polled beasts in fact seemed in better condition than the horned at the time of visit.

Polled or dehorned cattle suffer less injury in transit or when fighting. Many breeders of horned cattle dehorn their calves for this reason. It has been said that polled bulls spend too much of their time fighting compared to horned bulls which spread out and spend more time mating (Barton, 1967b). The polled trait is almost completely dominant over the horned trait in breeding.

Chisholm (1960) of Molesworth Station where a mixed Angus and Hereford herd is run, has stated that, "The Hereford is an old and reliable breed, usually well boned and can be trusted to make good under most conditions." This latter characteristic is the factor most often said to be in the Hereford's favour. But he goes on to say, "Herefords, and especially ones with little or no pigment in the eye, are liable to eye trouble" (cancer eye). Later (1968) he suggested that Herefords had a quicker response than Angus in the spring.

Other points often made in favour of the Hereford are its good foraging ability, its docility, its ease of fattening, its ability to thrive and grow a good calf under hard conditions, and its large size when mature. Barton (1967b) reports that in the United States the Hereford has for a long time been the most favoured beast on the range but the Angus is gaining in popularity. Tulloh (1961) ranked them quieter than Angus or Shorthorns.

Well-bred Hereford heifers and heifer calves have always fetched very high prices at South Island sales for breeding use.

The average price at the annual Molesworth steer sale over all pens for Hereford, Angus and cross store steers in 1971 was:

Hereford steers	\$137
Angus steers	\$128
Hereford x Angus steers	\$139

This repeated the order of the 1967 to 1970 averages.

9.22 ANGUS

Chisholm (1960) has observed that:

"The Aberdeen Angus and the cross on Molesworth appear to have just a shade on the Hereford in ability to forage, climb, and to weather out blizzard conditions. On the debit side, the blacks are more temperamental and inclined to deteriorate in stature. In the bulls of this breed, there is an alarming incidence of weakness in the feet."

Chisholm has said (Pers. comm.) that in free-grazing mixed-breed mobs, Angus will often be seen grazing higher than Herefords on hillsides.

Barton (1967b) stated that opinion favours the Hereford compared to the Angus for ease of handling and says that the Angus tends to be a little more timid if not handled regularly and thus is less suited for extensive farming conditions.

Breed advocates make several other claims.

The Angus is said to calve easily and have a low calf death rate - lower at any rate than Friesians (Mills, 1968). It is also claimed to convert feed more easily and efficiently into meat (Bratcher, 1968) and to shift better than the Friesian (Mills, 1968). Unfortunately these opinions are unsubstantiated and could be disputed. Rutherford (n.d.) states that, "... experiments at High Mowthorpe (England) indicate that Angus crosses in particular can hold their own better than most other lowland breeds (underlining ours - authors) under rigorous conditions. Where overwintering is unavoidable the Angus cows may be advisable and under intensive stocking its early maturity could well give earlier finishing." But, in spite of the claim, the actual report of the experiment (Jones and Rennie, 1956) reveals no such evidence of special hardiness in the Angus.

Fraser (1968) pointed to its preference for crossing in all major beef nations eating their own beef. its adaptability to a wide range of country, freedom from disease, foraging ability and ease of calving. He said it matured early, had an even fat covering and it was a polled breed incurring less risk of bruising and damage. However, Acland (1969) has remarked on its declining popularity in Britain because of its smaller size and slower growth rate than some other popular breeds, although

he himself (pers. comm.) prefers the breed on hill country because of the small size and low maintenance requirement but ability to produce big calves when crossed with other larger breeds, an advantage confirmed by Molineuvo (1967).

The fattening characteristic of the Angus as an example of the early-maturing type of animal is well pointed out by Butterfield (1966). He observes that because it is less capable than late-maturing breeds of absorbing large amounts of concentrated nutrition (as in barley feeding) while being fed to slaughter weights, it must gain weight more steadily if over-fatness is to be avoided, but it has the advantage that it can be rapidly fattened at almost any weight by increasing the nutritive intake. It seems to us that this characteristic gives the early-maturing breeds such as Angus, Hereford and Shorthorn a special place on the unimproved pastures which form a large part still of the hill and high country of the South Island.

The popularity of the Angus, in particular, seems to depend on whether a farmer is producing lean meat efficiently and in quantity (at which the Angus appears to be at a disadvantage) or is prepared to forego quantity in favour of smaller amounts of smaller cuts with a higher fat content but grading choice for markets which are prepared to pay extra for this type of beef.

There have been more general claims and counter-claims made about this breed than about any other, except perhaps the Friesian. Unfortunately this is too often based on opinion rather than fact and tends to obscure the specific advantages which any breed has for certain purposes.

9.23 SHORTHORN

The Shorthorn, once the most popular breed in New Zealand, has declined to less than 5% of the national herd. Acland (1969) has noted a similar trend in Britain due again, he says, to its reasonably small stature.

The Shorthorn is stated by a breeder (Giles, 1968) to be "an ideal beast for crossbreeding, imparting hybrid vigour and quick-maturing qualities". It matures, however, somewhat slower than the Angus and Hereford (Sampson, 1952). The cross with the Hereford is popular, particularly in the United Kingdom.

It is normally one of the most docile of the British beef breeds. It has always been known as a butcher's beast and is

famed for the size of its bullocks, but runholders have doubted its ability to adapt to low-quality feed as well as the other British breeds. They are doubtful too of its hardiness and foraging ability. Its size can restrict its agility. Although still popular on fattening farms, the lack of young stock coming forward from the back country has restricted the number available to farmers.

9.24 GALLOWAYS

The position of the Galloway in the South Island is something of a mystery. After introduction in 1947 it was hailed as the ideal hill-cattle breed. Certainly those properties which have persisted with it have no doubts about its hardiness and foraging ability. It has been reported to us that the Galloway x Hereford cross does much better than the straight Hereford in droughts (Boyle, pers. comm.)

However, it has been consistently priced lower than other breeds at cattle sales. In the face of this it has lost popularity. It is now run only on a few properties which are prepared to accept lower prices because of their belief that it is the best breed on tough hill country.

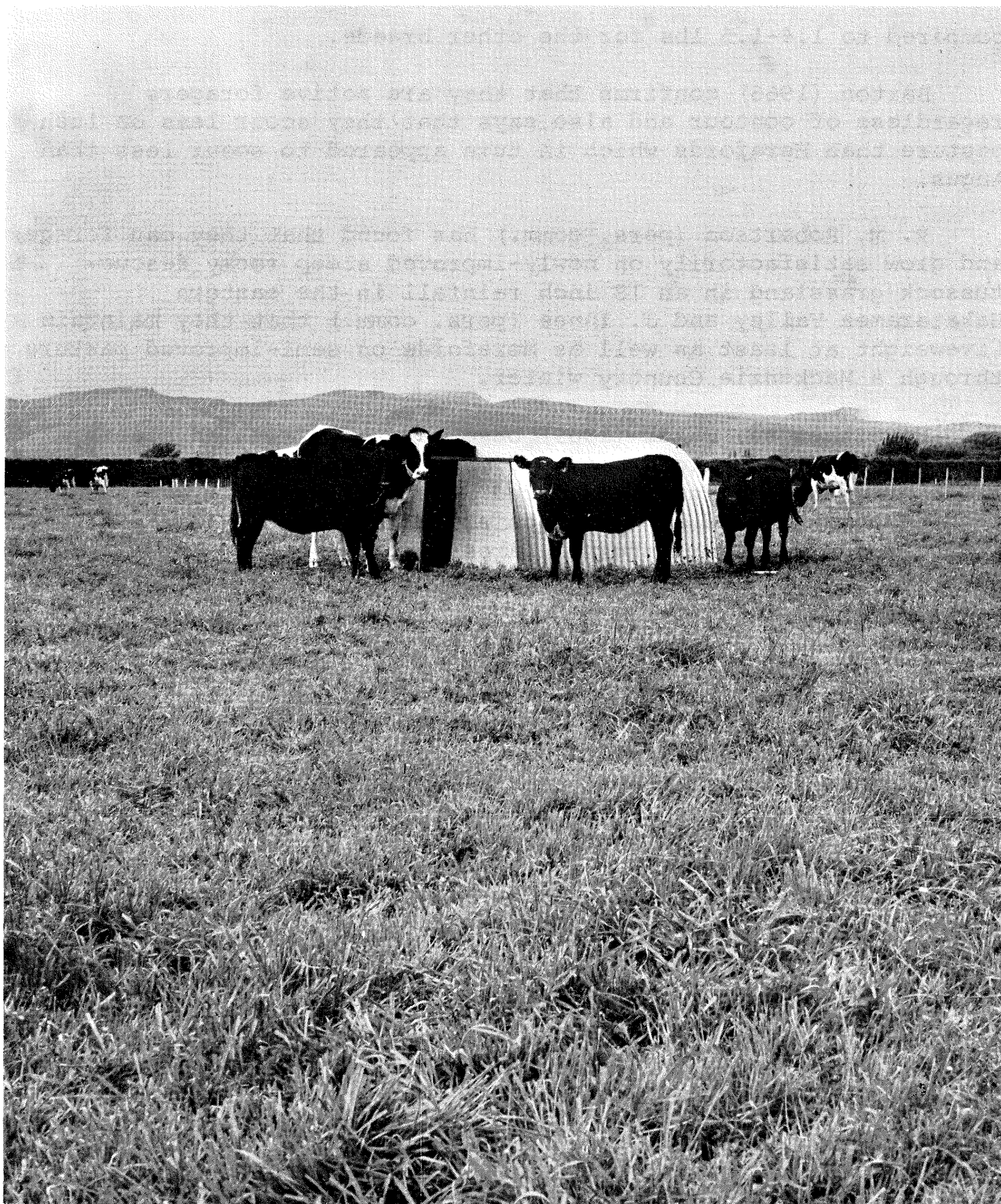
To some extent its unpopularity may have been the result of interbreed rivalry. Widely repeated criticism, (often by people who scarcely knew the breed) accused it of being temperamental, having too high a percentage of bone in the carcass and an inability to grow out or fatten rapidly. The story, as we have heard it often, was that the Angus cattle could go where the Galloways went and still produce more calves and meat. Certainly in a market which pays for size and little else the Galloway is at a disadvantage. It is a slow-growing calf (Davis, pers. comm.).

Bowden (1962) says that it is slow to mature under hard conditions and that the graining of the carcass meat is not as fine as in some other beef breeds.

But since hardiness and foraging ability are two accepted virtues in the back country, we consider that the meat-producing ability of the Galloway should be properly investigated in a comparison with other breeds.

9.25 FRIESIANS

Friesians are known for their high rate of gain, good milking ability and low ratio of fat to muscle in the carcass.



Friesians could markedly contribute to beef production on hill country because of the superior milking ability of dams and rapid weight gain of progeny. Friesian crossbreds for beef = mid Canterbury.

Photo: T.G.M.L.I.

compared to 1.4-1.5 lbs for the other breeds.

Barton (1966) confirms that they are active foragers regardless of contour and also says that they scour less on lush pasture than Herefords which in turn appeared to scour less than Angus.

R. M. Robertson (pers. comm.) has found that they can forage and grow satisfactorily on newly-improved steep rocky fescue-tussock grassland in an 18 inch rainfall in the eastern Hakataramea Valley and J. Innes (pers. comm.) that they maintain liveweight at least as well as Herefords on semi-improved pasture through a Mackenzie Country winter.

Nevertheless, Baker (1969) observed that Friesian steers seemed less able to tolerate conditions of stress than beef breed cross Friesian steers and required a longer period of additional feeding to make good any previous effect of lack of feed or effects of disease or internal parasites.

9.26 CHAROLAIS

Chisholm (1967b) commenting on the future of Charolais cross cattle, considered that "some of these crossbreeds will not produce meat and bone out of browntop, snow and ice."! Such a task would surely tax any breed but there is nevertheless considerable speculation on their place in the run country. As yet they have not been tested in high-country conditions.

Sutherland (1967) gave details of high rates of liveweight gains of calves from Charolais crossed with Friesian, Shorthorn or Angus cattle in his stud compared to those from straightbred Angus cattle.

Hollard (1968) confirmed the high rate of liveweight gains of the Charolais x Friesian cows but reported that this had been slightly bettered by pure Friesian cattle in the trial at that stage. He also spoke of calving difficulties and the lack of vigour of some new-born Charolais calves as has been reported overseas with this cross. Barton (1964) has also commented on possible calving difficulties which he says may be due to conformation. Sutherland, however, (op.cit.) reports no more than normal calving difficulties. He says that having the cow in the right condition at calving is important. J. Acland (pers. comm.), while conceding that there may be calving difficulties when both parents are Charolais, has personally found no problems with Charolais x Angus where the calves weighed about 80 lbs at birth.

Elsewhere Hollard (1968) reported that his Charolais cross calves had averaged 97 lbs at birth and that the trial mentioned above had shown average daily gains from weaning to about 16 months of age of: Friesian 1.80 lb, Charolais x Friesian 1.80 lb, Jersey x Friesian 1.62 lb, Angus 1.47 lb, Hereford 1.43 lb. But he cautioned care in interpreting the results because of the differences between the breeds in that some were bucket reared (dairy) and some nurse-cow reared (beef).

Charolais cattle may well be used mainly as sires for crossing. For instance, Acland (pers. comm.) found that at about 17 months of age Charolais x Angus cattle weighed on average 155 lbs more than straightbred Angus and the difference was worth (1970) some \$20 extra when the cattle were killed at 18 months of age.

Nor does Barton (1964) believe that the Charolais will become popular as straightbred beef animals on New Zealand hill country. Rather he considers that they will probably be used for crossing with dairy stock.

9.27 OTHER BREEDS

Although other breeds such as the Red Devon, South Devon, Brangus and Santa Gertrudis have been imported into New Zealand and the French Blond d'Aquitaine, Maine Anjou, Limousin and Simmental are likely to follow, there is as yet no evidence that any of these breeds could cause a significant improvement in the performance of South Island hill and high country herds. There has been a suggestion (Howes, Hentges and Davies, 1963; Moran, 1970 a, b; Anon, 1970) that Brahman-cross progeny may consume more low-quality roughage than British breeds and surprisingly they were even able to grow faster than straightbred Herefords in Canada both in summer and winter. But Preston and Willis (1970, p. 170) say that the view that Brahmans (representing Bos indicus species) convert high-roughage diets to better growth capacity than British-breed Bos taurus cattle has not been proven.

9.28 CROSSBREDS

There is enough evidence to suggest that first-cross animals have an advantage over their parents in most productive characteristics. However, the progeny must inherit good quality from good quality straightbred parents.

Therefore the question a producer must answer is whether he is selling stock to other straightbred breeders or to fatteners. If he is selling to fatteners, or fattening cattle himself, it is in his own interests to produce crossbreds.



The ability of cattle to travel on rough country is important on gorge runs.
Negotiating rapids during a minor flood in the Wilkin River, Mt Albert Station.

Photo: P. Gazzard

The problem of herd composition is not simple for cross-breeders. Either they have to buy in purebred replacement heifers or breed their own straightbred herd replacements. Dual breeding is feasible only if enough cows are carried to have, in reality, two herds - one of them producing enough heifer calves (allowing for a good culling rate) to keep the other going.

There is some advantage in using crossbred cows to produce stock for fattening, particularly if a third breed is used as the sire.

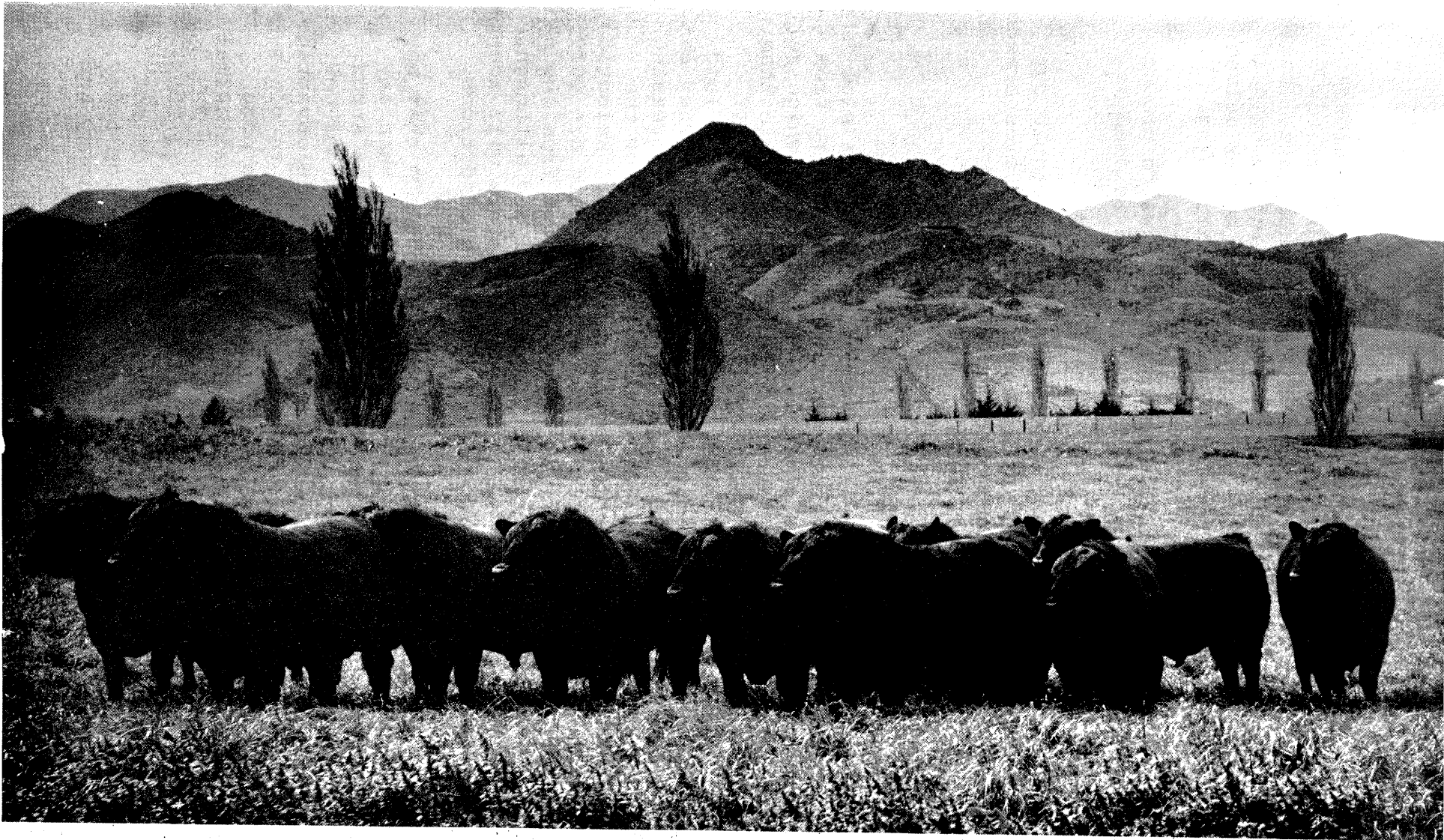
Our view is that there will continue to be profitable outlets for good progeny from both straight breeders and crossbreeders with the former supplying parent stock to the latter.

9.3 SUMMARY

The British breeds produce early-maturing beef at a slow rate of growth but with enough fat to grade prime quality from 18-21 months of age. They are suitable for properties which sell their progeny as calves to fatteners, or which will retain them to sell prime after a further 9-12 months of ownership. If carried on longer than 20-24 months, too much fat will be laid down for best beef quality even under hard conditions. They can, however, be fattened rapidly at almost any weight by increasing their food supply. Where nutritional conditions are poor the early maturity of the British breeds is an advantage. Selection to improve their rate of weight gain is needed. There are very good local and overseas markets for prime young beef from the British breeds. British-bred cattle fessick well and although at their best on high-quality hill or paddock pasture will adapt easily and thrive under hard-hill or high-country conditions.

We have no evidence with which to judge the claim that any breed is a more efficient converter of grass to meat than any other and little, as yet, to support the claim that the Angus produces the highest weight of calf for a given weight of cow. In short, we believe that while each breed may have an advantage in some particular characteristic, there is no reason to claim that any breed has overall superiority. Indeed, it is more profitable to consider the performance of the individual animal.

Although Everitt (1966) has stated that evidence is accumulating to show that the traditional beef breeds do not satisfy the three major requirements of beef production today, namely rapid growth rate, high feed conversion efficiency and



The Angus has a reputation of foraging well at high altitudes and producing quality beef at an early age. Breeder bulls, Parnassus, North Canterbury.

Photo: Courtesy F. F. Wilding

relatively late maturity, we consider that they will have a more important future in the back country as source stock than the Friesian or Charolais breeds and their crosses. There is still a large potential for improving the performance of the back-country herds.

The Friesian and Charolais breeds mature later than the British breeds but have a very fast rate of growth under suitable conditions. Since fat is laid down quite late in their development there is some difficulty getting them prime before the second winter. However, they can still be sold then and although grading less than prime will command the same price or only a little less per pound if they have reasonable fat cover. If carried on over the second winter they grow at a slower rate but can then be killed out at 2-2½ years in prime but not overfat condition at high carcass weights. They are thus very suitable for properties which need efficient working steers. Their meat is of no less tenderness and palatability than that of British breeds run under similar conditions and there is little difference in meat and fat colour. Jersey and Jersey-cross animals are an exception. The small amount of fat is, however, one of the dairy-type characteristics. The higher proportion of bone in the carcass compared to the British breeds balances the extra fat in the latter, leaving similar amounts of trimmed meat from each. The bone will be removed anyway in cutting but the fat has to be trimmed off only if present in excess amounts. Therefore removing excess fat is an additional cost whereas bone is not.

The Charolais cross has not been tested in this country under severe conditions but the Friesian is accepted as being hardy and a good fossicker. However, while they perform well on North Island hill country, we do not yet know if they will stand up to South Island back-country winters, especially on unimproved grassland, as well as the British breeds. They would seem to be most suited to those properties which, with a large proportion of improved pasture, can use their rapid weight-gaining ability to advantage. We accept that this type is the most efficient and profitable beef producer under these conditions.

Again, we believe that there is little to separate the Friesian and the Charolais for beef production. Each appears to have some advantages over the other. We have no evidence to suggest that the Charolais is a better beef producer or better sire of crossbred progeny when crossed with the British breeds than is the Friesian. The Friesian, of course, is a superior producer of milk, but the price penalty of the YAQ grading is a real hazard to light-weight progeny from it.

CHAPTER 10

STOCK HEALTH

Quite apart from losses due to poisonous plants described already, metabolic disorders and diseases can cause death in or reduce the productivity of the herd. The more important are discussed here:

10.1 REPRODUCTIVE DISORDERS AND DISEASE

10.11 INFERTILITY DUE TO POOR NUTRITION

Young (1965) found that nutritional stress was apparently responsible for a great deal of infertility in range cows on the East Coast of the North Island. This may be due to the quality of the feed.

Several workers have shown that a lack of some minerals, vitamins, protein or carbohydrate in a feed can cause infertility. That is, although the quantity of feed may appear adequate, the proportion of its constituents may be out of balance. Apparently quite minor changes can lead to infertility in cows ("Veterinarian" 1968c; McClure, 1968).

Coop (1952), Coop, Darling and Anderson (1953) and Macrae and O'Connor (1970) have shown the poor quality of some tussock grassland herbage. It therefore seems likely that cows put to the bull on the poorer grasslands could have depressed calving performance for this reason.

Infertility due to poor nutrition may cause failure to breed altogether in a season or delay conception for one or more heat periods. Bellows (1968) has pointed out that a late calf will be smaller at weaning and therefore lower priced at sale. This emphasises the importance of feeding cows well enough to have a high percentage calving early in the breeding season.

10.12 ABORTION

There are at least six different diseases which can cause abortion in cattle (N.Z.V.A., 1962). Of these, two are known to be present in South Island run cattle.

(a) Brucellosis - Two species of Brucella cause abortion in cattle and goats. In the former, both bulls and cows can be

infected. The disease is venereal and an infected cow remains a carrier even if she bears live calves later. A vaccine effective against Brucella abortus is available for injecting into beef heifer calves at 3-6 months of age to give them immunity. The Cattle Brucellosis Control Regulation 1966 provides for compulsory vaccination of calves and voluntary testing and slaughter of older cattle ("Veterinarian", 1966a).

(b) Vibriosis - This disease is caused by the Vibrio foetus organism and is transmitted at mating. An infected cow aborts within the first 2-6 weeks of pregnancy and may then return to the bull. She may not conceive for some time, if at all that season. An immunity to the disease then builds up so that the cow may conceive normally in the next and subsequent seasons. A low conception rate amongst heifers is an indication that the disease could be present. Bulls are also infected but the disease is very hard to detect in them ("Veterinarian", 1964, 1965).

This disease was almost unrecognised by runholders in the South Island until the Lands and Survey Department became aware that it was present in the Molesworth herd. Although the information which the Department made available to the public about their experience with the disease was unfortunately later used against them, veterinary opinion is that the disease does exist in many beef herds in the Island (Anon, 1967b). Molesworth Station, by vaccinating calves and keeping heifers and new bulls separate from older stock has restored their heifers calving percentage from 80-10% to 86-88% (Carter, 1965; Anon, 1967a). Recent tests on previously vaccinated cows now 3-5 years old gave no positive response for vibriosis (Chisholm, pers. comm.).

10.2 PARASITES

10.21 LICE

Several types of lice affect cattle - the long-nosed sucking louse Linognathus vituli which causes loss of appetite, anaemia, and loss of weight; the reddish-coloured biting louse, Damalinia bovis; and the small blue sucking louse, Solenoptes capillatus. They are spread by contact but cannot live away from their hosts for more than a few days. Cattle cannot be infected by lousy sheep. Cattle lice numbers tend to increase in winter when the hair coat is long, and the animal perhaps low in condition (Armstrong, 1966). Runholders, in general, have only recently become aware of the devastating effect of lice on calf health. On some properties dipping has led to a sig-

nificant improvement in winter thrift and decrease in deaths of calves. Older cattle also respond to lice control ("Veterinarian", 1967a, 1971). Well-fed beasts can harbour numbers of lice without apparent ill effect but when food becomes scarce, their loss of condition is compounded by the effect of the parasites.

With most insecticides spray dipping is recommended twice (at a 14-17 day interval) in May although it is wise to watch for and treat earlier infestation. The second spraying is necessary to kill the lice hatched from the eggs unaffected by the first spray. However, recently an insecticide spray has become available which persists in the coat long enough to kill the newly hatched eggs. One application of this is enough. A new product is claimed to kill lice systemically when poured on the beast's hide but this must be applied twice and because of this and its expense is suitable mainly for small herds without spray-race equipment. Again, spraying towards the end of the winter in August may be advisable.

It is well worthwhile to spray all cattle to reduce the risk of re-infestation but if this is not necessary, concentrate on the rising-one-year and rising-two-year beasts. The treatment costs only about 3c per calf. It can be done by handlance, by cattle spray race, or for young stock, in sheep shower dips (Munting, 1967).

10.22 INTERNAL WORMS

There are at least 11 different kinds of worms which can infect the digestive tracts of calves in New Zealand. Well-fed calves may be able to harbour quite large populations without showing signs of ill health. But for some reason, most often basically due to poor feeding of the calf, one or more species may rise to pathogenic levels (more than 200 eggs per gram of faeces), (McLeod, 1968). Calves suckling cows are usually little affected by worms but after weaning they can cause calves to show signs of unthriftiness ("Veterinarian", 1967a). There are several good anthelmintic drenches available but more than one dose must be given. It is recommended that, where necessary, calves be given two drenches at a 14 day interval at the end of May and middle of June (at the same time as spraying for lice). A later single drench in July may well be necessary ("Veterinarian", 1968a). If the calves have been suffering from a heavy worm infestation, a drenching programme coupled with the feeding of a high protein diet and rotational grazing on clean pasture can show remarkable improvements in growth rates. On the other hand, it is quite possible for well-fed, thrifty calves to show little response to drenching (McLeod, 1968).



The control of lice in calves may markedly reduce their death rate. Here calves are being sprayed for lice with a gorse gun. The method is a good supplementary measure to normal dipping and by taking the plant to the cattle this could reduce the mustering distance.

Photo: W. J. Tomlinson

But when large numbers of calves are run together, when the climate is severe, or when the grazing area is small, worms can be a very real problem. Correct feeding and drenching will then be needed to avoid losses or, at best, failure to gain weight ("Veterinarian", 1966c). Injection of anthelmintic drugs is now possible.

Lungworm (Dictyocaulus viviparus) in run calves causes coughing and difficult breathing and can result in death. The coughing is noticed most when calves are moved around. Tetramisole drench ("Nilverm") is effective against it. The decision whether or not worm drenching is necessary must be made on the appearance of the calves, their previous history, feed level and, if possible, on the results of trials on one's own property or faecal egg counts. The cost of one drench for a 250 lb calf is 19c for tetramisole ("Nilverm"), 36c for thiabendazole ("Bovizole"), or 13.5c for morantel tartrate ("Banminth II").

10.3 FOOT TROUBLES IN BULLS

Although some disease organisms infect the feet of run cattle, most problems are associated with faults in foot conformation. This can include overgrowth of the hoof wall, cracked hoof wall, elongation of the toes, and corns between the claws (particularly in over-fed cattle). Laminitis or founder (again in heavily-fed cattle), foot rot, dermatitis of the heels and pasterns, and arthritis of the stifle joint, can occur too (Ellis, 1965). Hard mud or a stone caught in the hoof can also cause a beast to limp.

Lameness can cause serious loss of production, particularly where it affects bulls expected to serve cows on extensive grazing blocks. A bull that cannot walk is useless (Chisholm, 1967; "Veterinarian", 1966d).

Bulls should be carefully selected for freedom from foot faults from breeders known to select for this within bloodlines which have a reputation for good feet. If later trimming is necessary, a tipping cradle makes the job easier. The risk of corns or laminitis can be reduced by not over-feeding cattle. Foot infections require veterinary treatment with antibiotics.

10.4 CANCER EYE

This is a complaint found in almost all breeds but is

much more common in Herefords. Beasts with light eye colour are more likely to contract the condition. There is some evidence to suggest that well-fed cows also are more prone to suffer from it ("Veterinarian", 1968e).

10.5 NUTRITIONAL DISORDERS ASSOCIATED WITH PASTURE

10.51 GRASS STAGGERS

This metabolic disorder is fortunately uncommon in the South Island. It is a complex ailment associated with the imbalance between the protein and energy provided by the diet, and by a lack of magnesium (Hickey, 1967). It is very common in North Island dairy and beef cattle, particularly in cows during the first month after calving. It is more common in older cows than younger ones.

Preventive measures are (i) provide carbohydrate supplements such as hay or molasses block when grazing clover-rich (or protein-rich) pastures just before and after calving. Better still, feed the cows on any mature saved pasture; (ii) topdress calving paddocks with magnesite and salt or provide a lick containing these, or add calcined magnesite to hay; (iii) apply only modest amounts of potash, if using it (Hickey, 1967; "Veterinarian", 1968d); (iv) inject magnesite into hay bales from a baler attachment (J. Fitzharris, pers. comm.)

10.52 MILK FEVER

Milk fever is fairly rare in back-country cow herds. It can affect overfed cows in late pregnancy or early lactation. Although susceptibility to it can be inherited, it is a metabolic disorder, associated with a fall in blood calcium. Injection with calcium borogluconate is an effective and sometimes spectacular treatment in the early stages of the disease. Prevention is by not overfeeding cows at this time and by avoiding sharp fluctuation in the food supply (Edgar et al, 1967).

10.53 BLOAT

Although sheep rarely die from bloat, it can cause severe losses of cattle.

Unfortunately, in tussock country, it is the owner who is topdressing his property and probably at the same time building

up his herd numbers, who is most likely to suffer. Quite a few runholders after buying expensive cattle for the first time to cope with the rich feed on a newly topdressed block have been less than happy to find beasts dead. It has caused some to be choosy about buying more. While one dead sheep is scarcely noticed, a dead cow may remind the owner that he paid \$120 for it.

Deaths by bloat occur when excess gas from the fermentation of ingested clover or lucerne builds up in the rumen. The process is complex and is still being studied. It is more likely to happen when the legumes are wet from dew or rain, or when stock are suddenly changed from hard feed to young grass. Some districts or farms seem to experience it more than others, and it can cause serious losses on some runs. For example, one property near Lake Hawea lost 60 cattle in the autumn of 1965. Although this is unusually high, losses of 10 head per season on runs are not uncommon.

Bloat has also been a serious cause of losses in dairy herds but several preventive measures can now be taken. These include: (1) spraying oil (Liquid paraffin or peanut oil), or fat emulsion on pastures so that each cow consumes 3 oz of oil or tallow per day; (2) adding anti-foaming agents called "pluronic" to drinking water or supplying them as drenches; (3) painting 1-2 ozs of bloat preventive on each cow's flanks for it to lick off. Application is by brush or automatic dispenser attached to a spring-tensioned contact arm in a race.

The bloat-preventing effect of oils in general does not last for more than 6-10 hours. The pluronics, and certain detergents have a faster action which also usually lasts longer than the oils (Veterinarian, 1967b). The D.S.I.R. has tested a substance, dimetridazole, which has kept cows bloat free for up to eight days (Clarke, 1966).

(4) A large slow-release pluronic-containing capsule lodged in the rumen shows promise of giving good short term and limited longer term bloat protection up to 32 days (Laby, 1969-70).

However, it is obvious that these measures do not apply to run cattle which usually drink from streams, graze whole blocks rather than breaks, and are in yards only two or three times in a season.

Careful management is the only feasible way to overcome the problem. In time, as improved hill pasture becomes more mature and the proportion of grass increases, the risk of bloat must

decrease. Until then, grazing of clover-dominant pasture should be restricted to dry stock which have already been gradually adapted to a clover-rich diet. Transferring hungry beasts, especially cows, from dry tussock blocks on to clover-rich feed is seeking trouble. Feeding out hay or ryegrass straw is a possible but not always practicable way of reducing the risk. Cattle can die from bloat on any part of any property where the climate, even for one season, is suitable for vigorous clover growth.



New pastures with abundant clover are a bloat risk. The inclusion of plants with a tannin content such as lotus major and birdsfoot trefoil on soils suitable to these species may help to prevent it. Improved pasture, in 1947, Port Levy - Banks Peninsula. Photo: Lincoln College

Some legumes are more likely to cause bloat than others. Pandey (1971, unpubl.) lists lotus major (Lotus pedunculatus) and birdsfoot trefoil (Lotus corniculatus) as non-bloating forages. He reports that the common haresfoot trefoil (Trifolium arvense) also contains tannin - a substance whose presence seems

to limit the production of foam in the rumen. All the nine important species of clover, and lucerne, contain no tannin and are likely to cause bloat. Unfortunately, plants with very high tannin are usually unpalatable to animals and of low nutritive value. The D.S.I.R. are investigating the breeding of low-tannin, non-bloating strains of white and red clovers and selecting for it in lucerne.

10.6 MINERAL DEFICIENCY

10.61 GENERAL

In spite of its importance to animal health very little is known about the mineral status of the food of stock in the South Island high country. There are properties, however, where selenium, and/or copper are known to be deficient and drenching with compounds containing these elements has been beneficial. A light-tan coat colour instead of deep red in Hereford cattle is often thought to be associated with copper deficiency in the diet (Wagon, Albaugh, Hart, 1960, p.246). Cold, wet weather, decreased food intake due to wet or unpalatable herbage or gastro-intestinal parasites may aggravate the condition (Hartmans, 1970). On soils already low in copper, a dietary deficiency may be induced if a fertiliser containing molybdenum is used - especially if the animal has a high inorganic sulphate intake, e.g. of sulphur-containing protein (Dick, 1956).

Selenium deficiency may be caused, amongst other reasons, by a sulphur suppression of selenium uptake by plants. It is particularly evident in the autumn and shows up as unthriftiness and scouring. Veterinary advice should be sought if these or other deficiencies are suspected. The Department of Agriculture can conduct trials to determine whether mineral supplementation is necessary.

10.62 SALT SUPPLEMENTATION

Sampson (1952) states bluntly that "grazing animals need more salt than they can get from the vegetation upon which they ordinarily exist". Smith et al (1950) showed that without available salt the digestibility of forage was lower to steers. They also showed that the intake of free salt by cows may vary with the amount of natural salt in the soil and plants. Unfortunately, we do not know the level of salt in New Zealand tussock grassland plants but we do not expect it to be high.

In this country salt is often used by runholders as a nutritional supplement for sheep. Unfortunately it is rarely

iodised and therefore its value for stock health is much lower than it could be. It is almost unknown for runholders to place salt to encourage stock into country which might otherwise be little used (Moir, 1961). Although run cattle seem to crave salt periodically (J. Aspinall, pers. comm.) it is not often put out specifically for them.

However, in the North American rangelands salt placement is considered an important part of range management. Stoddart and Smith (1955) state: "It is known that with sufficient salt, livestock are more contented and more easily handled, are healthier and freer from disease, and make better gains and develop better". Ranchers' experience is that cattle will travel quite a long way to get salt but do not necessarily hang around salt camps for long periods (Reppert, 1960). It need not be placed near water and research has shown that cattle may not drink for even several hours after eating salt (they drank mostly in the late afternoon and evening) (Bentley, 1941).

Salt is either placed loose in troughs, or blocks are spiked to tree stumps on forest range. Loose salt is recommended, as stock forced to lick may take too long to get enough. The usual ration is 2 lb per cow per month, ($\frac{1}{2}$ lb for sheep) although this may vary with the class of stock (young stock get less) and season of use. Good range management practice is to have one salt ground for every 40-50 head, sited about $\frac{1}{2}$ -1 mile from water where there is plenty of forage (Gay, 1965). As a general rule, the less the number of watering places or the more broken the country, the greater should be the number of "salt grounds" (Skovlin, 1965). Also more are needed when the grazing period is short and during spring when forage is more succulent. Recommended spacing of salt grounds range from one per 300 acres (Skovlin, 1965) to one per 600 acres (Sampson, 1952). The sites should be level, rock free, and near shade if possible.

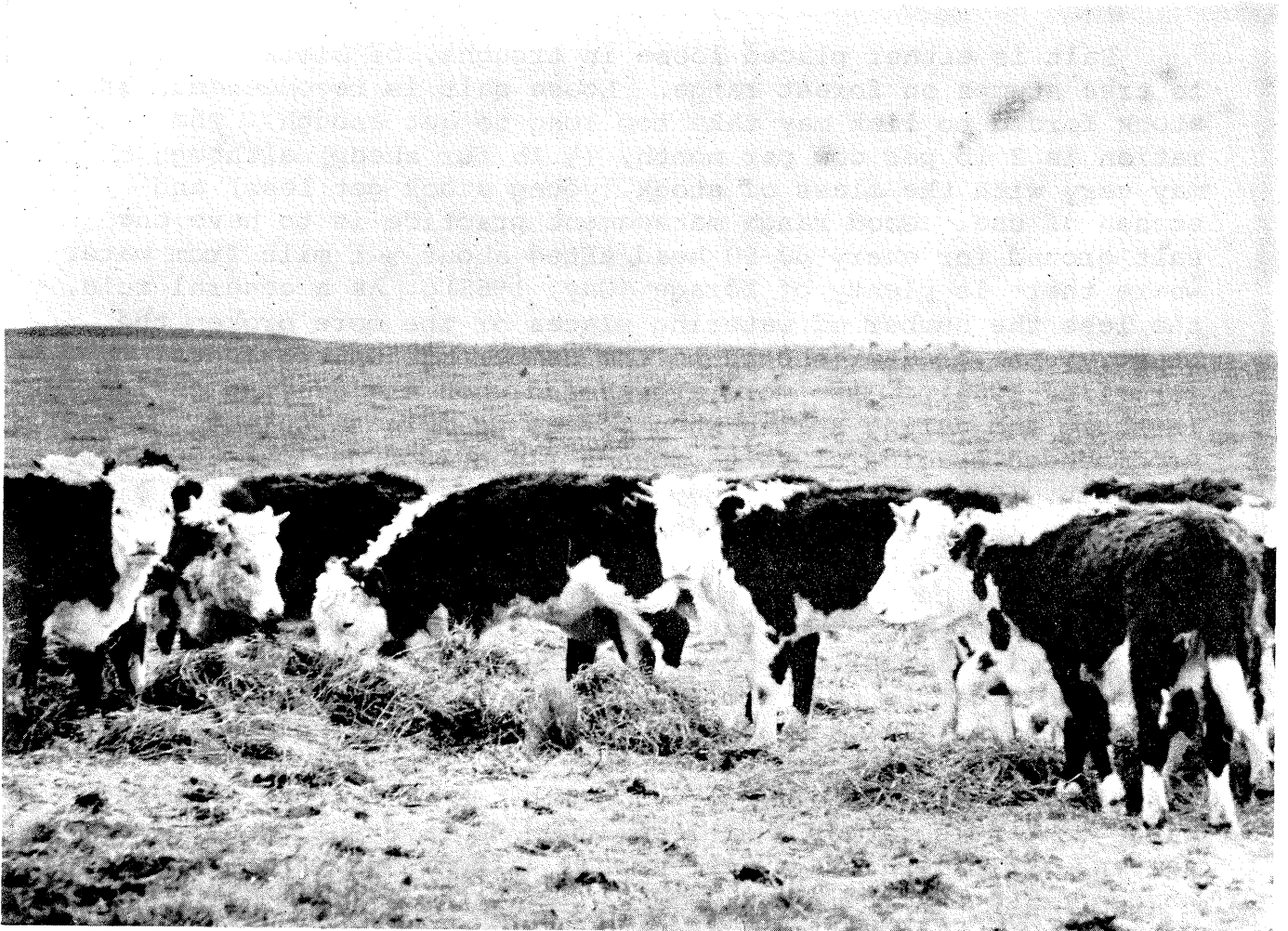
Salt can be used (a) to attract cattle to less-preferred forage, (b) to encourage cattle to make use of lower country, thus allowing higher or poorer country to seed before use, and (c) to hold cattle near temporary water liable to dry up later in the season. It is said that cattle will settle on a block better if salt is placed before they are turned on to it (Skovlin, 1965; Chisholm, pers. comm.) It is best to show salt sites to cattle rather than leave them to find the placing themselves. If bare areas appear around salt grounds, then more are needed to spread the use.

American ranchers set great store by moving cattle from place to place on their range. Shifting stock and packing salt keep them fully occupied (Skovlin, 1965; Boice, 1966). They estimate that one rider should be able to handle and pack for 500 beasts on 30,000 acres of hilly range (Skovlin, 1957).

In New Zealand, coarse agricultural salt costs \$3.30 per cwt and rock salt \$4.20 per cwt (1971). Fed at the rate of 2 lb per month the cost per cattle beast would be 6-8 cents per month.

We consider that the use of salt as an aid to improved grazing management should be investigated in New Zealand.

The key to stock health is good nutrition. Heifer calves at the end of winter, Dunrobin Station, Southland. Photo: B. Pinney



CHAPTER 11

CATTLE OR SHEEP

11.1 CATTLE SHEEP RATIOS

Much has been written on the best methods of managing both improved and unimproved pasture with stock for maximum productivity. Most of it has been orientated towards sheep and dairy cows in humid and subhumid climatic zones. We do not think it necessary to review the literature here. Little pasture research has been carried out with beef cattle alone in these or drier areas. Enough is known to suggest that the principles of good pasture utilisation with sheep also apply to cattle.

The ratio of cattle to sheep in New Zealand is as follows:

New Zealand	1 : 14
North Island	1 : 9.6
South Island	1 : 34.7

(Source: N.Z. Meat and Wool Boards' Econ. Serv. Publ. 1436, 1968)

The ratio changes between farm types:

	Cattle : Sheep
High country South Island	1 : 60
Foothill country South Island	1 : 25
Hard hill country North Island	1 : 8.6
Hill country North Island	1 : 13.2
Fattening breeding farms South Island	1 : 19.9
Intensive fat lamb farms South Island	1 : 45.6
Intensive fat lamb farms North Island	1 : 79.6
Mixed fattening farms North Island	1 : 78.6

(Calculated from N.Z. Meat and Wool Boards' Econ. Serv. Publ. B12/66)

The ratio of cattle to sheep in the high country of the South Island is shown in Appendix C.

11.2 THE INTERRELATION OF SHEEP AND CATTLE GRAZING

The 1949 Sheep Farming Commission wrote (p.98):

"We think it is now generally recognised that stocking with cattle is vitally important to pasture improvement. It has been

shown to us in evidence that a farmer stands to gain financially from a well-judged policy of reducing the number of sheep carried and increasing the number of cattle carried, for the remaining sheep will do better and fleece weights will be increased. There are still, however, numerous cases where insufficient cattle are being carried. To the farmers concerned, we can only say, 'You will ruin your pastures unless you cattle more'."

These comments would be endorsed by most farmers and it is this supporting role to sheep that cattle have most often played in the past. As Ward (1968) comments: "The beef animal ... has been used as a living agricultural implement to control roughage and keep pastures right for sheep."

Trolove (1953) credits them with being able to eliminate fern; control giant fescue, improve sheep feed, spread clover seed, consolidate the soil, and clean out and keep open gullies and dark faces thus allowing access to sheep. Madden (1962) commends their virtues for cleaning up scrubby hill country. Acland (1966) adds, however, that they will not eat and suppress weeds such as broom as much as sheep do. But he states that by eating off surplus roughage they make it easier to control footrot and grass grub (Jessep, 1965). Some farmers have commented that they believe the thrift of their sheep was better when run with cattle. They have also credited cattle with reducing the effect of worms in sheep but this may be due to sheep grazing trimmed pastures being more healthy and better able to resist them. Both J. Aspinall (pers. comm.) and C. J. Crutchley (pers. comm.) say that if cattle are run on a block with sheep they will make tracks in snow along which sheep can follow them to safer or clearer ground.

A practice successfully used by some runholders is to graze higher country first in the season with cattle, then replace them with sheep; and later, in the autumn when the sheep are mustered down, to in turn replace the sheep with cattle. It is considered good practice to wait until country recently grazed by sheep has been freshened up by rain or snow before turning cattle on to it.

11.3 PLANT PREFERENCES OF SHEEP AND CATTLE

Many authors have commented on the different plant preferences of sheep and cattle (Sampson, 1952; Cowlshaw and Alder, 1960; Heady, 1964; Van Dyne and Heady, 1965a, b; Cook, Harris and Young, 1967). The concensus is that cattle greatly prefer

grasses to other herbaceous plants or shrubs. They will eat mature grasses much more readily than sheep will and prefer certain grass species to others. They generally eat only the more broad leaved of the non-grass herbaceous plants and are fairly selective with this type of plant.

Sheep, on the other hand, prefer herbaceous plants other than grass and the more tender grasses. Many grasses will be eaten when young and green, but avoided when mature, except perhaps for the seedheads. Some unpalatable grasses such as hard tussocks are ignored altogether.

Heady (1964) discussed palatability as one of the factors affecting animal preference for certain plants. Chemical composition is probably the most important palatability factor. He referred to a number of papers which found a close link between the protein and/or oil content of plants and preference by cattle and sheep. Foods high in sugars were also preferred by cattle. He also suggested that the amount of grazing a species received to some extent depended on what other species were growing with it, on its succulence or harshness, its stage of growth, the climate, soils and topography and the kind and state of the animal. In all types of stock there are also wide preference differences between individual animals.

Both sheep and cattle prefer a variety of feed to any one species alone and prefer leaves and seeds to stems. They are quite happy to share grazing, and although a block can be eaten out by sheep so that it is unfit for cattle, the opposite is scarcely possible.

11.4 EXPERIMENTAL COMPARISONS OF PRODUCTIVITY

Until recently little formal research work had been done to confirm by quantitative evidence that sheep and cattle together increase the production of either or both. There are now a number of experiments reported to have shown the advantages of mixed grazing to sheep and cattle.

For example, in Texas it was shown that cattle gained an extra 2 lb and sheep 8 lb more an acre when run together than when run separately. In addition, meat yields were increased (Anon, 1967c).

Bevin (1961) and Walker and Lobb (1968) have reported that at Winchmore cattle and sheep produced more meat per acre than

either cattle or sheep on their own. The latter authors observed that the peak demands of the cattle and of the ewe flock dovetailed well. Table 21 summarises the results.

TABLE 21			
Meat Production Per Acre (from Bevin 1961)			
Year	Sheep Alone (lbs)	Sheep and Cattle (lbs)	Cattle Alone (lbs)
1957/58	210	(157 + 155) 312	310
1958/59	213	(152 + 130) 282	245
1959/60	270	(166 + 109) 275	261
1960/61	245	(150 + 150) 300	245 (est.)

In Table 21 above cattle-only and sheep-only gave roughly comparable figures of meat per acre. However, Joyce and Rattray (1969) reported trials where on similar pasture cattle-only gave 529-700 lbs of beef per acre while sheep gave only 256-386 lbs of lamb meat per acre (plus 76-114 lbs of wool). This meat advantage to cattle is to be expected because sheep have the double conversion of grass to ewes milk to lamb meat produced in only a short period of the year. On the other hand, cattle, after weaning, have simply a single-stage conversion of grass to beef all year round.

Suckling (1965) discussing his experience at Te Awa Hill Pasture Research Area, says that where sheep were grazed alone the area became patch grazed, even when the rate was 6½ ewes per acre. Clover became suppressed in the rank patches. Coarse weeds such as manuka and bracken fern increased rapidly on all except the 6½ ewe/acre area. Sedges and rushes still were uncontrolled at this.

The weed problems were not apparent when cattle were grazed with sheep. There was no evidence of fern or manuka re-invasion. He suggested that even on highly improved hill country there must be a balance of cattle to control species which sheep will not eat.

Also, whenever cattle were grazed with sheep, the sheep showed better liveweights, lamb weights and wool production than those grazed without cattle.

TABLE 22

Average liveweights of ewes grazed with and without cattle for a three-year period (From Suckling, 1962)

Treatment (ewes/acre)	Average liveweight of ewes (lbs)	
	Without Cattle	With Cattle
3 ewes	122.2	126.1
4 ewes	122.5	126.8
5 ewes	119.6	121.8
6 ewes	115.6	112.3

He has observed (1962) that cattle will eat good sheep feed until this has been cleaned up and only then will they condescend to eat roughage. He also noted that where cattle and sheep grazed together at lambing time, many lambs became bogged in seepage areas severely pugged by cattle.

Cook (1954) studied the use of range by sheep or cattle in northern Utah. He found that the area would carry either 560 animal units with cattle alone or 360 animal units with sheep alone.

But if cattle and sheep were grazed together, 652 animal units could be carried (65% as cattle, 35% as sheep).

Most recently, Conway (1970) in Ireland has reported that liveweight gains of cattle were greater under a mixed stocking system than when grazing alone but there was no suggestion of competition. Again, Bennett, Morley, Clark and Dudzinski (1970) at Canberra found that sheep grazing with cattle grew more wool, and produced more lambs with higher weaning weights than sheep grazing without cattle. But cattle showed slight depression of performance when grazing with sheep. Cattle grazing with sheep did less well than cattle grazing alone in autumn and winter but grew faster than the latter in spring and early summer.

Clearly, during the autumn and winter, cattle experienced competition by sheep for their preferred feed, but the reverse did not happen. These results were similar to those of Hamilton and Bath (1970).

There is good evidence that, as Culpin, Evans and Francis found in 1964, the total amount of liveweight gain from a pasture is more related to the stocking rate than to the proportions of species. Certainly the complementary effect with



increased performance from mixed grazing is much more evident under humid conditions and on large blocks of mixed vegetation, especially when a pasture is not fully utilised. In all environments when pastures are fully used there may be little benefit from mixed grazing.

The grazing management for sheep or cattle on newly-improved tussock country is worth mentioning.

After oversowing and topdressing, tussock blocks in an over-30" rainfall area should be grazed continuously by sheep and cattle, not shut up. Rank clover benefits neither plant or animal.

In the 20-30 in. rainfall zone sheep should be excluded for the first growing season from newly-oversown areas but cattle may be grazed right through.

On dry country with less than 20 in. rainfall the risk of eating out cocksfoot seedlings is too high for sheep (Other than just-weaned lambs) to be allowed on a newly-oversown block for 18 months. The cattle may pull out and trample some seedlings but since the small plants are less easily eaten by cattle than sheep, we think the mortality risk is low enough to be acceptable.

We conclude that on hill and high country, except at times of severe competition for food such as in mid winter, cattle grazing is beneficial to sheep under present levels of subdivision and partial development. Just what proportion of sheep to cattle is best under various conditions is, however, unknown.

A policy of grazing hill pastures with both cattle and sheep has many advantages. However, there is a suggestion that to do the stock well it is better to graze them separately rather than together.

Photo: E. R. Mangin

CHAPTER 12

THE RELATIVE PROFITABILITY OF BEEF TO THE FARMER

12.1 INTRODUCTION

This chapter aims to compare the financial returns of running beef cattle with those that can be derived from sheep. The analysis tends to be from the point of view of the farmer who is contemplating increases in present stock units, and wishes to choose between cattle and sheep. In some respects the considerations involved in such a comparison vary from what would be the case if a choice of all-cattle or all-sheep was required, e.g. if the complete replacement of existing sheep numbers with cattle was being considered. While the latter situation may exist on certain individual properties, complete re-stocking with cattle is not a feasible alternative in the aggregate nor therefore on the average farm. This analysis is hence mainly concerned with marginal increases in beef cattle or sheep.

12.2 CHOICE OF ENTERPRISE; AGE AT SALE OF SURPLUS LIVESTOCK

Farmers in the South Island hill/high country region have available to them a wide range of choice, not only in the proportions of sheep and cattle which they carry, but in the age/sex composition of their flocks and herds and in the age and manner of sale of surplus stock produced. In practice a wide variation in stocking policies is found within this region. However, characteristics of the local environment in most cases have a large bearing on the policy adopted by any individual farmer. The "best" system on one particular farm may be quite different from that on another.

The evaluation of the relative profitabilities of different enterprises, or combinations of enterprises, is likely to strongly influence the farmer's choice of what type of stock to run. Although the method of such evaluation may be very informal on some properties, it appears certain that most, if not all, farmers take such economic considerations into account in making their choice of enterprises. A formal comparison of the profitabilities of various alternatives on any one farm, implies the need for a prior definition of all the alternatives which may be considered as technically practicable and feasible in that particular environment. It may be necessary to look at an extensive property in terms of two or more quite distinct environments

(e.g. in the case of a high-country property - large river valleys and upper montane tussock) between which the available choice of grazing alternatives varies, or the physical productive performances of some types of stock being considered varies. For instance, rough country, on which only wethers or dry cattle could be run, should be considered separately from other parts of a property, where breeding ewes and breeding cows are also feasible alternatives.

The choice of an economic criterion for comparing alternatives will again depend on the individual characteristic of the farm business in question. Most commonly "profitability per acre" is used because, for most farmers, it is their particular area of land which limits the numbers of livestock they can carry. In some cases other measures will be more appropriate. For instance a tight capital-availability situation may prevent a farmer from stocking up to the full capacity of the land at his disposal. D. K. Crump and L. T. Evans (pers. comm.) both claim that the majority of rapidly developing farmers are in this situation. In such cases the profitability per unit capital invested in livestock should be used in comparing different livestock enterprises. It is also conceivable that in a few special cases a property is being run with a very small labour force, which, for one reason or another, the owner does not want to increase. Here profitability per unit labour may be the correct criterion of choice to use.

In this study, profitability per acre is used to compare alternative beef cattle and sheep enterprises, on the grounds that this is the most generally applicable criterion. It is worth noting, however, that, in general terms, where capital is limiting the profitability difference between sheep and cattle will be relatively more in favour of sheep, and where labour is limiting it will be relatively more in favour of cattle, than shown in the "per acre" results.

"Gross margin per acre"* is the particular measure used here. The technique employed is basically similar to that used previously in the same context by Crump (1967a). It takes into account all farm costs and revenues which vary as a result

* When direct costs of running cattle (such as hay, drench, labour) are subtracted from the income received from cattle the remainder is the gross margin. This gross margin is the cash which the cattle part of the business has brought in to help pay a share of the fixed costs of the whole property (such as rent and rates) with some over for net profit.

of varying the sizes of the particular enterprises being considered. Overhead costs, like rates and personal drawings, are not included as they are not directly relevant to the analysis. They will be the same irrespective of what livestock are carried. "Gross margin per ewe equivalent (stock unit)" represents profitability per unit of grazing capacity (usually in the most critical period), and is basically the same as "gross margin per acre".

The Technical Alternatives:

(1) Beef Cattle Enterprises

In order to narrow the almost infinite range of alternative policies which could be adopted, two important assumptions will be made at this stage about this particular region:

(a) That whatever the method of sale of surplus stock produced, the overall beef enterprise on farms in this region will be based on a breeding herd.

In fact the number of present exceptions to this are known to be few. On high country properties especially, as shown by a recent survey conducted by this Institute (Hughes, in prep.), the cases of farmers buying store cattle for other than breeding purposes are rare. It is believed that the same pattern will continue in the future, for although breeding may be carried out on all types of country, fattening is usually restricted to the lower, more fertile country. It may therefore be expected that the freely moving economic forces of the store market will reserve the better country for fattening, and will largely "push" breeding herds on to the less fertile country. Furthermore, in North Island hill country the weed and pasture controlling influence of cattle on rougher country has been shown to be far more profitably achieved with breeding cows, rather than store dry cattle. It is assumed that this latter conclusion applies also in the South Island hill country.

(b) That all surplus stock will be sold in the autumn period from this region.

As a result of the uneven pattern of pasture growth in all districts over the course of the year, more stock, and particularly more cattle, can be carried in the summer than in the winter on pasture alone. For this reason farmers tend to want to sell in the autumn, and buy in the spring. At the same time the market for finished beef, is, to a certain extent in the case of the export works and to a large extent in the case of the local

trade, an all-year-round one. As a result of these factors, there is a regular and predictable price premium in the spring on both the fatstock and the store beef markets (see, for example, Watson, 1964). It is suggested here that the size of this premium will depend on the incentive necessary to induce enough farmers to sustain the added costs of carrying cattle through the winter. It may be expected that farmers in an environment where wintering costs are lowest will be the first to take advantage of this spring price premium. At the point of balance between the spring supply and demand, the level of the premium will not be great enough to cover the wintering costs of cattle in those areas where the winters are characteristically longer and harder. This includes most South Island high-hill country. This is supported by Hughes (unpubl.) who notes that there is little sale of surplus stock in the spring from high country properties. Saleyard statistics show that by far the largest numbers of store cattle change hands in the autumn.

Having made these assumptions, the area of choice with respect to beef cattle policies becomes much clearer and simpler. Surplus stock produced from the herd (assuming own replacements are bred) may be sold:

- (a) as weaners
- (b) as 18-month stores
- (c) as 18-month for slaughter on export schedule
- (d) as 2½-year-old stores
- (e) as 2½-year-old on export schedule

Similarly cull cows may be sold:

- i. on the store market
- ii. as boners to the export works

A useful approach is probably to consider these alternatives in the light of the particular environment of the farm, and to choose the most profitable for comparison with a similarly-determined most profitable sheep policy. An attempt has been made, in general terms, to do this here.

The sale of weaners has been chosen as being probably the most generally profitable of the beef enterprise alternatives. It at least indicates the general level of beef cattle enterprise profitabilities, which are unlikely to be too dissimilar for any given beef price level. Most South Island hill-high country properties carrying beef cattle sell weaners. Most of the others (which include some of the "big" cattle runs like Molesworth,



The weaner market is likely to remain strong while buyers seek young heifers to build up their breeding herds and while the fattening of young steers is highly profitable on lowland farms. Marking calves on Mt Albert Station.

Photo: Courtesy J.E.N.Quaife

St James, and Bluff Stations) sell largely 2½-year store cattle to be fattened for the local trade, where, for such large cattle, prices are considerably more favourable than those offering on the beef-export schedule. This latter policy may compare very favourably with one of selling weaners. However, the local trade is likely to expand only very slowly in the future. It has therefore been assumed here that this market will not be available for most of the increases in beef cattle in the future.

At present the weaner market is buoyant. It seems unlikely that the difference in value of an 18-month beast (either steer or heifer, and either on the store market or slaughtered at schedule rates) compared to the value of the same beast as a weaner, would be sufficient to justify keeping it for that extra year, on most hill-high country properties. Calculations done under certain specific assumptions of store prices and growth rates have shown that, generally, such retention to sale at 18 months is not as profitable as selling weaners. Nevertheless, on some properties it may be a more profitable alternative.

The calculation is very straightforward. If the gross margin per ewe equivalent for the yearling cattle carried over is greater than that for the "breeding cow - weaner" selling enterprise, (see Chapter 12.3) then the overall gross margin will be greater. However, the numbers of breeding cows carried may be limited for one reason or another. In such a case it may still be more profitable to retain weaners for the extra year if their gross margin per ewe equivalent over this period is greater than the gross margin for the next best alternative, e.g. sheep.

Fig. 11 shows the possible value for weight of a beef breed steer in the late autumn, on the basis of the August 1968 beef export schedule prices. Fig 12 estimates the roughly corresponding value for age for such a steer. The growth, grading, and spring price premium assumptions used are shown in Appendix D. The growth rates implied in Fig. 12 result in 860 lb liveweight (440 lb carcass) animals, 50% being graded GAQ1 and 50% FAQ, at 20 months of age. These would probably be attainable on much South Island hill country.

The value of these animals at 20 months of age under these assumptions would average \$80. If the same animals had been worth an average of \$55 per head as weaners, then the margin, from which must be deducted direct costs, is \$25. Direct costs, calculated on the same basis as in the gross margins in Chapter 12.3 may be as follows:

Fig. 11

Value of ox under certain assumptions re grade changes with carcass weight (S.Is. beef export price schedule as at 15/8/68)

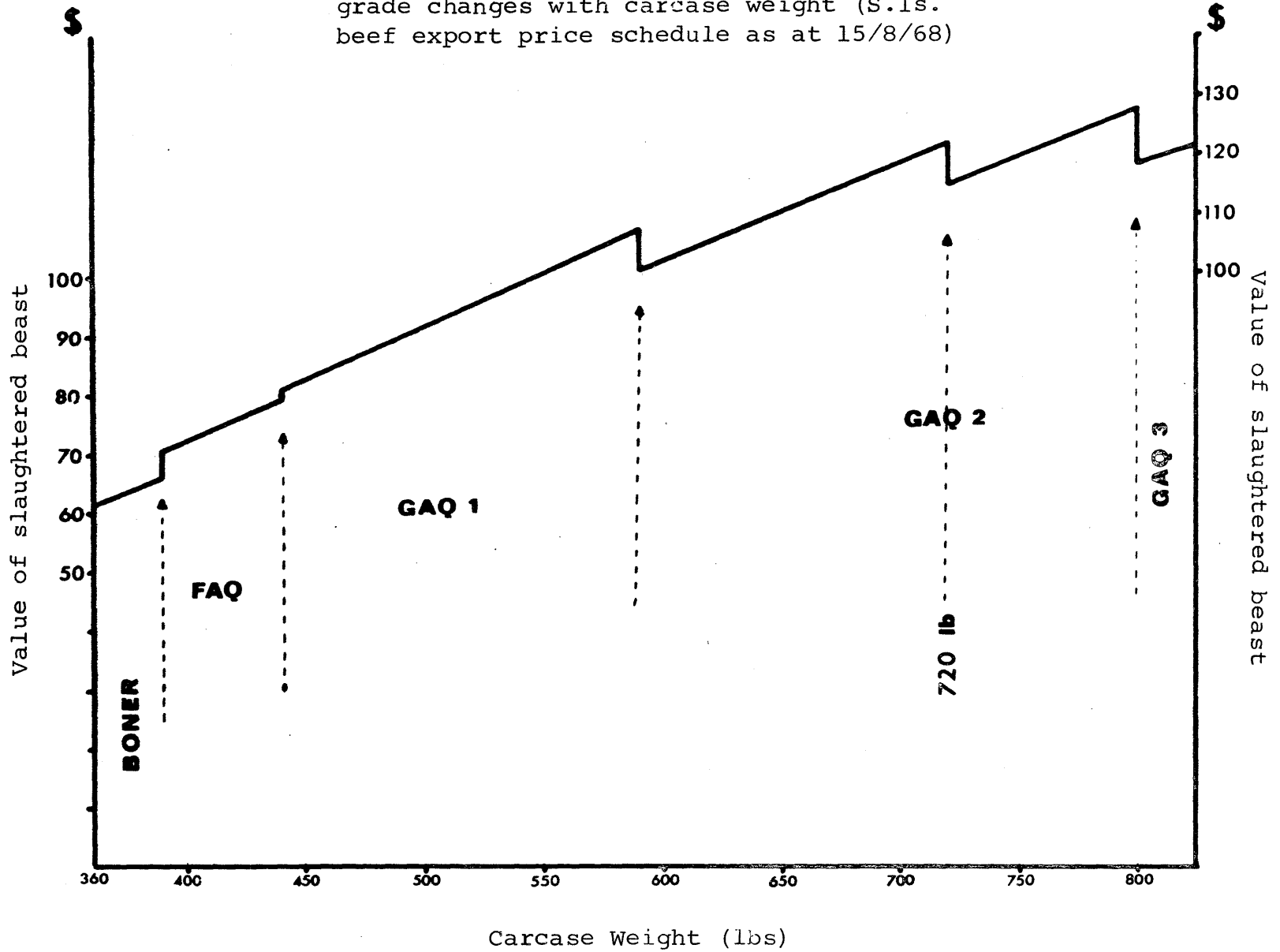
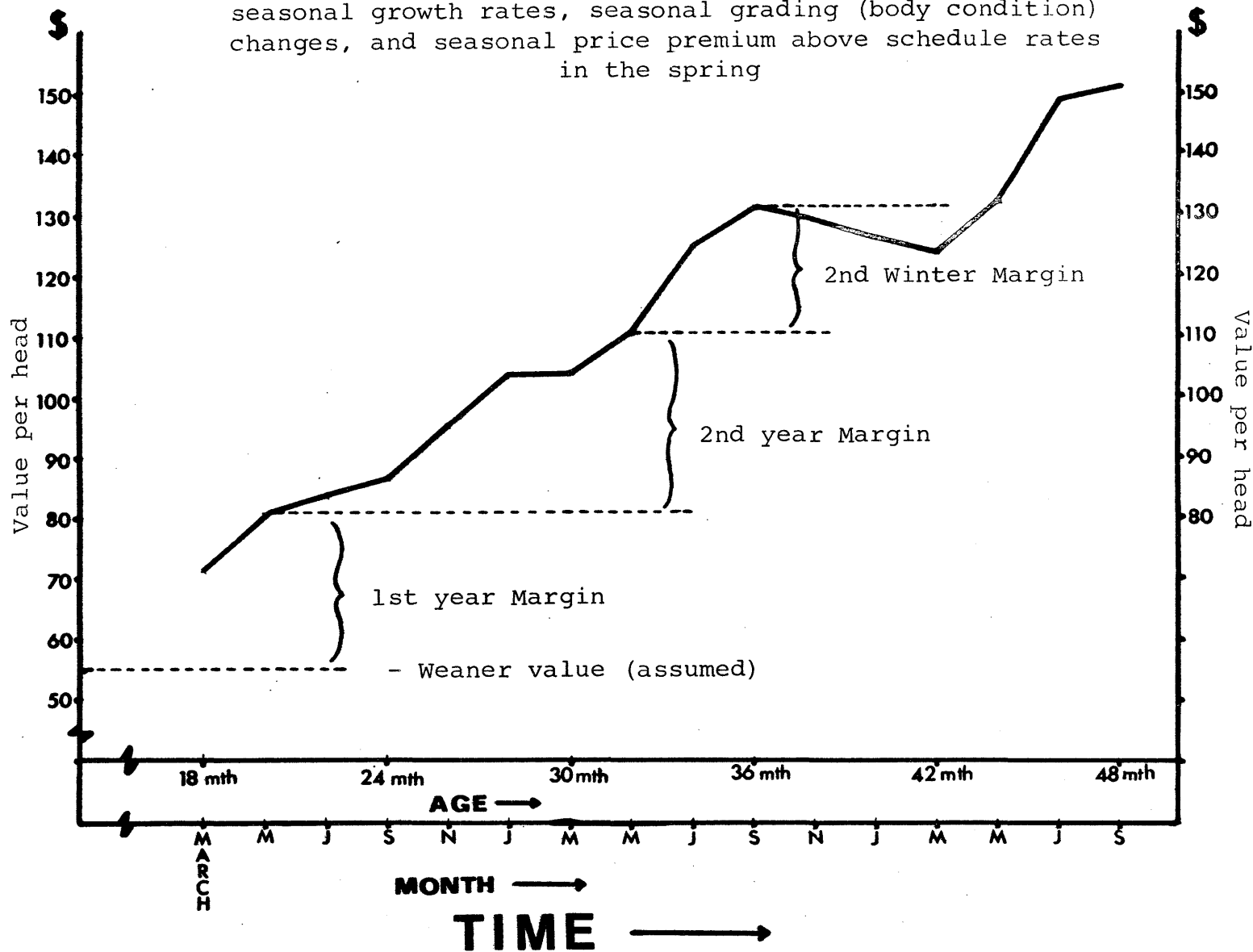


Fig. 12

Value for age graph based on Fig. 11 and assumptions re seasonal growth rates, seasonal grading (body condition) changes, and seasonal price premium above schedule rates in the spring



	\$
Freight (freight difference to point of sale between weaner and 20-month beasts roughly compensates for saving of 3% commission on weaner sales)	nil
Interest on capital 6% x \$50	3.0
Spraying, drenching, etc.	0.7
Winter feed costs	10.0
	<hr/>
Total direct costs	13.7
	<hr/>
Unit gross margin (Gross Revenue less direct costs)	11.3
	<hr/>
@ 3.5 EE/head, GM per EE =	3.2
	<hr/>

Reference to Table 21 (p. 208) will show that only on the poorest properties, where this rate of growth is unlikely to be achieved anyway, is this gross margin as good as that obtained for the breeding/weaner-selling enterprise, assuming \$55 per head for weaner steers.

Nevertheless it should be recognised that if the present state of affairs change, and the demand for weaners weakens, then this outlet can still provide quite a valuable one for beef breeders. With yield grading now in operation in all South Island freezing works, the possibility of hill and high country properties "finishing" beef animals to slaughterable condition has become quite real. However, it appears that farmers are only slowly becoming aware of this fact. The freezing works will accept animals of over 360 lbs carcass weight, and beef breed animals of over 400 lbs carcass weight would have had to be starved very hard to be graded below FAQ in the late autumn. With the reduced margin between FAQ and GAQ1, the beef breeder has in general become far less dependent on the store market as a sole outlet. This should have the effect of stabilising to a certain extent this rather uncertain market, which in turn should improve the strength of the demand for weaners, in the long run.

O. T. Kingma (1968) in a study on Canterbury plainsland farms, has concluded that, at the then wool and lamb prices and beef cattle prices, beef cattle enterprises tend to become more profitable than the fat lamb enterprise above the levels of

store and boner beef cattle prices which he suggests would correspond to a schedule price for GAQ1 ox of 15 cents per lb carcass weight, and assuming that these beef prices all move together. He also shows that the gross margin per ewe equivalent for the weaner fattening enterprise (\$6.60) is higher than the gross margin per ewe equivalent for the breeding enterprise (\$4.76), assuming prices of \$50 for weaner steers and 17 cents per lb for prime ox carcass.

A. M. Nicol (pers. comm.) points out that on mixed cropping farms the feeding of breeding cows on low-cost arable by-products for much of the year may make them equally as, or more profitable than, the weaner-fattening enterprise. He is of the opinion that, on most all-grass fat-lamb farms, buying weaners for sale on schedule at 16-20 months is clearly the most profitable beef fattening enterprise. A possible exception would be the specialist winter fattening on some farms of older cattle for the local spring trade.

The above evidence suggests that the weaner market is likely to remain strong, as a result of the weaner fattening enterprise being, in many or most cases, and at present prices, the most profitable of all livestock enterprises on fattening farms. Fig. 13 offers a "ready-reckoner" of breeding ewe and weaner fattening gross margins per ewe equivalent for the South Otago fattening area, for varying assumptions of wool, lamb, weaner, and beef schedule prices (supplied by, and reproduced here by kind permission of L. T. Evans, Farm Advisory Officer, Balclutha). This serves to re-affirm the relative profitability of beef weaners in such areas at present prices, and suggests that the future demand for weaners should continue to be strong.

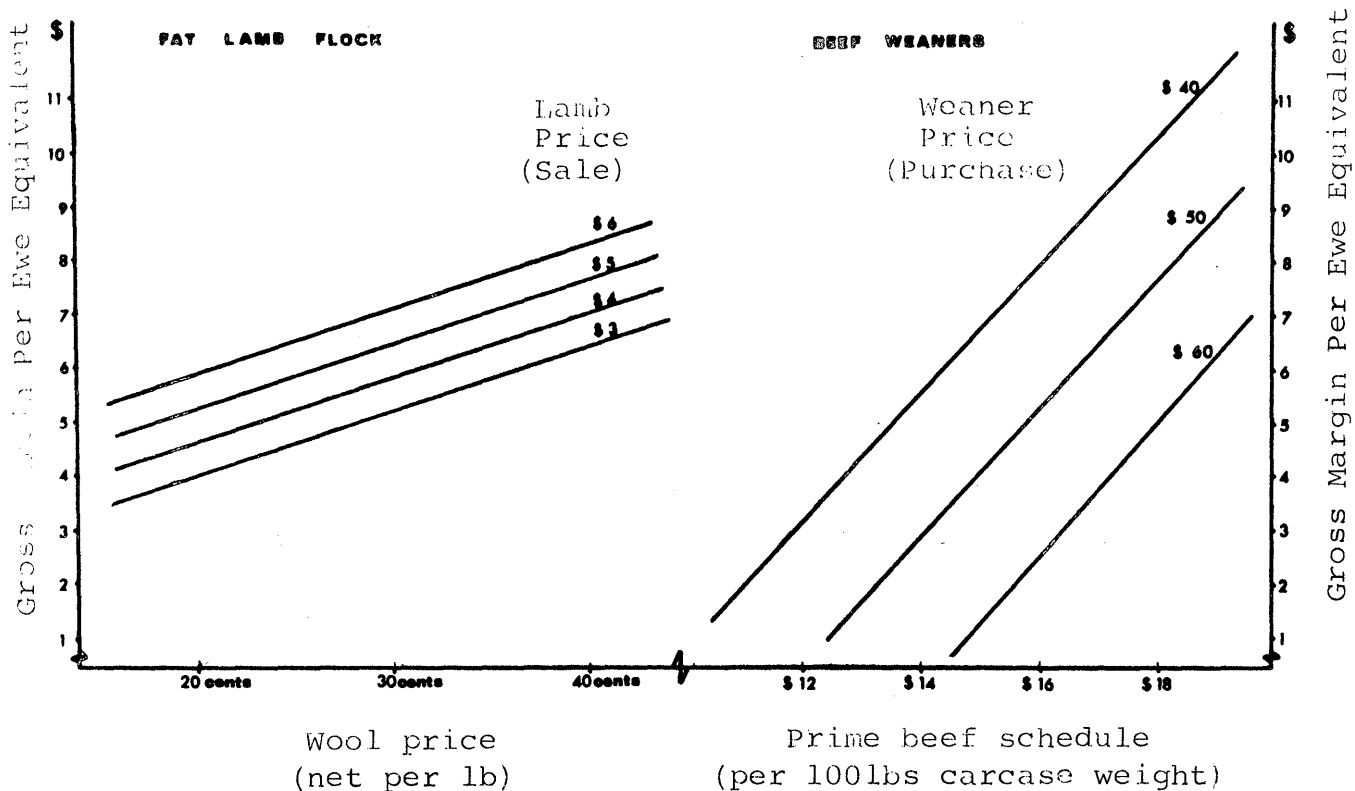
In view of the above discussion, it has been assumed here that South Island hill/high country farms will continue to run predominantly breeding herds, with the sale of weaners being by far the most important method of disposal of surplus store stock. The gross margins obtainable with the latter type of enterprise on any one class of property are taken here as indicative of the best economic performances that can be achieved with cattle.

(2) Sheep Enterprises

In similar vein the breeding ewe enterprise has been chosen to represent what can be achieved with sheep. Assumptions with respect to breed and method of disposal of surplus stock have

Fig. 13

Ewe flock (fat lamb production, breeding own replacements) versus weaner fattening gross margins (for South Otago area; after L.T. Evans).



Assumptions used:

(1) Breeding ewe productivities:

- Lambing % - 110%
- Wool per head - Ewes 10lb, Hgts 6lb, Lambs 4lb.
- Deaths - Ewes 3%, Hgts 2%.

(2) Weaner cattle productivities:

- 1 beast = 4 ewe equivalents
- Deaths 2%
- Growth 480 lbs carcass at 18-20 months.

(3) Interest charges included.

(4) No allowance for winter feed costs or labour costs - these assumed equal for each enterprise.

been varied with the class of country (see Chapter 12.3). There are many variations on these patterns (of breeds and methods of disposal) but again these appear to represent the most common types of policy, and it is felt that such variations as do exist probably will not alter the general level of profitability of the breeding ewe enterprise at any one time.

Claims have been made in the past that wethers, which form a very significant part of the total flock on high country, are either considerably less, or considerably more profitable than ewes. However, we consider that on the country that is at present carrying both wethers and ewes, the ewes have a higher profitability. It could be expected that if wethers were clearly more profitable, then the demand for, and hence price of, fine-woolled wether lambs would rise, with a consequent lowering of wether profits and raising of ewe profits until a balance was reached between the profitability of wethers and ewes.

In a few special cases there may be exceptions. For instance D. K. Crump (1967b) showed a relatively high gross margin for the wether activity on a mid-Canterbury high-country property, where the wethers were being sold at a relatively young age and high price for, ultimately, the local butchers' market. However, in aggregate terms this market for these wethers is very limited, and can only represent an outlet for a few of the total aged wethers slaughtered.

12.3 SUMMARY OF GROSS MARGINS CALCULATIONS

Gross margins per ewe equivalent wintered have been calculated for the breeding cow and breeding ewe activities respectively under a range of assumptions with respect to both prices, and productive performances (i.e. death rates, reproductive rates etc.). The object of such variation was to enable the enterprises to be compared for any one particular area within the region, for which evidence of actual performances was available. In general the higher death rates, and lower reproductive rates are associated with the higher and tougher country of the region. In the case of sheep, where breed differences appear to be more critical than with cattle, assumptions of breed, and, to a certain extent, the method of disposal of surplus stock, have also been varied.

The results of these calculations, together with the more important assumptions in each case are set out below in Table 23. Notes on the method of computation and further

TABLE 23

Summary of South Island hill/high country breeding ewe and breeding cow gross margins per stock unit under different price and performance assumptions

(a) BREEDING COW GROSS MARGINS

<u>Productivity Assumptions</u>	(1)	(2)	(3)	(4)	(4a)*	(5)	(5a)**	(6)
Calving rate (% weaned)	70	70	80	80	80	90	90	90
Death rate (% all stock)	10	7.5	7.5	5	5	5	5	3
Herd replacement rate (% per year : deaths plus culls)	20	18	15	13	13+(5)	10	10	8
<u>Gross Margins/EE (\$)</u>								
Prices (A), (Wnr Steer \$45) :	1.8	2.0	2.6	2.9	2.4	3.5	3.8	3.8
" (B), (" " \$55) :	2.5	2.9	3.6	4.1	3.4	4.9	5.3	5.2
" (C), (" " \$65) :	3.3	3.7	4.6	5.2	4.3	6.2	6.7	6.6

N.B. * (4a) - Same assumptions as (4) but assuming that herd growing at 5% per year

** (5a) - Same assumptions as (5) but assuming that heifers first calved down as 2-year-olds - all other gross margins assume first calve as 3-year-olds

<u>Prices assumed: (\$/hd)</u>	(A)	(B)	(C)
Weaner steers	45	55	65
Weaner heifers	35	48	60
Boner cow (500 lb carcass)	65	80	95
Potter bull (1,000 lb carcass)	160	190	230

(b) BREEDING EWE GROSS MARGINS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Wool type	Fine			Medium-Fine			Crossbred				
Probable breed	(Merino)			(Corr.-halfbred)			(Romney)				
Lambing % (to weaning)	70	80	80	80	90	90	90	100	90	100	110
Deaths % (total sheep)	10	10	6	6	6	3	6	6	3	3	3
Flock repl. rate (culls and deaths)	25	25	25	30	30	30	30	30	30	30	30
<u>Disposal of:</u>											
Aged ewes	(works - 25% lympho incidence)			(ann. draft - few to works)			(ann. draft - few to works)				
2T ewes	(-)			(ann. draft)			(ann. draft)				
Ewe lambs	(ann. draft)			(-)			(-)				
<u>Gross Margins/EE (\$)</u>											
Prices (A)	3.1	3.4	3.8	3.4	3.8	4.1	2.8	3.2	3.0	3.5	3.8
" (B)	4.7	4.9	5.4	4.8	5.3	5.7	4.1	4.6	4.4	4.9	5.3
" (C)							5.5	5.9	5.8	6.4	6.8

<u>Prices Assumed: (\$)</u>	(A)	(B)	(C)
Wool (av/lb auction)	Fine .40	.50	
	Medium-fine .30	.40	
	Crossbred .20	.30	.40
Wether lambs (av/hd fat and store)	Fine 4.0	5.5	
	Medium-fine 4.0	4.5	
	Crossbred 4.5	4.5	4.5
Ewe lambs (av/hd fat and store)	Fine 5.0	6.5	
2T ewe (draft)	Medium-fine 6.5	8.0	
	Crossbred 5.5	7.0	8.5
5-yr ewe (draft)	Medium-fine 5.0	6.5	
	Crossbred 4.0	5.5	7.0

N.B. All above gross margins were calculated to three decimal places, but are presented here correct to one decimal place to avoid giving an impression of false accuracy.

qualifying assumptions follow. In the next section these results are discussed in the light of known stock performance levels in certain areas of the general region.

Apart from the prices quoted above, the gross margins in Table 23 are calculated on the basis of the following costs, prices, and productivity coefficients:

Wool production (lb/hd)

	Fine-woolled	Medium-fine	Crossbreds
per ewes	7.5	8.5	9.5
per ram	11.0	12.0	13.0
per hogget	6.0	6.5	7.0

Prices of old ewes to freezing works

Fine-wool av. \$2.5/hd (adjusted for 25% lympho incidence)
Medium-fine av. \$3.0/hd
Crossbred av. \$3.5/hd

(not varied with wool price in these calculations)

Freight (not varied in these calculations)

Store lambs	25c	Fat lambs	30c
Draft ewes	30c	Works ewes	40c
Weaners	\$1.5	Boner cows	\$3

Interest on capital invested in livestock (not varied in these calculations)

Six percent of:

Breeding cows	\$75	Ewes	\$6
Bulls	\$400	Maiden 2TE	\$7
Weaner heifers	\$50	(fine wool only)	
Rising two-year heifers	\$70	Ewe hogget	\$5
Beef cattle yards \$4 per head		Rams	\$40

Stock health etc.

Cattle spraying (calves .10, rest .03) average \$0.05/hd
Heifer calf vaccination (Brucellosis \$0.5/hd
Fertility test bulls \$0.5/hd
Drench for hoggets 10c/hd
Dip 4c/hd; other stock health (footbath, ram vaccination and test, etc.) 0.5c/hd

Ewe and lamb lambing and docking expenses 2c/ewe

Commissions

3% of value on store lambs, draft ewes, weaners
2% of value on wool

Other Wool Expenses

Woolshed expenses (electricity, woolpacks, twine etc) 1c/lb
Shearing and crutching costs - fine wools \$36/100
(shearing tally=wintering medium-fine wools \$32/100
tally less deaths) Crossbred wools \$28/100
Freight 1c/lb
Receiving and sale preparation costs 2c/lb

Sire purchases (including freight - not varied with wool and
beef prices)

Bulls \$400
Rams \$40

Extra winter feed costs (not varied; average for all properties)

Beef weaners (100 days @ 10 lb hay/hd/day @ 1c/lb) \$10/hd
Hoggets - hay (1 lb/day) or crop \$1/hd

Labour costs saving with cattle

\$0.2 per ewe equivalent

Stock unit conversion factors (ewe equivalents - winter basis)

Breeding cow	6.0	Merino ewe	0.8
Bull	5.0	Corriedale, 1/2-bd ewe	0.9
Weaner heifer	3.5	Romney ewe	1.0
Rising 2-yr heifer	4.5	Maiden 2T Merino ewe	0.7
		Ewe hogget	0.6
		Ram	0.8

Notes on these gross margins

(1) No attempt has been made here to vary freight charges and winter-feeding costs between different classes of properties, as indicated by different death rates and reproductive rates. In practice these charges will vary considerably between properties on similar classes of country, and such variation if allowed

here would be very arbitrary. In that such costs are about the same per ewe equivalent for both the cattle and sheep enterprises, errors in those given above when applied to a particular property are likely to affect the gross margins of both to the same extent. The overall result is the same.

(2) Because of the much larger investment of capital per stock unit required with cattle, it is considered essential to include interest charges against this capital in the gross margins used for comparisons between the beef cattle and sheep enterprises.

In addition interest on capital invested in cattle yards has been included. Because nearly all properties are at present geared to sheep production, sheep could be increased in most cases with little or no modification to the existing facilities. However, appreciable increases of cattle would, on most properties, involve the construction or extension of cattle yards. Capital costs involved in new cattle yard facilities have been estimated at \$4 per head. Elsewhere we quote \$16 per beast worked (Chapter 4). The present figure is based on 25% of total herd numbers being yarded at any one time; i.e. it is assumed that yards in which 100 cattle can be worked will suffice for a herd of 400 head.

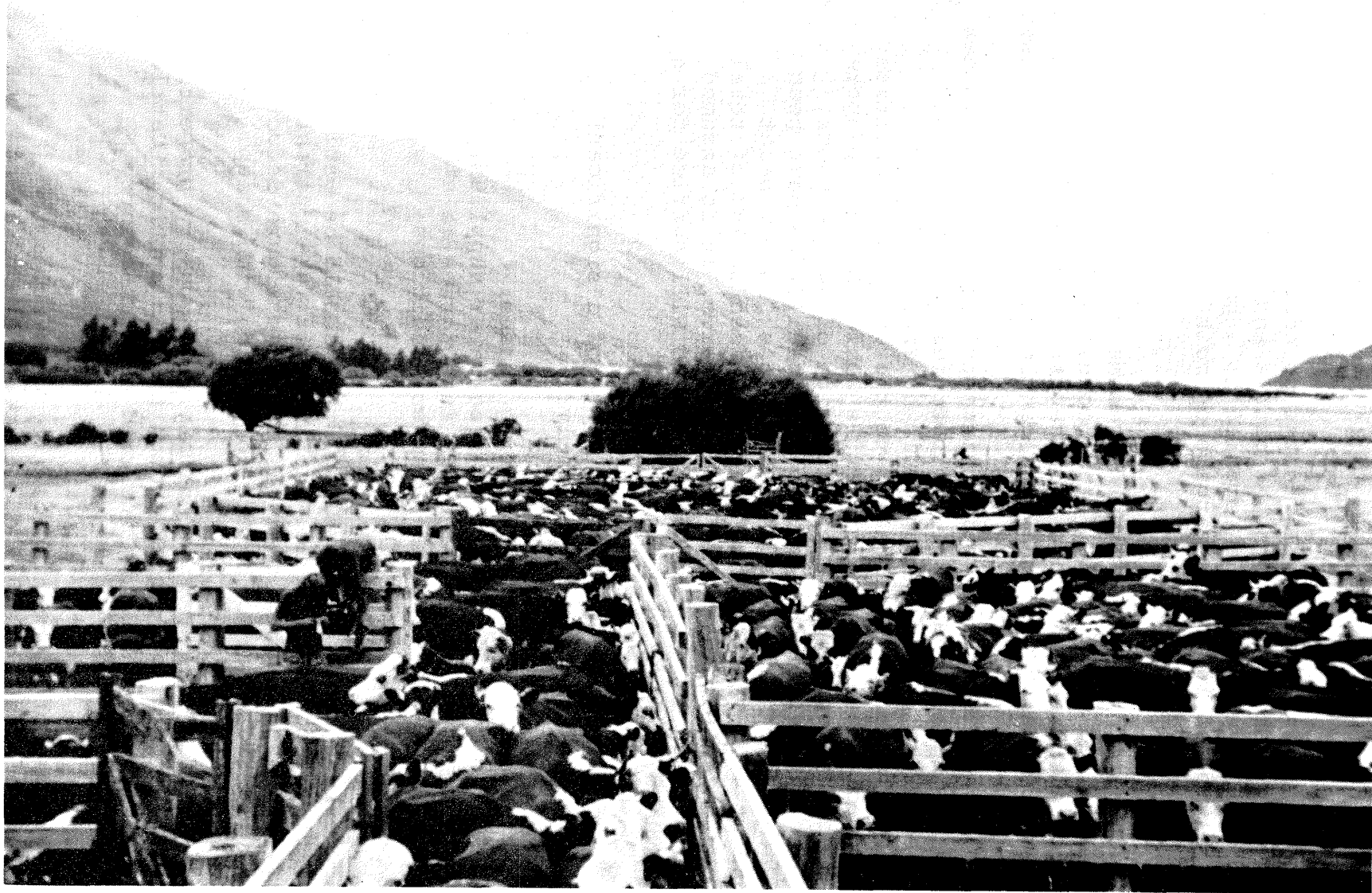
(3) Three further major capital costs of a significant shift into running cattle are frequently:

- (a) the costs of cattle-proofing fences;
- (b) the provision of further stockwater supplies;
- (c) the provision of large hay inventories as a hedge against adverse weather conditions (especially drought).

Where any of these costs are involved, they should be estimated on a per cattle stock unit basis, and interest (6% interest charge has been used in this analysis) on this figure deducted from the cattle gross margin before comparison with sheep.

Cattle-proofing of fences - On many hill-country properties most fences will be already good enough to hold cattle. Cattle proofing expense will mainly be incurred on high-country properties.

Over a sample of eight high-country properties the average length of fence was 0.5 chains per ewe equivalent carried (shared boundaries allowed at half cost). This would



The grading of beef carcasses for yield, in all South Island freezing works increases the opportunity for hill and high country properties to sell finished beef profitably for slaughter. The annual draft on Mt Albert Station, Wanaka. Cull cows are either sold down country or sent to the works.

Photo: J. E. N. Quaife

correspond to approximately 0.4 cattle per chain to be strengthened if a complete changeover to cattle was planned. At a cost of cattle proofing of \$2 per chain (as budgeted by the North Canterbury Catchment Board), the cost per ewe equivalent is \$1. Interest on this at 6% plus an added annual maintenance cost may result in an annual charge per beast of \$0.1 per cattle ewe equivalent.

Where a complete cattle proofing of fences was necessary even though cattle increases represented a small proportion of total stock carried, then the effective annual cost attributable to each cattle ewe equivalent may be of the order of \$0.5-\$1. This cost should be assessed for any particular property and the cattle gross margin shown above reduced by this amount. It may be appropriate, as a general guide to reduce the beef breeding gross margin by \$0.5 per ewe equivalent for high-country properties at present carrying negligible numbers of cattle.

Extra water supply and hay inventory - To some extent these will probably both be required on certain types of property, before cattle are appreciably increased. At the same time they may be alternatives.

Cattle need water much more than sheep in times of drought. This means concentrating them near water and, probably, feeding hay. Alternatively, if good, drought-proof water supplies are well distributed over the property, the need for cattle feeding at times of drought may be eliminated. In many cases the choice appears to be one of large expenditure on water supplies, or a lower expenditure on water supplies together with the provision of a large hay (or other supplementary feed) inventory.

No attempt is made here to generalise on the costs involved, as it is recognised that they will vary tremendously from property to property. It appears that on many of the better-developed hill-country properties, and on most high-country properties the water supply situation is already adequate. The drier hill country is likely to be most affected with extra water supply costs for cattle.

Once again, for any one property, or type of property, the estimated cost should be based on a per-increased-cattle-ewe-equivalent basis, and the appropriate breeding-cow gross margin reduced by the annual interest charge on this amount.

(4) The Cattle Gross Margins above have been credited with a saving in labour costs of \$0.2 per ewe equivalent.

It is fairly generally recognised that cattle demand less labour than sheep, although it is very difficult to obtain evidence to measure the actual extent. On the predominantly sheep runs of the Waimakariri catchment, Hayward (1967, p.121) reported that the permanent labour usage averaged one man per 2,500 sheep if no cultivation was done, and one man per 2,000 sheep where cultivation was carried out.

Molesworth runs all cattle with approximately 4,000 ewe equivalents per man, though this figure may not be representative for smaller properties, due to scale effects operating.

C. A. Chambers, the manager of Bluff Station, which has recently changed from mainly sheep to cattle, reports (pers. comm.) considerable savings in labour costs since this switch. In this case the permanent labour force has not been reduced but the savings are in casual labour costs, which have been reduced to almost nothing.

It would appear that many high country properties which traditionally employ a mustering gang for a few months of the year could achieve considerable reductions in this cost, without necessarily reducing permanent labour, if a major switch to cattle was envisaged. However, our main concern here must be with properties undertaking moderate increases in their carrying capacity with cattle, and perhaps marginal displacement of sheep by cattle. Only increases of this magnitude are possible in the aggregate (see Chapter 1). In such a case the extra labour costs to be imputed to the sheep gross margin, or, alternatively labour savings to be credited to the cattle gross margin, before comparison, would be considerable.

McClatchy (1966), after investigations in a North Island hill-country area, estimated that one cattle beast was the equivalent of 0.5 to 1.0 ewes in terms of its labour requirement, depending on the size of the herd carried. This implies a per-ewe-equivalent labour requirement of beef cattle of less than one half that of sheep. This was in an area where ewes were given intensive care over lambing, this often being the limiting period for labour. Wethers were estimated to require only one-quarter the amount of labour of ewes in the above study, and it is possible that in high country areas the differences between cattle and sheep in their per-ewe-equivalent labour requirements are not as great as suggested there.

In the light of the above evidence it appeared appropriate to allow, in general, a saving of 30% in labour costs per ewe equivalent with cattle compared to sheep. Data from the New Zealand Meat and Wool Boards' Economic Service's Sheep Farm Survey suggests that costs of wages and rations (excluding management) amount to approximately \$0.7 per ewe equivalent on both South Island high and foothill country farms. Hence the "savings" per ewe equivalent figure adopted here ($\$0.7 \times 0.3 = \0.2).

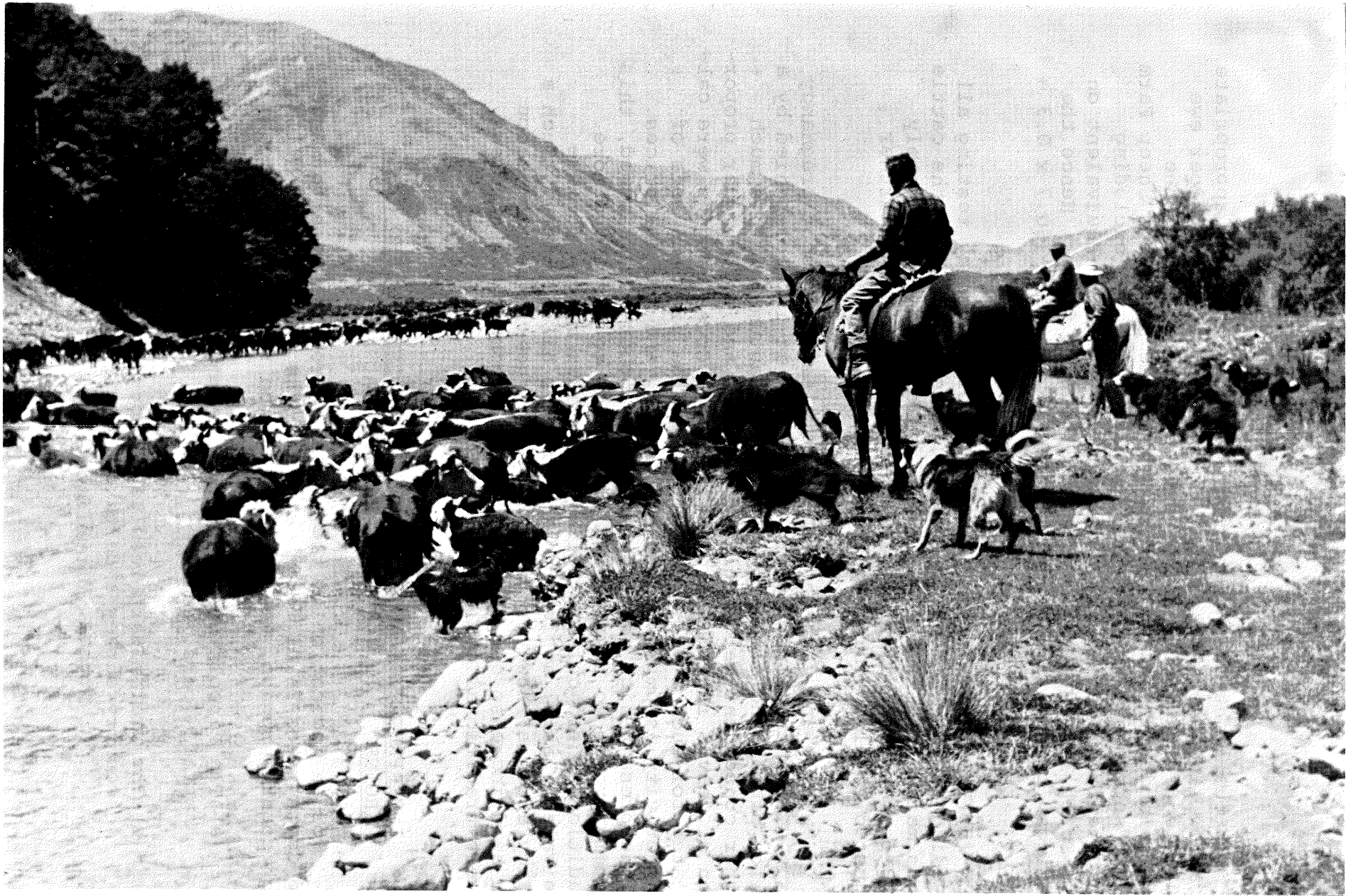
(5) Pregnancy testing - The cost of pregnancy testing all breeding cows in the autumn has not been included in the cattle gross margins. If it were it would amount to approximately \$0.8 per ewe equivalent. The gross margins may be further adjusted to allow for this factor if required.

Few hill and high-country properties at present pregnancy test. Its main value appears to be when it is accompanied by a policy of culling all empty cows in the autumn, with a much higher consequent herd replacement rate, and much higher proportion of calves reared per cow wintered. Gross margins were calculated for such a policy under two of the previous sets of productivity assumptions (see Table 23), and for all prices. At the present high relative values of boner beef assumed, this system appears to be slightly preferable to the above more traditional herd culling policy on a gross margin per ewe equivalent basis, at least on the better hill country. Such a policy as this, however, does not allow nearly as much scope for herd increase out of existing herd numbers, as the less severe traditional culling policy.

12.4 INTERPRETATION AND APPLICATION OF THE DERIVED GROSS MARGINS

For an indication of the actual reproductive performances and death rates in different areas of the South Island hill/high country region, we are dependent on three main sources:

- (a) The Lincoln College Farm Management Department staff (pers. comm.)
- (b) The preliminary results of South Island high country survey undertaken by T.G.M.L.I. (J. G. Hughes, unpublished)



- (c) Discussions with D. K. Crump and L. T. Evans, former Farm Advisory Officers from Dunedin and Balclutha respectively, who provided useful information on the Otago area.

These have provided only the ranges of each particular value for any one area. Because of considerable variation between properties averages are dangerous. At the same time there are probably several properties in any given area for which the average is a fairly good approximation. The approach here will be to consider the differences in the average deaths and reproductive rates of beef cattle in a given area, and assume that on properties where performances are below or above average for the area, then this will apply to both beef cattle and sheep.

In the discussion which follows, the region is arbitrarily split up into three sub-regions: high country, hard hill country, and easier hill country, respectively. Different areas in each sub-region are discussed in turn:

High Country

(a) Western Otago

Calving and lambing percentages here appear to be similar (e.g. 75%). Death rates, however, have been somewhat higher in the recent past with beef cattle (8%), although they are relatively high in this area with sheep too (e.g. 6%). Incidences of high cattle deaths have been recorded here, largely for two main reasons. These are tutu poisoning and bloat.

The gross margins more relevant to the high country in particular are reproduced here in Table 24 for convenience.

Opposite: Cattle demand less labour than sheep, but here is one time they need skilled attention - crossing the Hope River at The Poplars, Lewis Pass.

Photo: Courtesy T. A. Barrett

TABLE 24

High country breeding ewe and breeding cow gross margins

<u>BREEDING EWE</u>					
	Merino			Corr. - $\frac{1}{2}$ bd	
	(1)	(2)	(3)	(4)	(5)
Lambing percentage	70	80	80	80	90
Deaths percentage	10	10	6	6	6
<u>Gross Margins (\$/EE)</u>					
Wool price:					
A. { Merino 50c	4.7	4.9	5.4	4.8	5.3
{ Corriedale 40c					
B. { Merino 40c	3.1	3.4	3.8	3.4	3.8
{ Corriedale 30c					
<u>BREEDING COW</u>					
	(1)	(2)	(3)	(4)	
Calving percentage	70	70	80	80	
Deaths percentage	10	7.5	7.5	5	
<u>Gross Margins (\$/EE)</u>					
Prices:					
A. (Wnr steers \$65)	3.3	3.7	4.6	5.2	
B. (" " \$55)	2.5	2.9	3.6	4.1	
C. (" " \$45)	1.8	2.0	2.6	2.9	

In the Central Otago high country it would appear that with weaner steer sale prices averaging \$55 per head, ewes would be more profitable than breeding cows at Merino wool prices of both 40c and 50c per lb. If weaner steer prices in general average \$55, then those from this high country area may well be smaller on average, and bring only \$45. If weaner prices from this area rose as high as \$65 per head, then breeding cows would still not be as profitable as Merino ewes with wool at 50c per lb, though more profitable with wool at 40c per lb.

It will be apparent from the Tables 23 and 24 that poorer performances in terms of death rates and calving percentages affect the beef cattle gross margins much more than those for

sheep. This is to be expected where all income, in the case of cattle, is being derived from sales of surplus animals.

(b) North Canterbury and Marlborough High Country

Here the position is quite different, though the data available covers less of the region. Cattle performances appear to be on the whole considerably better than sheep with death rates in many cases only half as high (e.g. 4% for cattle vs 8% for sheep) and reproduction rates being perhaps 10% higher on average (e.g. beef cattle 80%, ewes 70%).

Reference to Table 24 will indicate that at such levels of performance, breeding cows are clearly superior to ewes in profitability where weaner steer prices average \$55 and Merino wool price 40c. If Merino wool price was to rise to 50c, then Merino ewes would be more profitable until weaner steer prices had risen somewhat on \$55. At \$65 for weaner steers, and 50c for Merino wool, cattle would again be more profitable here.

(c) Mackenzie Basin High Country

Performances here appear to be on average intermediate between those in the above two areas, with reproductive rates perhaps slightly in favour of cattle (say up 5% from 75% to 80%) and death rates about the same (5%). Here, as in the North Canterbury high country area, the break-even Merino wool price would appear to be somewhere between 40 and 50 cents per lb with weaner steers averaging \$55 per head.

Hard Hill Country

(a) Central Otago Dry Hill

This area is regarded by some, at least at the extremes of dryness, as country unsuitable for cattle. This appears to be partly because of the low growth habit of plants indigenous to the area, which may wither away to almost nothing in times of drought, and partly because of the generally high costs involved in providing adequate water. Nevertheless cattle are being run successfully on some properties.

Performances may slightly favour sheep in this area, with average lambing percentages (85%) perhaps 5% above average calving percentages, and deaths with sheep (3%) about 2% lower on average. In Table 25 gross margins more appropriate to the

performances generally being obtained on hill country are summarised. However, the better Merino sheep gross margins (fine wool) will in some cases be more applicable in this particular area.

Taking the medium-fine wools of Table 25, it appears that gross margins of roughly \$4 and \$5 respectively could be expected. This is on the basis of the above (average) performance levels, and for medium-fine wool price levels of 30c and 40c per pound respectively. Beef cattle gross margin at \$55 per weaner steer is \$4.1 according to this table. It should be remembered that extra water supply capital servicing charges may have to be deducted from the cattle gross margin figures for this area.

(b) North Canterbury and Marlborough Hard Hill

Evidence available is by no means conclusive, but it appears that in this general area lambing percentages tend to be better than calving percentages (e.g. 90% vs 85%), but cattle deaths on the other hand slightly lower than sheep deaths (e.g. 3-4%, 5-6%). Once again breeding cows, with weaner steers averaging \$55 per head, appear to be intermediate in profitability between ewes with medium-fine wool price at 30c per lb and ewes with the latter price at 40c per lb.

Easier and More Developed Hill Country

This country occurs in pockets in Marlborough, North Canterbury, South Canterbury and North Otago, with perhaps the biggest areas in coastal and South Otago, and Southland. In the latter areas at least, the breed of sheep run is predominantly the Romney.

Performances again vary, but calving rates of 90% and lambing percentages of 100-110% are frequently obtained. Death rates with cattle would tend to be slightly lower, perhaps 3% as compared to 5% with sheep. At such performance levels, cattle (breeding cows) are clearly more profitable than crossbred ewes with wool prices of 20c but of roughly the same level of profitability with crossbred wool price at 30c. This latter price corresponds roughly to what Philpott ~~et al~~ predicts will be the average for crossbred wools in the next decade (see e.g. Philpott, 1968, p.102). The above conclusions assume an average weaner steer price of \$55. Weaner steers from this area are better grown on average, and usually on

TABLE 25

Hill country breeding ewe and breeding cow gross margins

<u>BREEDING EWE</u>								
	Corr.- $\frac{1}{2}$ bd			Romney				
	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Lambing percentage	80	90	90	90	100	90	100	110
Deaths percentage	6	6	6	6	6	3	3	3
<u>Gross Margins (\$/EE)</u>								
Wool prices:								
A. (Medium-fine 30c Crossbred 20c)	3.4	3.8	4.1	2.8	3.2	3.0	3.5	3.8
B. (Medium-fine 40c Crossbred 30c)	4.8	5.3	5.7	4.1	4.6	4.4	4.9	5.3
C. (Crossbred 40c)				5.5	5.9	5.8	6.4	6.8
<u>BREEDING COW</u>								
		(4)	(5)	(6)				
Calving percentage		80	90	90				
Death rate		5	5	3				
<u>Gross Margins (\$/EE)</u>								
Prices:								
A. (Wnr steer \$45)		2.9	3.5	3.8				
B. (Wnr steer \$55)		4.1	4.9	5.2				
C. (Wnr steer \$65)		5.2	6.2	6.6				

may have brought \$60-65. Future prices for weaner steers from this area may well be of this order or higher.

For the better hill country areas with lambing rates of over 100% carrying medium-fine woolled ewes, it seems probable that at current prices, breeding cows and breeding ewes are of similar profitability, with a tendency towards cattle being slightly more profitable.



Summary of Section 12.4

The above discussions have been based mainly on an assumption of beef price levels roughly represented by average weaner steer prices of \$55, with smaller weaners bringing less, and well grown weaners more than this. In Chapter 1 reasons were given for accepting generally higher beef prices as a reasonable estimate of future averages.

With wool at present levels, the indications are that breeding ewes are less profitable than breeding cows in most areas. It appears that general wool price levels somewhere between the levels A. and B. used above would be a good basis for future expectations.

Assuming that prices follow our predictions, the most important conclusions to be derived from this exercise appear to be:

(a) In general, throughout this South Island hill/high country region the relative profitability of beef cattle (breeding cows) and sheep (breeding ewes) would appear to be similar. There may be a tendency for cattle to be slightly more profitable in general on the easier, more developed country, and slightly less profitable in the high country, depending on prices, but calving performance holds the key.

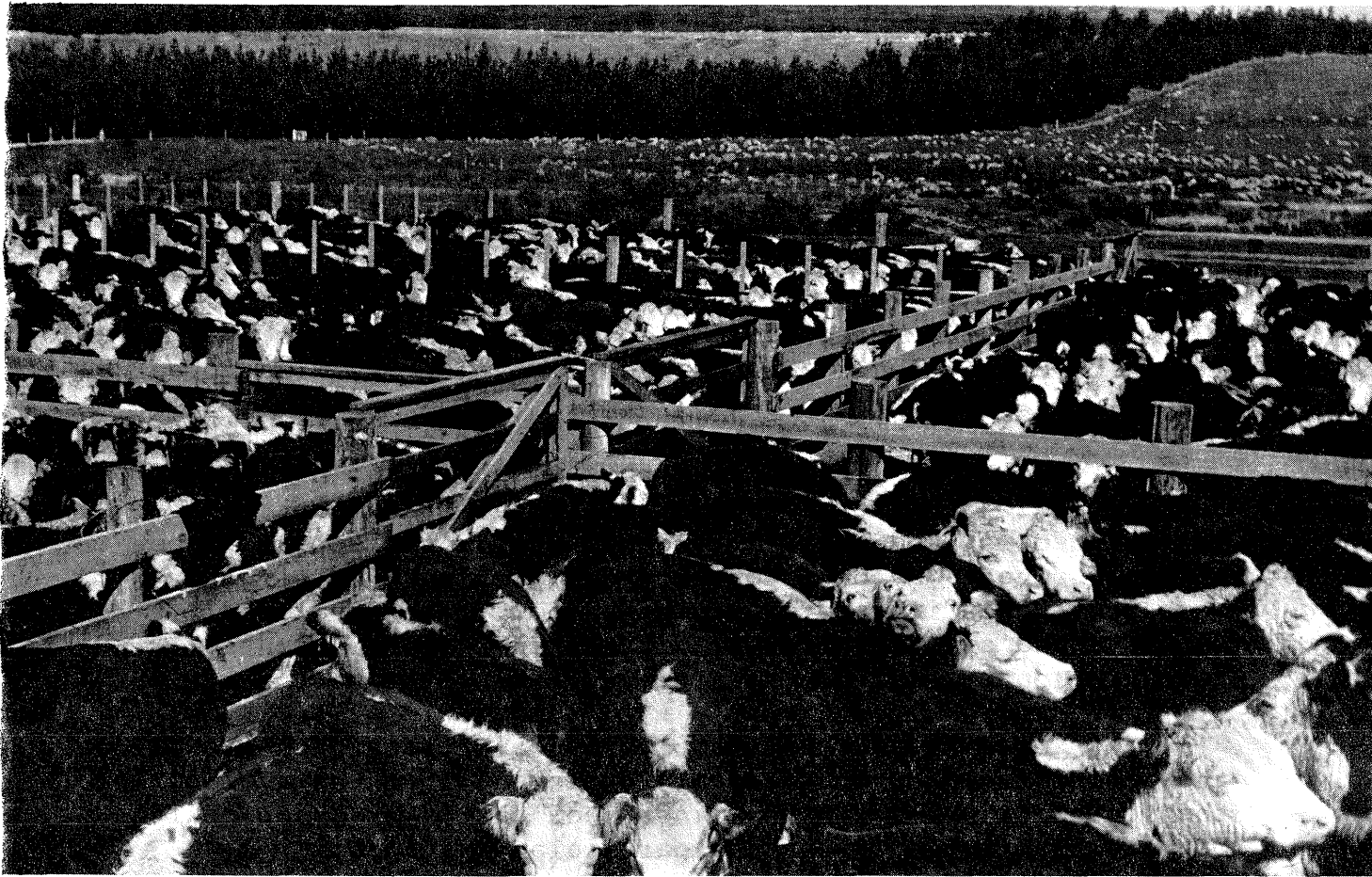
(b) However, as individual areas and properties are unique, the position may be considerably different from the average for the region or sub-region. Either beef cattle or sheep could be more profitable in any one particular instance.

12.5 SOME QUALIFICATIONS OF THE GROSS MARGINS APPROACH

The above analysis is based on the assumption that beef cattle and sheep are directly competitive for feed. Where they are not, then the conclusions must be modified.

For instance, if the introduction of a given number of

If capital is available for their purchase, cattle are more profitable than sheep in the use of available feed on the easier, developed country. Photo: T. Falconer



Where profitabilities of cattle and sheep are similar the farmer with stock units divided equally is in a more stable position than one with only one kind. Mt Possession Station, Canterbury.

Photo: Courtesy R. Chaffey

cattle on to a block would result in only half of their total intake consisting of feed which could otherwise be eaten by sheep, then the cattle gross margin should be doubled for comparative purposes. It is strongly doubted whether the differences in feed eaten are of this magnitude. However, there is enough evidence to show that on certain hill country areas, the addition of small numbers of cattle (actual number depending on stocking rate) to a predominantly sheep grazing system, can result in an increase in the productivity of the sheep already being carried without any reduction in their numbers (see Chapter 11). In such a situation gross margin comparisons are not very relevant at all.

Alternatively, it is conceivable that a steep block may contain areas accessible only to sheep. If a complete change-over to cattle resulted in only two-thirds of the available forage being utilised (the same thing may happen due to lack of water), then the valid comparison, on a gross margin basis, between cattle and sheep, would involve a deflation of the cattle gross margin by one-third.

Other factors will also affect the validity of the straight gross margin comparison. These are dealt with in other parts of this section or report, and are only summarised here:

(a) Soil conservation benefits with cattle as compared to sheep, where and if they exist.

(b) The existing degrees of utilisation of the permanent labour force on the property in question - further sheep increases may be obtained without an increase in existing labour, in which case it would not be valid to attribute a labour saving benefit to cattle.

(c) The availability of capital for investment in live-stock. Where this is tight and is preventing the full utilisation of available feed, then a comparison of gross margins per unit of capital invested will be more valid. This would approximately halve the cattle gross margin relative to the sheep gross margin, as compared to the relative values given above on a per unit feed basis. A rough and ready comparison of the relative magnitudes of beef cattle and sheep gross margins per unit capital invested can be obtained by matching the relevant sheep gross margin per EE above with the relevant cattle gross margin per EE $\times \frac{1}{2}$. For a comparison of capital margins refer to Appendix G.

(d) Interest charges on capital costs needed for appreciable cattle increases (for fence improvement, water supplies, hay purchases and storage) will on some properties greatly decrease the above gross margins for cattle.

A final point which should be considered is that of minimising risk by having more enterprises, and, consequently, more products whose prices tend to move in a largely unrelated fashion. It is suggested here that where unit profitabilities of cattle and sheep are similar, the farmer with 50% cattle and 50% sheep is in a much sounder and more stable position than one with 100% of one or the other. But the simplicity of a one-commodity enterprise should not be ignored.

12.6 GENERAL CONCLUSIONS

(1) Consideration of market and price trends, and very largely, the informed opinions of economists and trade people concerned with marketing, has led to certain prices being chosen as the main basis for a comparison of the profitabilities of beef cattle and sheep on South Island hill/high country.

(2) At the general level of prices chosen, beef and sheep appear to be, in most areas of the region, of roughly similar profitability.

(3) In the aggregate, and probably on most properties, future beef cattle increases will be marginal in terms of the existing total stock units carried; e.g. where increases in grazing capacity with normal development are taken up with increased cattle numbers, the cattle will be additional to rather than displacing to any great extent, the existing stock (largely sheep). There appear to be certain non-competitive aspects of increasing cattle at the margin, particularly with respect to the grazing capacity available and the existing labour situation. For these reasons it is considered that on many properties the opportunity cost of increasing cattle numbers may be considerably less than the level represented by the relevant sheep gross margin figure. That is, at the margin, cattle increases may well be considerably more profitable than sheep increases.

(4) Against the considerations of point (3) above must be weighed the extra costs for properties first moving in to cattle to a significant extent. The annual interest charge against these costs will tend to make cattle less profitable than that indicated by the above gross margins. In another

section of this report it is suggested that in order to spread these costs, the initial increase into cattle on any one property should be a reasonably large one. Existing taxation provisions may substantially lower these costs.

(5) We believe that in general these conclusions favour an increase in cattle. Even if the above considerations cancel each other out it appears that the less risky situation of having balanced numbers of cattle and sheep, would be sufficient to make cattle increases more justifiable on economic grounds than sheep increases on most properties. This conclusion applies to the region in question, where the ratio of cattle stock units to sheep stock units is much lower (though increasing faster) than in the North Island hill country areas. The same conclusion would appear to be valid both from the point of view of the individual farmer, and for the country as a whole.

(6) Given that increases of beef cattle are desirable, even up to the maximum rates of increase possible, then the improvement of credit facilities to enable farmers to considerably increase their livestock investment is also desirable. Beef cattle require a much higher capital investment per stock unit than sheep. For the individual with limited finance, the more profitable alternative may well be to increase sheep numbers, which may be in direct contrast to the interests of the country as a whole. It should be noted that where, at a given set of prices, beef production and sheep-meat/wool production appear to be equally profitable to the country, increases in cattle may be still more desirable than increases in sheep if accompanying beef output increases have a relatively less depressive effect on overseas market prices than alternative sheep-meat/wool increases.

REFERENCES

- ACLAND, J. 1957: In "Farmers' Experiences with Beef Cattle". Proc. 7th Linc. Coll. Farm Conf. 1957: 44-49
- ACLAND, J. O. 1966: The management and profitability of beef cattle on a South Canterbury Foothill Property. N.Z. Sheep Fmg A. 1966: 283-290
- _____, 1967: A critical look at the place of cattle on hill country. Proc. 17th Linc. Coll. Fmrs Conf. 1967: 93-96
- _____, 1969: John Acland on beef breeds. Rev. Tussock Grassld Mount. Lands Inst. 17: 2-9
- _____, (Mt Peel Station) Personal communication
- AGRICULTURAL RESEARCH COUNCIL (U.K.), 1965: The nutrient requirements of farm livestock: 2. Ruminants: summaries of estimated requirements. London: Agric. Res. Council.: 37pp
- ALDERFER, R. B., ROBINSON, R. R. 1947: Runoff from pastures in relation to grazing intensity and soil compaction. J. Am. Soc. Agron. 39: 948-958
- ALEXANDER, G. 1962: Energy metabolism in the starved new-born lamb. Aust. J. agric. Res. 13: 144-164
- _____, 1964: Lamb survival: physiological considerations. Proc. Aust. Soc. Anim. Prod. 5: 113-122
- ALEXANDER, G. I., SUTHERLAND, D. N., DAVEY, G. P., BURNS, M. S. 1960: Studies on factors in beef cattle production in a sub-tropical environment; 1. Birth weight. Qd J. agric. Sci. 17: 123-134
- AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS, 1967: Yearbook 1967, p.325
- ANDIK, I., DONHOFFER, Sz., FARKAS, Maria, SCHMIDT, P. 1963: Ambient temperature and survival on a protein-deficient diet. Br. J. Nutr. 17: 257-261
- ANON, 1965: Water intake of stall-fed beef cattle. The Press (Christchurch), 1st Feb. 1965
- _____, 1966a: Views on weighing cattle at Addington. The Press (Christchurch), 27th Aug. 1966
- _____, 1966b: Calf Rearing Problems. N.Z. Jl Agric. 113(5): 11
- _____, 1966c: Readers' cattle yard designs. N.Z. Fmr 87(15): 67-71
- _____, 1967a: Canterbury farmers fear spread of cattle disease. Timaru Herald, 21st Oct. 1967
- _____, 1967b: Move to stop Molesworth female cattle leaving property. Marlborough Express, 10th Oct. 1967
- _____, 1967c: Range wars didn't pay. Massey-Ferguson Review, April/June 1967
- _____, 1968a: Autumn v. spring calving compared at Ruakura. N.Z. Fmr 89(3): 37-39
- _____, 1968b: Why some farmers favour autumn-calving run cows. N.Z. Fmr 89(5): 2-5
- _____, 1968c: Guide to off-paddock wintering. N.Z. Fmr 89(1): suppl.
- _____, 1968d: Weaners wintered on lucerne at 2000 ft. N.Z. Fmr 89(6): 40-43
- _____, 1968e: More evidence of Friesians beef-producing ability. N.Z. Fmr 89(8): 6-7
- _____, 1968f: Wintering of weaners studied. The Press (Christchurch) 21st Dec. 1968
- _____, 1969a: Freeze branding and hide damage. N.Z. Fmr 90(15): 35
- _____, 1970: Brahmans in a cold climate. J. Agric. Vict. 68: 354-355
- ARMSTRONG, M. C. 1966: Serious unthrift can result from lice on cattle. N.Z. Jl Agric. 112(4): 20-21
- ASPINALL, J. C. 1968: Beef cattle on South Island tussock country. Rev. Tussock Grasslds Mount. Land Inst. 15: 13-21
- _____, (Mt Aspiring Station) Personal communication
- BAIN, A. 1965: Interview with Mr Arnold Bain. Rev. Tussock Grassld Mount. Lands Inst. 9: 2-4
- _____, (Dumbarton) Personal communication
- BAKER, H. K. 1968a: Beef performance and profitability. J. Univ. Newcastle-upon-Tyne Agric. Soc. 22: 3-8
- _____, 1968b: Modern methods of beef production. Pap. Symp. Beef Cattle Prod., Madrid, 1968. London: Roche Products Ltd: 30 pp
- _____, 1969: Beef production. J. Roy. agric. Soc. Eng. 130: 7-19
- BARR, N. 1968: Grazing cattle in tree plantations. N.Z. Fmr 89(13): 36-37
- BARRATT, Beryl C. 1968: Micromorphological observations on the effects of land use differences on some New Zealand soils. N.Z. Jl agric. Res. 11: 101-130
- BARRON, O. J. 1967: Applying research findings to commercial beef production. J. Range Mgmt 20: 182-184
- BARRY, T. N. 1970: A comparison of Friesian and Angus breeds. Proc. Invermay Fmrs Conf. 1970: 36-37

- BARTON, R. A. 1961: Two items of interest studied during a recent visit to America:
1. Winter feeding of beef breeding cows; 2. Performance testing of
beef bulls for higher gaining ability. Address to AGM of
N.Z. Hereford Cattle Breeders Assn (Inc.) 26th July 1961 (cyclostyled)
- _____, 1962: Improving the productive performance of beef cattle.
N.Z. Sheep Fmg A. 1962: 201-211
- _____, 1964a: Developments in cattle and beef and veal production overseas.
N.Z. Sheep Fmg A. 1964: 93-121
- _____, 1964b: Aims of beef cattle selection and methods of achieving these aims.
Proc. 14th Lincoln Coll. Fmrs Conf. 1964: 72-78
- _____, 1966a: The winter feeding of beef cows.
Rev. Tussock Grassld Mount. Lands Inst. 10: 20-25
- _____, 1966b: The performance of Aberdeen Angus, Hereford and Friesian steers.
N.Z. Sheep Fmg A. 1966: 61-74
- _____, 1966c: The characteristics of beef Shorthorn, Aberdeen Angus, Hereford and
Friesian ox carcasses. N.Z. Sheep Fmg A. 1966: 291-296
- _____, 1967a: A review of meat research at Massey University.
N.Z. Sheep Fmg A. 1967: 127-139
- _____, 1967b: Reported in Timaru Herald, 26th Aug. 1967
- _____, 1967c: Letter to The Press (Christchurch), 21st Oct. 1967
- _____, 1968a: Scope for bull-beef production. N.Z. Fmr 89(1): 49-51
- _____, 1968b: Cattle coat. in Herefords in New Zealand 2: 32-33
Wellington: N.Z. Meat Prod. Publ. Co.
- BEATTIE, W. A. 1966: Beef cattle breeding and management.
Melbourne: The Pastoral Rev. Pty Ltd: 4th edn, 508 pp
- BEATY, E. R., POWELL, J. D., FORTSON, J. C., SAUNDERS, F. B. 1963: Production aspects
of a beef cow-calf operation on grass pastures. J. Range Mgmt 18: 250-253
- BELLOWS, R. A. 1968: Improving reproductive efficiency in beef cattle.
N.Z. Aberdeen Angus Rev. 2: 18-19, 30
- BENNETT, D., MORLEY, F. H. W., CLARK, K. W., DUDZINSKI, M. L. 1970: The effect of grazing
cattle and sheep together. Aust. J. exp. Agric. Anim. Husb. 10: 694-707
- BENTLEY, J. R. 1941: Automatic recording of salting and watering habits of cattle.
J. For. 39: 832-836
- BEVIN, R. H. 1961: Beef cattle production. N.Z. Meat Wool Bds Econ. Serv. Publ. 308
(cyclostyled)
- BIANCA, W. 1959a: Acclimatisation of calves to a hot dry environment.
J. Agric. Sci. Camb. 52: 296-304
- _____, 1959b: Acclimatisation of calves to a hot humid environment.
J. Agric. Sci. Camb. 52: 305-312
- _____, 1966: Heat tolerance in dehydrated steers. J. Agric. Sci. Camb. 66: 57-60
- BILBOROUGH, A. I. 1965: Analysis of development costs on a North Canterbury hill country
property. Lincoln Coll. Fm Mgmt Pap. 3: 353-360
- BLAXTER, K. L., WAINMAN, F. W. 1961: Environmental temperature and the energy metabolism
and heat emission of steers. J. Agric. Sci. Camb. 56: 81-90
- BOICE, R. G. 1966: Livestock management. J. Range Mgmt 19: 98-100
- BONDY, F. 1950: Droughts in New Zealand. N.Z. Jl Sci. Technol B 32(2): 1-10
- BOWDEN, W. E. 1962: Beef breeding, production and marketing. London: Land Books, 448pp
- BOX, T. W., BROWN, G., LILES, J. 1965: Influence of winter supplemental feeding of
cottonseed cake on activities of beef cows. J. Range Mgmt 18: 124-126
- BOYLE, E. (Omarama) Personal communication
- BRATCHER, G. 1968: Efficiency of production keeps Aberdeen Angus growing faster than
other breeds in the U.S.A. N.Z. Aberdeen Angus Rev. 2: 8
- BROUGHAM, R. W. 1956: The rate of growth of short-rotation ryegrass pastures in late
autumn, winter and early spring. N.Z. Jl Sci. Technol. A38: 78-87
- BROWN, K. R. 1968a: The influence of herbage height at treading and treading intensity
on the yields and botanical composition of a perennial ryegrass-white
clover pasture. N.Z. Jl agric. Res. 11: 131-137
- _____, 1968b: Some effects of sheep treading on the herbage and seed yield of
four grasses grown in association with white clover.
N.Z. Jl agric. Res. 11: 883-890
- BRUMBY, P. J., WALKER, D. E. K., GALLAGHER, R. M. 1962: Growth rate in beef cattle.
Proc. Ruakura Fmrs Conf. 1962: 34-41
- BRYCE-JONES, K. 1968: The eating quality of meat from Charolais crosses.
Exp. Husb. 16: 25-38

- BUREAU OF AGRICULTURAL ECONOMICS (AUST.) 1968: The beef situation 12 (Mar. 1968), 47pp
Canberra
- BURGESS, J. B., LANDBLOM, Nellie, L. STONAKER, H. H. 1954: Weaning weights of Hereford calves as affected by inbreeding, sex, and age. J. Anim. Sci. 13: 843-851
- BURGY, R. H., POMEROY, C. R. 1958: Interception losses in grassy vegetation. Trans. Am. Geophys. Un. 39: 1095-1100
- BUTTERFIELD, R. M. 1966: Relative growth in beef cattle. Aust. vet. J. 42: 87-90
_____, 1967: Reported in Timaru Herald, 17th June, 1967
_____, 1968: Reported in "Boffins and beef cattle".
N.Z. Meat Prod. 12(7): 36-38
_____, (University of Sydney) Personal communication
- CAMPBELL, A. G. 1966a: The dynamics of grazed mesophytic pastures. Proc. 10th int. Grassld Congr. Helsinki 1966: 458-463
_____, 1966b: Effects of treading by dairy cows on pasture production and botanical structure on a Te Kowhai soil. N.Z. Jl agric. Res. 9: 1009-1024
- CAMPLING, R. C. 1966: The intake of hay and silage by cows. J. Br. Grassld Soc. 21: 41-48
- CANDY, R. A. 1967: Beef from the dairy herd. Proc. 17th Lincoln Coll. Fmrs Conf. 1967: 145-151
- CANTUAR, 1967: Do cattle pay better than sheep. N.Z. Fmr 88(10): 44-45
- CARROLL, F. D., NELSON, D. D., WOLF, H., PLANGE, G. 1964: Energy utilisation in heifers as affected by a low-protein isocaloric diet. J. Anim. Sci. 23: 758-763
- CARTER, W. E. 1965: Vibriosis may be unrecognised in other herds. N.Z. Meat Prod. 9(5): 47
- CAFFREY, P. J. 1970: Supplementation of poor quality roughages for store cattle. Ir. Grassld Anim. Prod. Ass. J. 6: 109-110
- CHAFFEY, R. S. (Mt Possession Station) Personal communication
- CHAMBERS, C. (Bluff Station) Personal communication
- CHAPMAN, L. P. 1954: Some aspects of tussock country management. Proc. 4th Lincoln Coll. Fmrs Conf. 1954: 77-84
_____, 1965: Reported in Straight Furrow, 19th May, 1965
- CHETWIN, J. M. 1968: Friesians v. Angus steers. N.Z. Fmr 88(23): 40
- CHISHOLM, M. M. 1960: The production and management of beef cattle on Molesworth for the store market. Proc. 10th Lincoln Fmrs Conf. 1960: 95-102
_____, 1967a: Bulls with bad feet. Rev. Tussock Grassld Mount. Lands Inst. 13: 34-35
_____, 1967b: Reported in Timaru Herald, 27th Apr. 1967
_____, 1968: Address to beef production symp. of Aberdeen Angus Cattle Breeders Assn, Invercargill, Aug. 1968 (cyclostyled)
_____, (Molesworth Station) Personal communication
- CLARK, O. R. 1937: Interception of rainfall by herbaceous vegetation. Science 86: 591-592
- CLARK, R. W. 1967: High stocking rates can be achieved in the South Island. Proc. 17th Lincoln Coll. Fmrs Conf. 1967: 133-138
- CLARKE, R. T. J. 1966: Bloat in cattle XVII - Preliminary observations with the anti-protozoal agent: 1.2 diurethyl-5-nitroimidazole for the prevention of bloat. N.Z. Jl agric. Res. 9: 437-43
- CONNIFFE, D., HARTE, F. J. 1967: The relation of rate of liveweight gain to measures of feed conversion efficiency in cattle. Ir. J. agric. Res. 6: 171-176
- CONNOR, H. E. 1951: The poisonous plants of New Zealand. Dep. Scient. Ind. Res. N.Z. Bull. 99: 141pp
- CONNOR, H. E., BAILEY, R. W., O'CONNOR, K. F. 1970: Chemical composition of New Zealand tall tussocks (*Chionochloa*). J.Z. Jl agric. Res. 13: 534-554
- CONWAY, A. 1970: Grazing management for beef production. J. Br. Grassld Soc. 25: 85-91
- COOK, C. W. 1954: Common use of summer range by sheep and cattle. J. Range Mgmt 7: 10-13
_____, 1966: Factors affecting utilisation of mountain slopes by cattle. J. Range Mgmt 19: 200-204
- COOK, C. W., HARRIS, L. E., YOUNG, M. C. 1967: Botanical and nutritive content of diets of cattle and sheep under single and common use on mountain range. J. Anim. Sci. 26: 1169-1174

- COOP, I. E. 1952: Nutritive value of some high-country pastures
Proc. 14th Conf. N.Z. Grassld Ass.: 109-113
- _____, 1961: The principles and practice of animal nutrition.
Wellington: N.Z. Govt. Printer, 2nd edn, 128p
- _____, 1965: A review of the ewe equivalent system. N.Z. agric. Sci. 1(3): 13-18
- _____, 1967: The efficiency of feed utilisation. Proc. N.Z. Soc. Anim. Prod. 27:
154-165
- _____, 1968: Reported in The Press (Christchurch), 18th Apri. 1968
(Lincoln College) Personal communication
- COOP, I. E., DARLING, M., ANDERSON, C. M. 1953: Chemical composition of some tussock
grassland pastures. N.Z. Jl Sci. Technol A34: 507-520
- CORAH, L. (Hamilton Res. Stn, Vict. Aust.) Personal communication
- CORBETT, J. L. 1969: The nutritional value of grassland herbage. pp 593-644 (Chapt. 17)
in International Encyclopaedia of Food and Nutrition, Vol. 17, Pt 2,
Oxford: Pergamon Press
- CORY, V. L. 1927: Activities of livestock on the range.
Texas agric. Exp. Stn Bull. 367: 47p.
- COSTIN, A. B., WIMBUSH, K. J., KERR, D., GAY, L. W. 1959: Studies in catchment hydrology
in the Australian Alps: I Trends in soils and vegetation.
C.S.I.R.O. Div. Pl. Ind. Tech. Pap. 13: 36pp
- COULTER, J. D. 1966: Dry spells in New Zealand as a factor in plant ecology.
Proc. N.Z. ecol. Soc. 13: 4-8
- COWLISHAW, S., ALDER, F. 1960: The grazing preferences of cattle and sheep.
J. agric. Sci. Camb. 54: 257-265
- CRAWFORD, R. 1969: Freeze branding of cattle could pay. N.Z. Meat Prod. 13(10): 39
- CRUMP, D. K. 1967a: Cattle or sheep: which pays best?
Rev. Tussock Grassld Mount. Lands Inst. 13: 2-7
- _____, 1967b: Profitability of wet v. dry sheep on high country.
N.Z. Fmr 88(18): 35
(Dep. Agric. Dunedin) Personal communication
- CRUTCHLEY, C. J. (Shortlands Station) Personal communication
- CULLEN, N. A. 1966: Pasture establishment on unploughable hill country in New Zealand:
factors influencing establishment of oversown grasses and clovers.
Proc. 10th int. Grassld Congr. Helsinki 1966: 851-855
- CULPIN, S., EVANS, W. M. R. FRANCIS, A. L. 1964: An experiment on mixed stocking of
pasture. Exp. Husb. 10: 29-38
- CURRIE, J. D. (Dep. Agric. Oamaru) Personal communication
- CURRIE, P. O. 1966: Marking cows with human hair dye. J. Range Mgmt 19: 306-307
- CUTLER, E. J. B. 1966: Some pedological factors of importance to the pasture ecosystem
in the South Island. Proc. N.Z. ecol. Soc. 13: 65-68
- DALY, G. T. (Lincoln College) Personal communication
- DARLING, M. 1951: A study of the nutritive value of untopdressed hill country pastures.
M. Agr. Sc. thesis, Lincoln Coll. library
- DAVIS, G. H. (Tara Hills High Country Res. Stn) Personal communication
- DE LISLE, J. F., BROWNE, M. L. 1967: The climate and weather of the Otago region in
New Zealand. N.Z. Met. Serv. Misc. Publ. 115(4): 13p
- DICK, A. T. 1956: Molybdenum and animal nutrition. Soil Sci. 81: 229-236
- DIGGINS, R. V., BUNDY, C. E. 1962: Beef Production.
Englewood Cliffs, N. J.: Prentice Hall, 2nd edn, 341 p
- DINGWALL, A. R. 1955: High country tussock grassland improvement in Canterbury.
N.Z. Jl Agric. 91: 554-555
- DONALDSON, L. E. 1968: The pattern of pregnancies and lifetime productivity of cows in
a Northern Queensland beef cattle herd.
Aust. vet. J. 44: 493-495
- DORTIGNAC, E. J., LOVE, L. D. 1960: Relation of plant cover to infiltration and erosion
in ponderosa pine forests of Colorado.
Trans. Am. Soc. Agric. Eng. 3: 58-61
- DOWLING, D. F. 1965: Adaptive aspects of beef cattle production.
Aust. vet. J. 41: 51-61
- DUKES, H. H. 1955: Physiology of Domestic Animals. London: Bailliere, Tindall and Cox,
7th edn, 1020 pp
- DURING, C., RADCLIFFE, J. E. 1962: Observations on the effect of grazing animals on
steepland soils. Trans. jt mtg Comm. IV, V int. Soc. Soil Sci.: 685-690
- EARLY, L. 1968: Beef production at its best. Herefords in New Zealand 2: 18-20
Wellington: N.Z. Meat Prod. Publ. Co.: 76 pp

- EDGAR, D. G., DODD, D. C., MCCLURE, T. J., OWENS, E. L., WALLACE, T. 1967: N.Z. Farmers Veterinary Guide. N.Z. Dairy Exporter Co. 2nd edn, 255pp
- EDMOND, D. B. 1960: Sheep's feet and pasture plants. Proc. 22nd Conf. N.Z. Grassld Ass.: 111-121
- _____ , 1957: The influence of treading on pasture. Proc. 19th Conf. N.Z. Grassld Ass.: 82-89
- _____ , 1958a: The influence of treading on pasture - a preliminary study. N.Z. Jl agric. Res. 1: 319-328
- _____ , 1958b: Some effects of soil physical condition on ryegrass growth. N.Z. Jl agric. Res. 1: 652-659
- _____ , 1958c: Some effects of treading on pasture. Proc. N.Z. Soc. Anim. Prod. 18: 43-49
- _____ , 1958d: Animal treading and pastures. Agric. Rev. 4: 8-15
- _____ , 1962: Effect of treading pasture in summer under different moisture levels. N.Z. Jl agric. Res. 5: 389-395
- _____ , 1963a: Animal treading of pastures. Proc. 13th Lincoln Coll. Fmrs Conf.: 77-81
- _____ , 1963b: Effects of treading perennial ryegrass (Lolium perenne L) and white clover (Trifolium repens L) pastures in winter and summer at two soil moisture levels. N.Z. Jl agric. Res. 6: 265-276
- _____ , 1964: Some effects of sheep treading on the growth of ten pasture species. N.Z. Jl agric. Res. 7: 1-16
- _____ , 1966: The influence of animal treading on pasture growth. Proc. 10th int. Grassld Congr. 1966: 453-457
- ELLIOTT, R. C. 1967: Voluntary intake of low-protein diets by ruminants: 1. Intake of food by cattle. J. agric. Sci. Camb. 69: 375-382
- ELLIS, I. G. 1965: Foot troubles in cattle affect limb soundness. N.Z. Meat Prod. 9(4): 40
- ELLISON, L., CROFT, A. R., BAILEY, R. W. 1951: Indicators of condition and trend on high range-watersheds of the intermountain region. U.S. Dep. Agric., Agric. Hndbk 19: 66pp
- ELY, D. G., LAUNCHBAUGH, J. L. 1969: Multiple iron holder for freeze branding. J. Range Mgmt 22: 135-137
- ENSOR, P. C. (Double Hill Station) Personal communication
- EVANS, L. T. (Dep. Agric., Balclutha) Personal communication
- EVERITT, G. C. 1961: Developments in the production and marketing of beef and veal. Proc. Ruakura Fmrs Conf. 1961: 85-102
- _____ , 1966: Development of the New Zealand beef industry. N.Z. Agric. Sci. 1(9): 20-25
- _____ , 1967: Modern ideas about beef production. Proc. Invermay Fmrs Conf. 1967: 5-16
- _____ , 1968: Reported in N.Z. Meat Prod. 12(9): 19
- _____ , 1969: (Ruakura Agric. Res. Centre) Personal communication
- EVERITT, G. C., PHILLIPS, D. S. M., WHITEMAN, D. P. 1968: Suckling: effects on the cow and calf. Proc. Ruakura Fmrs Conf. 1968: 158-175
- FAHEY, B. D. 1964: Throughfall and interception of rainfall on a stand of radiata pine. Jl Hydrol. (N.Z.) 3: 17-26
- FALLOON, G. (Masterton) Personal communication
- FITZHARRIS, J. (formerly Dep. Lands and Survey) Personal communication
- FITZHARRIS, M. J. 1966: Management of tussock country before and after oversowing and topdressing. Proc. 28th Conf. N.Z. Grassld Ass. 28: 114-118
- FOOD AND AGRICULTURE ORGANISATION, 1966: Committee on commodity problems: agricultural commodities - projections for 1975 and 1985. Vol. I, Meat. CCP 67/3 (Oct. 1966) Rome
- FRASER, A. 1959: Beef Cattle Husbandry. London: Crosby Lockwood, 256 pp
- FRASER, J. R. 1968: Reported in Timaru Herald, 1st June, 1968
- GALLAGHER, R. M. 1960: Selecting a beef bull. Proc. Ruakura Fmrs Conf. 1960: 46-51
- _____ , 1963: The modern concept of quality beef. Proc. Ruakura Fmrs Conf. 1963: 40-52
- GAY, C. 1965: Range management why and how. New Mex. State Univ. Co-op Ext. Serv. Circ. 376: 33p
- GILES, E. M. 1968: Reported in Timaru Herald, 1st June, 1968
- GILLINGHAM, A. 1964: A study of infiltration properties of a steepland yellow-brown earth under diverse conditions of vegetation at Porter's Pass. M. Ag. Sci. Thesis, Lincoln Coll. library

- GOEBEL, C. J. 1956: Water development on the Starkey Experimental Forest and Range. J. Range Mgmt 9: 232-234
- GOODELL, B. C. 1966: Watershed treatment effects on evapotranspiration. pp 477-482 in Sopper, W. E., Lull, H. W. (eds), Int. Symp. For. Hydrol. Pennsylvania 1965. New York: Pergamon Press, 812pp
- GOULD, R. D. 1968: Reported in The Press (Christchurch), 20th Apr. 1968
- GRADWELL, M. W. 1956: Effects of animal treading on a wet alluvial soil under pasture. Proc. N.Z. Soc. Soil Sci. 2: 37-39
- _____, 1960: Changes in the pore space of a pasture topsoil under animal treading. N.Z. Jl agric. Res. 3: 663-674
- _____, 1965: Soil physical conditions of winter and the growth of ryegrass plants: 1. Effects of compaction and puddling. N.Z. Jl agric. Res. 8: 238-261
- _____, 1966: Soil moisture deficiencies in puddled pastures. N.Z. Jl agric. Res. 9: 127-136
- COMMONWEALTH SECRETARIAT COMMODITIES DIVISION (U.K.), 1968: Meat and Dairy Produce Bull. May 1968: pp 49-51
- GREENALL, A. F. (undated): Burning of mid altitude snow tussock associations, northern Central Otago. Otago Catchment Board Rep.: 17p (cyclostyled)
- GREENFIELD, S. F. 1967: Water requirements for improved livestock performance on rangeland. J. Range Mgmt 20: 333-334
- GREGORY, K. E. 1964: Beef cattle breeding. U.S. Dep. Agric. Inf. Bull. 286: 43pp
- GRIGG, D. 1965: Reported in The Press (Christchurch), 17th July, 1965
- GUILBERT, H. R., HART, C. H. 1951: California beef production. Sect. II, Manual 2, Univ. of Calif. Davis
- GUTHRIE-SMITH, H. 1969: Tutira - The Story of a New Zealand Sheep Station. Wellington: Reed, 4th edn, 464p
- HAFEZ, E. S. E. 1967: Bioclimatological aspects of animal productivity. Wld Rev. Anim. Prod. 1967 3(14): 22-37
- HAFEZ, E. S. E., SCHWEIN, M. W. 1962: The behaviour of cattle. pp 249-296 (Chap. 10) in The Behaviour of Domestic Animals. Baltimore: Williams and Wilkins, 619pp
- HAFEZ, E. S. E., SCOTT, J. P. 1962: The behaviour of sheep and goats. pp 297-333 (Chap. 11) in The Behaviour of Domestic Animals. Baltimore: Williams and Wilkins, 619pp
- HALL, D. 1967: Hawkes Bay farm's switch to all-beef. N.Z. Fmr 88(19): 18-19, 21
- HAMILTON, D., BATH, J. G. 1970: Performance of sheep and cattle grazed separately and together. Aust. J. exp. Agric. Anim. Husb. 10: 19-26
- HAMMOND, J. 1952: Farm Animals - Their Breeding, Growth and Inheritance. London: Edw. Arnold, 2nd edn, 266pp
- HANCOCK, J. 1949: Studies in monozygotic cattle twins: 4. Uniformity trials - grazing behaviour. N.Z. Jl Sci. Technol. A 32: 4(22)-4(59)
- HARTE, F. J. 1968: Effects of plane of nutrition on calves for beef production: 1. Growth rate, feed conversion efficiency, carcass yield and offals. Ir. J. agric. Res. 7: 137-148
- HARTE, F. J., CONNIFFE, D. 1967: Studies on cattle of varying growth potential for beef production: 1. Growth rate, feed conversion efficiency, carcass yield and offals. Ir. J. agric. Res. 6: 137-152 2. Carcass composition and distribution of lean meat, fat and bone. Ir. J. agric. Res. 6: 153-170
- HARTMANS, J. 1970: The detection of copper deficiency and other trace element deficiencies under field conditions. pp 441-447 in Mills, C. F. (ed.) Trace Element Metabolism in Animals. Edinburgh and London: E. & S. Livingstone, 550pp
- HAYWARD, J. A. (comp.) 1967: The Waimakariri catchment. Tussock Grasslands Mount. Lands Inst. Spec. Publ. 5: 288p
- HEADY, H. F. 1964: Palatability of herbage and animal preference. J. Range Mgmt 17: 76-82
- HERBEL, C. H., ARES, F. N., NELSON, A. B. 1967: Grazing distribution patterns of Hereford and Santa Gertrudis cattle on a southern New Mexico range. J. Range Mgmt 20: 296-299
- HEWETSON, R. W. 1970: Differences in muscle : bone ratios between Zebu cross and British breed steers. Proc. Aust. Soc. Anim. Prod. 8: 100-105
- HIBBERT, A. R. 1967: Forest treatment effects on water yield. pp 527-543 in Sopper, W. E., Lull, H. W. (eds), Int. Symp. For. Hydrol. New York: Pergamon Press, 812p

- HIBBERT, A. R. 1969: Water yield changes after converting a forested catchment to grass. Wat. Resour. Res. 5: 634-640
- _____, 1971: Increases in streamflow after converting chaparral to grass. Wat. Resour. Res. 7: 71-80
- HICKEY, F. 1967: Control of grass staggers. N.Z. Agriculturist 18: 6-7
- HICKEY, W. C. Jnr, GARCIA, G. 1964: Range utilisation patterns as affected by fencing and class of livestock. U.S. For. Serv. Res. Note RM21: 7pp
- HIGHT, G. K. 1966a: The effects of undernutrition in late pregnancy on beef cattle production. N.Z. Jl agric. Res. 9: 479-490
- _____, 1966b: The management of beef cattle on hill country. Proc. Ruakura Fmrs Conf. 1866: 19-32
- _____, 1968a: Management of beef breeding cows. Rev. Tussock Grassld Mount. Lands Inst. 15: 41-49
- _____, 1968b: Plane of nutrition effects in late pregnancy and during lactation on beef cows and their calves to weaning. N.Z. Jl agric. Res. 11: 71-84
- _____, 1968c: Hill country beef cattle research at Whatawhata. Proc. N.Z. Soc. Anim. Prod. 28: 131-144
- _____, 1968d: A comparison of the effects of three nutritional levels in late pregnancy on beef cows and their calves. N.Z. Jl agric. Res. 11: 477-486
- _____, 1968e: Nutrition and management of the beef-breeding herd. N.Z. Sheep Fmg A. 1963: 113-130
- _____, (Whatawhata Hill Country Res. Stn) Personal communication
- HIRONAKA, R., PETERS, H. F. 1969: Energy requirements for wintering mature pregnant beef cows. Can. J. Anim. Sci. 49: 323-330
- HOLLARD, M. G. 1968: Beef production with Friesian and Friesian cross cattle. Proc. N.Z. Soc. Anim. Prod. 28: 177-179
- _____, (Lincoln College) Personal communication
- HOLMES, W., JONES, J. G. W., DRAKE-BROCKMAN, R. M. 1961: The feed intake of grazing cattle: 2. The influence of size of animal on feed intake. Anim. Prod. 3: 251-260
- HOOVEN, N. W. Jnr, 1968: Freeze branding for animal identification. J. Dairy Sci. 51: 146-152
- HOWES, J. R., HENTGES, J. F. Jnr, DAVIES, G. K. 1963: Comparative digestive powers of Hereford and Brahman cattle. J. Anim. Sci. 22: 22-26
- HUGHES, J. G. 1962: High country fencing. Tussock Grassld Mount. Lands Inst. Spec. Publ. 1: 27pp
- _____, 1963: The size of grazing blocks. Rev. Tussock Grassld Mount. Lands Inst. 5: 27-34
- _____, 1963: Why not silage? 2. A review of current practice. Rev. Tussock Grassld Mount. Lands Inst. 11: 6-17
- _____, 1969: The snow of November 1967. Tussock Grassld Mount. Lands Inst. unpubl. rep.: 190pp
- _____, (unpubl.) High-country run production survey 1965-1967
- HUNT, W. F. 1970: The influence of leaf death on the rate of accumulation of green herbage during pasture regrowth. J. appl. Ecol. 7: 41-50
- HUTCHINSON, K. J. 1971: Productivity and energy flow in grazing/fodder conservation systems. Herb. Abstr. 41: 1-10
- HUTTON, J. B. 1962: The maintenance requirements of New Zealand dairy cattle. Proc. N.Z. Soc. Anim. Prod. 22: 12-34
- INNES, J. I. S. (Haldon Station) Personal communication
- ITTNER, N. R., KELLY, C. F. 1951: Cattle shades. J. Anim. Sci. 10: 184-194
- IVES, D. W. (Soil Bureau, D.S.I.R.) Personal communication
- IVEY, I. K. (Glentanner Station) Personal communication
- IVON-WATKINS DOW LTD 1966: Tordon 50D nd 75T weedkiller. Tech. Bull. T216: 4pp
- JAGUSCH, K. T. 1970: Urea feeding. Rev. Tussock Grassld Mount. Lands Inst. 2
- JAMIESON, S., SCOTT, J. D. J. 1966: Extensive trials for next spring's Charolais cross. N.Z. Jl Agric. 112(5): 24-25
- JESSEP, B. E. 1965: Increasing production in high country. Proc. 15th Lincoln Coll. Fmrs Conf. 1965: 29-34
- JOBLIN, A. D. H. 1966a: Beef from grass. N.Z. Fertil. J. 29: 12-14
- _____, 1966b: Increasing beef production per acre. N.Z. Sheep Fmg A. 1966: 77-92

- JOBLIN, A. D. H. 1968: Winter feeding trials with beef cattle.
Proc. N.Z. Soc. Anim. Prod. 28: 145-156
- _____, 1969: Baby beef without concentrates - a feasibility study.
Proc. N.Z. Soc. Anim. Prod. 29: 137-146
- _____, (Ruakura Agric. Res. Centre) Personal communication
- JOBLIN, A. D. H., REARDON, T. F., PHIPPS, D. E. 1970: Concentrates for cattle.
N.Z. Jl Agric. 121(3): 102-3, 105
- JOHNSON, R. M. D. 1953: Cattle on tussock country.
Proc. 3rd Lincoln Coll. Fmrs Conf. 1953: 28-30
- JOHNSON, W. M. 1956: The effect of grazing intensity on plant composition vigour and growth of Pine-Bunchgrass ranges in Central Colorado.
Ecology 37: 790-798
- JOHNSTON, A. 1962: Effects of grazing intensity and cover on the water-intake rate of fescue grassland. J. Range Mgmt 15: 79-82
- JOHNSTON, A., DORMARR, J. F., SMOLIAK, S. 1971: Long-term grazing effects on fescue grassland soils. J. Range Mgmt 24: 185-188
- JOHNSTONE-WALLACE, D. B., KENNEDY, K. 1944: Grazing management practices and their relationship to the behaviour of grazing habits of cattle.
J. agric. Sci. Camb. 34: 190-197
- JONES, E. L., RENNIE, G. K. 1956: A comparison of different breeds and crosses for beef production. Exp. Husb. 1: 48-57
- JONES, J. G. W., DRAKE-BROCKMAN, R. M., HOLMES, W. 1965: The feed intake of grazing cattle.
Anim. Prod. 7: 141-151
- JORDAN, W. A., LISTER, E. E., ROWLANDS, G. J. 1968: Effect of varying planes of winter nutrition of beef cows on calf performance to weaning.
Can. J. Anim. Sci. 48: 155-161
- JOYCE, J. P. 1968: Heat loss in sheep and cattle.
Rev. Tussock Grassld Mount. Lands Inst. 14: 2-10
- JOYCE, J. P., MACLEAN, K. S. 1970: Feed requirements of livestock.
Proc. Ruakura Fmrs Conf. 1970: 15-23
- JOYCE, J. P., RATRAY, P. V. 1969: Effects of stocking rate on conversion efficiency and productivity of dairy beef cattle and breeding ewes.
Proc. N.Z. Soc. Anim. Prod. 29: 176
- KEEN, W. L., GOW, N. G. 1963: Financial analysis of New Zealand sheep farms.
Wellington: N.Z. Meat Wool Bds Econ. Serv. Bull. 12: 129p
- KIDSON, E. 1931: Mean temperatures in New Zealand. N.Z. Jl Sci. Technol 13: 146-153
- KIDWELL, J. F., MCCORMICK, J. A. 1956: The influence of size and type on growth and development of cattle. J. Anim. Sci. 15: 109-118
- KINGMA, O. T. 1968: Returns from beef cattle systems in Canterbury.
N.Z. Fmr 89(15): 45-49
- LABY, R. H. 1969-70: Bloat. Melbourne: C.S.I.R.O. Div. Anim. Physiol. Ann. Rep. 1969-70: 57
- LANG, D. R., HIGHT, G. K. 1969: Artificial breeding of beef cattle.
N.Z. Jl Agric. 118(5): 34-35, 37, 39
- LANG, D. R., HIGHT, G. K., ULJEE, A. F., YOUNG, J. 1968: A marking device for detecting oestrus activity of cattle. N.Z. Jl agric. Res. 11: 955-958
- LAYCOCK, W. A., CONRAD, P. W. 1967: Effect of grazing on soil compaction as measured by bulk density on a high elevation cattle range.
J. Range Mgmt 20: 136-140
- LEWIS, K. H. C. 1968: Winter feeding trials at Tara Hills.
Rev. Tussock Grasslds Mount. Lands Inst. 14: 38-44
- _____, 1970: Cattle breed evaluation on tussock country.
Proc. Invermay Fmrs Conf. 1970: 38-39
- LEWIS, D. C., BURGY, R. H. 1967: Water use by native vegetation and hydrologic studies.
Ann. Rep. 7, Dep. Wat. Sci. Engng, Univ. Calif. Davis
- LINCOLN COLLEGE FARM MANAGEMENT DEPT STAFF, Personal communication
- LOBB, W. R. 1959: Fertility problems of marginal areas of the South Island
N.Z. Jl agric. 99: 207-221
- _____, 1968: Reported in Southerner, Feb. 1968
- LODGE, R. W. 1954: Effects of grazing on the soils and forage of mixed prairie in southwestern Saskatchewan. J. Range Mgmt 7: 166-170
- LONG, P. A. 1966: Areas of soils of South Island, New Zealand.
N.Z. Soil Bureau Rep. 3/1966: 89pp
- LONGWILL, A. 1966: Autumn calving for your beef herd.
N.Z. Fmr 87(2): 10-11
- LOUW, D. J., HAVENGA, C. M., HAMERSMA, J. 1948: The walking habits of sheep.
Fmg S. Africa 23: 753-755

- LUDECKE, T. E. 1962: Formulation of a rational fertiliser programme in tussock country. Proc. 24th Conf. N.Z. Grassld Ass.: 29-41
- LULL, H. W. 1959: Soil compaction on forest and range lands. U.S. Dep. Agric. Misc. Publ. 768: 33pp
- _____, 1964: Ecological and silvicultural aspects. Sect. 6 in Handbook of Applied Hydrology. Chow, V. T. (ed.) New York: McGraw Hill
- LYONS, T., CAFFREY, P. J., O'CONNELL, W. J. 1970: The effect of energy, protein and vitamin supplementation on the performance and voluntary intake of barley straw by cattle. Anim. Prod. 12: 323-334
- MCCLATCHY, D. 1966: Report on a survey of farm labour in Patangata County, Hawkes Bay. Lincoln Coll. agric. Econ. Res. Unit Publ. 34: 61p
- MCCLURE, T. J. 1968: Malnutrition and infertility of cattle in Australia and New Zealand. Aust. vet. J. 44: 134-138
- MCCORMICK, W. C., GIVENS, R. L., SOUTHWELL, B. L. 1963: Effects of shade on rate of growth and fattening of beef steers. Georgia Agric. Exp. Stn Tech. Bull. 27: 13pp
- MCDANIEL, A. H., ROARK, G. B. 1956: Performance and grazing habits of Hereford and Aberdeen Angus cows and calves on improved pastures as related to types of shade. J. Anim. Sci. 15: 59-63
- MACDONALD, M. A. 1957: Slaughter weight of beef cattle for theoretical maximum energetic efficiency. N.Z. Jl Sci. Technol. A38: 706-708
- MCILVAIN, E. H., SHOOP, M. C. 1971: Shade for improving cattle gains and rangeland use. J. Range Mgmt 24: 181-184
- MCIVOR, A.R. 1967: Reported in N.Z. Jl Agric. 115(4): 60
(Lincoln College) Personal communication
- MACKENZIE, C. N. 1957: in Farmers Experiences with Beef Cattle. Proc. 7th Lincoln Coll. Fmrs Conf. 1957: 42-44
- MACKINTOSH, J. B. 1970: The supplementary feeding of cattle. N.Z. Sheep Fmg A. 1970: 1-10
- MCLEOD, C. C. 1968: Annual report on research work conducted by the South Canterbury Field Research Section, Department of Agriculture for the year ending 30th June, 1968 (cyclostyled), 29p
- MACRAE, J. C., O'CONNOR, K. F. 1970: The nutritive value of New Zealand tall tussocks (*Chionochloa*) fed to sheep. N.Z. Jl agric. Res. 13: 555-566
- MADDEN, E. A. 1962: The influence of cattle on pasture composition and second growth control. Proc. 24th Conf. N.Z. Grassld Ass. 1962: 90-94
- MARK, A. F. 1960: Vegetation in Land capability survey of the Mt Benger district - Central Otago. Otago Catchment Board report (cyclostyled)
- _____, 1965a: Central Otago vegetation and mountain climate. pp 69-91 in Central Otago. N.Z. Geogr. Soc. Spec. Publ. Misc. Ser. 5
- _____, 1965b: Effects of management practices on narrow-leaved snow tussock *Chionochloa rigida*. N.Z. Jl Bot. 3: 300-319
- _____, 1966: The narrow-leaved snow tussock. Rev. Tussock Grassld Mount. Lands Inst. 10: 28-40
- MARK, A. F., ROWLEY, Jennifer, 1969: Hydrological effects in the first two years following modification of snow tussock grassland. in Watershed Management Hayward, J. A. ed. Lincoln Pap. Wat. Resour. 8: 188-202
- MARTIN, S. C., BARNES, K. K., BASHFORD, L. 1967: A step towards automatic weighing of range cattle. J. Range Mgmt 20: 104-107
- MASON, I. L. 1966: Hybrid vigour in beef cattle. Anim. Breed. Abstr. 34: 453-473
- MASON, W. E., BEILHARZ, R. G. 1970: Performance recording of beef cattle. J. Aust. Inst. Agric. Sci. 36: 167-181
- MATTHEWS, L. J., ALLEN, F. C., DUNN, J. S. 1970: Weed Control Guide. N.Z. Fmr 91(16): suppl. 40pp
- MELTON, A. A., JONES, J. H., RIGGS, J. K. 1960: Influence of frequency of feeding protein supplement upon development and production of range beef females. J. Anim. Sci. 19: 1276 (abstract)
- MELTON, A. A., RIGGS, J. K., NELSON, L. A., CARTWRIGHT, T. C. 1967: Milk production, composition and calf gains of Angus, Charolais and Hereford cows. J. Anim. Sci. 26: 804-809
- MILLER, G. D., GEORGE, K. J. 1969: Scales = accurate liveweight. N.Z. Jl agric. 118(6): 58-59
- MILLS, B. S. 1968: Scientists paddling in murky waters. N.Z. Meat Prod. 12(11): 10-11

- MITCHELL, K. J. 1963: Production potential of New Zealand pasture land.
Proc. N.Z. Inst. agric. Sci. 9: 80-94
- MOIR, J. 1961: The place of cattle. Rev. Tussock Grassld Mount. Lands Inst. 1: 15-18
- MOLINUEVO, H. A. 1967: (Estimation of weaning weight per unit area of land and its relation to size of the cow.)
Rev. Invest. Agropecuar Ser. I, 4: 37-47
- MOLLOY, B. P. J. (formerly Research Div. N.Z. Dep. Agric.) Personal communication
- MONTGOMERY, R. G. 1968: Cattle Yards. Wellington: Govt. Printer, 44pp
- MORAN, J. B. 1970: Brahman proved in cold climates. Aust. Country, Jan. 1970: 81-82
- MORGAN, J. H. L., PICKERING, F. S., EVERITT, G. C. 1969: Some factors affecting yellow fat colour in cattle. Proc. N.Z. Soc. Anim. Prod. 29: 164-175
- MOTT, G. O. 1960: Grazing pressure and the measurement of pasture production.
Proc. 8th int. Grassld Congr. 1960: 606-611
- MUEGLER, W. F. 1965: Cattle distribution on steep slopes. J. Range Mgmt 18: 255-257
- MUELLER, R. G., HARRIS, G. A. 1967: Economics of selected alternative calving dates.
J. Range Mgmt 20: 67-69
- MUNTING, J. F. 1967: Cattle treated under sheep showers. N.Z. Jl Agric. 115(2): 24-25
- MURRAY, D. M., YEATES, N. T. M. 1967: Walking trials with cattle: 2. A comparison of bulls, steers and heifers. J. agric. Sci. Camb. 69: 71-78
- NEW ZEALAND DEPARTMENT OF AGRICULTURE, 1968: Tara Hills High Country Research Station - experiments in progress. (Cyclostyled) Jan. 1968
- NEW ZEALAND DEPARTMENT OF STATISTICS, 1970: New Zealand Official Yearbook. Wellington: Govt. Printer, 1170pp
- NEW ZEALAND DEPARTMENT OF STATISTICS, Report on the Farm Production Statistics of New Zealand. Vols 1958/59 to 1967/68 incl. Wellington: Govt. Printer
- NEW ZEALAND HEREFORD CATTLE BREEDERS ASSOCIATION, 1968: Herefords in New Zealand. Vol. II Wellington: N.Z. Meat Prod. Publ. Co., 76pp
- NEW ZEALAND MEAT AND WOOL BOARDS ECONOMIC SERVICE, 1960: Annual Review of the Sheep Industry 1959/60. Publ. 303, 42pp
- _____, 1967: Financial analysis of New Zealand sheep farms 1965/66. Publ. B 12/66, 34p
- _____, 1970: Annual Review of the Sheep Industry. Publ. 1500, 40pp
- _____, 1970: Sheep farm survey 1968/69 Publ. 1508, 49p
- NEW ZEALAND METEOROLOGICAL SERVICE, 1966a: Summaries of climatological observations at New Zealand stations to 1960.
N.Z. Met. Serv. misc. Publ. 122: 59pp
- _____, 1966b: Meteorological observations for 1964.
N.Z. Met Serv. misc. Publ. 109: 106pp
- NEW ZEALAND VETERINARY ASSOCIATION (INC.) TECHNICAL COMMITTEE, 1962: Diseases of domestic animals in New Zealand. N.Z. Vet. Ass. Hndbk, 328pp
- NEUMANN, A. L., SNAPP, R. R. 1969: Beef Cattle. New York: John Wiley, 6th edn, 767pp
- NEVILLE, W. E. Jnr, 1962: Influence of dams milk production and other factors on 120- and 140-day weight of Hereford calves. J. Anim. Sci. 21: 315-320
- NICOL, A. M. 1969: Nutrition of beef animals. N.Z. Meat Prod. 13: 37,39
- _____, (Lincoln College) Personal communication
- NICOL, A. M., COOP, I. E. 1970: Nutrition of growing beef cattle. pp 224-234 in Campbell, A. G. (ed.) New Zealand Beef Production, Processing and Marketing. Wellington: N.Z. Inst. Agric. Sci.: 638pp
- NORDBYE, D. J., CAMPBELL, D. A. 1951: Preliminary infiltration investigations in New Zealand.
C.R. Ass. gen. d'Assoc. Int. d'Hydrol. sci. Bruxelles 2: 98-101
- NORWESTER, 1970: Mt Peel using own A.B. on beef breeding herd.
N.Z. Fmr 91(8): 33,35
- NOTT, J. H. 1969: Winter feeding vital to weaner weight gain.
N.Z. Jl Agric. 119(5): 30-31
- O'CONNOR, K. F. 1956a: Influence of treading on grasslands. Ph.D. thesis, Cornell Univ., Univ. Microfilms, Ann Arbor, Mich. 156p
- _____, 1956b: Influences of wheel and foot treading on soils under grasslands.
Proc. N.Z. Soc. Soil Sci. 2: 35-37
- _____, 1959: Plant production in difficult environments.
Proc. N.Z. Inst. agric. Sci. 1959: 86-94

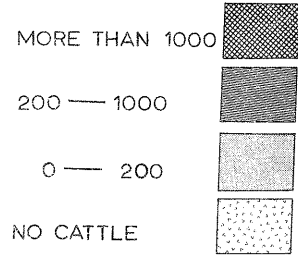
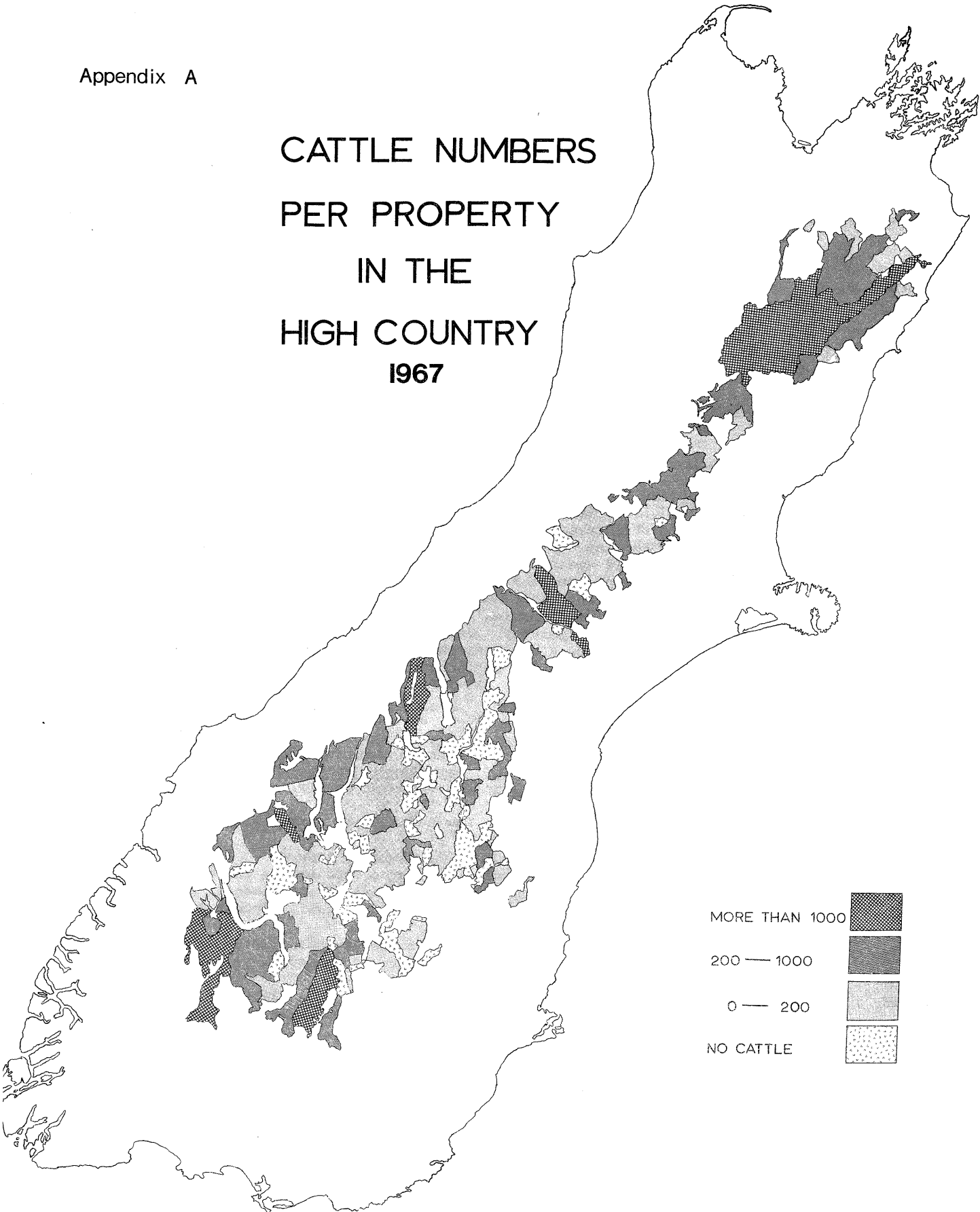
- O'CONNOR, K. F. 1960: Production in the mountains.
Proc. 10th Lincoln Coll. Fmrs Conf. 10: 82-94
- _____, 1963: The establishment of grasses in humid tussock grassland regions.
Rev. Tussock Grassld Mount. Lands Inst. 5: 20-24
- _____, 1965: The utilisation and development of tussock grasslands in New Zealand. Proc. 9th int. Grassld Congr. Sao Paulo: 1675-1679
- _____, 1966a: A scientific basis for potential use of land in the Mackenzie.
Proc. 16th Lincoln Coll. Fmrs Conf. 16: 77-87
- _____, 1966b: The improvement and utilisation of tussock grasslands: a scientists viewpoint. Cycling of nitrogen for production.
Proc. 28th Conf. N.Z. Grassld Ass.: 59-78
- _____, 1967: Research related to land production and protection. pp 132-154 in Hayward, J. A. (comp.) The Waimakariri Catchment.
Tussock Grassld Mount. Lands Inst. Spec. Publ. 5: 132-154
- _____, 1968: Effects of agricultural land use on water quality.
Lincoln Pap. Wat. Resour. 1: 41-65
- _____, 1971: Utilising tall tussock.
Rev. Tussock Grassld Mount. Lands Inst. 21: 10-20
- O'CONNOR, K. F., CLIFFORD, P. T. 1966: Fertiliser economy in run development.
Rev. Tussock Grassld Mount. Lands Inst. 11: 46-49
- O'CONNOR, K. F., LAMBRECHTSEN, N. C. 1964: Studies on the management of snow tussock grassland III The effects of burning, fertiliser and oversowing on a mid-altitude tall-tussock grassland in South Canterbury, New Zealand.
N.Z. Jl agric. Res. 7: 264-80
- O'CONNOR, K. F., POWELL, Alison, J. 1963: Studies on the management of snow tussock grassland, I Effects of burning, cutting and fertiliser on snow tussock at a mid-altitude site in Canterbury, New Zealand.
N.Z. Jl agric. Res. 6: 354-366
- O'CONNOR, K. F., VARTHA, E. W., BELCHER, R. A., COULTER, J. D. 1968: Seasonal and annual variation in pasture production in Canterbury and North Otago.
Proc. 30th Conf. N.Z. Grassld Ass.: 50-63
- OLIVER, W. M., CARTWRIGHT, T. C. (Undated): Double muscling in cattle: a review of expression, genetics and economic implication.
Tech. Rep. Dep. Anim. Sci. Texas agric. Expt Stn: 55pp
- OSBORN, B. 1954: Effectiveness of cover in reducing soil splash by raindrop impact.
J. Soil Wat. Conserv. 9: 70-76
- PANI, S. N. 1968: Maternal influence in animals: a review.
Wld Rev. Anim. Prod. 19/20: 88-99
- PARKER, E. R., JENNY, H. 1945: Water infiltration and related soil properties as affected by cultivation and organic fertilisation.
Soil Sci. 60: 353-376
- PATTERSON, T. C. 1967: Design considerations for small pipelines for distribution of livestock water on rangelands. J. Range Mgmt 20: 104-107
- PEARSON HUGHES, G., ALDER, F. E., REDFORD, R. A. 1959: The overwintering of beef stores.
Emp. J. exp. Agric. 23: 145-157
- PENNYCOOK, C. 1968: Winter feed on Makarora Station.
Rev. Tussock Grassld Mount. Lands Inst. 15: 32-38
- PETERSON, R. A., WOLFOLK, E. J. 1955: Behaviour of Hereford cows and calves on short grass range. J. Range Mgmt 8: 51-57
- PHILPOTT, B. P. 1968: Overseas trends affecting New Zealand agriculture.
Proc. 18th Lincoln Coll. Fmrs Conf. 1968: 97-110
- PIEPER, R. D. 1969: The role of consumers in a grassland ecosystem. pp 316-329 in Dix, R. L., Beidleman, R. G. (eds), The Grassland Ecosystem. Range Sci. Dep. Sci. Ser. 2. Fort Collins: Colorado State Univ. 437p
- PLUMMER, R. (Dep. Agric. Wellington) Personal communication
- PRESTON, T. R., WILLIS, M. B. 1970: Intensive beef production. Oxford: Pergamon Press, 544pp
- PURDY, H. B. 1967: Reported in The Press (Christchurch), 23rd Sept. 1967
- QUINN, J. A., HERVEY, D. F. 1970: Trampling losses and travel by cattle on Sandhills Range. J. Range Mgmt 23: 50-55
- RADCLIFFE, Joan E. 1968: Soil conditions on tracked hillside pastures.
N.Z. Jl agric. Res. 11: 359-370
- RAUZI, F. 1963: Water intake and plant composition as affected by differential grazing on rangeland. J. Soil Wat. Conserv. 18: 114-116

- RAUZI, F., HANSON, C. L. 1966: Water intake and runoff as affected by intensity of grazing. J. Range Mgmt 19: 351-356
- REEVES, S. D. 1967: Beef on the plains. Proc. 17th Lincoln Coll. Fmrs Conf. 1967: 97-103
- RENBARGER, R. E., SMITHSON, L. J., STEPHENS, D. F., POPE, L. S. 1964: Effect of nutrition before and after calving on performance of beef heifers. J. Anim. Sci. 23: 293 (abstr.)
- REPPERT, J. N. 1960: Forage preference and grazing habits of cattle at the eastern Colorado Range Station. J. Range Mgmt 13: 58-65
- REYNOLDS, E. R. C., LEYTON, L. 1963: Measurement and significance of throughfall in forest stands. pp 127-141 in Rutter, A. J. Whitehead, F. H. (eds) The Water Relations of Plants, Br. ecol. Soc. Symp. no. 3: 394pp
- RIDDOLLS, A. W. 1958: Farm Engineering. Wellington: N.Z. Govt. Printer, 442 pp
- ROBERTSON, R. M. (Hakataramea Valley) Personal communication
- ROLLINS, W. C., CARROLL, F. D., ITTNER, N. R. 1964: Comparisons of the performance of $\frac{3}{4}$ Hereford, $\frac{1}{4}$ Brahman calves with Hereford calves in a variable climate. J. agric. Sci. Camb. 62: 83-88
- ROSENBERG, N. J., WILLITTS, N. Z. 1962: Yield and physiological response of barley and beans grown in artificially compacted soils. Proc. Soil Sci. Soc. Am. 26: 78-82
- ROWLEY, Jennifer, 1970a: Effects of burning and clipping on temperature, growth, and flowering of narrow-leaved snow tussock. N.Z. Jl Bot. 8: 264-282
- _____, 1970b: Lysimeter and interception studies in narrow-leaved snow tussock grassland. N.Z. Jl Bot. 8: 478-493
- ROWLEY, J. K., WARRINGTON, A. J. 1970: The development of Lake Hawea Station. Rev. Tussock Grassld Mount. Lands Inst. 19: 32-38
- ROWLEY, J. K. (Lake Hawea Station) Personal communication
- ROYAL COMMISSION TO INQUIRE INTO AND REPORT UPON THE SHEEP FARMING INDUSTRY IN NEW ZEALAND, 1949: Report. Wellington: Govt. Printer, 220p
- RUTHERFORD, M. B. (Ministry of Agriculture, Fisheries and Food, National Agric. Advis. Serv. Wales) Personal communication
- SAMPSON, A. W. 1952: Range management - principles and practices. New York: John Wiley, 570 pp
- SCAIFE, A. S. 1963: Some experiences in tussock grassland development and management. Proc. 13th Lincoln Coll. Fmrs Conf. 1963: 46-53
- SCALES, G. H. (N.Z. Dep. Agric. Tara Hills High Country Res. Stn) Personal communication
- SCHUSTER, J. L., ALBIN, R. C. 1966: Drylot wintering of range cows - adaption to the ranching operation. J. Range Mgmt 19: 263-268
- SCOTT, R. S. 1963: The effect of mole drainage and winter pugging on grassland production. Proc. 25th Conf. N.Z. Grassld Ass.: 119-126
- SEARS, P. D., EVANS, L. T. 1953: Pasture growth and soil fertility - III The influence of red and white clovers, superphosphate, lime and dung and urine on soil composition and on earthworm and grass grub populations. N.Z. Jl. Sci. Technol A35 (suppl. 1): 42-52
- SEWELL, D. S. 1968: Reported in The Press (Christchurch), 29th June, 1968
- SHEPPERD, J. H. 1921: The trail of the short grass steer. N. Dak. agric. Exp. Stn Bull. 154: 8p
- SKOVLIN, J. M. 1965: Improving cattle distribution on western mountain rangelands. U.S. Dep. Agric. Fmrs Bull. 2212: 14pp
- _____, 1967: Range riding, the key to range management. J. Range Mgmt 10: 269-271
- SKYRME, H. P. 1965: Autumn calving in beef cattle has many advantages. N.Z. Jl agric. 110: 247
- SMITH, E. F., PARRISH, D. B., CLAWSON, A. J. 1950: Effect of addition of salt v. no salt upon digestibility of certain rations, growth and conditions of steers. J. Anim. Sci. 9: 668 (abstr.)
- SOIL SURVEY STAFF 1951: Soil survey manual. U.S. Dep. Agric. Hndbk 18: 503pp
- SQUIRES, V. R., WILSON, A. D. 1971: Distance between food and water supply and its effect on drinking frequency, and food and water intake of Merino and Border Leicester sheep. Aust. J. agric. Res. 22: 283-290
- STODDART, L. A. 1960: Determining correct stocking rate on rangeland. J. Range Mgmt 13: 251-254
- STODDART, L. A., SMITH, A. D. 1955: Range Management. New York: McGraw-Hill, 2nd edn, 433pp

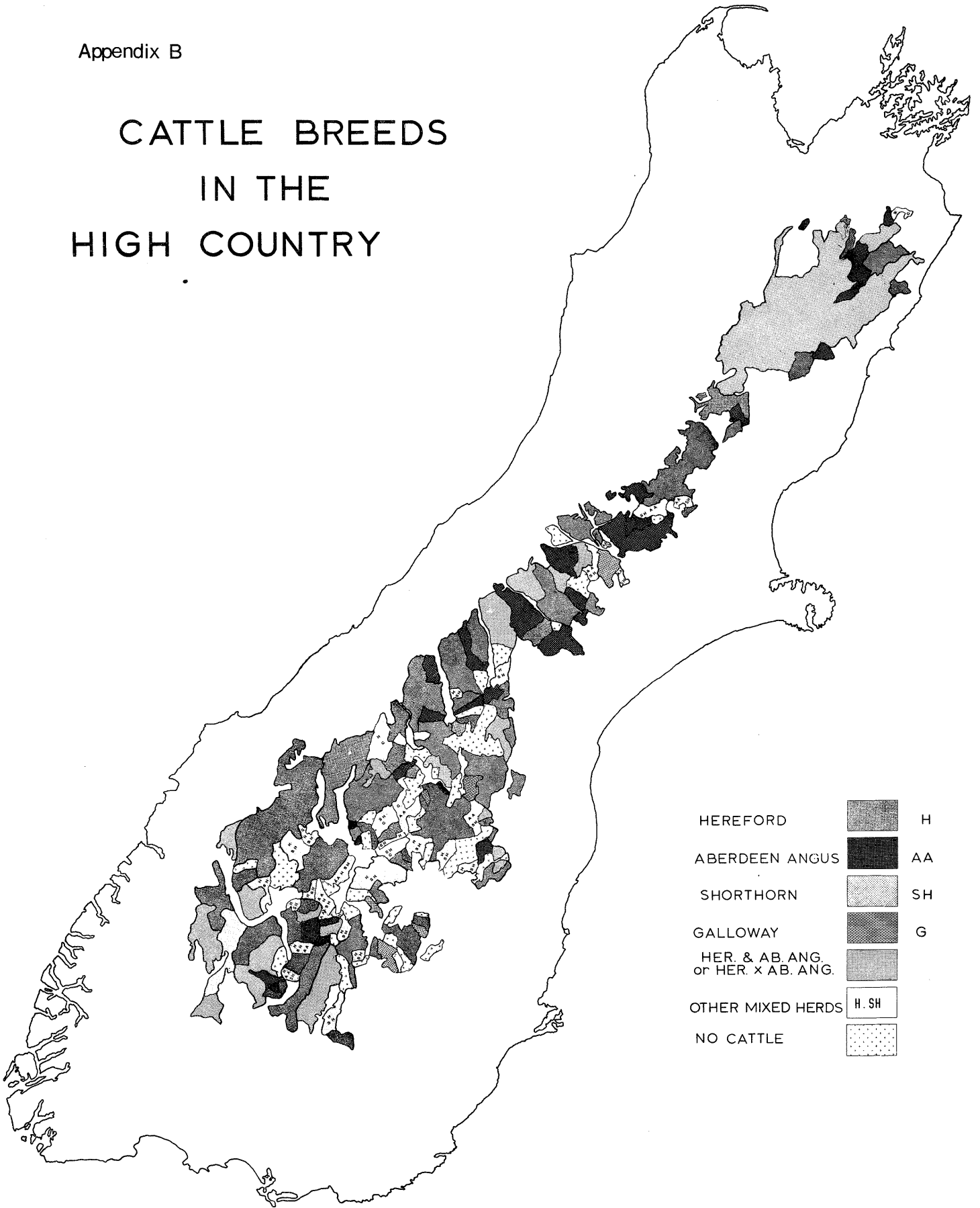
- STRUTHERS, G. A. 1968: Reported in Southerner, Aug. 1968
- SUCKLING, F. E. T. 1962: Recent trials at the Te Awa Hill Pasture Research Station. N.Z. Sheep Fmg A. 1962: 181-197
- _____, 1965: Hill pasture improvement. Newton King Group Cos, N.Z. Dep. Scient. Ind. Res.: 57pp
- SUTHERLAND, J. M. 1967: Reported in The Press (Christchurch), 28th Sept. 1967
- SWIGER, L. A., GREGORY, K. E., KOCH, R. M., ARTHAUD, V. H. 1961: Effect of inbreeding on performance traits of beef cattle. J. Anim. Sci. 20: 626-630
- SYKES, J. F. 1955: Animals and fowl and water. pp 14-18 in Water. U.S. Dep. Agric. Yb. 1955: 751pp
- TAYLER, J. C. 1966: Relationships between the herbage consumption or carcass energy increment of grazing beef cattle and the quantity of herbage on offer. Proc. 10th int. Grassld Congr. Helsinki, 1966: 463-470
- _____, 1968: The control of grazing behaviour of cattle for intensive animal production from pasture. Vet. Ann. 1968: 238-248
- THOMAS, G. W., DURHAM, R. M. 1964: Drylot all-concentrate feeding - an approach to flexible ranching. J. Range Mgmt 17: 179-185
- TOEBES, C., SCARF, F., YATES, M. E. 1968: Effects of cultural changes on Makara experimental basin. Pub. Int. Ass. Scient. Hydrol. XIIIe Année 3: 95-122
- TRIPP, C. W. H. 1953: Cattle in Southland. Proc. 3rd Lincoln Coll. Fmrs Conf. 1953:33-36
- TROLOVE, B. H. 1953: Cattle in Marlborough and Nelson. Proc. 3rd Lincoln Coll. Fmrs Conf. 1953: 36-40
- TROTTER, W. B. 1968: Reported in The Press (Christchurch), 1st June, 1968
- TROUSE, A. C. Jnr, BAVER, L. D. 1962: The effect of soil compaction on root development. Trans jt mtg Comm. IV, V int. Soc. Soil Sci.: 258-263
- TULLOH, N. M. 1961: Behaviour of cattle in yards: 2. A study of temperament. Anim. Behav. 9: 25-30
- TURNER, J. W., FARTHING, B. R., ROBERTSON, G. L. 1968: Heterosis in reproductive performance of beef cows. J. Anim. Sci. 27: 336-338
- TURTON, M. 1953: Cattle on the foothills. Proc. 3rd Lincoln Coll. Fmrs Conf. 1953: 23-27
- VALENTINE, K. A. 1947: Distance from water as a factor in grazing capacity of rangeland. J. For. 45: 749-754
- VAN DYNE, G. M., HEADY, H. F. 1965a: Inter-relations of botanical and chemical dietary components of animals grazing dry annual range. J. Anim. Sci. 24: 305-312
- _____, 1965b: Botanical composition of sheep and cattle diets on a mature annual range. Hilgardia 36: 465-492
- VAN DYNE, G. M., LOFGREEN, G. P. 1964: Comparative digestion of dry annual range forage by cattle and sheep. J. Anim. Sci. 23: 823-832
- VAN DYNE, G. M., MEYER, J. H. 1964: Forage intake by sheep and cattle on dry annual range. J. Anim. Sci. 23: 1108-1115
- VETERINARIAN, 1964: Vibriosis in cattle. N.Z. Fmr 85(18): 29
- _____, 1965: Vibriosis infection. N.Z. Fmr 86(20): 29
- _____, 1966a: Brucellosis. N.Z. Fmr 87(20): 25
- _____, 1966b: Quality in beef. N.Z. Fmr 87(18): 27
- _____, 1966c: Parasites in young cattle. N.Z. Fmr 87(12): 33
- _____, 1966d: Foot troubles in bulls. N.Z. Fmr 87(10): 25
- _____, 1967a: Watch out for lice. N.Z. Fmr 88(16): 29
- _____, 1967b: Keeping down losses from bloat. N.Z. Fmr 88(17): 25
- _____, 1967c: Crossbreeding. N.Z. Fmr 88(1): 23
- _____, 1968a: Worms in weaners. N.Z. Fmr 89(5): 25
- _____, 1968b: Whats wrong with fat. N.Z. Fmr 89(10): 23
- _____, 1968c: Feeding and infertility in cattle. N.Z. Fmr 89(10): 25
- _____, 1968d: Grass staggers in beef cows. N.Z. Fmr 89(11): 31
- _____, 1968e: Eye conditions in cattle. N.Z. Fmr 88(22): 25
- _____, 1969: Crossbreeding. N.Z. Fmr 90(16): 63
- _____, 1971: Lice control in cattle. N.Z. Fmr 92: 65
- VINE, R. 1966: How cattle weighing improved beef herd. N.Z. Fmr 87(11): 59
- VOISIN, A. 1959: p 69 in Grass Productivity (trans. C. T. Herriot) London: Crosby Lockwood, 353p
- WAGNON, K. A. 1963: Behaviour of beef cows on a California range. Calif. agric. Exp. Stn. Bull. 799: 58p
- WAGNON, K. A., ALBAUGH, R., HART, G. H. 1960: Beef cattle production. New York: Macmillan, 537pp








- WALKER, D. E. K. 1963: Milk production of beef heifers.
Proc. Ruakura Emrs Conf. 1963: 52-60
- WALKER, S. D. 1966: Reported in The Press (Christchurch), 24th Sept. 1966
- WALKER, S. D., LOBB, W. R. 1968: Beef production: potential and output in mid Canterbury. Proc. 30th Conf. N.Z. Grassld Ass.: 94-101
- WALLER, J. A., GOLD, S. F., SINCLAIR, A. W. 1958: Developing springs or seeps. V.P.I. Agric. Ext. Ser. Blacksburg, Virginia, Circ. 773: 3pp
- WARD, F. L. 1968: Future requirements for expanded beef production in New Zealand. Proc. N.Z. Soc. Anim. Prod. 28: 121-130
- WARDROP, I. D. 1966: Effects of the plane of nutrition in early post natal life on the subsequent growth and development of cattle.
Aust. J. agric. Res. 17: 375-385
- WARRINGTON, A. J. (Otago Catchment Board) Personal communication
- WARWICK, E. J. 1966: Breeding beef cattle for improved productivity and market desirability. N.Z. Sheep Fmg A. 1966: 252-270
- _____, 1968a: Modern concepts of beef production in Herefords in New Zealand 2: 11-12. Wellington: N.Z. Meat Prod. Publ. Co.: 68pp
- _____, 1968b: Crossbreeding and line crossing beef cattle - experimental results. Wld Rev. Anim. Prod. 4(19-20): 38-45
- _____, 1969: Effective performance recording in beef cattle, pp 149-159 in Proc. 2nd Wld Conf. Anim. Prod. Maryland, 1968: 537pp
- WATSON, A. R. 1967: Reported in The Press (Christchurch), 22nd Apr. 1967
- WATSON, D. M. S. 1943: Beef cattle in war and peace.
Emp. J. exp. Agric. 41: 191-236
- WATSON, N. 1964: Seasonal livestock values. N.Z. Sheep Fmg A. 1964: 56-68
- WATT, J. P. C. (Otago Catchment Board) Personal communication
- WEAVER, J. E., ROWLAND, N. W. 1952: Effects of excessive natural mulch on development, yield and structure of native grassland. Bot. Gaz. 114: 1-19
- WESTON, L. H. 1968: Electric Fencing.
Tussock Grassld Mount. Lands Inst. Special Publ. 7 (2nd edn): 34pp
- WILLHITE, F. M., GRABLE, A. R. 1966: Greater profit from livestock in the intermountain west with efficient ranch management. J. Range Mgmt 19: 112-118
- WILLYAMS, M. B. (South Island Freezing Companies Association) Personal communication
- WILSON, R. W. (formerly Dep. Lands and Survey) Personal communication
- WILTBank, J. N., ROWDEN, W. W., INGALLS, K. E., GREGORY, K. E., KOCH, R. M. (1962): Effect of energy level on reproductive phenomena of mature Hereford cows. J. Anim. Sci. 21: 219-225
- WINCHESTER, C. F. 1964: Environment and growth. J. Anim. Sci. 23: 254-264
- WINCHESTER, C. F., ELLIS, N. R. 1956: Delayed growth of beef cattle.
U.S. Dep. Agric. Tech. Bull. 1159: 25pp
- WINCHESTER, C. F., HOWE, P. E. 1955: Relative effects of continuous and interrupted growth on beef steers. U.S. Dep. Agric. Tech. Bull. 1108: 34pp
- WINCHESTER, C. F., MORRIS, M. J. 1956: Water intake rates of cattle.
J. Anim. Sci. 15: 722-740
- YANDLE, C. A. 1968: An econometric study of the New Zealand meat market with special reference to pigmeats.
M. Agr. Sc. thesis. Lincoln Coll. Library, 296p
- YATES, M. E., SCARF, F. 1969: The effect of modifying cover type by man and animals on some flow characteristics in some New Zealand experimental basins.
(Proc. Symp. Watershed Mgmt in Wat. Resour. Devel. Lincoln Coll. 1969)
Lincoln Pap. in Wat. Resour. 8: 203-220
- YECK, R. G., STEWART, R. E. 1959: A ten year summary of the psychoenergetic laboratory dairy cattle research at the University of Missouri.
Trans. Am. Soc. Agric. Engng 2: 71-77
- YOUNG, J. S. 1965: Infertility in range cattle. N.Z. vet. J. 13: 1-10
- _____, 1967: Some observations on reproductive performance in selected commercial beef herds. N.Z. vet J. 15: 167-173
- _____, 1968: Breeding patterns in commercial beef herds; 3. observations on dystocia in a Devon herd. Aust. vet. J. 44: 550
- _____, 1970: Studies on dystocia and birthweight in Angus heifers calving at two years of age. Aust. vet. J. 46: 1-7

CATTLE NUMBERS PER PROPERTY IN THE HIGH COUNTRY 1967



CATTLE BREEDS IN THE HIGH COUNTRY

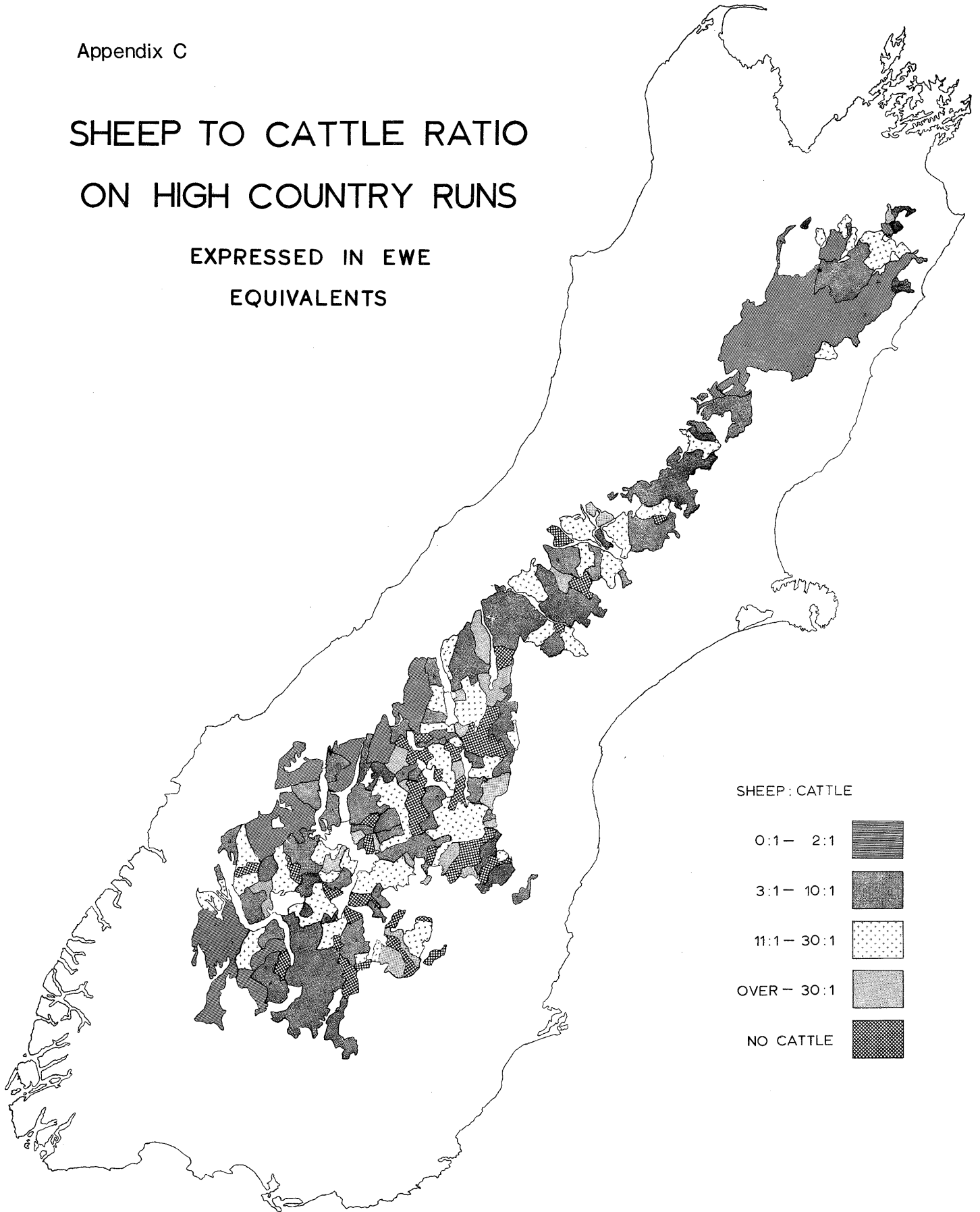


HEREFORD		H
ABERDEEN ANGUS		AA
SHORTHORN		SH
GALLOWAY		G
HER. & AB. ANG. or HER. x AB. ANG.		
OTHER MIXED HERDS		
NO CATTLE		

Appendix C

SHEEP TO CATTLE RATIO ON HIGH COUNTRY RUNS

EXPRESSED IN EWE
EQUIVALENTS



APPENDIX D

Maximum sustained rate of increase of beef
breeding herd: method of calculation.

- Where: R = annual replacement rate of breeding herd (replacement of deaths and culled animals)
 C = average calving rate (survival to weaning as proportion of cows put to bull)
 D = average annual death rate in young replacement female stock
 S = proportion of weaner heifers which are suitable for retaining for breeding purposes
 B_i = size of breeding herd in year
 W_i = number of yearling heifers in year
 H_i = number of two-year heifers in year

then it is postulated that, where the average age of first calving is as three-year-olds (heifers first to bull as two-year olds):

$$B_i \leq B_{i-1} \cdot (1-R) + H_{i-1} \cdot (1-D) \quad (1)$$

$$H_i \leq W_{i-1} \cdot (1-D) \quad (2)$$

$$W_i \leq B_{i-1} \cdot \frac{C}{2} \cdot (1-D) \cdot S \quad (3)$$

from which can be derived:

$$B_i \leq B_{i-1} \cdot (1-R) + \frac{C}{2} \cdot B_{i-3} \cdot (1-D)^2 \cdot S \quad (4)$$

The maximum sustained rate of increase is given by solving for $\frac{B_i}{B_{i-1}}$ in terms of R, C, S, and D, in the inequality (4) under the condition that it is an equation. This was not attempted analytically, but, instead, the absolute value of B_i was computed for each year for a 20-year period, for given initial values of B_{i-1} , B_{i-2} , B_{i-3} . These initial values correspond to beef breeding cow numbers in 1965, 1966, and 1967 respectively. It was found that the annual value of $\frac{B_i}{B_{i-1}}$ has stabilised (as between successive years; at least to four significant figures) after 20 years.

The values of $\frac{B_i - B_{i-1}}{B_{i-1}}$ in the 20th year under each of several assumptions of the values of R, C, S and D are shown in the table below. Assumption (5) represents those considered as most generally applicable in the South Island high/hill country region.

	Assumptions				Value of $\frac{B_i - B_{i-1}}{B_{i-1}}$
	S	R	C	D	
(1)	.95	.11	.90	.02	18.3%
(2)	.80	.25	.80	.05	2.5%
(3)	.90	.20	.85	.03	9.8%
(4)	.90	.20	.90	.03	11.0%
(5)	.90	.20	.80	.03	8.7%

APPENDIX E

Growth, grading, and spring price premium assumptions adopted for calculation of value for age graph for typical beef-breed steer (see Figures 11 and 12).

Month	Age (months)	Live-weight (lbs)	Carcase weight as % of liveweight	Carcase weight (lbs)	Export Grade of Carcase	Value on Export Schedule (\$)	Spring price premium adjustments (\$)	Adjusted carcase value (\$)
Sept (birth)	0	55	56					
Oct	1	80	55					
Nov	2	120	54					
Dec	3	180	53					
Jan	4	240	52					
Feb	5	300	50					
Mar	6	370	47					
Apr	7	440	"					
May	8	490	"					
Jun	9	500	48					
Jul	10	510	"					
Aug (1 year)	11	520	"					
Sept	12	550	49					
Oct	13	590	"					
Nov	14	635	"					
Dec	15	680	50	340	Boner 1	57.8		
Jan	16	715	"	359	"	61.0		
Feb	17	740	"	374	"	63.6		
Mar	18	785	"	398	FAQ	71.6		
Apr	19	830	51	423	"	76.1		
May	20	860	"	441	GAQ 1	80.5		
Jun	21	880	"	453	"	82.7		
Jul	22	890	"	461	"	84.1		
Aug	23	900	52	468	FAQ	84.2		
Sept (2 years)	24	920	"	481	"	86.6		
Oct	25	950	"	499	"	89.8		
Nov	26	990	"	522	GAQ 1	95.3		
Dec	27	1040	53	551	"	100.6		
Jan	28	1070	"	570	"	104.0		
Feb	29	1100	"	589	GAQ 2	100.1		
Mar	30	1140	"	613	"	104.2		
Apr	31	1180	54	637	"	108.3		
May	32	1200	"	651	"	110.7		
Jun	33	1210	"	659	"	112.0		
Jul	34	1220	"	668	GAQ 1	121.9	+ 2.5	124.4
Aug	35	1230	55	677	"	123.6	+ 2.5	126.1
Sept (3 years)	36	1250	"	691	"	126.1	+ 5.0	131.1
Oct	37	1280	"	710	"	129.6	+ 5.0	134.6
Nov	38	1320	"	736	"	127.0	+ 2.5	129.5
Dec	39	1370	56	767	GAQ 2	122.7		
Jan	40	1400	"	788	"	126.1		
Feb	41	1430	"	808	GAQ 3	129.3		
Mar	42	1480	"	840	"	123.9		
Apr	43	1530	57	872	"	128.6		
May	44	1560	"	893	"	131.7		
Jun	45	1570	"	903	GAQ 2	144.5		
Jul	46	1580	"	915	"	146.4	+ 2.5	148.9
Aug	47	1600	"	928	"	148.5	+ 2.5	151.0
Sept (4 years)	48	1640	"	955	"	152.8	+ 5.0	157.8

APPENDIX F

Cattle Wintering Costs as at October, 1971

A. R. McIvor*

Though the following wintering systems have been presented as independent techniques of arranging feed supply, many combinations of these feeds are possible. The policy should be to reserve high value "growth" feeds for growing young cattle, and low value "non growth" feeds to adult stock.

Growth Feeds

Grass
Tama
Grain
Good meadow hay
Turnips (variable)

Maintenance or non Growth Feeds

Straw
Silage

Estimates of Costs of Alternative Feeds

Grass all farm costs incl. 5% interest on total capital	.4c 1b DM
Nitrogen response in grass	1.0c 1b DM
Hay 60 lb bale at 30c in shed	.5c 1b weight in bale
Hay 60 lb bale at 60c	1.0c 1b weight in bale
Straw 40 lb bale at 30c	.75c 1b weight in bale
Tama cost of sowing \$7, winter growth 3000 lbs	.24c 1b DM
Turnips cost of sowing \$5	.23c 1b DM
Silage at \$2 per ton measured in pit	.4c 1b DM
Silage at \$3 per ton measured in pit	.6c 1b DM

Supplementary Feeding of Breeding Cows

Three systems of providing winter feed for breeding cows are presented. These systems envisage a dry environment where supplementing is necessary from April to August with some hay in September. They incorporate straw, hay, Tama, and turnips in a series of alternatives in an endeavour to reflect the cost effect of extensive use of hay or straw for bridging periods of feed shortage due to crop failure or delayed crop development.

* Farm Management Department, Lincoln College

Feeding Rates used for Cows

Straw	½ bale at 30c	15c day
Hay	¼ bale at 30c	7½c day
	¼ bale at 60c	15c day
Silage	1 ton for 40 days at \$2	5c day
	at \$3	7½c day

Turnips and Hay

Turnips 4 cows per acre for 100 days	at \$5	1.25c
Hay at 1 bale to 10 cows	at 60c	6.00 7.25c day

Alternative Methods of Supplementing - costed per cow per day

1. Silage April/May	60 days	at 7.5c day	4.50
Turnips June/July/August	90 days	at 7.5c day	6.75
Hay September at 1/10 bale	30 days	at 6c day	1.80
			<u>\$13.05</u>
2. Straw or Hay April/May	60 days	at 15c day	9.00
Tama June-August 6 lb	90 days	at 2.4c day	2.15
Hay June-August 1/10 bale	90 days	at 6.0c day	5.40
Hay September 1/10 bale	30 days	at 6.0c day	1.80
			<u>\$18.35</u>
3. Straw April-June	90 days	at 15c day	13.00
Hay July/August ¼ bale	60 days	at 15c day	9.00
Hay September 1/10 bale	30 days	at 6.0c day	1.80
			<u>\$23.80</u>

Effect of Wintering Cost & Store Calf Premium on Breeding Cow Profitability

60	Gross Profit \$51	Gross Profit \$46	Gross Profit \$40	Store Premium \$12	29c Store	
				Straw + Hay	24c Schedule	
					Silage + Turnips	
					Bull & Anim. Hlth	
50						
40						
30						
20						
10						

Analysis of Alternative Wintering Systems

	Income per Cow	Wintering Cost	Bull & Animal Health	Gross Profit	Gross Profit without Premium
Silage + turnips	68	13	4	51	39
Straw + Tama	68	18	4	46	34
Straw + hay	68	24	4	40	28

Wintering of Weaners

Young cattle are capable of converting medium to high quality feeds to meat at the rate of about 1 lb of meat per 14 lbs of dry matter of feed. Conversion rate through the cow is near 1 lb of meat to 35 lbs of dry matter. Because there exists two price levels for selling cattle at the end of winter to late October, i.e. local trade/store sales and schedule, high quality, high cost feed can be used in various combinations to give fast growth rates and substantial profits when properly tuned. The key to this, however, lies largely in costing the daily feed ration against the daily rate of gain.

Alternative Methods of Wintering Weaners

<u>Growth Income Per Day in Cents</u>		At				
		Live Weight	Carcase at 50%	Schedule 24c	Store Price 31c	
Growth per day		$\frac{1}{2}$ lb	$\frac{1}{4}$ lb	6c	8c	
		1 lb	$\frac{1}{2}$ lb	12c	16c	
		$1\frac{1}{2}$ lb	$\frac{3}{4}$ lb	18c	24c	
<u>Barley Straw</u> + Grain.	Gain per day $\frac{1}{2}$ lb					Gain Per Acre Per Day
10 lb Straw at .75c = 7.5						Per Day
4 lb Barley at 2.0c = 8.0		15.5c	-9.5c	-7.5c	loss	Feed lot area not significant
<u>Meadow Hay</u> + Grain.	Gain per day $1\frac{1}{2}$ lb					
10 lb Hay at 1.0c = 10.0						
4 lb Barley at 2.0c = 8.0		18c	-	+6c	gain	" "
<u>Turnips</u> 1 acre to 6 weaners for 100 days (\$5).	Gain per day $1\frac{1}{2}$ lb.					<u>Carcase Value</u> at 24c at 31c
Turnips per day say 1c = 1c						
Hay 1 bale to 10 = 6 lbs at 1c = 6c		7c	+11c	+17c	gain	66c \$1.02
<u>Tama</u> at 3 per acre per 100 days (\$7).	Gain $1\frac{1}{2}$ lb.					
Tama alone at 2.5c = 2.5c day			+15.5	+21.5	gain	46.5 64.5
<u>Tama</u> + Hay at 6 per acre.	Gain per day $1\frac{1}{2}$ lb.					
Tama per day = 1.3c						
Straw 6 lb per day at 1c = 6.0c		7.3c	+10.7	+16.7c	gain	64.2 \$1.00

Appendix F cont.

Profitability of Different Wintering Systems

Problems arise in calculating the per acre gross profit, particularly in the case of turnips and semi-feed-lot situations where grain and hay are used until cattle go onto winter saved grass in September. In these cases the limitation becomes the availability of spring grass. It has been assumed for this exercise that three yearlings per acre are carried for this period.

Analysis of Gross Profit Per Acre Assuming October Sale

Both store value of 31c per lb and schedule value of 24c per lb are shown. The example refers to the average 460 lb liveweight steer purchased in April at \$68 and \$2 animal health costs have been charged.

Gross Profit with Sale Value at 31c lb

	120 day Winter cost	Oct. L.Wt	Price Yearling	Profit per Beast	Profit per Acre
Barley Straw + Grain	\$18.60	645	\$100	\$11.40	\$34.20
Hay + Grain	\$21.60	765	\$117	\$25.40	\$76.20
Turnips + Hay	\$8.40	765	\$117	\$38.60	\$115.80
Tama	\$3.00	765	\$117	\$44.00	\$132.00
Tama + Hay	\$8.80	765	\$117	\$38.20	\$114.60

Gross Profit with Sale Value at 24c lb

Barley Straw + Grain	\$18.60		\$78	-\$10.60	-\$31.80
Hay + Grain	\$21.60		\$92	.40c	\$1.20
Turnips + Hay	\$8.40		\$92	\$13.60	\$40.80
Tama	\$3.00		\$92	\$19.00	\$57.00
Tama + Hay	\$8.80		\$92	\$13.20	\$39.60

APPENDIX G

Comparison of Capital Margins as at March 1971

J. D. Currie*

Production Levels Assumed

	<u>Ewes</u>	<u>Wethers</u>	<u>Cows</u>
Stock units	1.0	0.6	6.0
Wool lbs	8.0	9.5	-
Lambing and calving %	80	-	85
Age at mating	2-tooth	-	15 months
Productive years	4	5	5
Deaths %	5	5	3

Stock Margin Calculations

A. Ewes

	<u>\$</u> <u>Head</u>	<u>\$</u> <u>Total</u>	<u>S.U.</u>	<u>\$/S.U.</u>
Capital stock				
100 ewes	5	500	100	
30 e. hoggets	6	180	18	
3 rams	20	60	3	
		<u>740</u>	<u>121</u>	<u>6.10</u>

Income - wool

Ewe	775		
Hoggets	155		
Rams	30		
	<u>960</u>	at 30c. net	288

Income - lambs

Wethers	38		
Ewe	8	at \$4	184

Income - Ewes

A/draft	23	at \$4	<u>92</u>	564
---------	----	--------	-----------	-----

* Farm Advisory Division, N.Z. Department of Agriculture, Oamaru

Expenditure (direct)

Rams 1 at \$36	36	
Dip and drench at 10c./ewe	10	
Shearing at \$35/100	44	
Woolpacks	5	
Freight	11	
Hogget wintering at 50c.	15	
	<hr/>	
	121	
Interest \$740 capital at 8%	60	\$181
	<hr/>	

Margin	\$383	52%	interest paid
Margin/S.U.	\$3.16	52%	" "
Margin on capital		60%	" unpaid

B. Wethers

<u>Capital stock</u>	<u>\$</u> <u>Head</u>	<u>\$</u> <u>Total</u>	<u>S.U.</u>	<u>\$/S.U.</u>
100 wethers	4.00	400	60	
23 wether hoggets	4.00	92	14	
		<hr/>	<hr/>	
		492	74	6.65

Income - wool

Wethers	930	
Hoggets	115	
	<hr/>	
	1045	at 30c. net 314

<u>Wethers</u> - Cull 17 at \$3	51	365
	<hr/>	

Expenditure (direct)

Wether lambs 23 at 4.00	92	
Dip and drench	9	
Shearing \$35/100	42	
Woolpacks	5	
Freight	10	
Hogget wintering at 50c.	11	
	<hr/>	
	169	
Interest \$492 capital at 8%	40	\$209
	<hr/>	

Margin	\$156	32%	int. paid
Margin/S.U.	\$2.10	32%	" "
Margin on capital		40%	" unpaid

C. Breeding Cows*

	<u>\$</u> <u>Head</u>	<u>\$</u> <u>Total</u>	<u>S.U.</u>	<u>\$/S.U.</u>
<u>Capital stock</u>				
100 cows	100	10,000	600	
30 heifers (1 year)	90	2,700	120	
3 bulls	200	600	15	
		<u>13,300</u>	<u>735</u>	18,000

Income

Weaners - steers	42 at \$65	\$2,730	
- heifers	12 at \$60	720	
Cows - cull	27 at \$90	2,430	
Bull - boner	¾ at \$160	120	
		<u>6,000</u>	

Expenditure

Bull ¾ at \$400	300
Stock health	75
Freight	120
Hay at \$2.50 for 50 (1 & 2 yrs)	125
	<u>620</u>
Interest \$13,300 capital at 8%	1064
	<u>1,684</u>

Margin	4,316	32%	interest paid
Margin/S.U.	\$5.87	32%	" "
Margin on capital		40%	" unpaid

* In this example heifers are mated at 15 months. If mated at 2¼ years the margin on a higher capital value of the herd would be fractionally lower than shown.

Summary of Stock Margin Calculations

	<u>Ewes</u>	<u>Wethers</u>	<u>Cows</u>
Basic stock - \$	5.00	4.00	100.00
Cost/S.U. incl. replacements	6.10	6.65	18.00
Return/S.U.	3.16	2.10	5.87
Margin/\$ % invested	60	40	40
Margin/\$ % invested, interest paid at 8%	52	32	32

Comparison for 1,000 Stock Units

	<u>Capital Cost</u> \$	<u>Margin</u> \$	<u>% Return</u> <u>after</u> <u>interest 8%</u>	<u>% Return/\$</u> <u>invested</u>
Cows	18,000	5,850	32	40
Ewes	6,100	3,200	52	60

Comparison for Identical Capital

	<u>Capital</u>	<u>Margin</u>
Breeding ewes	\$1,800	\$10,800
Breeding cows	\$1,800	\$7,200

Stock Increases as an Investment

- (a) Increased breeding ewes even at lower ruling prices will give a high return for the lowest capital investment. Ewes should be the first consideration where a costly development programme is planned and where limited capital is available.
- (b) Wethers should be considered only for country unsuitable for ewes or cows.
- (c) Breeding cows have a relatively high return with current buoyant market prices and have an added advantage in their role of utilising feed that is already surplus. They can make the most profitable use of available feed on a per acre basis in high country.
- (d) The current low prices for fine wool will encourage the present trend of replacing wethers with breeding cows.

