Lincoln College
Department of Farm
Management and
Rural Valuation

Farm Budget Manual
Part 1 Technical 1977

1878 1978

Lincoln College

UNIVERSITY COLLEGE OF AGRICULTURE

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FM/RF/MM

MEMORANDUM FOR : Heads of Department
- Agricultural Engineering
  Agricultural Microbiology
  Animal Science
  Entomology
  Horticulture
  N.Z.A.E.I.
  Plant Science
  Soil Science
  T.G. & M.L.I.
  Veterinary Science
  Wool Science
  R.D.E.C.
  A.E.R.U.

SUBJECT : Lincoln College Farm Budget Manual - Part I 'Technical'

We are about to undertake the revision and updating required to enable publication of the 1979 Budget Manuals.

The Part 1 'Technical' Manual was last revised in late 1976 and as there are relatively few copies still available it is proposed to publish a new edition in 1979.

Would you please bring this matter to the attention of all your departmental staff and ask if they could kindly assist with this task of updating the Technical Manual.

If any staff member has available current information which would assist in revising the Technical Manual would they please forward such to Mr R.J. Diprose, Farm Management Department.

In addition, if anyone has any comments or suggestions to make in relation to material which should be included or removed, or the format of such altered in any way in the Manual would they kindly put this in writing and forward to Mr Diprose.

It would be appreciated if all information and comments could be forwarded by the 17th November 1978.

For your information a copy of the existing Technical Manual is enclosed.

12 October 1978

R. Frizzell, Acting Head
Department of Farm Management

CONTENTS

Preface

This booklet, the first of a two part Lincoln College Farm Budget Manual is revised and published biennially. Whilst no claim is made that the contents are exhaustive, they are, we feel, quite comprehensive.

Users of this manual will note that it is fully metricated even though the agricultural sector has not yet reached that point, but the areas of discrepancy are few.

Acknowledgement must be made of the work of Mr B. Brook and Mr G. Bulmer for their conscientious work in revising this edition.

Neil G. Gow
Senior Lecturer in Farm Management
EDITOR
March 1977

(1) CAPITAL

(a) Land and Buildings

Where a recent Government Valuation is available this is probably the best guide there is to the overall value of the property. If the Government Valuation is three or four years old then some adjustment of the figures may be necessary. This should be done in the light of the movement in land values since its release and include any major improvements made on the farm since the last Valuation.

For budget purposes this is split up between Land and Buildings. If varying grades of land are found on the property then the land value may be split up into several sections valued differently, the total of these summing to the overall Paddock Value. The Capital Value is usually also expressed as a figure per hectare of the farm, and per stock Unit carried on the farm or per unit of production (e.g. per kg butterfat) for comparative purposes.

(b) Stock

The numbers to be used in assessing capital tied up in stock should include only the normal breeding animals and replacements which will be carried. Thus fattening lambs or cull boner dairy cows still on hand when a property was visited in April would be included in Capital Stock. The value used per head should be autumn clearing sale or Ewe Fair values interpreted on a reasonably conservative basis. As stock numbers are written down the overall carrying capacity in stock units can also be determined.

(c) Plant

Valuations of plant should also be made on the basis of local clearing sales interpreted conservatively. The up-to-date price list for new equipment is very useful in assisting with these assessments.

(d) Working Capital

This is a part of the necessary capital needed to run the property but is often forgotten by people when purchasing a property. On sheep farms and certain types of horticultural properties (e.g. tobacco) income is concentrated in one part of the year but expenses must be met throughout the year and money for this purpose must either be set aside or borrowed. On dairy properties incomes are fairly evenly spread and this difficulty is not mėt to the same extent.

There are two sources of working capital:

(1) Farmer's own cash.

(2) Borrowed money. In this case working capital is largely provided by stock firms and Banks. The amount of working capital needed for any one particular farm is a function of total expenditure and the time pattern of income.

With stock firm and bank advances interest is charged on the day to day balance of the account hence the average of level of the advance is the working capital figure required for budget purposes. It should not be forgotten however that some farming enterprises reach a peak of advances at certain times of the year much greater than their average level. This may well present financial problems which are not immediately obvious when the average figure is assessed.

Working capital requirements are difficult to assess accurately. Each property and each farming type tend to have their own individual characteristics. The table below presents a rough guide only to student use. It is constructed by considering the working capital requirements as a percentage of the value of land, buildings, stock and plant.

Table I **Working Capital Requirements of Various Farm Types**

Farm Type	Percentage of Value of Land, Building Stock and Plant
Dairying (Intensive)	2%
Dairying and Mixed	3%–4% depending on comparative size of dairy enterprise
Sheep and Cropping	4%–5% depending on amount of crop and small seeds.

Table I (Continued)

Farm Type	Percentage of Value of Land, Building, Stock and Plant
Sheep (Intensive Fat Lamb)	5%
Sheep (Hill Country Store)	6%
Poultry	5%
Market Gardening	5%–10% depending on spread of sales
Orchard or Nursery	10%–15% depending on spread of sales
Tobacco and Hops, etc.	10%–15% depending on spread of sales

At the end of the set out of capital a summary is usually made showing the total capital involved in the farm. This figure is used later to assess efficiency and it is a very useful guide for later work on farm finance.

(e) Working Capital Profile

This is the term used to describe the way a farmer's net monthly balance of income and expenditure moves over the period of a year. It is important for students to realize that although two farms may have the same average working capital requirements the monthly patterns of these may be entirely different. Some examples of different working capital profiles are given over page.

Farm A

Town Supply Dairy Farm – 170 cows, 220 acres
(Buying in Feed October and December)

Month	Income	Expenditure	Monthly Balance	Working Capital Profile
				0
July	$ 3,401	$ 1,497	$ 1,904	$ 1,904
August	2,349	1,506	843	2,747
September	2,645	1,423	1,222	3,969
October	2,921	5,776	– 2,855	1,114
November	4,016	3,097	919	2,033
December	4,057	7,177	– 3,120	– 1,087
January	2,028	713	1,315	228
February	2,855	3,176	– 321	– 93
March	2,355	2,596	– 241	– 334
April	3,635	1,328	2,307	1,973
May	2,915	2,301	614	2,587
June	4,477	4,566	– 89	2,498
TOTAL	**37,654**	**35,156**		

Farm B

Hill country sheep farm – 1200 acres, 2300 ewe, 900 hoggets
50 breeding cows, pre lamb shearing

Month	Income	Expenditure	Monthly Balance	Working Capital Profile
				0
July	–	1,257	– 1,257	–1,257
August	–	745	– 745	– 2,002
September	5,385	1,235	4,150	2,148
October	–	1,706	– 1,706	442
November	3,816	1,936	1,880	2,322
December	986	4,395	– 3,409	– 1,087
January	55	1,665	– 1,610	– 2,697
February	4,186	1,298	2,888	191
March	–	1,976	– 1,976	– 1,785
April	6,544	1,009	5,535	3,750
May	1,288	4,968	– 3,680	70
June	1,357	662	695	765
TOTAL	**23,617**	**22,852**		

Farm C

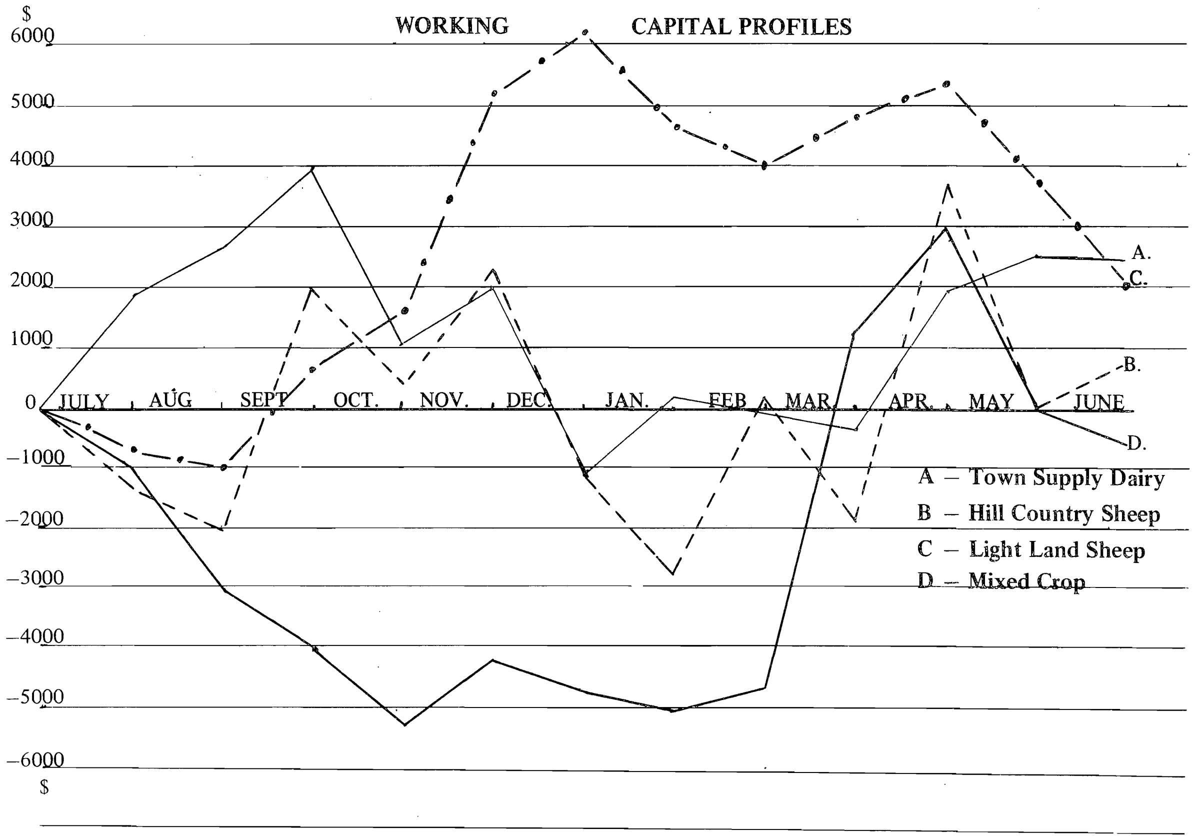
Light land Sheep farm – 950 acres, 2200 Ewes, 600 ewe hoggets
July and October Shearing

Month	Income	Expenditure	Monthly Balance	Working Capital Profile
				0
July	60	751	– 691	– 691
August	729	1,029	– 300	– 991
September	3,190	1,550	1,640	649
October	1,836	870	966	1,615
November	5,723	2,115	3,608	5,223
December	3,818	2,767	1,051	6,274
January	–	1,563	– 1,563	4,711
February	1,040	1,695	– 655	4,056
March	2,418	1,594	824	4,880
April	2,570	2,049	521	5,401
May	–	1,604	– 1,604	3,797
June	620	2,259	– 1,639	2,158
TOTAL	**22,004**	**19,846**		

Farm D

Mixed cropping farm — 340 acres, 150 acres grain, 50 acres peas 50 acres ryegrass seed, 50 acres white clover, 500 ewes

Month	Income	Expenditure	Monthly Balance	Working Capital Profile
				0
July	541	1,513	– 972	– 972
August	44	2,063	– 2,019	– 2,991
September	437	1,465	– 1,028	– 4,019
October	—	1,182	– 1,182	– 5,201
November	4,686	3,627	1,059	– 4,142
December	790	1,309	– 519	– 4,661
January	1,086	1,387	– 301	– 4,962
February	1,670	1,335	335	– 4,627
March	8,070	2,165	5,905	1,278
April	4,943	3,192	1,751	3,029
May	2,512	5,533	– 3,021	8
June	1,713	2,236	– 523	– 515
TOTAL	**26,492**	**27,007**		


WORKING CAPITAL PROFILES
$
6000
5000
4000
3000
2000
1000
0
–1000
–2000
–3000
–4000
–5000
–6000
$
JULY
AUG
SEPT
OCT.
NOV.
DEC.
JAN.
FEB
MAR.
APR.
MAY
JUNE
A.
C.
B.
D.
A – Town Supply Dairy
B – Hill Country Sheep
C – Light Land Sheep
D – Mixed Crop

(2) CHARACTERISTICS OF DOMESTIC ANIMALS

(Source—Farm Management Handbook, Qsld Dept of Primary Industries)

General Information†

When caring for livestock, the following information concerning normal temperature, pulse and respiration rates, breeding cycles and age determination, may be required, particularly in the case of disease problems.

Normal and Expected Range of Temperature, Pulse and Respiration

	Body Temperature Deg. °C Daytime (Rectal Average)	Pulse (Beats/Min)	Respiration (Breaths/Min)
Sheep	38.9 (37.2 – 40.5)	75 (60–120)	12–20
Cattle	38.6 (37.8 – 39.3)	70 (40–100)	31 (27–40)
Pig	39.3 (38.8 – 40.3)	(55–86)	8–18
Horse	37.8 (37.2 – 38.1)	44 (23–70)	11.9 (10.6–13.6)
Dog	38.9 (36.7 – 40.5)	(100–130)*	18 (11–38)
Goat	39.3 (37.8 – 40.5)	90 (70–135)	19

* Heart rate varies in all these animals according to body weight, but the very great range of size in breeds of dog make this difference more marked. Thus, a Great Dane has a resting pulse of about 80, while toy breeds have a resting rate of about 130.

The temperature will vary considerably for each animal within a certain range. Thus, it is highest in the afternoon and lowest soon after midnight. In cattle under paddock conditions, for instance, this range may cover 4 deg. Fahrenheit. The range is not so marked in housed cattle, or where the climate is temperate.

Exercise, feeding and excitement, will raise the temperature. Drinking cold water and bleak conditions will lower the temperature.

The increase in temperature outside the normal range is of the utmost importance generally indicating some infectious condition. A subnormal temperature may be of great importance as indicating the nature of the disease. For example, a cow after calving may go down and become semi-comatose; if the temperature is high, it points to the possibility of septicaemia. If the temperature is low, it points to the possibility of a metabolic disease such as milk fever.

The temperature should always be taken if, for example, symptons are being noted in order to telephone a veterinarian for advice. It is often the most important single piece of information. It should be taken in the rectum, with an ordinary human clinical thermometer, a half-minute thermometer being left in a minute and a half, to obtain an accurate reading.

The pulse and respiration should also be taken in conjunction with the temperature, as they often give most valuable evidence. The simplest way to count the pulse is to hold the hand over the heart area (under the elbow) and count the impulses of the heart beat.

The pulse and respiration will vary widely with exercise, excitement, or weather conditions, quite apart from the effect of disease.

Puberty†
(Age at Which Animals Will Breed)

	Normal Time (Age in months)
Ewe	8 – 12
Cow	12 – 18
Sow	4 – 5
Mare	12 – 24
Bitch	7 – 10
Nanny	8 – 12

Puberty varies widely with feeding, breed, strain and climate. For example, a Jersey heifer has been known to mate successfully at under 3 months of age having a calf while under 12 months.

Telling The Age of Animals

Age of Horses

Location of teeth	Ages at eruption of permanent teeth	"Cups" disappear from wearing surfaces of permament teeth lower jaw
First pair of middle incisors	2½ years	6 years
Second pair of incisors (Located at either side of "nippers")	3½ years	7 years
Third pair of corner incisors	4½ years	8 years

The age of older horses is more difficult to determine but, in general, the shape of the wearing surface of the teeth gradually changes from oval to triangular, the forward pitch becomes more marked, and the neck of the teeth at the gums becomes narrower. At 10 years, a groove, known as Galvayne's Groove, appears on the Upper Corner Incisor. At 15 years this groove is halfway down the tooth, and at 20 years it is the full length of the tooth.

Age of Cattle

The age of cattle is usually determined by general appearance. However, the time that the teeth erupt can be used as a guide to age. During the first few weeks of life, four pairs of temporary incisors in the lower jaw usually appear. These are replaced by the same number of permanent ones as follows:—

Teeth	Age at Eruption
First or middle pair of incisors	22 to 34 months
Second pair of incisors	27 to 41 months
Third pair of incisors	33 to 42 months
Fourth pair of incisors	41 – months

The state of dentition, taken alone, is not a reliable guide to the age of cattle.

Age of Sheep

The age of sheep can be gauged by the time of the appearance of permanent incisors, there being four pairs, all in the lower jaw. They erupt as follows:—

Teeth		Age at Eruption
First or middle pair of incisors	2 tooth	12 to 18 months
Second pair of incisors	4 tooth	21 to 24 months
Third pair of incisors	6 tooth	30 to 36 months
Fourth pair of incisors	8 tooth	42 to 48 months

Type of feed and pasture have a good deal of influence on the age at which teeth of a sheep begin to wear and fall out, but normally a sheep is cast for age at 6 years.

Breeding Table

Time of Service		Calving Date		Lambing Date		Farrowing Date	
July	9	April	17	December	5	October	31
July	23	May	1	December	19	November	14
August	6	May	15	January	2	November	28
August	20	May	29	January	16	December	12
September	3	June	12	January	30	December	26
September	17	June	26	February	13	January	9
October	1	July	10	February	27	January	23
October	15	July	24	March	13	February	6
October	29	August	7	March	27	February	20
November	12	August	21	April	10	March	6
November	26	September	4	April	24	March	20
December	10	September	18	May	8	April	3
December	24	October	2	May	22	April	17
January	8	October	17	June	6	May	2
January	22	October	31	June	20	May	16
February	5	November	14	July	4	May	30
February	19	November	28	July	18	June	13
March	5	December	12	August	1	June	27
March	19	December	26	August	15	July	11
April	2	January	9	August	29	July	25
April	16	January	23	September	12	August	8
April	30	February	6	September	26	August	22
May	14	February	20	October	10	September	5
May	28	March	6	October	24	September	19
June	11	March	20	November	7	October	3
June	25	April	3	November	21	October	17

Sheep: 5 months less 4 days. Cows: 9 months plus 9 days.

Table of Oestrum

	Duration of Oestrum	Return after Parturition	Recurrence if not impregnated
Ewe (Merino)	36–48 hrs	60–150 days if no suckling, otherwise, 4–6 months.	17 (12–19) days
Cow	14 hrs (10–18 hrs)	41–60 days	21 (18–24) days
Mare	4½–9 days	9–14 days	21 (13–25) days
Sow	2–3 days	7 days after weaning	21 (14–26) days
Bitch	4–13 days	5–6 months	5–6 months

Periods of Gestation

	Shortest Period	Usual Period	Longest Period
	Days	Days	Days
Mare	322	347	419
Ass	365	380	391
Cow	240	283	321
Ewe	146	154	161
Sow	109	115	143
Goat	150	156	163
Bitch	55	60	63
Cat	48	50	56
Rabbit	20	28	35
Turkey sitting) Hen	27	24	28
on the eggs) Duck	24	27	30
of the ..) Turkey	24	26	30
Hen sitting on) Duck	26	30	34
the eggs of the) Hen	19	21	24
Duck	28	30	32
Goose	27	30	33
Pigeon	16	18	20

(3) SHEEP PERFORMANCE

New Zealand Sheep Statistics

Sheep Numbers by Statistical Areas as at 30 June 1974 and actual tailing percentages (1973/74 season)

(Source: Annual Review of Sheep Industry 1974/75 N.Z. Meat & Wool Boards Economic Service).

	Numbers (000)	%	Tailing %
Northland	1,382	2.5	89.6
Central Auckland	788	1.4	83.1
South Auckland/Bay of Plenty	7,655	13.7	85.3
East Coast	2,500	4.5	83.7
Hawkes Bay	6,824	12.2	87.2
Taranaki	1,420	2.5	82.1
Wellington	8,827	15.8	87.5
North Island	29,396	52.6	86.2
Marlborough	1,290	2.3	86.5
Nelson/Westland	836	1.5	80.7
Canterbury	9,318	16.7	88.7
Otago	7,215	12.9	95.4
Southland	7,828	14.0	100.4
South Island	26,487	47.4	96.0
New Zealand	55,883	100.0	90.9

NEW ZEALAND EXPORT MEAT GRADES

Source: N.Z. MEAT PRODUCERS BOARD OCT. 1975

LAMB

Lamb is divided into 4 ranges of fat cover as shown in the table below with those carcases devoid of fat, known as grade A, while at the other end of the fat cover range are those carcases with excess fat cover represented by the grade symbol F.

The carcases with a P type fat cover are broken into two grades on the basis of conformation. These two grades are known as P and O.

Fat Cover	Devoid	Light	Medium	Excess
	A	**Y**	**P**	**F**
Conformation			Compact	Leggy
			P	**O**

P grade lamb has an adequate, but not excessive fat cover over the carcase. The carcase has well muscled legs and is fully fleshed in the loin so that there is no sign of the backbone.

Weight Range	*Grade Symbol*
8.0 – 12.5	PL
13.0 – 16.0	PM
16.5 – 25.5	PH

Y grade lamb has less fat cover than P grade carcases, but while fat cover is light it is not deficient. Muscle development is variable in the legs and loin.

Weight Range	*Grade Symbol*
8.0 – 12.5	YL
13.0 – 16.0	YM
16.5 – 25.5	YH

A grade is a light weight lamb that is deficient in fat cover.

Weight Range	*Grade Symbol*
To 12.5 kg (no min. wt.)	A

O grade lamb has a similar fat cover to the P grade, but the legs are elongated and weakly muscled.

Weight Range	*Grade Symbol*
8.0 – 12.5	OL
13.0 – 16.0	OM

F grade lamb comprises carcases that have an excessive fat cover especially evident over the loin and rib areas.

Weight Range	*Grade Symbol*
8.0 – 25.5	F

SUMMARY

kg.	A	Y	P	O	F
8.0 – 12.5	A	YL	PL	OL	F
13.0 – 16.0		YM	PM	OM	
16.5 – 25.5		YH	PH		

Carcases that are not eligible for export due to trimming or mutilation are graded Cutter 1 or Cutter 2. Cuts from these carcases may be exported.

Cutter 1 grade comprises carcases not eligible for export due to trimming, but where all primal cuts are intact.

Cutter 2 grade is where the trimming deemed necessary to remove a defective portion of the carcase results in the damage or removal of one or more of the primal cuts.

For schedule purposes the Cutter 1 grade is broken into two weight ranges namely 8.0-12.5 kg. There is only one schedule payment for Cutter 2 carcases.

Manufacturing grade comprises lambs that are too lean or thin for export in either carcase or cuts form, as well as lambs having yellow carcases.

Weight Range	*Grade Symbol*
All wts.	M

EWE

Ewe carcases are divided into 4 grades principally on the basis of fat cover.

Grade	*Fat Cover*
MM	Devoid
X	Light
E	Medium-Heavy
FM	Excess

E grade ewes have a complete, but not excessive cover of fat. The carcases are medium to well muscled.

Weight Range	*Grade Symbol*
To 22.0	EL
22.5 – 26.0	EM
26.5 – 30.0	EH 1
30.5 – 36.0	EH 2

X grade ewe carcases have only a light external fat cover with the muscling generally weaker than E grade ewes especially in the loin.

Weight Range	*Grade Symbol*
To 26.0 kg	EX

FM grade carcases are devoid of fat cover, with the backbone and ribs being visibly prominent.

Weight Range	*Grade Symbol*
All wts.	MM

MM grade carcases have an excessive fat cover especially on the loin, ribs and shoulders.

Weight Range	*Grade Symbol*
All wts.	FM

Carcases not eligible for export in the carcase form due to trimming to remove some defect are graded either Processing 1 or Processing 2.

Processing 1 grade to include trimmed EL, EM or EX carcases where all primal cuts are intact.

Processing 2 grade to include any trimmed EH 1, EH 2, FM or MM carcase as well as EL, EM or EX carcases that have a damaged primal cut.

	Weight Range	*Grade Symbol*
Processing 1 —	All wts.	P1
Processing 2 —	All wts.	P2

SUMMARY

Wt. Kg.	MM	X	E	FM	P1	P2
To 22.0	MM	EX	EL	FM	P1	P2
22.5-26.0			EM			
26.5-30.0			EH1			
30.5-36.0			EH2			

- Ewe carcases over 36.0 kg are graded FM.
- X grade carcases over 26.0 kg are graded FM

WETHER

There are two grades —

W grade of a similar type to E grade ewe.

X grade of a similar type to X grade ewe.

WEIGHT RANGES AND GRADE SYMBOLS

Wt. Kg.	X	W
To 22.0	WX	WL
22.5-26.0		WM
26.5-30.0		WH1
30.5-36.0		WH2

- Wether X grade carcases over 26.0 kg are graded FM
- Wethers with qualities of MM grade ewe are graded MM
- Wethers with qualities of FM ewes are graded FM.
- Carcase not eligible for export as a carcase due to trimming or mutilation will grade either P1 or P2 as defined for ewes.

HOGGET

As with wether, there are two grades H and X —

grade being similar in type to E grade ewes.

grade being similar in type to X grade ewes.

WEIGHT RANGES AND GRADES SYMBOLS

Wt. Range kg	X	H
To 22.0	HX	HL
22.0-26.0		HM

- X grade carcases over 22.0 kg grade WX.
- Hoggets with qualities of MM grade ewe are graded MM.
- Hoggets with excess fat will grade FM.
- Carcases not eligible for export as a carcase due to trimming or mutilation grade either P1 or P2.

RAM

There is only one ram grade covering all weights.

Lambing Percentage

There are two common methods of calculation

1. $$\frac{\text{Number of Lambs Docked}}{\text{Number of Ewes Put to Ram}} \times \frac{100}{1}$$

2 $$\frac{\text{Number of Lambs Docked}}{\text{Number of Ewes alive at Docking}} \times \frac{100}{1}$$

The first method is the more usual but the second method is used by some farmers. The first is the only true basis and students should be careful to obtain and calculate the correct figure on each property.

Mortality

An average figure for a ewe flock on low country is 4 to 5 per cent (usually 5 per cent for budget work). In hard country death rates become much higher and less regular from season to season. Deaths in lambs are irregular. Evidence suggests that they are of the order of 15 per cent of the total ewe flock on Plains land between dropping and docking and there is an opportunity here for better farm management. In budget work this loss is neglected and death rates are considered from docking to sale. Store lambs are normally sold at weaning and fats partly off mothers and partly off feed. Average death allowances are 2–3% for stores and 3–4% for fats.

Lambing Survival

A useful budget approach is to include deaths from docking to sale in a blanket calculation of a lambing survival percentage known as "Percentage Survival to Sale or Flock." This figure will usually be 2–3% less than a farmers tailing percentage.

Flock Replacements

The useful life of a breeding ewe varies considerably depending on the type of country on which it is being carried. Eventually ewes must be culled to breed on easier country, or (apart from a few used for dog tucker) sent to the freezing works. It is necessary to make provision for replacement of the total annual loss from the flock (which includes death as well as culls) if static flock numbers are to be maintained.

Age Ear-Mark and Cast-for-Age

On many hill properties an age ear-mark is applied at docking as well as the registered ear-mark. Such properties usually set cast ewes as "guaranteed Four Year Olds" or "guaranteed Five Year Olds" meaning they have produced 3 and 4 crops of lambs respectively and these sheep command a premium at ewe fairs. Other hill properties discard solely on an inspection of the mouths in the autumn and these lines command prices in direct relation to their mouths and general appearance. In many cases there is doubt as to the genuineness of the title "Four Year Old" or "Five Year Old" given to these lines at ewe fairs or main saleyards.

Culling

It is usual to cull to some extent in hill breeding ewe flocks using Romney, Corriedale or Half-Bred rams and unusual to cull much in fat lamb flocks using the Down type of ram. Culling is heavy in ewe lambs and 2 tooth ewes. Usually total numbers of ewe lambs are sufficient to allow fairly heavy culling in selection of ewe lambs to go into winter and culls will have a ready sale as ewe lambs to Plains buyers. Even so it is normal to take at least 110% of 2 tooth ewes plus deaths into the winter as ewe hoggets and often 120 to 125%. Ewe lambs winter differently and for this reason it is desirable to be able to cull to some extent as 2 tooth ewes the following autumn. These cull 2 tooths are sold in truck lots at ewe fairs and often bring high prices.

In large ewe flocks on hill country it is the practice to cull in the autumn at the 4, 6 and 8T stage for such things as bearing trouble, bad udders, poor constitution etc., and small lines of 4, 6 and 8T ewes may be offered at ewe fairs. Usually these are a particularly bad buy for Plains farmers.

Home Killing and Dog Tucker

On sheep properties an allowance of ½ a sheep per household per week is an approximate guide. Where single men are employed this allowance should be stepped up. It is usual to carry over cull lambs for house meat but wether hoggets may be bought. On small properties dogs will be fed on household scraps, offals from home killings and an occasional old ram or ewe. On larger holdings more dogs are needed and a proportion of old ewes will be killed for dog tucker.

Rams

It is usual to purchase rams as "one-shear" at local ram fairs. Ram fairs are stud or flock and the average farmer purchases at "flock" fairs. Rams will last "on average" 4 breeding season and are usually disposed of by killing for dogs. The usual allowance is 5 per 200 ewes with more rams on harder country and perhaps as low as 1 per 100 ewes on the best flats and lowlands where the country is good and rams are tested by a veterinary surgeon before the season starts.

Fat Lamb Standards

Fat lambs should be 14–16 kg dressed weight at 3–4 months

$$\text{Dressed Weight} = \frac{(\text{liveweight} + 1)\ \text{kg}}{2}$$

Sheep Reconciliation and Methods of Calculating Numbers Necessary to Maintain the Ewe Flock

Example 1:

It is essential in any budgetary estimate to state the class, number and performance of the sheep flock on the property and to tie this up in a stock reconciliation covering a twelve month period. An example is given here of a store sheep unit carrying 2,000 ewes and breeding own replacements. Ewes last 5 seasons and 100 per cent of lambs survive to weaning. Mortality in the ewe flock is 5 per cent and approximately 5 per cent of the 4, 6 and 8 tooth ewes and the 5 years ewes are culled each year. Twenty per cent of the 2 tooth ewes are culled before going into the ewe flock.

Procedure is as follows:

1. Establish the total loss from the ewe flock annually which is 5% deaths and 5% culling or approximately 200.
2. Ewes are kept 5 seasons so divide this total loss by 5 to get the approximate loss in each age group of the flock 200 ÷ 5 = 40. There are more sheep in the younger age groups but stock losses tend to increase with age after the 2T year so equal annual losses have been allowed.

3. In a flock being kept for 5 season, more than 1/5th of the sheep are 2T, more than 1/5th are 4T, approximately 1/5th 6T, less than 1/5th are 8T and less again are 5 year olds because of deaths. The flock composition is found by taking 1/5th of the total flock and calling this 6T ewes,
e.g. 2,000 x 1/5th = 400 6T ewes
The number of sheep in each other age group is then found by adding or subtracting the appropriate number of annual losses per age group.
e.g. number of 2T ewes =

$$400 + (2 \times 40) = 480 \text{ 2T}$$

4. Flock Composition:

480	2T ewes
440	4T ewes
400	6T ewes
360	8T ewes
320	5 year ewes
2,000	

5. Cull mixed age ewes for sale. These make up half of the annual loss per age group, e.g. $\frac{40}{2}$

∴

20	4T ewes
20	6T ewes
20	8T ewes
20	5 year ewes
80	for sale annually

6. Cast for age ewes for sale are 320 less half the annual loss per age group (deaths only, as they are all being culled.)
e.g. $320 - \frac{40}{2}$

= 300 less say 20 for dog tucker

= 280 C.F.A. ewes to sell

7. Two tooth ewes required are sufficient for 20% culling.

∴ $480 \times \frac{120}{100} = 576$ of which 96 will be culled.

Ewe lambs to be kept at weaning to ensure this number of 2T ewes allowing 5% death rate in ewe hoggets.

= $576 \times \frac{100}{95} = 607$, say 610 and cull 99 2T

8. Lamb disposal: 100% survival to sale or flock

∴ 1,000 wether lambs to sell less 50 killers
1,000 ewe lambs less 610 to flock gives 390 to sell
Less 20 culls for house mutton and dog tucker
= 370 ewe lambs to sell

9. This stock performance will now be formally summarized in a stock reconciliation. (over page).

10. Summary of Sales:

Wether Lambs:	Prime fat off the mothers	9%	=	90		
	Second fat off the mothers	1%	=	10		
	Prime fat off Feed	50%	=	500		
	Seconds fat off Feed	35%	=	350	=	950
Ewe Lambs					=	370
2T Ewes					=	99
Mixed Age Ewes (Culls)					=	80
Cast for Age Ewes					=	280

Summary of Sheep Killed:

49 Wether hoggets and 2T wethers for the houses
20 Ewe hoggets (some for the house, rest for the dogs)
20 Old thin ewes for dogs
10 Old rams for dogs

Sheep Reconciliation (For Example 1)

Class	On hand 1st July	Bought	Natural Increase	Transfer	Sold	Deaths	Killed	On hand 30 June
Wether Lambs			1000	50	950			
Ewe Lambs			1000	630	370			
Ewe Hoggets	630		630	480	90	31	29	630
2 tooth Ewes	480		480	440	20	20		480
4 tooth Ewes	440		440	400	20	20		440
6 tooth Ewes	400		400	360	20	20		400
8 tooth Ewes	360		360	320	20	20		360
5 year Ewes	320		320		280	20	20	320
Rams	50	13				3	10	50
Killers	60		50			1	49	60
Totals	2740	13	4680	2680	1770	135	108	2740

$\underbrace{2740 + 13 + 4680}_{7433}$ $\underbrace{2680 + 1770 + 135 + 108 + 2740}_{7433}$

MATHEMATICAL TECHNIQUE

This simple accurate method can be adopted to fit any situation.

Example 1:

Flock of 1900 ewes.
5% death rate. 5% culling rate.
Ewes bought as 5 yr. c.f.a. and last 2 years.

Problem:

How many 5 yr. ewes to be bought each year?

We know that we have two age groups –
5-year ewes and 6-year ewes.

We know that the number of 6 yr. ewes is the number of 5 yr. ewes less 10% (5% deaths + 5% culls).

We know that the 5 yr. ewes + 6 yr. ewes = 1900.

Therefore mathematically the number of 5 yr. ewes + 90% of the 5 yr. ewes = 1900.

So let the number of 5 yr. ewes required = x.

$$\begin{aligned} \text{Therefore} \quad x + .9x &= 1900 \\ \therefore \quad 1.9x &= 1900 \\ \therefore \quad x &= \frac{1900}{1.9} \\ x &= 1000. \end{aligned}$$

∴ the number of 5-year ewes to be bought is 1000.

The number of 6-year ewes in the flock will be .9 x 1000 = 900.

Example 2:

From example one assume that instead of ewes lasting 2 years that half will in fact produce 3 crops of lambs. Now have 5 yr., 6 yr., and 7 yr. ewes.

Death rate still 5%.

Culling rate of 5% for rising 6 yr. ewes and 50% for rising 7 yr. ewes.

Let number of 5 yr. ewes required = x
number of 6 yr. ewes = .9x
number of 7 yr. ewes will be the number of 6 yr. ewes less 5% deaths, less 50%.

$$\text{e.g.}\quad \frac{.95\,(.9x)}{2} = .4275x.$$

$$\therefore \quad x + .9x + .4275x = 1900$$

$$2.3275x = 1900$$

$$x = \frac{1900}{2.3275}$$

$$x = 816$$

$\therefore$ Number of 5 yr. ewes required is 816

$\therefore$ Number of 6 yr. ewes is $.9(816) = 735$

$\therefore$ Number of 7 yr. ewes is $\dfrac{.95(735)}{2} = 349$

1900 ewes

Example 3

The method is equally well applied to any mixed age flock.

Take 1000 ewe flock. Buy 2 tooth replacements. Take 4 crops of lambs – 5% death and 5% cull rate. Sell 5 yr. ewes.

	Let 1x			=	number of 2 tooths required.
$\therefore$	.9x			=	number of 4 tooths
$\therefore$	(.9) (.9x)	=	.81x	=	number of 6 tooths
$\therefore$	(.9) (.81x)	=	.729x	=	number of 4 yr. ewes
			3.439x	=	1000

$$x = \frac{1000}{3.439}$$

$$= 290.7 = \text{say } 291$$

Say number 2 ths.	=	291
4 ths.	=	262
6 ths.	=	235
4 yr.	=	212
		1000

Example 4:

A two-flock system of 2000 Corriedale ewes. Aim is to breed own replacements from part of flock – balance to the fat lamb sire.

We require a 20% culling margin in ewe hoggets, i.e. cull 1 in 5 of the ewe hoggets.

Take 5½ crops of lambs, and build in a 5% death rate + 5% culling rate in age groups.

Then let	$1.0x$	=	number of 2 tooths required.
	$.9x$	=	number of 4 tooths
$.9\,(.9x) =$	$.81x$	=	number of 6 tooths
$.9\,(.81x) =$	$.729x$	=	number of 8 tooths
$.9\,(.729x) =$	$.656x$	=	number of 5 yr. ewes
$\dfrac{.9\,(.656x)}{2} =$	$.295x$	=	number of 6 yr. ewes

$$\therefore \quad 4.39x = 2000 \text{ ewes}$$

$$x = \frac{2000}{4.39} = 456 \text{ 2 tooth ewes.}$$

Flock Structure:

456	2 tooths
410	4 tooths
369	6 tooths
332	8 tooths
299	5 yr. ewes
134	6 yr. ewes
2000	

Given that we need 456 2 tooths then with a 115% lambing and 4% hogget death rate, what number of ewes do we need to put to the Corriedale ram?

456 2 tooths represent 80% or .8 of the ewe hoggets.

$\therefore$ Number of ewe hoggets required $= \dfrac{456}{.8} = 570$

and to allow for the 4% death rate 570 ewe hoggets represent .96 or 96% of the ewe lambs at weaning.

$\therefore$ Ewe lambs at weaning $= \dfrac{570}{.96} = 594$

Assuming that ewe lambs represent ½ or 50% of lambs born to Corriedale ram then total Corriedale lambs required to obtain 594 weaned ewe lambs = 594 x 2 = 1188.

Given a lambing % of 115 then the number of ewes required to produce 1188 lambs $= \dfrac{1188}{1.15} = 1033.$

In summary then, of the 2000 ewes 1033 go to the Corriedale ram and 967 go to the fat lamb sire.

(B) Stock Reconciliation

On Hand 1/7/74		Nat. Incr.	Killed	Deaths	Sold	Purchased	On Hand 30/6/75	
Wth. LAMBS		1150		10	1090			
Wth. Hgts	50		28	2			50	Wth. Hgts.
Wethers	20		19	1			20	Wethers
							—	
Total Wethers	70						70	Total Wethers
Ewe Lambs		1150		14	556			
Ewe Hoggets (Total)	580			10	114		580	Ewe Hoggets (Total)
2th Ewes	456			23	23		456	2th Ewes
4th Ewes	410			20	21		410	4th Ewes
6th Ewes	369			19	18		369	6th Ewes
4yr Ewes	332			16	17		332	4yr Ewes
5yr Ewes	299			15	150		299	5yr Ewes
6yr Ewes	134			13	121		134	6yr Ewes
Aged Ewes	—						—	Aged Ewes
Total Ewes	2000						2000	Total Ewes
Ram Lambs		—						
Ram Hgts.	—					12		Ram Hgts.
2th Rams	12		1		—		12	2th Rams
M.A. Rams	38		9	2	—		11 / 27	M.A. Rams
TOTAL Rams	50						50	TOTAL Rams
TOTALS	2700	2300	57	145	2110	12	2700	TOTALS
	A	B	C	D	E	F		

TOTALS A 2700 + B 2300 + F 12 = 5012 (1) Total 1 must

TOTALS G 2700 + C 57 + D 145 + E 2100 = 5012 (2) equal Total 2

(4) WOOL PRODUCTION

Adult sheep are usually shorn once per year, dry sheep in September October and wet sheep after the dry shearing. Wet ewes may also be shorn pre-lambing (usually August). The practise of shearing 3 times every 2 years (pre-lambing every second year) is also used by some farmers. In the South Island most sheep are first shorn as hoggets 13 months after birth although a proportion are shorn in January. This practice is more common in the damper districts and particularly in the North Island.

Crutching

Lambs which are not shorn are crutched in January–February. Ewes are crutched in June–July and may also be lightly crutched or "ring-crutched" before rams go out.

Main Classification

The trend today in shed preparation is towards simplification, particularly with average and low grade wools, where little skirting is being done.

The main types of wool considered for budgeting purposes include fleece, necks, pieces, bellies and locks at main shearing and lambswool, crutchings and deadwool at other times.

Where skirting is carried out at main shearing the following proportions are likely to occur.

Type	Weight (kg)	%
Fleece	3.40	75
Necks	.13	3
Pieces	.40	9
Bellies	.30	7
2nd Pc's/Locks	.27	6
	4.50	100

Ewe crutchings amount to .2 to .3 kg, making a total clip of 4.75 kg per year, for well fed sheep.

The range in annual clip per sheep as a guide is approx. 5.5 kg to 3.0 kg. X-bred hoggets not shorn as lambs average the same as or slightly more than ewes, whereas the slower maturing finer wool breeds average slightly less than ewes.

When shorn as lambs, hoggets would produce 1.0 to 1.5 kg as lambs, and approx. 3.0 kg as hoggets.

Lambs crutch about .1 kg.

Budgeting Procedure

When quoting wool weights it should be clear that figures refer to numbers actually shorn and that weights include crutchings and do or do not, include lambs wool (if it is district practice to shear lambs.)

Obtain shearing tallies by deducting 1/2 to 2/3 of the annual deaths, depending on the month of shearing. Assess the wool weight per class of sheep and obtain the total wool yield per class of sheep. Add the totals, then, with the weighted price of the whole of the fleece clip, assess the income from wool. Normally current quotations for the Average Grade of the major class of wool in the clip are a good guide to overall price per kg.

An example:

No's at 1.4.__	Less Deaths	Shearing tally	Wgt/sheep including crutchings	Total
1000 ewes	30	970	4.5k	4365
400 hoggets	6	394	3.4k	1340
1050 lambs shorn		1,040	1.1k	1144
lambs crutched				
100 rams and killers	30	70	4.5k	315
	Total shorn	2,484	Total Clip	7,164 kilos

Summary of Wool Characteristics of Breeds

(Source—Wool and Woolclassing—Henderson)

Breed	Range of Quality	Average Staple Length (mm)	Crimps per cm.	Nature of Crimp in Staple	Shape of Staple	Lustre	General
Merino	60s–90s	100 – 50	3 – 6	Precisely defined and mostly V-shaped	Rectangular aggregate of small staples. Tip is flat or nearly flat	Bright	Softness is main and outstanding characteristic. Staples are firm.
Quarterbred (¾ Merino, ¼ Lincoln or English Leicester or Romney)	58s–64s	115 – 75	2.5–3.5	Well defined. Usually rounded.	Tends to be rectangular. Tip is nearly flat and is more open than Merino.	Bright	Soft wool but falls short of Merino in this respect. Of good staple length and staple is firm.
Polwarth	58s–64s	115 – 80	2.5–3.5	Well defined. Usually rounded.	Tends to be rectangular. Tip is nearly flat and and is more open than Merino.	Bright	Soft wool but falls short of Merino in this respect. Of good staple length and staple is firm.
Corriedale	50s–58s	130 – 80	1.5–2.5	Well defined. Usually rounded.	Most rectangular. Tip nearly flat in finer wools and slightly pointed in coarser wools.	Bright	Moderately soft. Staple is firm.
Halfbred (½ Merino, ½ Lincoln or English Leicester or Romney)	50s–58s	130 – 80	1.5–2.5	Well defined. Usually rounded.	Rectangular and often large. Tip nearly flat in finer wools and slightly pointed in coarser wools.	Bright	Moderately soft. Staple is firm.

Summary of Wool Characteristics of Breeds (continued)

Breed	Range of Quality	Average Staple Length (mm)	Crimps per cm.	Nature of Crimp in Staple	Shape of Staple	Lustre	General
Romney	44s–52s	180–115	.75–2.5	Round	Usually oval or rounded. Pronounced pointed tip on most coarse wools	1st or 2nd demi-lustre	Staple is usually rather open in the tip and is much less firm than the coarsest Halfbred or Corriedale wools which overlap the finer Romney wools in quality.
Border Leicester	44s–46s	200–150	.75–1.25	Round. In some wools plane of crimp spirals round staple.	Round or flat. Tip on many fleeces tightly curled in form of corkscrew.	2nd lustre or 1st demi-lustre	Staple is firm throughout its length. Corkscrew nature of crimp and staple tip. particularly in round stapled wools, is a marked characteristic.
English Leicester	40s–44s	230–150	.6–1.0	In individual fibres is round and in staple the wave appears very deep. Carried well to tip of staple.	Very flat with pronounced pointed tip.	1st or 2nd lustre	A heavy handling wool with firm staples.
Lincoln	36s–40s	250–200	.5–.75	Round	Oval to flat with pointed tip	1st lustre	Very firm handling staples. Plane of crimp sometimes spirals about the staple but does not curl in tightly at tip as in Border Leicester.

Summary of Wool Characteristics of Breeds (continued)

Breed	Range of Quality	Average Staple Length (mm)	Crimps per cm.	Nature of Crimp in Staple	Shape of Staple	Lustre	General
Cheviot	50s–56s	130– 75	1.5–2.5	Round–not very precisely defined	Rectangular. Has a slightly pointed tip.	Chalky or 2nd demi-lustre	A full-handling rather spongy wool
Perendale	48s–56s	150–100	1.5–2.5	Round	Usually oval. Sometimes rectangular.	2nd demi-lustre	Staple is mostly similar to fine Romney. Generally a full handling wool.
Ryeland	54s–56s	90– 60	1.5–2.5	Round or may be indefinite	Rectangular or may be definite. Tip flat	Chalky or 2nd demi-lustre	Usually a very full-handling spongy wool. Some of the 2nd demi-lustre wools have well-defined staple.
Dorset Horn	50–56s	115– 90	1.5–2.0	Not well defined	Rectangular. Staple tip flat or slight pointed	Chalky or 2nd demi-lustre	Individual fibres well crimped but irregularly. Rather spongy wool

Summary of Wool Characteristics of Breeds (continued)

Breed	Range of Quality	Average Staple Length (mm)	Crimps per cm.	Nature of Crimp in Staple	Shape of Staple	Lustre	General
Suffolk	54s–56s	100– 75	1.5–2.0	Not well defined and usually apparent only in wool from young sheep or in shoulder wool.	Rectangular and large. Staple tip flat or slightly pointed	Chalky	Spongy full-handling wool. Individual fibres well but irregularly crimped. Many fleeces do not show any clear staple crimp. Since all of this group have coloured legs and head, edges of fleece may contain coloured fibres. Generally body wool is free of colour. Because of great similarity of wools within this group, individual breed wools cannot be distinguished with any consistent certainty.
Shropshire	56s–58s	90– 60	1.5–2.0				
Hampshire	54s–56s	100– 75	1.5–2.0				
Dorset Down	54s–58s	90– 60	1.5–2.0				
South Suffolk	52s–56s	90– 60	1.5–2.0				
South Doreset Down	56s–58s	75– 50	1.5–2.0				
Southdown	58s–64s	60– 40	Not Apparent	Not apparent	Indefinite	Chalky	Finest and softest of the Down type wools. Very full-handling and spongy. May have coloured fibres on edge of fleece from about legs and head.

Clean Wool Yields

(Source—Wool and Woolclassing—Henderson)

Fleece Wool (B Grade)

Breed	Quality Quality	Average Yield
Lincoln, English Leicester,	36/40s	75
Border Leicester, Romney,	44s	75
Romney crossbred, Cheviot,	46s	75
Perendale	48s	74
	50s	73
	52s	72
	54s	71
Halfbred, Corriedale	50s	70
	54s	69
	56s	67
	58s	65
	60s	63
Quarterbred	58s	65
	60s	63
	64s	61
Merino	60s	60
	64s	57
	70s	54
Southdown, Suffolk, Ryeland	54s	71
Dorset Horn, Dorset Down,	56s	69
Hampshire, South Suffolk,	58s	68
Shropshire, South Dorset Down	60s	66
	64s	64

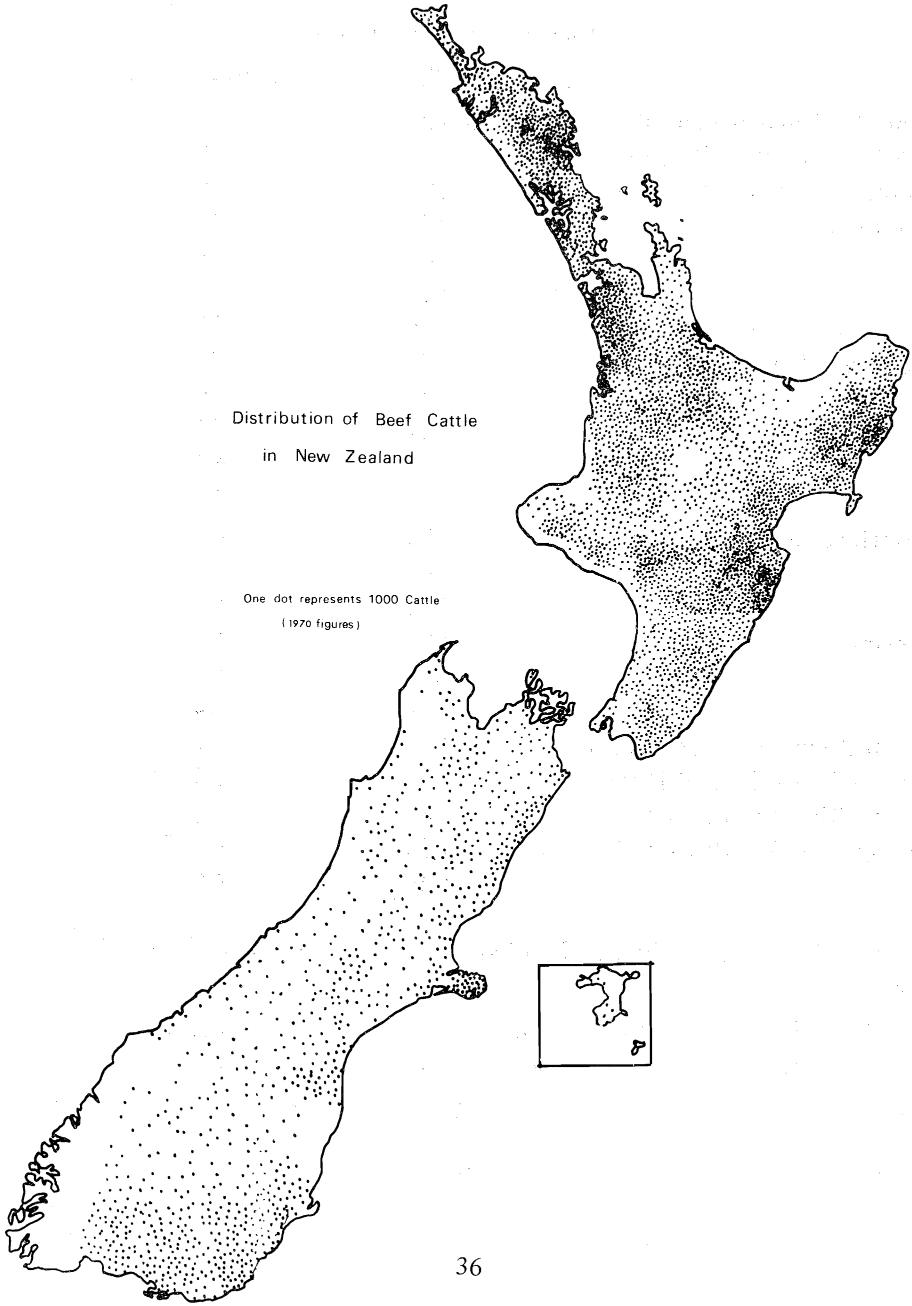
Average Percentage Yield of Lambswool and Oddments of Good/Average Grade.

Quality	Lambs' Wool	Necks	Bulky Pieces & Crutchings	Bellies	Second Pieces	Locks
44/48s	76	71	65	58	55	48
48/50s	76	71	62	58	52	46
50/56s	71	68	58	54	48	39
56/58s	70	63	56	52	46	36
60/64s	62	54	46	42	39	32

(5) BEEF CATTLE PERFORMANCE

5.1 Distribution of Beef Cattle in N.Z.

(Source – Agricultural Statistics 1971/72)



	Numbers	%
Northland	527,706	9.9
Central Auckland	239,796	4.5
South Auckland/Bay of Plenty	1,184,238	22.2
East Coast	418,725	7.8
Hawkes Bay	709,894	13.3
Taranaki	187,392	3.5
Wellington	863,518	16.1
North Island	4,131,269	77.3
Marlborough	103,602	1.9
Nelson	84,679	1.6
Westland	63,535	1.2
Canterbury	380,670	7.1
Otago	314,485	5.9
Southland	265,556	5.0
South Island	1,212,517	22.7
Total	5,343,796	100.0

5.2 Factors Influencing Beef Cattle Performance

The major factors influencing beef cattle performances are the physical performance of the cattle and the level of market returns.

5.2.1 Physical Performance

(a) Calving percentage.

The average calving percentage of a hill country breeding herd is 80–85%. However, in very rough country or under harsh climatic conditions it may fall as low as 60%. On the other hand, under good conditions and management, calving percentages of 95% are not uncommon.

(b) Death rate.

A figure of 2–3% is acceptable for breeding cows, but this can rise considerably in years with hard winters and late springs, which may also increase deaths in calves, from birth to weaning, from 3–4% to over 10%. After weaning death rates are low, 2–3% and the main cause of loss is bloat.

(c) Replacement rate.

A breeding cow on hill country will produce on average 4–6 calves before being replaced. Under good conditions this could be considerably longer. This means about 20% of the herd may require replacing annually. This figure is greater if the herd is in an expansion phase.

The majority of heifers are mated to calve for the first time as 3 yr. old but an increasing number are being mated 1 year earlier.

Bulls are used for an average of 3–4 seasons.

(d) Growth rate.

The growth rate of growing beef cattle is affected by the quality and quantity of feed available and by the breed or cross of the animal. The actual weight gains vary greatly but calves single suckling beef cows gain from 0.5 – 1kg/day. The average figures for weaners would be

Autumn	**Winter**	**Spring**	**Summer**	
0.5	0.0 – 0.6	1.0 – 1.2	0.6 – 0.8	(kg/day)

5.2.2 Stock Sale Policy

(a) Breeding herds.

The most popular breeding herd policy is to sell all **weaner** steers and heifers, (in excess of replacement requirements) at 6 – 9 months of age in the Autumn weaner sales.

However, on some properties all, or a proportion of weaners, are kept over the winter and sold as **yearlings**. Where breeding herds are situated on properties with some high quality grazing area the steers may in fact be held right through to 20 months and sold in a finished or prime condition.

Cull cows are normally sold in the autumn.

On very hard hill country steers may not be sold until they are **2 – 3 years** of age, still in store condition.

(b) Finishing Cattle.

Many policies are possible, but the main ones are:

(i) Purchase of weaners in autumn to sell the following autumn at 18 – 20 months.

(ii) Purchase of yearlings in the spring to sell at 18 – 20 months.

(iii) Purchase of 2 year olds in spring for sale the following summer/autumn.

(iv) Purchase of 2½ steers in autumn to sell on the local winter market.

5.3 Methods of Selling Cattle

There are a number of alternative methods of selling cattle as follows.

5.3.1 By Auction

The majority of **weaners, yearlings and older store** stock are sold by public auction in many recognised centres. Prime stock for local consumption are also sold this way.

5.3.2 By Private Treaty

A small but increasing number of **store** stock change hands by private treaty. The price is normally agreed on a per head basis but some sales on a per kg liveweight basis are made. Private sales may also be for delivery at some forward date.

A number of prime cattle are sold to both the local and export trade on a per head private deal.

5.3.3 On Schedule

The New Zealand meat export companies issue a price list or schedule indicating the base price, by grade, for cattle sold for export. This price is paid on the carcase weight.

The majority of **steers, heifers, cull cows and bulls** destined for export are sold on this basis.

5.4

BEEF CARCASE GRADING

Source: N.Z. Meat Producers Board Oct 1975

The beef grading system divides carcases firstly into one of three age groups which have distinctly different meat qualities.

A Steers, Heifers, Cows and Bulls
B Vealers
C Bobby Calves

For grading purposes carcases are firstly classified as to gender, namely —

Steer
Heifer
Cow
Bull

STEERS AND HEIFERS

After being identified for sex, the grading system applicable to steers and heifers is identical.

The carcases are firstly classified into one of 5 categories depending on the external fat cover. As shown below, two of those fat covers are then further segregated on the basis of the degree of muscling in the hind quarter, which is commonly known as conformation. There are two conformation classes.

	Deficient ←		→ Excess		
Fat Cover	M	L	P	G	T
Conformation		Compact 1 Leggy 2	Compact 1		

As a basis for determining the fat cover category that the carcase falls into, fat measurements on the cold carcase have been set down as shown, relating to the depth of subcutaneous fat over the fourth quarter of the eye muscle, the carcase having been quartered between the 12th and 13th rib.

The fat thickness measurements are used as a guide by Board Supervisors and Company Graders. Other factors that may override the measurement include the evenness of the fat cover and the degree of cover at other points of the carcase.

SYMBOL	FAT THICKNESS	POTENTIAL USE
M	1 mm	processing
L	1-3mm	lean cuts or processing
P	4-12 mm	prime export cuts
G	13-18 mm	Cuts after trimming
T	over 18 mm	cuts after substantial trimming

The L level of fat cover is broken into two conformation classes known as Class 1 and Class 2.

Class 1 carcases have a well muscled hind quarter. Class 2 carcases are weaker in the hind quarter.

Well muscled carcases that have a P level of finish or fat cover are segregated into one grade namely P1.

Steer and heifer carcases are segregated into various weight ranges depending on the grade. The weight ranges for the six grades are shown below.

Grade	Weight Ranges (kg.)
M	To 140/140.5 up
L1 L2 P1 G	160-220 220.5-270 270.5-340 over 340
T	All weights

Carcases under 160 kg grade M irrespective of fat cover.

ii COWS

Cows are broken into 4 levels of fat cover. The M and L grades for steers and heifers are amalgamated into one grade known as M while the P, G and T grades are similar to steers and heifers.

As with steers and heifers, cows with a P level of fat cover and conformation of the Class 1 type are segregated into one grade known as Cow — P1.

The weight ranges for the four grades of cow are as follows:

Grade	Weight Ranges (kg.)
M	To 140/140.5 up
P1 G	160-200 over 200
T	All weights

Carcases under 160kg grade M irrespective of fat cover.

iii BULLS

Bull is not classified into groups of fat cover or conformations. Bull is graded only into one of three weight ranges.

Weight Ranges (kg.)
To 160 160.5-260 over 260

B. VEALERS

Calves up to approximately 14 months of age of all genders, i.e. maiden females, castrated males, or entire males except those showing bull characteristics. The fat is white in colour while the muscle colour is pinkish and finely textured.

There are three grades of veal based on the external fat cover, namely M, L and P. The three levels of fat cover are defined as for steers and heifers.

Each of the three grades are broken up into three weight ranges for schedule payment purposes.

Grade	Weight Range (kg.)
M	0-60
L	60.5-115
P	115.5-160

C. BOBBY CALVES

BOBBY VEAL CARCASES ARE NOT SUBDIVIDED INTO GRADES

5.5 Dressing Out Percentages

The most important single factor influencing the value of a store or prime beef animal is its carcass weight. Carcass weight can be estimated from liveweight when dressing out percentage is known.

$$\text{Dressing out \%} = \frac{\text{carcass weight,}}{\text{liveweight}} \times \frac{100}{1}$$

For example:

	Dressing out %
Store cattle	45 – 48
Grass finished	50 – 53
Crop finished	52 – 55
Grain finished	54 – 58

5.6 Beef Stock Reconciliation

An example is given here for a breeding cow policy, using a balance date of 30th June. It is important to note that the balance date chosen affects the classes of stock chosen, i.e. whether heifers are referred to as 20 month heifers or rising 2 year olds.

Policy: Angus cows mated to Angus bulls, selling all surplus calves as weaners and rearing own replacements.

The 'variables' within the policy, otherwise referred to as production parameters, include the following:–

(a) Calving percentage or natural increase.

(b) Deaths and losses.

(c) Culling percentage of each class of stock.

(d) Replacement numbers required, being determined by the combined deaths and culling rates.

(e) Age at which heifers first go to the bull, i.e. at 14 months of age or 26 months of age.

(f) Time of calving: spring or autumn.

(g) Number of bulls per number of cows.

(h) Replacement rate of bulls.

Decisions relating to each of these factors are then incorporated in the stock reconciliation.

For this example, these decisions are:–

(a) Calving percentage 75%.

(b) Deaths and losses –

Calves	6%
Yearlings	4%
Heifers	4%
Cows	5%
Bulls	2%

(c) Culling programme. Calves are culled as weaners and only replacements are kept. Major culling then is on age, constitution and whether or not the cow is in calf. Figure used 18–20%.

(d) Replacement numbers required 25 per 100 cows.

(e) Heifers go to the bull at 26 months of age.

(f) Spring calving.

(g) Number of bulls, 1 per 33 cows.

(h) Each bull does on average 3 seasons.

The above data is then included in the annual reconciliation as below:—

BEEF RECONCILIATION:

	On hand 1/7/73	Purchases	Natural Increase	Sales	Deaths & Missing	On hand 30/6/74
Steer calves	–		38	36	2	–
Heifer calves	–		37	8	2	–
Rising 1 year heifers	27				1	27
Rising 2 year heifers	26				1	26
Rising 3 year heifers	25			4	1	25
Mature Cows	75			16	4	75
Bulls	3	1		1		3
TOTALS	156	1	75	65	11	156

Reconciling the numbers is the major objective of the exercise:—

On hand 1/7/73		156	
plus purchases		1	
plus natural increase		75	
			232
must balance	On hand 30/6/74	156	
	Sales	65	
	Deaths & Missing	11	
			232

(6) DAIRY STOCK PERFORMANCE

6.1 Milk Products – Physical Data

(a) Dairy Companies will measure milk by the litre (volume) and farm separated cream by the kilogram (weight). Payment for milk and cream will be on kilograms of milkfat.

Milkfat will be shown on advice notes as kilograms per litre (kg/litre) for milk and kilograms per kilogram (kg/kg) for cream.

1 litre of milk weighs 1.0275 kg.

6.2 Estimation of the Yield of Products from Milk

The quantities of products obtained from 50,000 kg milk have been calculated assuming:

(a) that the whole supply was used for manufacture of (i) butter, (ii) buttermilk powder, and (iii) skim milk powder OR casein,

OR

(b) that the whole supply was used for cheese.

6.3 Composition of the Milk

Milk fat	4.68%
Protein	3.73%
Casein	2.86%
Solids-not-fat	8.97%

Separation of the whole milk will yield:

Cream (40% fat)	5,740 kg
Skim milk	44,250 kg

Butter yield at 1.216 kg per kg milk fat	=	2,845 kg
Buttermilk, 60% of cream less 16% retained in butter and wash water	=	2,898 kg
Buttermilk powder at 9% yield	=	261 kg
Solids in skim milk (9.5%) = 4,204 kg		
Skim milk powder at 98% recovery and 3.5% moisture		4,264 kg
Casein in skim milk (3.003%) = 1,329 kg		

Casein yield at 98% recovery and 11% moisture	=	1,445 kg
Cheese yield at 2.496 kg per kg fat	=	5,841 kg
Whey fat recovery at 6.2% of the milk fat entering the cheese-making process	=	145 kg

---

Yields of butter, buttermilk powder, skim milk powder, and casein are based on milk composition with allowance for losses and over-run, i.e. moisture content etc. in commercial products. The cheese yield is calculated from factory data.

BASIS OF PAYMENT FOR MILK (Compiled by M.G. Hollard)

Payment for milk on the basis of milk fat content alone has been the rule in New Zealand for many years. In earlier times, while butter was the only product of many companies and the milk or cream was delivered to the factory door by the supplier, the level of inequity with payment based solely on the fat content of the milk, would have been negligible. This has never been true for cheese factory suppliers. It is moreover, many years since butter-only companies predominated; for years, products derived from non-fat milk have made a significant contribution to the earnings of many companies. The problem, which has scant recognition from the industry in general, is that income from **non-fat** products is distributed to suppliers according to the **fat** content of their milk which can be quite different from the ability of the milk to yield casein, skim-milk powder, or cheese.

Payment for milk on the basis of fat content alone would only be satisfactory in a diversified industry if there were a perfect relationship for all milks between fat and yield of non-fat and part-fat products. It has been known for many years that this is far from the case.

Admittedly, until the mid-sixties, there was difficulty in measuring the quantity of components other than fat with reasonable accuracy and at reasonable cost. However, suitable analytical methods have become available since that time.

Schemes involving the payment for non-fat constituents of milk as well as milk-fat, involve payment partly for fat and partly for protein, the most valuable non-fat constituent which can be rapidly and accurately estimated in milk.

To determine the relative amounts to be paid for milk fat and protein, an estimate must be made of the quantity of products which could be manufactured from a given quantity of milk. The approximate yield of cheese can be calculated from the milk fat and protein content of the milk, and the yield of casein from the protein content alone. Yields of milk powders, however, cannot be determined unless the solids-not-fat content of the milk is known.

The S.N.F. in milk is, in addition to protein, made up of lactose, mineral matter, and a small quantity of minor constituents.

It is the non-protein portion of the S.N.F. which determines the osmotic pressure and freezing point of milk, both of which are constant.

A decrease in lactose in always balanced by an increase in other soluble constituents. As however, the freezing point depends on molar and/or ionic concentrations, a drecrease of 1% in lactose can be balanced by a smaller increase in material of lower molecular weights e.g. 0.1% sodium chloride. Appreciable variations in the total non-protein S.N.F. constituents can therefore occur.

The lactose content of milk shows definite lactational trends, in particular a decline at the end of lactation. However, over a complete lactation there is no significant correlation between lactose content and either fat or protein content.

The mineral content of milk remains fairly constant until near the end of lactation.

While there is a wide variation in non-protein S.N.F. through the season, the values in the period of main milk production (September to January) are comparatively constant between 5.2 and 5.4%. Further, Jersey and Friesian herds give similar values for non-protein S.N.F. through all but the latter part of the season.

Thus a mean value of non-protein S.N.F. applying to all herds, when added to the laboratory-determined mean protein content for a particular herd, should give an approximate indication of the mean S.N.F. of that milk supply for the season.

Milk which contains a higher ratio of S.N.F. or protein to milkfat than the average ratio for the company as a whole may be underpaid if payment for milk is on a fat-only basis. Conversely, some suppliers may be paid more than the value of their milk to the company.

Yield and Composition of Cream and Skim Milk

Assumed that the wholemilk is skimmed to give cream containing 40% (W/W) milkfat. Thus the yields of skim milk and cream are:

$$SM = WM \times (40 - F)/(40 - 0.09) \qquad (i)$$
$$CR = WM - SM \qquad (ii)$$

where WM = the weight of wholemilk, SM the weight of skim milk, CR = weight of cream, and F = % milkfat content of the wholemilk.

The serum, making up 60% of the cream, is assumed to have the same composition as the skim milk. Since skim milk contains 0.09% milk fat, the concentration of the other components would be $(100 - 0.09)/(100 - F)$ times that in wholemilk.

The percentage of protein in skim milk is thus:

$$P \times (100 - 0.09) / (100 - F) \qquad \text{(iii)}$$

where P is the percentage protein content of the wholemilk.

Since protein is the only non-fat constituent determined in milk supplies, an estimate of the S.N.F. content of the skim milk requires the use of assumed values for the content of lactose and other non-protein constituents. The term "skim milk solids" (SMS) is used to denote the material (which includes some milk fat) obtained by spray-drying skim milk.

There is little information on the content and seasonal variation in non-fat constituents of typical N.Z. milks. However, there are seasonal variations in the lactose content of milk of individual cows, and a poor correlation between lactose content and either milkfat or protein content. It seems that a **seasonal average** for non-protein SMS of about 5.53% would apply to the milk of all factory suppliers, and that this figure does not vary with mean milkfat or protein content of the milk supply.

The percentage of SMS in skim milk is thus:

$$(P + 5.53) \times (100 - 0.09) / (100 - F) \qquad \text{(iv)}$$

Yield of Products:

(a) **Butter and Buttermilk**

On the basis of national data, it can be assumed that butter manufacture yields 1.216 kg butter per kg milkfat in the cream, and that the loss of buttermilk into the butter and wash water is 16% of the weight of the butter produced.

$$\begin{aligned} \text{Hence BU} &= CR \times 40/100 \times 1.216 && \text{(v)} \\ \text{BM} &= CR \times 60/100 - BU \times 16/100 \\ &= CR \times 0.60 - CR \times 0.40 \times 1.216 \times 0.16 \\ &= CR \times 0.4864 && \text{(vi)} \end{aligned}$$

where BU is the weight of butter produced and BM is the weight of buttermilk.

(b) **Skim Milk Powder**

The yield of SMP, based on 98% recovery and 3.5% moisture in the powder, can be taken as 1.0155 times the SMS as calculated above. Hence, from equation (iv) –

$$SMP = SM \times (P + 5.53) \times (100 - 0.09)/(100 - F) \times 1.0155/100 \qquad (vii)$$

where SMP is the weight of skim milk powder produced.

(c) **Buttermilk Powder**

The composition of buttermilk can be assumed to be the same as that of skim milk plus an additional 1.0% lipid material. A recovery of 98% and a moisture content of 3.5% in the powder can be assumed, giving a yield of 1,0155 times the total solids content of the buttermilk. Hence, from equation (iv) –

$$BMP = BMx(P+5.33)x(100-0.09)/(100-F)+1.0x1.0155/100 \qquad (viii)$$

where SMP is the weight of buttermilk powder produced.

(d) **Casein**

The ratio of casein to total protein in milk can be assumed to be 0.768. Yield of commercial casein at 11% moisture can be taken as 1.13 times the available casein in the milk. (No allowance has been made for casein losses in manufacture). Hence, from equation (iii):

$$CA = SMx(100-0.09)/(100-F)xP/100x0.768x1.13 \qquad (ix)$$

where CA is the weight of casein produced.

(e) **Cheese**

Yield of cheese from milk is related to the casein and the milkfat content of the milk as

$$CH = (1.62\,P + 1.21\,F) \times WM/100 \qquad (x)$$

where CH is the weight of cheese produced from a quantity WM of whole-milk containing P percent protein and F percent milkfat. (It has been assumed the average ratio of casein to total protein is 0.768).

(f) **Whey Butter**

The milkfat content of whey is proportional to the milkfat content of the original milk. The average recovery of whey fat is assumed to be 6.20% of the milkfat. Hence –

$$WF = 6.20 \times F/4.68 \qquad (xi)$$

where WF is the whey fat percentage recovery for individual milks of average milkfat percentage, and where the factor 4.68 is the company average milkfat test.

The yield of whey butter calculated on the same basis as butter yield (from equation (v)) is thus:

$$WB = WF/100 \times F/100 \times WM \times 1.216 \qquad \text{(xii)}$$

where WB is the weight of whey butter produced.

(g) **Other Products**

The yields of other products can be calculated in a similar manner to those outlined above, e.g. the yield of wholemilk powder would be based on the total solids content of the milk.

Method of Calculating Payment for Milk

As mentioned above, the net income of co-operative dairy companies is distributed to their suppliers on the basis of the milkfat supplied over a dairy season.

Inequities arising from this system, in regard to a multiproduct factory, could be overcome if the manufacturing costs associated with each product were identified, the yield of each product from milks of varying composition calculated, and the realised value for each product taken into account.

The formula to use would be –

Payout = A kg milkfat + B kg protein – C kg milk,

where A relates to the net value per kg milkfat of products such as butter, in which milkfat predominates; B relates to the value per kg protein of the non-fat products manufactured, taking into account only costs of manufacture connected with the weight of product produced (i.e. including costs of milk collection and manufacture associated with the volume of milk handled, and C is the factor which takes into account of these volume costs in terms of weight of milk processed.

All investigations to date have stressed the fact that the difference between the true net value of the products that could be derived from the milk and the payment on a milkfat-only basis depended largely on the relative value of the skim milk products, and that lower values for those would reduce inequities.

Milkfat Basis v. Formula Basis of Payment

(a) **Butter, Casein and BMP**

With "low realisations" for products, the milkfat-only system of payment will incur only minor disparities, no supplier being over- or under- paid by more than $30 per 13,600 kg (30,000lb) milkfat.

However, under "high realisations" with casein valued more highly than butter, the average disparity in payout with the milkfat-only system of payment for the average supplier of 13,600 kg milkfat will be $275. Individual suppliers will vary widely from the average – some 13% will be underpaid and some 8% overpaid by more than $500 per 13,600 kg milkfat, and some 2% by $1000 or more.

With "high realisations", a greater proportion of the low test suppliers were underpaid on the milkfat-only system of payment.

With the formula system of payment, the above disparities are reduced very considerably.

(b) **Butter, SMP and BMP**

With a fat-only system of payment, the disparity per 13,600 kg milkfat ranges from $121 to $78 at "low realisations", and about twice this amount at "high realisations".

When account is taken of the net value of the SMP and the BMP in the calculation of the payout, using a fixed factor for this net value irrespective of the protein content of the milk, there is a major reduction in the disparity – but a larger number of suppliers are still being significantly under- or overpaid – particularly when realisations are high.

However, when account is taken also of the SMP and BMP associated with the non-protein SMS (by using a weighted seasonal average of 5.53% SMS which does not vary with cream milkfat or protein content of the milk), the disparity in payout is reduced so much that no supplier would be under- or overpaid by more than $30 per 13,600 kg milkfat.

For this product group, on a fat-only system of payment, nearly all the low test suppliers are underpaid and nearly all the high test suppliers are overpaid. However, the number of suppliers being substantially underpaid is much greater than the number being overpaid, so that the redistribution on a more equitable basis of the returns from the manufacture of butter, SMP and BMP would result in a large number of suppliers having their payout substantially increased.

(c) **Cheese and Whey Butter**

For these products, disparities between formula-calculated and milkfat-based payouts are wide, but the disparity between suppliers can be reduced in a spectacular fashion by the use of the formula, even when realisations are high.

Discussion on Above Situation

For all of the product groups discussed, the total disparity between the value of the suppliers' milk and current payout based on weight of milkfat supplied is substantial.

The product-yielding capacity of milk can readily be calculated.

With the application of appropriate formulae, embodying the product-yielding capacity of milk and the manufacturing costs associated with each product, the disparity between payout and net value of milk can be reduced to acceptably small limits for both "low" and "high" product realisations.

Even for the "high" realisations, the maximum under-or over-payment for an average-sized supply of 13,600 kg milkfat would not be more than $30. For milk of similar composition, the extent of under- or overpayment would be directly related to the amount of milkfat supplied.

Some assumptions necessarily have to be made in calculations such as those considered. The major assumption is that all milk supplies have a constant non-protein SMS content of 5.53%. This is, in fact, likely to be very close to the actual average value.

However, the slight uncertainty surrounding the precise figure to be used does not affect the validity of the assumption of a constant percentage of non-protein SNF. Even for individual cows, the lactose content of milk has been shown to be largely independent of breed and of both milkfat and protein content. It would be expected that the differences between herds would be much less than between individual cows; hence it appears reasonable to assume that the quantity of non-protein SNF (and consequently non-protein SMS) will depend only on the volume of milk supplied.

When the suggested formula "Payout = A kg milkfat + B kg protein – C kg milk"

is applied to the product groups of butter, casein and BMP, and cheese and whey butter, it provides a disincentive to the addition of water to the milk supplies, since the greater the total volume of milk supplied, the greater the "liquid weight" deduction. This is not, however, the case for the product group butter, SMP and BMP where, through the use of the constant 5.53 for non-protein SMS percentage, the greater proportion of the net value of the milk powders is related to the weight of milk supplied and exceeds the "liquid weight" reduction. Under these circumstances it is most important that steps be taken to eliminate added water since any dilution of the supply would invalidate the assumption of a constant percentage of non-protein SMS and would unfairly overpay the supplier concerned.

It should be noted also that some of the assumptions made in the above calculations are applicable to a whole season's operations, and because of the seasonal nature of milk production in New Zealand and the changes which occur in milk composition throughout the season would not be valid on a month to month basis.

Example of the Application of the Payout Formula

In respect of the product group of butter, skim milk powder (SMP) and buttermilk powder (BMP), the formula might be applied as follows:

$$A = \frac{(RBU - CBU) \times BU}{F/100 \times WM}$$

$$B = \frac{(RSMP - 0.6510\ CSMP) \times SMP + (RMBP - 0.6510\ CBMP) \times BMP}{P/100 \times WM}$$

$$C = \frac{(0.0327\ CSMP \times SM) + (0.0327\ CBMP \times BM)}{WM} + T - B \times 0.0223$$

where RBU, RSMP & RBMP are the realisations and CBU, CSMP and CBMP are the costs of manufacture per kg respectively of butter, skim milk powder and buttermilk powder; BU, SMP and BMP are the weights in kg of butter, skim milk powder and buttermilk powder produced;

WM, SM and BM are the weights of whole milk, skim milk and buttermilk processed;

F & P are the average milk fat and protein percentages of the company wholemilk supply; and T is the cost of tankering wholemilk in c/kg milk.

SM and BM would be calculated from the total weight of milk processed using equations (i) and (vi) respectively.

Total payment to each individual supplier for the whole season's supply would then be calculated from the formula:

$$\text{Payout (cents)} = \text{A kg milkfat} + \text{B kg protein} - \text{C kg milk} - \text{PE} + \text{PR}$$

PE and PR are respectively the total monetary value (in cents) of the penalties imposed during the season for downgraded milk, antibiotics, added water etc., and premiums earned where incentives are being paid for higher quality milk etc.

6.3 Cow Production

(a) Butterfat Production

Work from milkfat figures supplied to the factory not from herd test figures. For budget purposes obtain from the farmer as many years factory production as possible, the number of cows and heifers to be milked that season and estimate the number of effective milkers, assess factory fat per cow and compare the total production with previous production, taking due regard of the season and also efficiency, past and present of the management of the farm.

(b) Town Milk Production

The above remarks also apply to town milk producing properties. Here the concept is total litres sold. The main difficulty in assessing litres per cow, is to obtain the effective number of cows milked in the year. A useful method is to total the number of cows milked per month for the whole year. A Town supply cow usually milks for 9½ months so this total is then divided by 9.5.

6.4 Herd Replacements

(a) Herd Wastage

Analysis of wastage and culling figures produced in 1971–72 by the N.Z. Dairy Production Marketing Board are as follows:

Cause of Wastage	%
Sold for Dairying	1.36
Accident or Injury	.36
Low Production	5.69
Old Age	.73
Unsuitable Temperament	.47
Unsuitable Dairy Type	.14
Sold – reason not given	2.53
Disease	%
Bloat	.77
Calving troubles	.12
Catarrh	.09
Facial Eczema	.36
Johnes Disease	—
Lameness (including arthritis)	.08
Leptospirosis	.05

Disease continued ...

Mastitis	.81
Metabolic:	
Grass Staggers	.05
Milk Fever	.10
Other	.05
Reproductive:	
Abortion and Brucellosis	1.12
Low Fertility	3.33
Tuberculosis	.09
Salmonellosis	.01
Deaths – cause unknown	.27
Wastage – all diseases	7.30
TOTAL WASTAGE	18.58

For budgeting purposes 18–23% could be taken, the figures assessed after obtaining all the pertinent factors about the farm, the management and the district. Cull cows are invariably sold as boners; for prices see Beef Schedule. M. Grade.

(b) **Vital Statistics of Dairy Cows**
(Source: N.Z. Dairy Board Farm Production Division)

	%
Percentage of yearlings not in calf at end of mating season	7.4
Percentage of milking cows not in calf at end of mating season	6.9
Percentage of cows in calf to first service	
(i) Natural service –49 day period conception rate	68–70
(ii) Artificial breeding – 49 day period conception rate	67
Percentage of 2 year olds in calf which abort	3.6
Percentage of older cows in calf which abort	2.6
Percentage of cows calving within 6 weeks of district median calving date	85

	%
Percentage of all calves born that are female	48
Percentage of heifer calves dying before one week of age	5.7
Percentage of heifers dying between one week and one year of age	6.4
Percentage of yearling heifers dying before two years of age	3.0

The effective calving % then being calves alive after one week of age, to cows mated is approx. 86%.

(c) Number of heifers available as replacements

In effect this is 43 heifer calves available for rearing, but it includes late calves and free martins which are not suitable and are disposed of as bobby calves. They amount to approximately 20%. Thus you have left 32 heifer calves suitable for rearing. Losses from one month to 2 years approximate 10% and of those which survive to the 2 year old stage 5% prove not in calf. Thus we eventually have 27 heifers that will calve into the herd. As approximately 20% are required to maintain the numbers in a herd, it can be seen that there are 7 heifers which can be sold for dairying or need not have been reared. It is usual for a farmer to ensure he has sufficient replacements by having the number of yearling heifers equivalent to 25% of his milking herd.

(d) Bulls

The average herd life of bulls is 4 years, this means that having been used in the herd for the first time when 15 months old the average bull would be 6 years old when culled.

The main causes of loss or disposal are, prevention of inbreeding, poor results from progeny, sterility, accidents, and because of not being able to manage a bad tempered beast. The increasing use of A.B., plus the high remuneration received from a potter bull in recent years has tended to reduce the active life of a bull in the herd.

(For potter bull realisations see Beef Schedule).

(e) Effective Milkers

Average fat per cow was formerly calculated by dividing the amount of milkfat supplied to the dairy factory by the effective number of cows, i.e. the number of cows in milk on 15 January increased by 5%, to give effective average production. In recent years it became apparent that the 5% correction was too high, and it was decided to stop using a conversion factor and the term "effective number of cows", from the 1968-69 season onwards. Instead, the number of cows in milk in December in the North Island and January in the South Island has been used.

Stock Reconciliation (Seasonal Supply Herd)

An example is given here of a reconciliation for the Omeheu Demonstration Farm in the Bay of Plenty.

For budget purposes the balance date used more often than not is 30th June, which coincides with the herd's dry period.

STOCK RECONCILIATION:

Class	On hand 1/7/73	Purchases	Natural Increase	Sales	Deaths & Missing	On hand 30/6/74
Cows to calve	173	4	–	44	2	131
Heifers to calve	57	–	–	6	2	49
Yearling heifers	69	–	–	19		50
Heifer calves	–	–	112	63	2	47
Bull calves	–	–	112	110	2	–
Bulls		3		3		
TOTALS	299	7	224	245	8	277

Reconciling the numbers is the major objective of the exercise:—

On hand 1/7/73	299		
plus purchases	7		
plus natural increase	244		
	530		
must balance with	On hand 30/6/74	277	
	plus sales	245	
	plus deaths	8	
			530

Stock Reconciliation (Town Supply Herd)

As observed earlier the idea of a stock reconciliation is to account for the movement in stock numbers within the various classes over a 12 monthly period.

The balance date or twelve monthly period spoken of affects the classes of stock as at the particular date.

In this example the balance date is March 31st.

On Hand 1/4/73			**On Hand 31/3/74**		
Mature cows	94		Mature cows	100	
In-calf heifers	24		In-calf heifers	28	
Yearling heifers	30		Yearling heifers	42	
Heifer calves	12		Heifer calves	10	
Bulls	2		Bulls	3	
		162			183
Purchases:			**Sales**		
Heifer calves	6		Cull cows	16	
Bull calf	1		Bobby calves	46	
		7			62
Natural Increase	100		**Losses:**		
		100	Cows	2	
			Heifers	2	
			Calves	20	
					24
		269			269

Town Milk Production

The milk year operates from September 1st to August 31st. The price in any one particular year is by a special formula to the price for milkfat supplied to butter and cheese factories. It is computed by the N.Z. Milk Board who purchase the milk, on a guaranteed quota basis, from local producer associations. The system of payment for quota milk, quantities in excess of quota, penalties for deficiencies, standards that town milk have to comply with, and seasonal payouts will become apparent when students visit town supply farms.

1. Quota Milk

The N.Z. Milk Board is guaranteed a daily quota supply by the local association, who in turn organise the obtaining of this quantity by allocating to farmer suppliers a daily quota for the whole year. The afrmer must take out shares in the association to become a supplier and his milking shed and stock must comply with certain standards as set down by the Agriculture Department. The basis for allocation of quotas varies from one district to another, but with Canterbury Dairy Farmers Ltd., increases in quota are now (1973) related to the amount of surplus milk supplied in the months of February, June, July and the supplier's other lowest month of the year.

2. Quantities in excess of Quota (surplus milk)

All milk produced on a town supply farm is taken by the local association, and the milk in excess of requirements is usually sent in from the receiving depot to a local dairy factory, where a lower price is obtained. In the spring months nearly all producers send in milk above their quota, but in other months of the year a proportion of the producers are unable to meet their full quota, whilst other farmers do have an excess supply, and it is in these months that this excess milk is accepted at full quota prices.

The acceptance of surplus milk varies with the season; and throughout the country. For example; The Canterbury Dairy Farmers Ltd., pay out on the following basis:

September to January	–	full price paid for quota + 5% All excess at surplus milk prices.
February to April	–	full price paid for quota + 20% All excess at surplus milk prices.
May to July	–	full price paid for quota + 25% All excess at surplus milk prices
August	–	full price paid for quota + 20% All excess at surplus milk prices.

3. Calving Pattern and Analysis of Production

Because the seasonal production of milk is so important on a town supply farm it is necessary to estimate the likely pattern of production (quota and non-quota milk) on a monthly basis so that likely deficiencies can be remedied and income can be more accurately estimated. To do this a table showing cows calving, and numbers in each month of their lactation, is drawn up. In such a table cows calving means the number which actually calve down and enter the herd rather than total cows carried, (i.e. effective milkers). Another point to note is that if say 10 cows are calving in August then because some calve late in the month there will only be an effective 5 for the whole month.

Besides a knowledge of numbers of cow in milk each month and the month of lactation which they are in, it is necessary to know the average production per cow per day in each month of lactation, to assess overall monthly production. The average Canterbury town supply herd produces and sells about 3410 litres of milk per effective cow. A good herd of Friesians well managed and fed should produce about 4090 litres per effective cow while one or two top herds are producing about 5450 litres per cow. Lactation patterns of production in gallons per day per cow for each month of lactation are given below for each of these three levels of production.

Period	**3410 litres/cow**	**4091 litres/cow**	**5455 litres/cow**
1st month	16 litres/day	18 litres/day	25 litres/day
2nd month	18 litres/day	20 litres/day	27 litres/day
3rd month	16 litres/day	18 litres/day	25 litres/day
4th month	14 litres/day	18 litres/day	23 litres/day
5th month	14 litres/day	16 litres/day	20 litres/day
6th month	11 litres/day	14 litres/day	18 litres/day
7th month	9 litres/day	11 litres/day	16 litres/day
8th month	7 litres/day	9 litres/day	11 litres/day
9th month	4.5 litres/day	7 litres/day	9 litres/day
10th month	4.5 litres/day	4.5 litres/day	7 litres day

4. Milk Sales and Calving Schedule

The example included is for the Lincoln College Town Supply herd and the estimates are for the 1975/76 season.

QUOTA: 1866 litres 1974/1975
2142 litres 1975/1976

MILK SALES AND CALVING PATTERN

	Full Quota Milk Price		Cows/Heifers Calving		July	Aug.	Sept.	Oct.	Nov.	1975 Dec.	1976 Jan.	Feb.	Mar.	Apr.	May	June	Totals
JANUARY	6.8227	1976	42	19	23	20	16				21	42	42	42	42	42	
FEBRUARY	8.9375	1976	29		28	20	15	15				14	29	29	29	29	
MARCH	8.9375	1976	29		29	25	20	20	15				14	29	29	29	
APRIL	11.5737	1976	52	17	35	35	30	30	30	20				26	52	52	
MAY	11.5737	1976	26		26	26	26	20	20	20	15				13	26	
JUNE	11.5737	1976	42	19	23	23	23	20	20	20	18	16				21	
JULY	11.5737	1975	22	9	11	22	22	22	22	22	20	20	18				
AUGUST	11.5737	1975	21			10	21	21	21	20	20	20	20	15			
SEPTEMBER	11.5737	1975	16				8	16	16	16	16	16	16	12	10		
OCTOBER	6.8227	1975	36	18	9			18	36	36	36	36	26	26	20	20	
NOVEMBER	6.8227	1975	18		16	9			9	18	18	18	18	18	16	16	
DECEMBER	6.8227	1975	13		12	12	6			6	13	13	13	12	12	12	
Estimated No. of cows			**346**	**82**	**212**	**202**	**187**	**182**	**189**	**178**	**177**	**195**	**196**	**209**	**223**	**247**	
Average litres/cow					12.3	12.8	13.5	14.2	14.2	13.9	13.9	13.7	13.6	13.6	12.6	12.6	
Estimated litres per day					2607	2560	2524	2584	2683	2474	2460	2671	2665	2842	2809	3112	
Litres per month					80817	79360	75720	80104	80490	76694	76260	77459	82615	85260	87079	93360	975,218
Litres quota					75175	69409	67470	69719	67470	69719	69719	74530	79670	80310	82987	83520	889,698
Litres surplus					5642	9951	8250	10385	13020	6975	6541	2929	2945	4950	4092	9840	85,520
$ Quota					8700	8033	7808	4756	4603	4756	4756	6661	7120	9295	9604	9665	
$ Surplus					229	326	335	422	529	283	266	119	119	201	166	400	
Bonuses																	
ESTIMATED TOTAL $					**8929**	**8359**	**8143**	**5178**	**5132**	**5039**	**5022**	**6780**	**7238**	**9496**	**9770**	**10065**	**$89,151**

Surplus Milk: 4.069 c/l

TECHNICAL INFORMATION IN PIG PRODUCTION (N. Stables)

1. Statistics

Due to delays in the publication of statistical returns recent information is available only on a provisional basis for some of the important parameters. Where possible, likely significant changes will be indicated on the basis of observations in the industry.

PIG DISTRIBUTION IN N.Z. (30/6/72)
(Source: Agricultural Statistics 1971/72)

	%	Numbers
Northland	5.3	25,027
Central Auckland	12.2	58,266
South Auckland/Bay of Plenty	24.3	116,281
East Coast	0.9	4,420
Hawkes Bay	2.5	11,818
Taranaki	13.4	63,830
Wellington	12.9	61,463
NORTH ISLAND	71.5	341,105
Marlborough	3.5	16,804
Nelson	4.0	18,899
Westland	0.3	1,317
Canterbury	14.1	67,294
Otago	3.4	15,989
Southland	3.2	15,581
SOUTH ISLAND	28.5	135,884
NEW ZEALAND		476,989

Comments:
Northland, Taranaki, Marlborough, Nelson and Westland will have reduced populations due to loss of skim-milk and whey supplies, with all meal feeding being uneconomic in these areas.

PORK, BACON AND HAM AND CHOPPER PRODUCTION AND LOCAL CONSUMPTION

(N.Z. Official Year Book 1975)

Pigmeat Production (,000 tonnes)

	64-65	65-66	66-67	67-68	68-69	69-70	70-71	73-74
Pork	18.6	16.4	15.0	16.5	16.3	17.3	N.A.	N.A.
Bacon and Ham	23.6	21.6	19.4	19.1	18.6	21.4	N.A.	N.A.
Chopper	2.7	2.5	0.9	2.4	2.0	1.7	N.A.	N.A.
TOTAL	44.9	40.5	35.3	38.0	36.9	40.4	39.3	34.4

Total Consumption (,000 tonnes)

	64-65	65-66	66-67	67-68	68-69	69-70	70-71	73-74
Pork	15.5	15.4	14.4	15.5	15.4	16.7	N.A.	N.A.
Bacon and Ham	20.5	20.3	18.6	20.1	19.4	20.3	N.A.	N.A.
Chopper	2.5	2.2	2.4	2.3	2.4	2.0	N.A.	N.A.
TOTAL	38.6	38.0	35.5	38.0	37.3	39.0	38.6	36.2

Consumption per head of population (KG)

	64-65	65-66	66-67	67-68	68-69	69-70	70-71	1972
Pork	5.9	5.8	5.3	5.6	5.5	5.9	N.A.	N.A.
Bacon and Ham	7.8	7.6	6.8	7.3	7.0	7.2	N.A.	N.A.
Chopper	1.0	0.8	0.9	0.9	0.9	0.7	N.A.	N.A.
TOTAL	14.7	14.2	13.0	13.8	13.4	13.8	13.2	13.2

Comments:

Some indications that total pork consumption increasing, while total bacon and ham decreasing.

NUMBER OF BREEDING SOWS IN RELATION TO PIGS SLAUGHTERED

(Source: Pork Industry Council Annual Report 1972-73)

Year	Breeding Sows (as at 31 Jan.)	Total Pigs Slaughtered (year ended 30 Sept.)	Pigs Marketed Per Sow	Slaughtered Animals: 18-54kg Porkers	Slaughtered Animals: 55-90kg Baconers	Slaughtered Animals: Over 90kg Choppers	Est. total weight of pigmeat in Carcase form (tonnes)
1964	95,179	1,002,100	10.2	527,600	448,000	26,500	47,667
1965	90,048	949,500	10.5	495,000	429,700	24,700	44,900
1966	81,746	852,000	10.4	413,300	413,100	25,900	40,500
1967	75,910	770,000	10.1	377,000	373,000	20,000	35,400
1968	77,412	801,000	10.3	426,000	348,000	27,000	36,600
1969	69,223	770,000	11.1	239,000	362,000	19,000	35,600
1970	73,204	805,000	11.0	413,100	374,300	18,400	39,500
1971	77,431	901,000	11.6	471,824	406,544	22,690	41,600
1972	–	877,600	–	472,100	377,600	28,000	39,800
1973	60,319	751,600	12.4	400,618	333,235	17,751	33,500

Comments:

Number of breeding sows as at 31 January 1974 probably less than 60,000.

2. Nutrition

With the large reductions in the supply of skim-milk and whey as pig feeds, barley, and to a lesser extent maize, are being used as substitutes. Cereal grains are a concentrated source of digestible energy (DE) but are inadequate in terms of protein quantity and quality for both the young growing pig and the adult sow in the reproduction cycle. Many of the essential vitamins and minerals are also in short supply, but these are usually adequately supplied by the inclusion of a mineral/vitamin proprietary mixture. Three exceptions are:

(1) Calcium and Phosphorus – usually added in various combinations of ground limestone, steamed bone flour, dicalcium phosphate and rock phosphate.

(2) Sodium and Chlorine – added in the form of common salt (0.25% of air dry diet).

(3) There is field evidence that sows may benefit in certain situations from additional supplies of the vitamins A, D and E during gestation.

The modern pig farmer using an all-meal diet, and who has control over the composition of the rations he uses, is principally concerned with the protein portion of feed requirements for both nutritional and economic reasons. Therefore some guidelines in ration formulation with particular emphasis on protein are included here. Calculations of protein requirement on a crude protein basis are now not considered sufficiently reliable for accurate ration formulation. In choosing the types and levels of protein supplements, emphasis is placed upon the supply of lysine, tryptophan and methionine plus cystine since these are most likely to be the limiting amino acids in cereal based diets.

REQUIREMENTS OF PIGS ACCORDING TO LIVEWEIGHT FOR APPARENT DIGESTIBLE ENERGY (ADE) AND LYSINE, TRYPTOPHAN, METHIONINE PLUS CYSTINE CALCIUM AND PHOSPHORUS (% AIR DRY WEIGHT).

(Source: ARC [1967] and N.R.C. [1968]).

	Starter 4-9kg	Creep 9-17kg	Weaner/ Grower 17-44kg	Porker 44-70kg	Baconer 70-90kg	Breeder
ADE (MS/Kg)	14	13.8	12.5	12.5	12.5	12.5
Lysine (%)	1.2	1.0	0.85	0.8	0.7	0.5
Tryptophan (%)	0.18	0.17	0.17	0.15	0.15	0.10
Methionine plus cystine (%)	0.65	0.60	0.55	0.50	0.50	0.35
Calcium	1.1	1.1	1.1	1.1	1.1	1.5
Phosphorus	0.8	0.8	0.8	0.8	0.8	1.0

ESTIMATED AVERAGE LEVELS OF CERTAIN NUTRIENTS IN SELECTED N.Z. FEEDSTUFFS (AIR DRY BASIS)
(Source: N.Z. Poultry Research Centre, Massey Pig Research Centre, Lincoln College Wheat Research Institute, N.R.C. [1968]).

	ADE (MJ/kg)	Lysine (%)	Trypt. (%)	Meth. & Cys. (%)	Ca. (%)	P. (%)	Upper Inclusion limit (%)
Barley	12.8	0.3	0.17	0.35	0.03	0.35	–
Maize	14.2	0.2	0.08	0.3	0.02	0.30	–
Wheat	14.1	0.3	0.12	0.28	0.05	0.40	–
Meat and bone meal	12.0	2.4	0.19	1.20	10.5	5.20	20
Dried Blood meal	11.3	7.5	1.10	2.20	0.28	0.22	5
Dried liver meal	16.3	4.8	0.60	2.20	0.50	1.25	5
Skim-milk powder	14.6	2.8	0.50	1.30	1.25	1.00	–
Buttermilk powder	14.6	2.8	0.50	1.20	1.30	0.90	–
Fish meal (whole)	13.4	6.0	0.90	2.5	4.50	2.00	–
Uniwhite lupin meal	12.8	1.6	0.25	0.64	0.07	0.48	–
Pea meal	14.6	1.6	0.22	0.45	0.17	0.42	–
Dehydrated lucerne	8.2	0.9	0.50	0.45	1.43	0.25	5
Ground limestone					34.00	0.02	
Steamed bone flour					24.00	12.00	
Dicalcium phosphate					26.00	18.00	
Rock phosphate					34.00	14.00	

A more complete list of feedstuffs can be found in the Pork Council Advisory Service Manual.

EXAMPLE FORMULATIONS FOR PORKER PIGS (%), WITH CALCULATED LEVEL OF LYSINE (AIR DRY BASIS) (1)

	DIET			
	A	**B**	**C**	**D**
Barley	78	55	85	–
Maize	–	–	–	83
Maize and Bone Meal	12	–	10	11
Dried Blood Meal	–	–	4	5
Skim milk Powder	10	–	–	–
Uniwhite Lupin Meal	–	40	–	–
Steamed Bone Flour	–	5	1	1
Lysine (%)	0.80	0.81	0.80	0.81

(1) Further additions to these diets would be a suitable vitamin/mineral supplement and finely ground salt (0.25%).

Since cereals and protein concentrates fluctuate in price on a seasonal and annual basis, it is recommended that the cost of energy and the critical amino acids be calculated for all the possible alternatives. After selecting the economically desirable sources, then formulations can be made to satisfy requirements on an approximate least cost basis.

3. **Feeding Scale:**

On all meal feeding, it is generally recommended that growing pigs be allowed to consume meal *ad libitum* up until approximately 30 kg, from which time they are fed restricted amounts. The following feeding scale is designed to allow an acceptable growth rate and feed conversion efficiency, but producing a carcase of reasonable quality where the diet is nutritionally adequate.

Average Pen Weight (kg)	Daily Intake (kg meal/pig) (1)
17.5 – 20.0	1.00
20.0 – 22.5	1.09
22.5 – 25.0	1.27
25.0 – 27.5	1.36
27.5 – 30.0	1.45
30.0 – 32.5	1.54
32.5 – 35.0	1.63
35.0 – 37.5	1.68
37.5 – 40.0	1.72
40.0 – 42.5	1.80
42.5 – 45.0	1.86
45.0 – 47.5	1.90
47.5 – 50.0	2.00
50.0 – 52.5	2.04
52.5 – 55.0	2.09
55.0 – 57.5	2.13
57.5 – 60.0	2.18
60.0 – 62.5	2.18
62.5 – 65.0	2.22
65.0 – 67.5	2.25
67.5 – 70.0	2.25
70.0 – 72.5	2.35
72.5 – 75.0	2.40
75.0 – 77.5	2.45
77.5 – 80.0	2.49
80.0 – 82.5	2.54

(1) This scale is assuming 3,000 kcal. (12.5MJ) digestible energy/kg. Where the energy density is higher (for example: due to the use of wheat or maize as a significant fraction of the diet), daily intake will need to be adjusted accordingly.

SUGGESTED LEVELS FOR BREEDING STOCK

Gestating Sows	2 – 2.5 kg/day
Lactating Sows	1.5 kg/day for sow plus 0.5kg/ piglet
Mating Sows	3 – 3.5 kg/day
Boars	2.5 kg/day

(8) FEEDING STANDARDS FOR LIVESTOCK

In any integrated programme of production whether of livestock only, or of stock and crops in combination, it is necessary to be sure that adequate provision has been made for the livestock it is proposed to carry. Two aspects are involved here. On the one hand it is necessary to assess the probable amount of feed which will be grown on the property at different seasons of the year, and on the other hand it is necessary to assess the probable requirements of the livestock in these seasons and balance the stock requirements with the feed available.

The technique used to assess feed supply and demand will vary according to the problem, the availability of basic data and the degree of accuracy with which future feed sources can be predicted. It is important to consider these aspects in light of the problem as a whole. Once rationalised, one can use a variety of techniques ranging from the very much simplified ewe equivalent system through to the more accurate system using megacalories of metabolisable energy.

The ewe equivalent system is briefly identified in the form of a classification table. Reference is made to the original work of Professor I. E. Coop. Dr. K. T. Jagusch's section deals in detail with the system using megacalories of metabolisable energy. This is the recommended reference.

The Pasture Production Section gives production figures for a number of regions. It is important to remember that these are at one place at one point in time. They, therefore, provide a convenient basis, with personal experience and expertise being the final determinants. Reference is also made to a number of relevant articles. The list is by no means exhaustive and again forms a basis for more reference material.

TABLE III: CLASSIFICATION OF VARIOUS CLASSES OF LIVESTOCK IN EWE EQUIVALENTS

Class of Stock	Average Live-Weight Kg	Ewe Equivalents			
		May -August	Sept. -Dec.	Jan. -April	Season
Sheep					
Ewe					
B/L x Romney	65	1.1	1.1	1.1	1.1
Romney	55	1.0	1.0	1.0	1.0
Corriedale	45	0.9	0.9	0.9	0.9
Merino	35	0.8	0.8	0.8	0.8
Hoggets—Ewe	25-40	0.6	0.5	1.0	0.6
Hoggets—Wether	35-40	0.6	0.5	1.0	0.6
Wethers M.A.	50-55	0.7	0.5	1.0	0.7
Rams	75	0.8	0.5	1.0	0.9
Studs—Ewe	65	1.125	1.125	1.125	1.125
Studs—Ewe Hoggets	25-50	1.0	0.75	1.125	1.0
Cattle					
(1) Beef					
Br. Cow	455	6.0	6.0	6.0	6.0
Heifer—Weaner	135-270	3.5	3.5	4.0	3.5
Yearling	270-365	4.0	4.0	4.5	4.0
2 Yr. Old	365-455	4.5	4.5	6.0	4.5
Steer—Weaner	160-340	4.0	3.5	4.5	4.0
Yearling	340-500	5.0	4.0	6.0	5.0
(2) Dairying					
Seasonal					
Cow—Friesian	450-500	7	6.5	8	7
Jersey	365	6.5	6.0	7	6.5
Yearling	180-320	3.0	3.5	4.0	3.5
Calf	25-180	—	—	2.0	2.0
Bull	450	5	4	5	5
(3) Dairying					
Town Supply					
Cow—Friesian	545	8	7.5	10	8.5
Heifer 2 Yr. Old	430-545	5.0	5.5	7	6.0
1 Yr. Old	225-430	3.5	4.0	5	4.5
Calf	35-225	—	2	3	2.5
Bull	635	5	4	6	5.5
Horses: Hacks		7	5	9	7

LIVESTOCK PRODUCTION FROM PASTURE

by

K. T. JAGUSCH

The main theme of animal evolution has been dictated by the dietary environment, so that animal and plant development have more or less remained in phase with each other. Plants contain celluloses, polymers of glucose which make up that fraction of plant dry matter called "fibre". It is therefore anomalous that during evolution animals failed to develop cellulase enzyme to break down cellulose that could be secreted in the digestive juices. This anomaly is particularly apparent because cellulose is one of the most abundant naturally occurring organic compounds found on land.

Herbivores have overcome this deficiency by developing capacious diverticulae in their digestive tracts in order to harbour symbiotic microorganisms, which have, in fact, become the animal's cellulase producing tissue. These microorganisms digest by fermentation the fibrous and soluble constituents of plants. Unfermented fibre is excreted in the faeces, but the small amount of soluble constituents which passes on down the digestive tract together with other food material, including microorganisms, becomes subject to normal enzymic digestion. The single nutrients produced by microbial fermentation, mainly acetic, propionic, and butyric acids, are absorbed by the organ acting as the fermentation vat. These acids can contribute 60–80% of the animals energy requirements.

Ruminants utilise pasture by presenting the food for fermentation in the rumen prior to the gastric and intestinal digestion in the post-rumen gut. Livestock production from pasture primarily concerns wool, meat and milk from ruminant animals such as sheep, beef cattle and dairy cows. In order to measure livestock production the nutritive value of pasture has to be assessed, the food requirements of ruminants for particular performance (e.g. rate of liveweight gain, milk production) within a physiological state (maintenance, growth and fattening, lactation) have to be listed, and the annual demand for food by farm animals has to be profiled. If this procedure is followed livestock production from pasture can be calculated.

8.1 Nutritive value of pasture

The nutritive value of pasture is closely related to the composition of the dry matter, particularly the content of fibre and protein. High quality pastures have low amounts of fibre and high quantities of protein. Legumes at the same stage of growth as grasses are better in this respect too.

Average values for the chemical analysis of grass clover and lucerne pastures, together with the hay made from these swards, are given in Table 8.1. The values for protein and fibre show that pasture is most nutritious when young and grazed in *situ*, and that lucerne hay is of higher quality than grass-clover hay (meadow hay). It can also be seen that pasture contains low quantities of fat (ether extract) but more than adequate amounts of gross minerals (ash). The nitrogenfree extract contains soluble sugars and other compounds which are generally, but not invariably, less resistant to microbial fermentation in the rumen than fibre. This latter value, calculated by difference from 100%, unfortunately gives little indication of the nutritive value of pasture because it is so variable.

8.1 Nutritive Value of Pasture

TABLE 8.1

Chemical composition of pasture fodder

	Dry matter percentage	Protein (Nx6.25)	Ether extract	Ash	Crude fibre	Nitrogen-free extract
		(as per cent of dry matter)				
Young pasture	20	28	5	12	15	40
Mature pasture	25	14	4	8	28	46
Young lucerne	18	26	8	10	18	38
Mature lucerne	25	18	4	10	28	40
Pasture hay	85	13	2	8	30	47
Lucerne Hay	90	17	2	9	26	46

The season of the year and the stage of growth within a season affect the protein and fibre contents of pasture. Examples of this for rye-grass white clover pasture are given in Tables 8.2 and 8.3 respectively. The dry matter content of pasture is as low as 15% in spring and as high as 30% in summer. Short leafy pasture is typical of good sheep feed in spring, long leafy pasture is indicative of rotationally grazed dairy pasture, and the preflowering and flowering stages correspond to material for silage and hay respectively. Obviously, grazing management will affect the nutritive value of pasture through control of the stage of growth.

TABLE 8.2

Mean values for the protein and fibre content of grass/clover pasture according to season of the year

Season	Height (cm)	Protein (Nx6.25)	Crude fibre
		(per cent of dry matter)	
Spring	10-20	26	14
Summer	10-20	10	30
Autumn	10-20	28	14
Winter	10-20	20	19

TABLE 8.3

Mean values for the protein and fibre content of grass/clover pasture according to stage of growth in spring

Stage of growth	Height (cm)	Protein (Nx6.25)	Crude fibre
		(per cent of dry matter)	
Short leafy	5-10	27	17
Long leafy	15-20	21	20
Preflowering	25-35	16	26
Flowering	40-50	11	30

8.2 Evaluation of pasture

Under most feeding conditions grazing ruminants consume a surfeit of protein and minerals in their requirements. Amino-acid deficiencies are unknown in pasture-fed ruminants and, where certain areas show a soil deficiency in a specific mineral (e.g. selenium in Canterbury, cobalt on the pumice lands of the North Island, iodine in Southland), preventative measures are taken to supplement the animals (see Section 9.5). This can be done by administering the mineral to the animal directly by drench, by injection or by a mineral lick, or indirectly by incorporating the mineral into fertilisers. Therefore pasture needs to be evaluated solely in terms of the amount of energy in the food that is available to the animal after digestion and metabolism. This available energy is called metabolisable energy (ME). It is equal to the gross energy of a food as it is eaten, less the energy lost in the faeces, urine and as gases from the digestive tract.

Table 8.4 gives the metabolisable energy values of common pasture fodders. The values are expressed in terms of the megajoules (MJ)* of metabolisable energy in a kilogram (kg) of dry matter (D.M.).

When 1 kg of dry matter from pasture is burnt to its ultimate oxidation products, about 18.4 MJ of gross energy are evolved. Thus a value of 7.5 MJ ME/kg DM means that in every 1 kg of dry matter eaten 10.9 (i.e. 18.4 – 7.5) MJ of energy are unavailable to the animal. This quantity of energy lost by the animal through excretion in the faces, urine, and as gas from the digestive tract. Low metabolisable energy values are typical of ruminants given poor quality meadow hay or silage. On the other hand a high value of 12.5 MJ ME/Kg DM means that only 5.9 (18.4 – 12.5)MJ of energy were excreted after digestion and metabolism. This is indicative of new grass and lush pasture.

It can be seen from the values in Table 8.4 that the available energy can vary from as low as 6.7 MJ ME/kg DM for poor quality hay to as high as 12.5 MJ ME/kg DM for new grass. Under restricted grazing conditions the concentration of metabolisable energy in the dry matter within the broad range of values given here controls voluntary intake of pasture. When feeding *ad libitum* voluntary intake is greatest for pastures low in fibre and high in protein. Such pastures have a high concentration of metabolisable energy in the dry matter. As the quality of pasture decreases the bulk of the fodder limits voluntary intake because of the increasing fibre content of the plant.

Pasture quality is in a dynamic state all the time, because of such factors as the age of the pasture, effects of climate or irrigation, grazing management, fertiliser practice, botanical composition of the pasture, which all affect the relative stage of growth or the rate at which pasture plants mature, so that even within any one classification a narrow range of values has to be given. However, for most practical situations pasture fodder can be classified as poor, fair, good, or excellent and simply given values of 7.5, 9.2, 10.7 and 12.5 MJ ME/kg DM respectively. This allows for ease of use of the ME values under normal feeding conditions. Only in scientific experiments where stringent accuracy is needed would a specific value be required. Under these circumstances the pasture in question would be screened in a metabolism trial with sheep fed at the maintenance level of nutrition.

* 1 Megajoule (MJ) = .239 Megacalories = 239,000 calories.
1 calorie = heat required to raise the temperature of 1g water by $1^{0}C$ ($15–16^{0}C$).

TABLE 8.4

Metabolisable energy values for common pasture fodders

Foodstuff	Dry matter percentage	Metabolisable energy (MJ ME/Kg D.M.)
New or lush pasture	14	11.7–12.5
Short leafy pasture	16	10.9–11.7
Long leafy pasture	18	10.0–10.9
Preflowering pasture	20	9.2–10.0
Flowering pasture	25	8.4– 9.2
Winter pasture	20	10.0–10.9
Brown summer pasture	30	8.4– 9.2
Young lucerne	14	10.9–11.7
Flowering lucerne	22	10.0–10.9
Poor quality hay	85	6.7– 7.5
Medium quality hay	85	7.5– 8.4
Good quality hay	85	8.4– 9.2
Clover hay	84	8.8– 9.6
Lucerne hay	90	8.4– 9.2
Pasture silage	20–30	7.5– 9.6

8.3 Requirements of ruminants for pasture

Authoritative feeding standards are published periodically by the Great Britain Agricultural Research Council (A.R.C.) and the National Research Council (N.R.C.) in the United States. Like in all average figures, a great deal of commonsense is needed when applying tabled feeding standard values to an individual enterprise. No-one should misunderstand and assume that average values are highly precise under all feeding conditions. At best they are guides to feeding practice, and this applies to all feeding tables in spite of certain claims to the contary.

The food requirements of sheep, beef cattle and dairy cows are given in the following tables in this section. They are based on the A.R.C. feeding standards but have been increased by 30 per cent to allow for the extra energy cost of grazing under New Zealand farming conditions. A recent symposium on the food requirements of grazing ruminants was held by the New Zealand Society of Animal Production at their annual conference in 1971. On reviewing the situation all contributors found that the energy requirements of grazing ruminants were from 10–50 per cent higher than classical feeding standards would indicate.

8.3.1 *Adult Sheep.* Adult sheep spend virtually their entire life at maintenance which in respect to the grazing animal cannot explicitly mean zero energy retention. It is well known that within any system of flock management, management, fluctuations in liveweight of the ewes are generated, when feed supply is adjusted to the animal's requirement in a particular period fluctuations in liveweight of the ewes are generaged, when feed supply is adjusted to the animal's practical requirement in a particular period during the year. The maintenance requirements of sheep, fed on pasture containing different concentrations of ME, are shown in Table 8.5. The maintenance requirement increases with the liveweight of the ewe but decreases as the quality of pasture improves. The food requirement of adult ewes just prior to tupping and during the last four weeks of pregnancy is 1.5 times maintenance; whilst during early lactation the ewe requires to be fed at 3.0 times maintenance decreasing to 2.0 times maintenance by the 3rd month of lactation.

TABLE 8.5

Metabolisable energy requirement (MJ/day) for Maintenance of Adult Sheep

Liveweight (kg)	ME concentration (MJ/kg DM) of pasture 7.5	9.2	10.9	12.5
40	8.8	8.4	7.9	7.5
55	10.0	9.6	9.2	8.8
70	10.9	10.4	10.0	9.6

8.3.2 *Weaned lambs.* The metabolisable energy requirement of lambs from the time of weaning to the hogget stage are given in Table 8.6. It can be seen from these values that, for a particular rate of liveweight gain, lambs require a greater metabolisable energy intake with low quality pasture fodder compared with that of high quality. Rapid rates of gain cannot be achieved with low quality pasture because, in general, the bulk of food in the rumen limits intake before sufficient ME has been ingested to achieve high weight gains. Furthermore, the margin between low and high quality pasture, in terms of requirement for good performance, becomes more marked as daily liveweight gain increases, because of differences in the efficiency of utilisation of metabolisable energy. The metabolisable energy of low quality pasture is used less efficiently than that of high quality pasture.

TABLE 8.6

The metabolisable energy requirement (MJ/day) of weaned lambs and weight gain according to liveweight

Liveweight (kg)	ME concentration (MJ/kg DM)	*Daily liveweight gain of lamb (g/day)*				
		0	50	100	200	300
	7.5	5.4	8.8	–	–	–
20	9.2	5.4	7.5	10.0	–	–
	10.9	5.0	7.1	9.2	14.6	–
	12.5	4.6	6.7	8.4	12.5	18.4
	7.5	7.1	10.5	–	–	–
30	9.2	7.1	9.6	12.5	–	–
	10.9	6.7	8.8	11.3	17.1	–
	12.5	6.3	8.4	10.5	15.0	20.9
	7.5	8.8	12.5	–	–	–
40	9.2	8.4	11.7	14.6	–	–
	10.9	7.9	10.5	13.0	19.2	–
	12.5	7.5	9.6	12.1	16.7	23.0

8.3.3 *Beef cattle.* The metabolisable energy requirements of growing and fattening beef cattle are given in Table 8.7. In practical terms they represent the requirements of a beef beast weaned at 150 kg which gains increments of 50 kg to a finished weight of 450 kg. The comments made for weaned lambs also apply here.

Table 8.7

The Metabolisable Energy Requirement (MJ/day) of Growing and Fattening Cattle

Liveweight (kg)	ME concentration (MJ/kg D.M.) of pasture	Daily liveweight gain (kg/day) 0	0.25	0.50	0.75	1.00	1.25	1.50
	7.5	46.8	57.3	70.2	85.7	–	–	–
200	9.2	45.1	53.1	62.7	74.0	88.6	–	–
	10.9	43.5	50.2	57.7	66.7	77.7	90.7	–
	12.5	41.8	47.2	53.9	61.4	70.6	81.1	94.0
	7.5	57.3	69.4	83.2	102.0	–	–	–
300	9.2	55.6	64.8	75.6	88.6	106.2	–	–
	10.9	53.1	61.0	69.4	79.8	93.6	110.3	–
	12.5	51.0	57.7	65.6	74.0	84.8	97.8	114.1
	7.5	67.3	81.9	97.8	119.9	–	–	–
400	9.2	65.2	76.5	89.0	104.9	124.5	–	–
	10.9	62.7	71.9	81.5	94.5	109.9	130.0	–
	12.5	60.2	68.5	76.5	86.9	99.5	115.8	135.8

Unlike the adult ewe, beef cattle for meat production are required to grow. The faster they grow the more efficient, energetically speaking, is beef production because the daily effect of the maintenance requirement on total production is reduced. Thus feeding cattle to appetite results in a considerable saving of pasture if rapid growth is maintained.

8.3.4 *Lactating dairy cows.* The metabolisable energy requirements of lactating dairy cows are given in Table 8.8. The values show that animals yielding heavily require high quality rations to achieve the necessary intake of metabolisable energy to maintain such production.

The metabolisable energy requirements of pregnant, non-lactating Friesian and Jersey cows are given in Tables 8.9 and 8.10 respectively.

TABLE 8.8
The Metabolisable Energy Requirements (MJ/day) of Lactating Dairy Cows

Liveweight (kg)	ME concentration (MJ ME/kg D.M.) of pasture	Milk Yield (kg/day) 0	5	10	15	20	25	30	35
363 (4.9% fat in milk)	7.5	52.7	99.9	–	–	–	–	–	–
	9.2	50.6	91.1	138.7	–	–	–	–	–
	10.9	48.9	85.3	126.2	171.3	224.0	–	–	–
	12.5	46.8	83.2	121.2	161.7	204.8	251.2	–	–
500 (3.8% fat in milk)	7.5	66.9	105.3	153.8	–	–	–	–	–
	9.2	64.8	97.8	135.4	177.6	–	–	–	–
	10.9	61.9	92.8	125.4	160.9	198.9	210.2	–	–
	12.5	59.8	90.7	121.6	155.0	188.9	224.0	261.2	–
590 (3.6% fat in milk)	7.5	76.1	112.4	156.3	–	–	–	–	–
	9.2	73.6	105.3	140.8	179.3	224.0	–	–	–
	10.9	70.2	99.9	131.6	164.7	199.8	237.4	281.3	–
	12.5	68.1	97.4	128.3	159.2	191.8	225.7	259.5	296.3

TABLE 8.9
The Metabolisable Energy Requirement (MJ/day) of a Pregnant, Non-Lactating Friesian cow

ME concentration of pastures (MJ/kg DM)	Weeks from term 8–4	4–2	2–0
7.5	66.0	84.4	93.6
9.2	61.0	76.9	84.0
10.9	56.4	71.0	77.3
12.5	52.2	66.5	72.3

TABLE 8.10

The Metabolisable Energy Requirement (MJ/day) of a Pregnant, Non-lactating Jersey Cow

ME Concentration (MJ/kg DM)	Weeks from term 8–4	4–2	2–0
7.5	44.7	56.8	62.3
9.2	42.2	53.5	58.5
10.9	39.7	50.2	54.7
12.5	36.8	46.8	51.0

8.4 Profile of annual demand for pasture by ruminants

Pasture can grow all the year and rates of growth are faster in spring and autumn, although the extent of spring flush growth can be increased by irrigation. Under pastoral conditions it is practical to conserve pasture as hay or silage during the periods of abundant supply (usually late spring and early summer) and feed this fodder to the animals when grass growth is slow. This means that ruminants will not only eat pasture *in situ* varying in quality, but also conserved feed that will generally be of lower quality than the pasture being grazed. It is important to profile the annual demand for food by domestic animals according to the physiological state of the animal and the required performance in that state (e.g. rate of liveweight gain in growing beef steers), because pasture quality varies throughout the year.

8.4.1 *Sheep.* The profile of feed demand for a ewe rearing at least one lamb to prime weight at 12 weeks of age is given in Table 8.11. With the exception of the lactation period, the ewe is fed at and about maintenance nutrition, However, it is important to have the ewe gaining some weight during flushing, tupping, and in late pregnancy when the foetus is growing rapidly. It is also good practice to have the ewe gain the weight lost at lambing during lactation so she enters the summer maintenance feeding period in good condition.

TABLE 8.11

Profile of annual feed demand for a ewe

Month of the year	Liveweight (kg)	Physiological state	Minimum quality of feed required (MJ ME/kg DM)
January	55	Maintenance	7.5
February	55	Maintenance	7.5
March	58	Supermaintenance	10.9
April	61	Supermaintenance	10.9
May	56	Submaintenance	6.7
June	53	Submaintenance	6.7
July	55	Supermaintenance	10.9
August	60	Supermaintenance	10.9
September	52	Lactation	10.9-12.5
October	53	Lactation	10.9
November	60	Lactation	9.2
December	55	Maintenance	7.5

It must be emphasised that the last column in Table 8.11 gives the minimum quality of feed tolerated by the ewe according to her physiological state. Pasture fodders of the order of quality below that given in Table 8.11 are liable to result in a reduced harvest of lamb in spring because the bulk limitation to appetite results in the ewe not achieving sufficient intake to maintain fitness for production. On the other hand in seasons of pasture abundance or in situations where farms are understocked, it does not matter if the quality of the pasture is higher than it need be. Under such conditions the positive changes in liveweight will be magnified.

8.4.2 *Beef cattle.* The profile of feed demand for a beef animal grown for meat production differs from the ewe in that cattle remain in the physiological state of growth and fattening from birth to weaning. It can be seen from the example given in Table 8.12, that performance according to the type of pasture available during different periods of the year, is the important issue.

TABLE 8.12
Profile of annual feed demand for a growing beef animal

Month of the year	Liveweight (kg)	Growth performance (kg/day)	Quality of feed required (MJ ME/kg DM)
March	150	1.0	10.9
April	181	1.0	10.9
May	211	0.5	50% hay at 7.5
June	226	0.5	50% pasture at 10.9
July	241	0.5	Ave. May-August
August	256	0.5	= 9.2
September	271	1.5	12.5
October	316	1.5	12.5
November	361	1.0	10.9
December	391	0.5	9.2
January	406	0.5	9.2
February	421	1.0	10.9
March	449	–	–

The profile represents the feed demand of a beef animal born in September-October at about 30 kg liveweight and weaned in March, 5-6 months later at 150 kg liveweight, onto good quality autumn pasture. Such pasture available at this time would result from adequate summer rainfall, irrigation or hay aftermath. Liveweight gains are good during this period because of cooler autumn conditions. Cold weather in the May-August period leads to slower liveweight gains because pasture growth is reduced and it is necessary to supplement 50% of the animal requirement with medium quality hay. In spring, lush pasture promotes rapid liveweight gains that tail off in summer because of the temperature conditions and the drying out of pasture. It is assumed that the farmer was able to supply good quality pasture in February so that a finished 18 month old beast is turned to market in March at about 450 kg.

Of course, the profile of feed demand for beef will vary with the geographic location of the property and from season to season. However, the data given so far in this chapter will enable the agriculturalist to profile feed demand according to circumstance.

8.4.3 *Dairy cows.* The profile of feed demand for a lactating dairy cow is similar to that of a beef animal, in that performance, namely yield of milk, is important. Only in the dry period does the physiological state of the animal change and then super maintenance feeding is required because of approaching parturition.

An example of a feed profile for an above average milking cow, weighing 450 kg, that calved on 1st August and was mated again on 15th October, is given in Table 8.13. It was assumed that the farmer had good quality autumn saved pasture that he could break-feed in August, and also that during this period meadow hay furnished only one quarter of the cow's food requirement. Peak milk yield coincides with flush spring growth, and the animal was able to keep on producing well going into late lactation, because of good grass growth in autumn. During the dry period hay made a large contribution to the animal's food requirement.

TABLE 8.13

Profile of annual feed demand for a 450 kg dairy cow

Month of the year	Physiological state	Milk yield performance (kg/day)	Quality of feed required (MJ ME/kg DM)
August	Early lactation	20	10.9
September	Peak lactation	25	12.5
October	Peak lactation	25	12.5
November	Peak lactation	20	10.9
December	Mid lactation	15	9.2
January	Mid lactation	15	9.2
February	Mid lactation	15	10.9
March	Late lactation	15	10.9
April	Late lactation	10	10.9
May	Late lactation	10	9.2
June	Dry period	–	9.2
July	Dry period	–	9.2

8.5 Livestock production from pasture

It will be appreciated from the preceding tables in this chapter, that the food requirements of ruminants for a given performance within a physiological state is fairly constant with pasture of known quality. Therefore, the main determinant of total livestock production is the amount of pasture that can be produced, and which can be harvested by the animal or conserved as hay or silage. The number of stock carried depends on the yield of DM per hectare.

Calculations of the annual feed demand of a ewe rearing a single lamb, a growing beef steer, and a lactating dairy cow, based on the above feed profiles given, are shown in Table 8.14–8.16 respectively. The ME requirements (MJ/day) were given in Tables 8.5, 8.7, and 8.8 respectively.

Knowing then the quality of the pasture and the type of production required, the dry matter requirements, expressed on a daily, monthly and annual basis, are easily calculated.

The metabolisable energy requirement of the beef steer (Table 8.15) is based on those periods of the year when the animal weighed, on average, about 200, 300 and 400 kg respectivley. Since the steer is growing all the time, its daily consumption of dry matter on March 1st (150kg liveweight) would be about 6 kg DM/day building up to an intake of about 11kg DM/day on February 28th (449kg liveweight).

TABLE 8.14

Calculation of the annual feed demand of a 55 kg ewe

Month of the year	Physiological state	Food quality (Mcal (MJ ME/kg DM)	ME requirement (MJ/day)	Pasture D.M. requirement (kg/day)	(kg/month)
January	Maintenance	7.5	10.0	1.33	41.2
February	Maintenance	7.5	10.0	1.33	37.2
March	1.5 Maintenance	10.9	13.8	1.27	39.4
April	Maintenance	10.9	13.8	1.27	38.1
May	0.8 Maintenance	6.7	8.4	1.25	38.8
June	Maintenance	6.7	8.4	1.25	37.5
July	1.5 Maintenance	10.9	13.8	1.27	39.4
August	Maintenance	10.9	13.8	1.27	39.4
September	3.0 Maintenance	12.5	26.3	2.10	63.0
October	2.5 Maintenance	12.5	22.2	1.77	54.9
November	2.0 Maintenance	10.9	18.4	1.69	50.7
December	Maintenance	7.5	10.0	1.33	41.2
			Annual requirement		520.8 kg

TABLE 8.15

Calculation of the annual feed demand of a growing beef steer

Month of the year	Liveweight (kg)	Growth performance (kg/day)	Food quality (MJ ME/kg DM)	ME requirement (MJ/day)	Pasture DM requirement (kg/day)	(kg/month)
March	150	1.0	10.9	77.7	7.15	221.7
April	181	1.0	10.9	77.7	7.15	214.5
May	211	0.5	9.2	62.7	6.82	211.4
June	226	0.5	9.2	62.7	6.82	204.6
July	241	0.5	9.2	62.7	6.82	211.4
August	256	0.5	9.2	75.6	8.23	255.1
September	271	1.5	12.5	114.1	9.10	273.0
October	316	1.5	12.5	114,1	9.10	282.1
November	361	1.0	10.9	110.0	10.12	303.6
December	391	0.5	9.2	89.0	9.68	300.1
January	406	0.5	9.2	89.0	9.68	300.1
February	421	1.0	10.2	110.0	10.12	283.4
	449 (Slaughterweight)			Annual requirement		3061.0Kg

The dry matter requirements of a lactating dairy cow (Table 8.16) are based on its metabolisable energy requirement. It is important to note that the pattern of dry matter intake by a dairy cow over the season differs to that given in Table 8.16. Cows tend to mobilize their body reserves in early lactation (i.e. milk off their back) to furnish their ME requirement when the demand is high. Hence the cow in the present example would probably be eating about 12–13 kg D.M./day in early lactation, building up to 19 kg D.M./day by January-February. These reserves are replaced in mid and late lactation by eating food surplus to her requirement thus balancing total annual intake. If such surpluses are not available during this period then the cow will compensate by reducing her requirement through decreased milk production.

TABLE 8.16

Calculation of the annual feed demand of a 450 kg dairy cow

Month of the year	Milk yield performance (kg/day)	Food quality (MJ ME/kg DM)	ME requirement (MJ/day)	Pasture D.M. requirement (Kg/day)	(Kg/month)
August	20	10.9	198.9	18.3	567.3
September	25	12.5	224.0	17.9	537.0
October	25	12.5	224.0	17.9	554.9
November	20	10.9	198.9	18.3	549.0
December	15	9.2	177.6	19.3	598.3
January	15	9.2	177.6	19.3	598.3
February	15	10.9	160.9	14.8	414.4
March	15	10.9	160.9	14.8	458.8
April	10	10.9	125.4	11.5	345.0
May	10	9.2	135.4	14.7	455.7
June	Dry period	9.2	61.0	6.6	198.0
July	Dry period	9.2	79.4	8.6	266.6
			Annual requirement		5543.3kg

The data from these examples were used to calculate the hypothetical number of stock units that could be run for a range of pasture yields. The results are presented in Table 8.17. Obviously this type of calculation is restrictive, because allowances have not been made for the pasture required by replacement stock, in the case of the sheep and dairy enterprises, or for the requirements of the breeding beef herd (cf. requirements for dairy cows). Furthermore, financial comparisons of this type are probably more meaningful in the long run. However, the methods of expressing livestock production from pasture are many and varied (e.g. weight ratios, energy ratios, stocking rates, gross margins, etc), but the first step is to calculate such production.

TABLE 8.17

Carrying capacity in relation to type of enterprise and yields of pasture (Stock no./ha.)

Type of Enterprise	Yield of harvestable dry matter (kg/ha) 10,000	12,000	15,000
Sheep (521 kg D.M./annum)	19.2	23.0	28.8
Beef (3061 kg D.M./annum)	3.3	3.9	5.9
Dairy (5543 kg D.M./annum)	1.8	2.2	2.7

8.6 Discussion

In this chapter an attempt has been made to quantify livestock production from pasture. In order to make these calculations the student of agriculture and the agriculturalist must learn to grade pasture according to its quality, estimate the dry matter content, and determine the yield per unit area. Once the performance wanted of the animal is known, within the managerial scheme of the farming enterprise, the question then becomes a mathematical problem for which data have been provided in this chapter and elesewhere.

In some farming systems, particularly those in the South Island, and also town milk farms where winter milking is carried out, pasture is the important but not the sole food source. Thus it may be necessary, when calculating livestock production from pasture, to fit foodstuffs, such as grains, succulents, straws and concentrates, into the programme when the profile of feed demand is being determined. The metabolisable energy values for various supplementary foodstuffs, given in Table 8.18, will facilitate this.

TABLE 8.18
Metabolisable energy values of pasture supplements

Foodstuff	Dry matter percentage	Metabolisable energy of supplement (MJ ME/kg DM)
Wheat straw	86	5.9
Barley straw	86	6.7
Oat straw	86	6.7
Ryegrass straw	86	7.1
Chou Moellier	15	11.3–12.1
Rape	14	12.5
Green maize	25	10.0
Swedes	12	12.1–12.9
Turnips	9	12.1–12.9
Fodder beet	15	10.4
Barley	87	12.9
Oats	87	11.7
Wheat	87	13.8
Maize	87	12.9
Sheep nuts	89	12.1

A number of people, including many farmers, have the experience and practical skill to look at an area of pasture, and evaluate it in terms of the number of stock-days that it will carry. Whilst one has to admire such a subjective assessment, the student of agriculture does not have this ability through lack of experience. Therefore, the time is ripe to think of the nutritional value of pasture in terms of the physiological state and performance required of an animal in relation to the profile of annual feed demand. It may well be that errors in application may swamp the advantages of using specific values for particular performances. Even so, the Tables given in this chapter give a precise scheme for the calculation, planning and costing of livestock production from pasture.

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(9) PASTURE PRODUCTION

Identification of Grasses

CU = Creeping underground stems   CA = Creeping above ground

Name of Grass	Habit	Ligule	Auricle	Hairs	Basal Sheath	Leaves in Bud	Special Botanical Features	Look for these Points
Perennial ryegrass	Tufted	Short blunt	Present	Absent	Red	Folded	Leaves dull above, glossy below.	Red basal sheath, folded leaves in bud.
Italian ryegrass	Tufted	Medium	Present	Absent	Red	Rolled	Edge of leaves rough.	Red basal sheath, rolled leaves in bud.
Tall fescue	As for Italian ryegrass, but coarser throughout.							
Crested dogstail	Tufted	Short blunt	Absent	Absent	Yellow	Folded	Leaves dull above, glossy below.	Yellow basal sheath
Meadow foxtail	CU	Short blunt	Absent	Absent	Chocolate	Rolled	Dark green—early spring grower.	Chocolate basal sheath.
Yorkshire fog	Tufted or CA	Ragged	Absent	Present	White sheath red veins	Rolled	Pale Green thin soft hairy leaves.	Red veins on white basal sheath.
Timothy	Tufted	Long	Absent	Absent	White	Rolled	Swollen base to stem, blue-green leaves.	Swollen base to stem
Cocksfoot	Tufted	Variable	Absent	Absent	White	Folded	Very flat shoot.	Very flat shoot, hairless.
Poa trivialis	CA	Long pointed	Absent	Absent	White	Folded	Two white lines down centre of leaf, leaf shiny below.	Creeping above ground, two white lines on leaf.
Poa pratensis	CU	Small or absent	Absent	Absent	White	Folded	Two white lines down centre of leaf, leaf dull below.	Creeps below ground, lines on leaf.

Identification of Grasses continued

CU = Creeping underground stems CA = Creeping above ground

Name of Grass	Habit	Ligule	Auricle	Hairs	Basal Sheath	Leaves in bud	Special Botanical Features	Look for these Points
Poa Annua	CA or tufted	Large	Absent	Absent	White	Folded	Two white lines down centre of leaf, leaf dull below.	Creeps above ground, lines on leaf
Danthonia pilosa	CU (slight)	Small	Absent	Present	White	Folded	Long narrow leaf. Tufts of long hairs at the collar.	Narrow long leaf, hairs at collar.
Sweet Vernal	CU or tufted	Large	Absent	Present	White	Rolled	Sweet smell, tufts of long hairs at the collar.	Sweet smell, hairs at collar.
Doabor Bermuda-grass	CA	Hairy	Absent	Present	White	Folded	Grows on light dry soils. Tufts of long hairs at the collar.	Creeps above ground, hairs at collar.
Paspalum	CU	Long	Absent	Present	White	Rolled	Broad reddish leav leaves, long hairs at the collar. Stem swollen at base.	Red leaves, swollen stem, hairs at collar.
Brown Top	CA CU	Short	Absent	Absent	White	Rolled	Leaf rough from tip to base.	Small ligule rough leaf.
Red Top	CU CA	Long or medium	Absent	Absent	White	Rolled	Leaf rough from tip to base; a twitch.	A twitch. Larger ligule rough leaf.
Creeping bent	CA	Long pointed	Absent	Absent	White	Rolled	Leaf rough from tip to base long pointed ligule.	Pointed ligule rough leaf. Creeps above ground.
Oldman twitch	CU	Short	Present	Present	White	Rolled	Leaves coarse, sheath hairy a bad twitch.	Twitch with hairy sheath.

Identification of Grasses continued

CU = Creeping underground stems   CA = Creeping above ground

Name of Grass	Habit	Ligule	Auricle	Hairs	Basal Sheath	Leaves in Bud	Special Botanical Features	Look for these Points
Prairie Grass	Tufted	Large	Absent	Present	White	Rolled	Broad light green leaves, very hairy sheath.	Very hairy sheath, light-green broad leaves.
Floating sweet grass	CA	Long and white	Absent	Absent	White	Folded	Leaf broad, soft and dull green. Leaf edges rough near tips.	Weak creeping stems when growing in shallow water.
Phalaris tuberosa	CU or tufted	White, ½" long tapers to a blunt end.	Absent	Absent	Sometimes Pink	Rolled	Leaf is long, soft, limp and smooth except on margins.	Very pronounced ligule.
Barley grass	Tufted	Short and blunt	Present	Present	White	Rolled	Leaf hairy on both surfaces. Upper leaf sheaths may be hairless.	Auricles hairy leaves.
Tall Oat grass	Tufted	Blunt, medium length	Absent	Present	White	Rolled	Leaf long and narrow with hairs in parallel lines. Leaf sheath may be sparsely hairy.	Roots chrome yellow.
Ratstail	CU tufted	Absent	Absent	Present	White	Rolled	Leaf sheath hairy on upper part. Leaf still, inrolled, dark green and narrow, hairy on lower margins.	Two tufts of hairs where auricle normally rises.
Chewings fescue	CU tufted	Absent or short and blunt.	Absent	Absent	Pink	Folded	Leaves permanently rolled.	

Identification of Grasses continued

CU = Creeping underground stems CA = Creeping above ground

Name of Grass	Habit	Ligule	Auricle	Hairs	Basal Sheath	Leaves in Bud	Special Botanical Features	Look for these Points
Coarse grass	Tufted	Thin, short and slightly ragged.	Absent	Present	White	Rolled	Leaf thin and covered with fine hairs. Leaf sheath covered with long soft hairs.	

Identification of Clovers

Name of Clover	Growth	Stipule	Hairs	Leaf Shape and Markings	Flower	Special Botanical Features	Look for these Points
Red Clover or Cowgrass	Mainly upright	Large and attached to the stem for most of its length conspicuously veined.	Usually very hairy	Leaflets oval with white markings on upper surface.	Reddish purple	Leaflet veins much branched towards edge of leaf.	Oval leaflets, densely hairy on the back.
Alsike	Erect	Green, with free ends drawn out to a long point.	Absent	Leaflets toothed and obtuse at the apex.	Pink or almost white	Veins on leaflets sparingly branched near the edge of the leaf.	Upright growing clover without hairs.
White Clover	Prostrate	White, Membranous	Absent	Leaflets heart-Shaped.	Usually white turn brown on fading.	Moderate branching of leaflet veins at ends.	Spreading over ground stems rooting at the nodes.
Suckling Clover	Generally prostrate except where supported by other vegetation.	Broad green and pointed. Hairy on the margin.	Stem and leaves slightly hairy.	Leaflets broadest near the tip. Central leaflet is stalked.	Small yellow flowers with 12 or more florets which turn brown on fading.	Veins in leaflets unbranched.	Slender small leafed clover much branched at the base, central leaflet stalked.

Identification of Clovers continued

Name of Clover	Growth	Stipule	Hairs	Leaf Shape and Markings	Flower	Special Botanical Features	Look for these Points
Strawberry Clover	Prostrate	Similar to white clover but larger and veining more prominent.	Absent or only sparsely present on upper part of leaf stalk.	Leaflets usually oval.	White with pinkish tinge becomes swollen after flowering.	Leaflet veins much branched near the edge and arched.	Strong overground stems rooting at the nodes.
Subterranean Clover	Prostrate	Broad with membranous edges indistinctly veined.	Present on leaves and stems particularly on under side leaflets.	Leaflets usually heart shaped and frequently with black markings on upper surface.	Usually 2–3 florets, white or pale pink. After flowering turn down to the soil.	Leaflet veins few in number but branched slightly towards edges.	Hairy, prostrate clover with dark leaf markings.
Clustered Clover		Short but long pointed and toothed.	Usually hairless	Leaflets egg shaped.	Small and pink flower stalk absent.	Leaflet veins unbranched.	A slender hairless clover with egg shaped leaflets and toothed stipules.
Striated Clover	Prostrate to ascending	Broad but ending in a fine point.	Conspicuously hairy	Leaflets egg shaped.	Small and pink stalkless heads at end of stems in angles of leaf stalks.	Leaflet veins branched.	A slender hairy clover with egg shaped leaflets.
Haresfoot Trefoil	Erect	Narrow, long pointed, reddish	Hairy	Leaflets long and narrow.	Silky round or elongated flower head.	Little or no branching in leaflet veins.	An upright stemmy and hairy clover with narrow leaflet.
Sweet Clover	Erect	Narrow and Sharp pointed	Almost hairless	Leaflets egg shaped, longest stalk on central leaflet margin toothed.	Flower head spike like cultivated type white, wild varieties yellow.	Veins straight and and almost unbranched.	Upright clover with narrow stalked leaflets.

Identification of Clovers

Name of Clover	Growth	Stipule	Hairs	Leaf Shape and Markings	Flower	Special Botanical Features	Look for these Points
Lotus Major	Weak partly erect growth	Replaced by two leaflets with mid ribs	Sparsely hairy	Oval and pointed middle leaflet stalk the longest.	5–12 florets in the flower rich yellow.	Few leaflet veins	Rather straggly, branching clover with paired stipules.
Lotus Hispidus	Mainly erect	Similar to lotus major.	Very hairy	Usually smaller than lotus major.	2–4 florets in the flower yellow.	Leaflet veins few and straight.	Very hairy clover with paired stipules.
Burr Clover	Prostrate to ascending	Large with fine conspicuous teeth.	Usually hairless	Leaflets egg shaped. Sometimes a black brown spot on each leaflet. Margin toothed at free end.	2–9 florets yellow.	Leaflet veins straight with very little branching.	Rather prostrate clover, central leaflet on longer stalk and stipule finely divided.
English Trefoil or Black Medic.	Prostrate with ascending tips	Broad and tapering and generally toothed.	Hairy	Leaflets heart shaped. Mid rib extends beyond leaf tip.	Round flower head. Yellow petals fall on fading.	Leaflet veins straight, with very little branching.	Prostrate hairy clover with leaflet mid rib extending beyond edge of leaflet.

New Zealand Herbage Seeds

(Source N.Z. Dept. of Agriculture Publication 1969) [Certified 'Grasslands' Varieties]

OECD SEED CERTIFICATION

NUCLEUS SEED OF BRED VARIETIES

Supplied by Grasslands Division of D.S.I.R.

To be sown out for further seed production under contract to Department of Agriculture

produces

CERTIFIED BREEDERS SEED

Which is distributed by the Department of Agriculture through Mercantile channels to selected seed producers.

To be sown out primarily for further seed production

produces

CERTIFIED BASIC SEED

Which is marketed in N.Z. through Mercantile channels (cannot be exported)

To be sown out largely for further seed production

produces

CERTIFIED FIRST GENERATION (BLUE LABEL)

Which is marketed in N.Z. and overseas through Mercantile Channels

To be sown out in N.Z., largely on areas likely to be used for further seed production

produces

CERTIFIED SECOND GENERATION (RED LABEL)

Which is marketed in N.Z. and overseas through Mercantile Channels

Varieties of New Zealand Herbage Seeds and Their Characteristics

'Grasslands Ariki' Ryegrass

Origin –	Bred from crosses between 'Grasslands' Manawa and 'Grasslands' Ruanui.
Season Growth –	Perennial Ryegrass, wide seasonal spread or production.
Establishment –	Vigorous early growth, thus frequent grazings are necessary to prevent supression of associated clovers.
Persistency –	Flourishes and perists under severe grazing.
Palatability –	Stock prefer Ariki to Ruanui, and even in early seedhead, palatability is still relatively high.
Remarks –	Vigorous perennial ryegrass requiring high fertility conditions for maximum performance. More resistant than other ryegrasses to Argentine Stem Weevil and highly resistant to leaf rust.

'Grasslands Manawa' Ryegrass

Origin –	Hybrid produced by selection from crosses between Ruanui and Paroa. Previously known as H1 or short rotation ryegrass.
Season Growth –	Winter production is extremely high. Autumn and spring growth are good. Liable to severe check under dry summer conditions.
Establishment –	Autumn sowings give rapid establishment and good early winter growth.
Persistency –	Where soil fertility is high, moisture adequate, and summer grazing lenient, Manawa can persist for years. Under severe summer grazing it may lack persistency, and can be vulnerable to grassgrub and stem weevil attack.
Palatability –	Manawa is highly palatable at all stages of growth.
Remarks –	Common component of general purpose and mixtures. Its contribution to establishment and early production is very valuable.

'Grasslands Paroa' Italian Ryegrass

Origin –	Developed by selection from N.Z. and overseas lines.
Seasonal Growth –	The main period of high production is in winter and early spring.
Establishment –	Rapid in a new sowing, particularly under good fertility and moisture conditions.
Persistency –	Paroa is regarded as an annual species, however under good growing conditions and lenient grazing it may persist for several years. Nevertheless, it is essentially a component of temporary pastures, or a temporary component of permanent pastures.
Palatability –	At all stages, even approaching the head stage, palatability is high.
Remarks –	Paroa's role in permanent pasture mixtures is being taken over by Manawa. Paroa is mainly used in short term pastures where winter greenfeed production is the main object.

'Grasslands Ruanui' Perennial Ryegrass

Origin –	Developed by plant breeding with outstanding plants from ecotypes which had developed, under N.Z. conditions.
Seasonal Growth –	Truly perennial grass with a wide seasonal spread of production.
Establishment –	Ready and rapid. Care is needed to prevent suppression of associated clovers.
Persistency –	Very persistent. Capable of withstanding severe grazing and treading. Under heavy stocking and high fertility conditions it can become the dominant grass.
Palatability –	Not as high as the annual grasses, but well accepted except when allowed to form seed heads.
Remarks –	Requires medium to high fertility and adequate moisture. Given these conditions, production is high and sustained.

'Grasslands Apanui' Cocksfoot

Origin –	Bred from selections made from N.Z. ecotypes.
Seasonal Growth –	Vigorous growth is maintained over a longer period than for other N.Z. varieties.
Establishment –	At the seedling stage, Apanui is vulnerable to competition from ryegrasses.
Persistency –	Once established, Apanui is persistent, especially where grazing is lenient. Under close sheep grazing, both survival and yield are reduced.
Palatability –	When managed so that the plants provide fresh green leafage, cocksfoot is palatable to all classes of stock. Where dead leaf and/or stalk material is allowed to accumulate, palatability declines rapidly.
Remarks –	Though not recommended as a component of every pasture mixture, cocksfoot can make a valuable contribution where the grazing regime is not severe, or where rainfall and soil fertility are less than is needed for good growth of ryegrass.

'Grasslands Kahu' Timothy

Origin –	By breeding and selection from Welsh S48 and N.Z. varieties.
Seasonal Growth –	Particularly valuable for its contribution to production in spring and early summer. Favours soils of high average moisture content.
Establishment –	Slow to establish and can suffer from the competition of vigorously establishing ryegrasses in the seedling stage.
Persistency –	Under suitable conditions e.g. the heavy damp soils of Southland, Kahu can be persistent and make a contribution, where fertility is high. On lighter droughty soils it is likely to perform poorly.
Palatability –	Kahu is extremely palatable to all stock and under close grazing tends to be eaten out of the sward. When managed to allow moderate leafage it is much more productive.

Remarks –	Should be considered as a palatable component of a pasture mixture on heavy, damp soils and can withstand heavy winter treading.

'Grasslands Huia' White Clover

Origin –	Bred from the best ecotypes which have developed in N.Z.
Seasonal Growth –	Good growth from spring through to autumn and extends well into early winter.
Establishment –	Slower than ryegrass, and may be smothered if grass growth is not controlled.
Persistency –	A true perennial, highly persistent and remaining vigorous.
Palatability –	Palatable at all growth stages to all classes of stock.
Remarks –	Huia is a large leafed, densely growing variety. When well established in pasture, it is tolerant of competition and may become dominant in summer when grass growth diminishes.

'Grasslands Turoa' Montgomery Red Clover

Origin –	Breeding and selection of Montgomershire clover introduced into N.Z. 30 or 40 years ago.
Seasonal Growth –	Spring growth commences some three weeks later than 'Hamua', but similar summer and early autumn growth.
Establishment –	Seedling vigour is greater than white clover but smothering danger still exists.
Persistency –	More suited for permanent pastures than is Hamua. Tolerates drier areas better.
Palatability –	Good–can withstand fairly intensive grazing, but production is better where the sward is allowed to make moderate growth.
Remarks –	Can make a valuable contribution to the summer production of short term or permanent pastures, particularly in regions of low summer rainfall, where there is little growth from white clover.

'Grasslands Hamua' Broad Red Clover

Origin –	Breeding and selection from N.Z. lines of cow-grass.
Seasonal Growth –	Winter and early spring production less than Huia, but summer growth is greater.
Establishment –	Similar to Turoa.
Persistency –	Not as persistent as Turoa particularly under severe grazing. Tends to decline after 2–3 years unless management has been such as to permit reseeding.
Palatability –	Good, which is a disadvantage under severe grazing conditions as the plant does not tolerate intensive defoliation.
Remarks –	Hamua can be a valuable component of mixtures for short duration swards, and can make a worthwhile contribution to the production of a long term pasture in its early years.

ATTRIBUTES OF IMPENDING NEW GRASS AND CLOVER RELEASES
(Source: NZSFM Proceedings 1975 N.A. Clark, Palmerston North)

The five new cultivars and their commercial availability are as follows:

New 'Grasslands' Cultivars		Commercially Available
Matua	Prairie	Now
Nui	Ryegrass	1976 Also uncert. line
Maku (Tpd)	Lotus	1976 (Autumn)
Pawera (Tpd)	Red Clover	1977
Pitau	White Clover	within 2 yrs

'Maku' Lotus (Tpd)

Advantages:
- Palatable, early flowering, vigour, bigger.
- Better production in wet, shade, and low pH .
- More tolerant – grass grub, porina, black beetle.
- No bloat.
- Erosion recovery.

Disadvantages:
- Slow establishing.

Uses:
- Replacement red and white – low P, moist, and low pH.
- 18% more DM than White Clover on Low P.
- Recommended sowing rate as the only legume sown. 3 kg/ha and innoc.
- Recommended sowing rate as for damp spots in a pasture mix 1/8 kg/ha.

'Pitau' White Clover

Advantages:
- Winter active.
- Better N. fixation – winter.
- Comparable Huia White Clover rest of year for DM.

Disadvantages:
- No superiority in South Island – no safer bloat.
- Slow to establish.
- Susceptible overgrazing.

Uses:
- North Island dairying particularly Town supply.
- Likes lax grazing – good soil fertility.

'Matua' Prairie Grass

Advantages:
- Perennial.
- Winter active – palatable.
- Rapid recovery from rotational, lax grazing.
- Still persistent in summer.
- Suits sand country.

Disadvantages:
- May be eaten out first year.
- Susceptible head smut – Treat benlate 0.5 kg/100 kg seed.
- Large seed.

Trials: In paddock trials at Massey Dairy No. 3 its winter and spring production in a pure stand was equal to that of a pure stand of Tama.
Also the milk production from this area equated that from Tama. On dry matter analysis, Matua Prairie was on average 2% better.

In MAF trials in Taranaki, its summer production was equal to that of Tetraploid (Tpd) Ariki Ryegrass.

During its selection it averaged 47% better total production that the old New Zealand strain of Prairie Grass.

Recommended sowing rates – in a dairy pasture mixture 6.5 kg/ha.

For under sowing – 4.6 to 6.5 kg/ha.

Uses:
- Fills gap – early spring production, still good summer.
- Pasture mixture and undersowing.
- Every dairy and beef farm.

'Pawera' Red Clover (Tpd)

Advantages:
- More persistent.
- More disease resistant.
- Better recovery from grazing.
- Larger plant, later flowering.
- Greater production + 20% DM average.

Disadvantages:
- No safer – oestrogen
  – bloat

Uses:
- Drier areas – summer-autumn production.

'Nui' Ryegrass

Advantages:
- More resistant to summer temperatures and droughts.
- Stands hard grazing and heavy stocking.
- Stays greener in summer.
- Remarkable recovery after autumn rain.

Disadvantages:
- Slow to establish
- Under pure stands, Nui is less palatable than other ryegrasses but this is not expected to be significant in a pasture mixture.

Trials: Indications are that it out-yields all other ryegrasses, particularly over the summer and autumn months.

Recommended sowing rate – similar to other ryegrasses but no more than 6.5 kg/ha in a pasture mixture.

For under-sowing up to 4.7 kg/ha.

Uses:
- All sheep, dairy and beef farms in New Zealand.

Seasonal Ranking, Ryegrass–Clover Swards

(Smetham M.L. Pers. Comm.)

Winter	Tama	>	Manawa	>	Paroa	>	Ariki	>	Ruanui
Spring	Tama	>	Paroa	>	Manawa	>	Ariki	>	Ruanui
Summer	Ariki	>	Ruanui	>	Manawa	>	Paroa	>	Tama
Autumn	Ariki	=	Ruanui	>	Manawa	>	Tama	=	Paroa

Annual Dry Matter Yields from Improved Pasture On North & South Aspects (Kg/hectare)

(1 kg/hectare = 0.89 lbs/acre)

Site	Rainfall (mm)	North (Sunny)	South (Shady)
Whatawhata, Hamilton (Radcliffe 1971)	1600 (63")	9960	9940
Te Kuiti, (Radcliffe 1971)	1450 (57")	4530	3880
Te Awa, Palmerston North (Suckling 1959)	1060 (42")	9740	9070
Coopers Creek, Oxford (Radcliffe, 1971)	1070 (42")	2370	4220
Hunua, North Canterbury (White, unpubl.)	650–750 (26"-30")	2100	4190

Pasture Production in New Zealand

The seasonal pattern of pasture production is measured by a uniform cutting technique at a number of sites throughout New Zealand by Staff of the Ministry of Agriculture and Fisheries. Some results for the 1972/73 production year are given in Table 1. These yields were obtained from predominately perennial ryegrass-white clover pastures under sheep or sheep plus cattle grazing with adequate supplements of mineral fertilizers excluding nitrogen. The pasture was harvested regularly every 2 or 3 weeks by the "rate of growth" cutting technique described by Lynch and Mountier 1954.

It is important to realise that yields measured in this way do not express maximum or potential pasture growth because of the limitations imposed by the cutting technique and pasture management. Nor do they necessarily represent growth in a district, because the sites were not replicated in space. However they do give a guide to the seasonal distribution of growth at the trial sites.

The variability in pasture growth from year to year is often not fully appreciated. Some data from South Island sites illustrate this point (see Table 2).

References

Lynch, P.B.; Mountier, N.S. 1954: Cutting techniques in grassland experiments. N.Z.J. Science & Technology 36A: 375–85.

Table 1: Pasture Production in 1972/73 (kg DM/ha)
Source: Ministry of Agriculture & Fisheries. Annual Report of Soil & Field Research Section

Location	SOIL TYPE	Annual Yield	% Contribution to Annual Yield			
			Winter*	Spring	Summer	Autumn
North Island						
Whangarei	Whakapara clay loam	6470	8	32	41	19
Helensville	Redhill sandy clay	9800	25	45	9	21
Hamilton	Hamilton clay loam	7660	9	42	27	22
Wairakei-hill	Oruanui sand	6800	12	46	34	8
-flat	Atiamuri sand	3530	7	54	31	8
Masterton	Kokotau silt loam	10080	15	56	6	23
Bulls	Himitangi sand	15000	16	31	30	23
Takapau	Takapau silt loam	10330	8	60	21	11
South Island						
Nelson	Rosedale	8300	18	64	8	10
Takaka	Puramahoi	11050	3	40	33	24
Westport	Pakihi (Addison)	10180	14	28	39	19
Winchmore – dryland	Lismore slit loam	4680	11	57	24	8
Winchmore – irrigated	Lismore slit loam	10430	5	36	42	17
Invercargill	Waikiwi	11800	3	38	43	16

* Seasons based on 3-monthly periods. Winter is June, July, August.

TABLE 2. The variability of pasture yields at South Island Sites*
Yields in kg Dry Matter/ha

LOCATION	No. of yrs of measurement	ANNUAL YIELD	Standard error over all yrs	Range of Annual Yield Lowest		Highest
Southland						
Mona Bush	6	14 610	2760	10 170	–	17 290
Winton	11	12 010	2290	8 870	–	16 000
Central Otago						
Arrowtown irrigated	6	10 850	1230	8 880	–	12 180
Cromwell irrigated	11	8 320	1590	5 820	–	11 260
Ida Valley dryland	10	2 800	1430	770	–	4 570
irrigated	12	8 740	2250	6 350	–	11 660
Otago						
Invermay hill	19	8 890	2230	3 240	–	13 500
Invermay flat	11	10 390	1600	7 520	–	12 760
Canterbury						
Winchmore dryland	13	5 870	1110	4 240	–	7 750
irrigated	13	10 150	1020	9 050	–	12 020
Wesport	4	10 150	1920	8 760	–	11 490

*Radcliffe unpublished data.

(10) CASH CROP AND SMALL SEED PRODUCTION

STANDARDS FOR MARKETING CASH CROPS AND SMALL SEEDS

Field Peas

Field Peas are grown mainly on the medium quality soils and may be either contract or free. The bulk of the crop is exported, being sold in two grades after Machine Dressing

Standards are	No. 1 Grade	No. 2 Grade
Minimum Size	92% over 6.35mm (¼") in dia. 8% tolerance down to 5.56mm ($^{7}/_{32}$")	85% over 5.16mm ($^{13}/_{64}$") in dia. 15% tolerance down to 3.97mm ($^{5}/_{32}$")
Splits	Not to exceed 0.5%	Not to exceed 2%
Damaged & Sprouted	Not to exceed 1.5%	Not to exceed 2%
Foreign Matter	Not to exceed 0.5%	Not to exceed 2%
Moisture	Not to exceed 15%	Not to exceed 15%
Condition	Sound, dry and in good keeping condition at time of shipment	
Colour	F.A.Q. of Season	

Garden Peas

A big proportion of this crop is exported but part of it is used as seed for the production of processed freezing peas, a sub-section of the Garden Pea trade. Garden peas whether processing for or threshing are usually grown on the better medium-heavy and heavy soils. Process peas are contracted in specific areas near factories while the bulk of the garden peas for threshing are also contracted.

Standards for Garden Peas

Machine Dressing loss not greater than 7½%
Maximum Moisture – 15%
Earth – deduction by weight
Note–all percentages are calculated by weight.

For further information on peas consult New Zealand Journal of Agriculture Volume 100 page 57, Volume 102 page 357.

Wheat

The principal basis of the wheat market is the F.A.Q. milling standard:

Sprout – a sprout index of not more than S1
i.e. No more than 10% sprouted grains in a line

Baking Score – Minimum of 30.

Screenings – up to 5%, but anything over 3% is a deduction from the grower.

Weed Seeds – not more than 0.5%

Moisture – not more than 15%, but anything over 14.5% is a deduction from the grower.

Freedom from weed seeds and musty grains. Wheats are paid for on the F.A.Q. basis at fixed prices.

Fowl Wheats

Owing to the shortage of wheat in New Zealand, the balance of milling requirements being made up by subsidizing imports, non-milling wheat finds a ready market at milling prices as fowl wheat if quality is at all reasonable.

Seed Wheats

There is a small volume of pedigree wheat produced by a few growers from Government stock grade but this can be disregarded for ordinary budgetary purposes. The main seed wheats are produced as Mother (from Pedigree) and Commercial (from Mother)

Good lines of milling are of course suitable farmer's seed.

Barley

Malting barley is grown on contract and Feed barley may be contract or free.

Malting Standard:	Skinned grains – not more than 5%.
(No. 1 Grade)	Screenings (Pinched grain) not more than 15%
	Moisture content–not more than 15.5% sacks
	14.0% bulk

Oats

This crop is usually grown on the medium and lighter soils as it is a lower fertility demander than wheat or barley. The main sections of the trade are–(a) Milling Oats grown on contract to the porridge manufacturing firms–(b) Grainfeed Oats grown for seed to provide stockfeed.–(c) Greenfeed Oats–(d) Oats for chaff.

The New Zealand average yield of oaten chaff is about 3 tonnes/ha (variation 1–3½ tonnes). Good chaff has a bright colour, a sweet smell and a high proportion of grain to straw. 25–28 bags to the ton is a good standard. Approximately 27 bushels to the ton, grain to straw ratio 45/55.

Linseed

Grown chiefly on the "clay downs" type of country but also a useful crop on heavy land (e.g. Eiffleton) or any reasonably fertile country which is assured of summer showers. The re-establishment of the linseed oil industry in this country has stimulated new interest in this crop. Grown on contract to the manufacturers.

Potatoes

Reference: New Zealand Journal of Agriculture Volume 101 page 218.

The New Zealand crop can be divided into new potatoes and main crop. Approximately 8000 hectares are grown each year to satisfy New Zealand's requirements.

(a) New Potatoes

The main variety of new potato is Ilam Hardy.

Average yields are probably about 20 tonnes/ha of marketing potatoes.

(b) Main Crop

The New Zealand and Canterbury average potato yields are approximately 25 tonnes/ha. Certified seed invariably yields 20–25% more than uncertified seed.

In Canterbury a 12 ton/ac crop (30 tonne/ha) would comprise approximately:–

3	tons table potatoes	(7.5 tonnes/ha)
9	tons seed	(22.5 tonnes/ha)
12	tons	(30.0 tonnes/ha)

"Good Table" potatoes are of good shape according to variety, not more than 15% of which can be passed through a square the sides of which have an inside measurement of 2", the lot shall be free (2%) from green potatoes, second growth, dry or wet rots including blight or frost damage; the lot shall be practically free from earth which shall not exceed 4% by weight of the lot; the weight of the lot affected by mechanical injury including bruises and cuts shall not exceed 6%, the lot shall be practically free from scab or other defects not herein mentioned.

F.A.Q. potatoes are similar to the above except for the figure in brackets.

The Potato Board have a guaranteed payout for surplus potatoes grown on contract.

Payments for surplus potatoes are to be determined on the basis of the F.A.Q. proportion held in pits or sheds at the end of the season. It should be remembered that considerable loss through shrinkage will have taken place by this time.

Seed prices fluctuated widely and no reliable information regarding these is usually available until the crop has been lifted.

The Potato Board levy will be payable on both table and seed potatoes, excepting certified seed carrying the official certification tag of the Department of Agriculture and not exceeding a maximum certification grading size of 181 gm, and uncertified seed where the largest tubers are under 124 gm in weight. Levy is 50c per tonne.

Small Seeds

The best general reference for these crops is

Scott's chapter II in Pastures and Pasture Plants.

Ryegrasses and Clovers are usually taken as crops from first and second year pasture areas sown with the crop in mind though some specialist crops are grown. Cocksfoot and Timothy are normally grown as specialist seed areas.

Cash Crop and Small Seed Varieties

(Source–J.G. White, Pers. Comm.)

Wheat –	Aotea, Hilgendorf, winter-early spring (Canterbury) and Spring (Southland)
–	Arawa – where mildew in Canterbury
–	Kopara – Canterbury
–	Gamenya, North Island
	Karamu – North Island –spring wheat in South Island
Oats –	Milling–Gartons(63), Mapua Chaff and Feed Grain–Mapua, Taiko, Amuri Greenfeed–Amuri, Algerian, Winter grey, Duns
Barley –	Malting–Zephyr, Research, Kenia Feed–Zephyr, Carlsberg, Argentine II (Auckland)
Ryecorn –	C.R.D.
Maize –	Double hybrids e.g. W.575
Linseed –	Redwood
Peas –	Maple – Tasmanian Partridge (W.R.) Blue – Blue Prussian (67) Rondo, Rovar White – White Prolific, Rovar Garden – William Massey, (early) Greenfeast, Victory Freezer, Poha, Onward, Ajax.
Lupins –	Western Australian White
Potatoes –	Ilam Hardy, Rua(late) Sebago, Aucklander short top, Katahdin (early)
Rape –	Rangi, Giant (winter feed)

Swedes –	Doon Major, Doon Spartan (Aphid resistant) Wilhelsm-burger (late), Calder & Sensation (drought and aphid resistant), Wye (clubroot resistant), Rewa
Turnips –	Purple and Green top – yellow Green Globe, York Globe – (early) Kapai (aphid resistant
Choumoellier –	Medium Stemmed (sheep) Giant (cows)
Fodderbeet –	Yellow Daeno
Lucerne –	Wairau Chanticleer (early) College Glutinosa (creeping)
Ryegrass –	Ruanui, Ariki, Manawa, Paroa, Tama

Ryegrass Greenfeed – Tama, Paroa, Manawa

Cocksfoot –	Apanui
White Clover –	Huia
Red Clover –	Montgomery – Turoa Broad red clover (cow grass) – Hamua

SOWING AND HARVESTING OF FARM CROPS
(Pers. Comm. J. G. White and B. J. P. Ryde)

Crop	Varieties	Rate of Sowing/ha	Width of Rows and Depth	Time of Sowing	Time of Harvesting
Wheat	Aotea Arawa – where mildew Kopara Hilgendorf Karamu Gamenya – N.I.	Autumn 100-135 kg Spring 135-170 kg Southland 135-200 kg	17.8 cm rows 3 cm deep	May-June August-September	January-February Feb.–Mar. (Southland)
Oats	Milling – Gartons Mapua Grainfeed – Mapua – Taiko – Amuri Greenfeed – Amuri – Algerian – Black Supreme – Winter Grey	Autumn 90-110 kg Spring 110-135 kg Southland 135-180 kg N.I. 110-160 kg	17.8 cm rows 3 cm deep	February for greenfeed May-June or August-September	January-February Feb.–Mar. (Southland)
Barley	Malting – Zephyr – Research – Kenia Grainfeed – Zephyr – Carlsberg – Argentine II	Autumn 90-110 kg Spring 110-170 kg	17.8 cm rows 3 cm deep	March for green-feed May-June on light land November on heavy land	January-February
Ryecorn	CRD	Greenfeed 135-200 kg Seed 110-135 kg With grass 70 kg	17.8 cm rows 3 cm deep	January-February for greenfeed April-May for crop	January

Crop	Varieties	Rate of Sowing/ha	Width of Rows and Depth	Time of Sowing	Time of Harvesting
Maize	Double hybrids W575 early maturing W647 medium maturing W690 late maturing	Seed 25 kg Forage 30 kg Silage 25 kg	230 cm rows	October-November	April-June (seed) February-March (silage)
Linseed	Redwood	45-80 kg	17.8 cm rows 2.5 cm deep	September-November	February-March
Field Peas	Mapel – Tasmanian – Partridge – Marathon Blue – Blue Prussian – Rondo – Rovar White – White Prolific	200 kg	17.8 cm rows 5 to 6 cm deep	May-June September-October	January-February
Garden Peas	William Massey (Early) Greenfeast Victory Freezer Ajax Onward; Poha	270-340 kg	17.8 cm rows 5 to 6 cm deep	September-November	Processing December - early Feb. Seed-January-Feb.

Crop	Varieties	Rate of Sowing/ha	Width of Rows and Depth	Time of Sowing	Time of Harvesting
Lupins	Uni White Uni Harvest	Seed – 135-200 kg With forage crops – 35-100 kg	17.8 cm rows 2.5 cm deep	For seed. April or Sept.-Oct. For forage. Jan.-Feb.	December-February
Potatoes	Ilam Hardy Rua (late), Sebago Aucklander Short Top, Katahdin	30-55g seed – 1880 kg/ha 55-85g seed – 2760 kg/ha	76 cm rows 7.5 cm deep 15 cm apart	Main crop – mid October in S.I. Nelson – May-August Manawatu-August October Pukekohe – May-July	S.I. May-June Nelson Jan.-Feb. Manawatu Feb-May Pukekohe Aug-Nov
Rape (for forage)	Rangi, Giant (winter feed)	2.8 kg alone 1.2-1.7 kg in mixtures	17.8 cm rows 2.5 cm deep	October-December	
Rape (for seed)	Rangi, Giant (winter feed)	4.5-5.5 kg	17.8 cm rows 2.5 cm deep	March	mid-end December
Swedes (for forage)	Doon Major Doon Spartin (Aphid rest.) Wilhelsmburger (late) Calder and Sensation (drough and aphid rest.) Wye and Rewa (club root rest.)	6g-8g in 4g-7g in	17.8 cm rows 53 cm rows 2.5 cm deep	October-December	

Crop	Varieties	Rate of Sowing/ha	Width of Rows and Depth	Time of Sowing	Time of Harvesting
Choumoellier (for forage)	Medium Stemmed Giant	1 -1.7 kg in 1.7-2.2 kg in 2.2-3.4 kg in	53 cm rows 35 cm rows 17.8 cm rows 2.5 cm deep	October-for summer grazing October (drier districts) December-early January	
Choumoellier (for seed)	Medium Stemmed Giant	4.5-5.5 kg	17.8 cm rows 2.5 cm deep	November-early December	late December early January
Fodder beet	Yellow Daeno	1.7-2.3 kg (80% germination)	Precision drill 35 cm rows 2.5 cm deep	September	
Lucerne	Wairau Chanticleer (early) College Glutinosa	11 kg	9 cm-17.8 cm rows 1 cm deep	September-October	
Ryegrass	Ruanui, Ariki Manawa, Paroa Tama	22.5 kg	9 cm-17.8 cm rows 2.5 cm deep	January-March	Late December early January
Cocksfoot	Apanui	4.5-5.5 kg	17.8 cm rows 2.5 cm deep	January-March	Early January

Crop	Varieties	Rate of Sowing/ha	Width of Rows and Depth	Time of Sowing	Time of Harvesting
White Clover	Huia	2.2-4.5 kg	9 cm-17.8 cm rows 1 cm deep	February-March (with Ryegrass) June (with Wheat) August (with wheat) August-October with spring crops	January-February
Red Clover	Turoa (Montgomery) Hamua (Cow grass or Broad red)	4.5-5.5 kg	9 cm-17.8 cm rows 1 cm deep	Same as white clover	March-May

(11) HORTICULTURAL AND PROCESS CROP PRODUCTION

SEED SOWING – GUIDE FOR VEGETABLES

Species	Seeding Rate/ha. kg
Peas	120-180
Beans, Broad	50-60
Beans, Dwarf	40-80
Beans, Runner	15-20
Beetroot	5-6
Broccoli	0.25
Brussels Sprouts	0.25-0.5
Cabbage	0.25-0.5
Carrot	2-4
Cauliflower	0.25
Celery	0.25
Corn	10-12
Cucumber	2
Leek	2
Lettuce	1-2
Melons	1.5-2
Onion	4
Parsley	3-4
Parsnip	3-6
Pumpkin	2-3
Radish	10-12
Rhubarb	2
Spinach	10-15
Squash	2-4
Tomato	1-2
Turnip	2
Vegetable Marrow	2-3

YIELD OF VEGETABLES: AVERAGE PRODUCTION TABLE.

Vegetable	Yield tonnes/ha	Vegetable	Yield tonnes/ha
Asparagus	5.75	Melons, Water	15
Beans (Broad)	10.0	Melons, Rock	7.5
Beans, Dwarf (French)	7.5	Melons, Pie	38
		Onions	30
Beans, Runner (Stringless)	10 to 12	Onions, Spring	13
		Parsley	10
Beetroot	28	Parsnips	33
Broccoli	25	Peas	7.5
Broccoli, Sprouting or Asparagus	7.5	Potatoes	23 to 25
		Pumpkins, Squash	20
Brussel Sprouts	10 to 12	Pumpkins, Red, Crown etc	20
Cabbage, Spring	17.6	Pumpkins, Buttercup and Butternut	33
Cabbage, Winter	25		
Cabbage, Summer	20	Radish, Red & White	10
Carrots	30 to 38	Rhubarb	15 to 18
Cauliflower, Early	20	Spinach	7.5
Cauliflower, Late	25 to 28	Silverbeet	23
Celery, Green	63	Swedes	50
Celery, White	30	Sweet Corn	7.5 to 10
Cucumber	45	Tomatoes, Dwarf	30
Kumara	18	Tomatoes, Staked	35
Leeks	25	Turnips, white	30
Lettuce, Spring	28 to 30		
Lettuce, Summer	25		
Marrow	20		

References:

- New Zealand Commercial Grower
  (Official Journal of the N.Z. Vegetable and Produce Growers' Federation, Inc.)

- The Orchardist of New Zealand
  (Official Journal of the N.Z. Fruitgrowers' Federation Ltd, and N.Z. Apple and Pear Marketing Board)

- Commercial Horticulture
  (Official Journal of N.Z. Nurseryman's Assn. (Inc.)

- Lincoln College Dept. of Horticulture Bulletins

  e.g. No. 13. Labour Management in Horticulture and Agriculture
  No. 14. Parks Management Seminar
  No. 6. Horticultural Management Handbook

(12) ELECTRICITY

(Source—Farm Management Handbook—Queensland Dept. of Primary Industries)

Electrical Terms Defined

Ampere –	the unit in which electricity current strength is measured
Ohm –	the unit in which resistance to the flow of an electric current is measured
Volt –	the unit of electric pressure. A pressure of 1 volt is required to force a current of 1 amp through a resistance of 1 ohm.
Watt –	the unit of power or rate of doing work = volts x amperes
Kilowatt Hour –	for commercial purposes, electrical energy is charged for in units of 1000 watt hours – kilowatt hours.

$$\text{kWh for DC current} = \frac{\text{Volts x amps x hours}}{1000}$$

$$\text{kWh for AC current} = \frac{\text{Volts x Amps x hours x power factor}}{1{,}000}$$

Useful Formulae

1 kilowatt	= 1,000 watts
	= 1.341 horsepower
	= 44,253 foot pounds per minute
	= 56.869 British Thermal Units (B.t.u.) per minute

$$\text{Kilowatts to heat water in 1 hour} = \frac{\text{Gallons x Temperature rise } (^\circ F)}{341.2 \text{ x efficiency } (\%)}$$

(With water at an average tap temperature of 50° F, 1 kilowatt will boil 2.1 gal/hour at 100% efficiency).

1 Kilowatt hour	= 3,412 B.t.u.
1 B.t.u.	= Heat required to raise 1 lb of water 1° F
1 Calorie	= Heat required to raise 1 gm water 1° C
1 Therm	= 100,000 B.t.u.s. 29.34 KW/hr
1 horsepower	= 745.7 Watts = 42.407 B.t.u.s./minute

ELECTRICITY CONSUMPTION–UNIT PERFORMANCE DATA

*Such data can be used only as a guide, as actual electricity consumption will vary considerably throughout the year according to scale of production, air temperature and other factors.

SECTION (A)–DAIRY

Application	Description & Type	Herd Size	Motor Rating	Unit Performance	Average kWh Consumption per Annum
MILK COOLER (Water)	400 lph (2 can) 20 mm centrifugal pump	30-100	0.20 kW	–	40
	500 lph (3 can)	Over 100	0.20 kW	–	50
MILKING MACHINE	Required pump capacity–1/min				
2 single units	350- 450	10- 30	0.75 kW	15-25kWh per cow per 10-month lactation	400- 600
3 single units	450- 500	30- 40	0.75 kW	15-25kWh per cow per 10-month lactation	600- 800
4 single or 2 double	500- 600	40- 60	0.75 kW	15-25kWh per cow per 10-month lactation	800-1 000
6 single or 3 double	650- 750	60- 80	1.00 kW	15-25kWh per cow per 10-month lactation	000-1 200
8 single or 4 double	750- 900	80-100	1.50 kW	15-25kWh per cow per 10-month lactation	400-1 600
10 single or 5 double	900-1 000	100 +	1.50 kW	15-25kWh per cow per 10-month lactation	600-1 800
WATER HEATER	80 1 storage (65 1 draw-off)	30 (20-40)	1 000 watt	60 kWh/cow/annum (700 1 hot water/cow/annum)	1 800 40 kWh/450 1 65°C)
	100 1 storage (80 1 draw-off)	60 (over 40)	1 200 watt	60 kWh/cow/annum (700 1 hot water/cow/annum)	3 600 65°C)

ELECTRICITY CONSUMPTION–UNIT PERFORMANCE DATA–*continued*

(B) GENERAL

Application	Description & Type	Rating of Motor	Average kWh Consumption per annum	Unit Performance
Air Compressor	0.09m^3/min. 165 kg/cm^2	0.35 kW	Variable	0.50 kWh per hr.
Battery Charger	Electric fence	100 watts	30	1.00 kWh per charge
Chaff Cutter	2-blade-heavy type	2.25 kW	360	3.00 kWh per tonne
	3-blade-heavy-type	3.75 kW	300	2.00 kWh per tonne
Drill (portable)	6 mm drill (170 watts)	0.20 kW	Variable	0.20 kWh per hour
Emery wheel grinder	150-200 mm wheel	0.35 kW	10	0.25 kWh per hour
Grindstone	550-750 mm	0.20 kW	10	0.25 kWh per hour
House (average farm)	Lighting, minor appliances, refriger-ators and hot water service	–	6 000	–
Irrigation–Pumps		0.2-3.75 kW	–	2 700-6 800 l/kWh (depending on total head)
15 m vertical head	27 300 1/hr	3.75 kW	6 000	0.50 kWh/4 550 1
30 m vertical head	36 400 1/hr	5.60 kW	7 000	0.75 kWh/4 550 1
30 m vertical head	54 500 1/hr	7.45 kW	8 000	1-1.5 kWh/4 550 1
100 m (sprays) (25 m head)	27 200 1/hr	3.75 kW	6 000	20 kWh/cm/hectare
100 m (sprays) (45 m head)	27 300 1/hr	7.45 kW	10 000	30 kWh/cm/hectare
Saw bench (wood)	600 mm Saw	3.75 kW	150 kWh	5 kWh per tonne
Sheep shearing	–	0.05-0.35 kW	–	–
Soldering iron	25 mm diameter bit	180 watts	Variable	0.2 kWh per hour
Water Supply	Pressure system 1 150 1/hr	0.2-0.35 kW	50 kWh per annum	1 kWh per 4 550 1
Water Supply	Overhead tank system 2 250 1/hr	0.2 kWh	50 kWh per annum	0.5 kWh per 4 550 1

(13) FERTILIZERS

Essential Elements

There are 16 essential plant elements

Carbon	)	
Hydrogen		Drawn from air and water, with adequate amounts available.
Oxygen	)	
Nitrogen	)	Major elements, drawn from the soil
Phosphorus		(Nitrogen in specific instances is first fixed from
Potassium	)	the atmosphere by nitrogen-fixing plants)
Sulphur	)	
Calcium		Secondary elements
Magnesium	)	
Iron	)	
Copper	)	
Zinc	)	
Manganese	)	Trace Elements
Boron	)	
Chlorine	)	
Molybdenum	)	

The yield of the crop is limited by the plan nutrient element present in the smallest quantity, relative to the crop's requirements.

Fertilizer Information

(Source–K. P. Supplement)

FLOWMASTER FERTILISERS

Flowmaster Super 0 8 0 10

A specially manufactured fertiliser incorporating 10% Ground Serpentine, with excellent flowing and storing qualities for use in drills, spreaders and aircraft.

Recommended for topdressing established pasture and drilling with new grass, greenfeed and cereals under medium to high fertility situations. Apply 250 kg/ha in low rainfall areas, 375-500 kg/ha high rainfall.

30% Potash Super 0 6 14 7

Use where Potassium deficiency is likely, such as pastures under irrigation, dairy farms, forage crops and lucerne stands where total removal of herbage is practised. Apply at 375 kg/ha and if sown with a legume crop it is advisable to broadcast and work in rather than sow in contact with seed.

10% Sulphur Super 0 7 0 19

For topdressing Sulphur deficient pasture, particularly marginal land recently developed from bush or tussock areas. Apply 250 kg/ha every two years if Phosphorus levels are adequate, 125-250 kg/ha annually where Phosphorus is low and 375 kg/ha in high rainfall areas.

Multipurpose 4-5-10-11

A complete N-P-K-S fertiliser for intensively cropped soils where potash removal is high can be used for field crops such as fodder beet, mangolds, cereals, chou moellier and as a starter for vegetable crops. Apply 375-625 kg/ha.

Nitrogen Super 6 6 0 14

A very useful mixture of Nitrogen, Phosphorus and Sulphur with wide application to cropping and pastoral farming. Used increasingly on hill country. Apply at 125-375 kg/ha for new grass, 250-375 for cash crops, lowland and hill country pasture.

Note: where clovers are slow to establish request the inclusion of Molybdenum as a special mixture.

Potato Fertiliser 4 5 10 11

Specially formulated for seed and table potato crops. Where potato crops are grown for processing with irrigation request special high analysis mixture. Apply 500-750 kg/ha.

Boron Super 0 8 0 10

Topdress pastures where Boron deficiency has been identified. Unthrifty legume growth is a symptom and can be confirmed by foliage analysis. Topdress when leaves are dry to avoid leaf burn. Never allow contact with seed. Apply 250 kg/ha on low rainfall land and 500 kg/ha on high or with irrigation.

Cobalt Super 0 8 0 10

Contains 0.150% Cobalt Sulphate, an essential micronutrient for ruminants, affecting growth rate. If suspected consult your Veterinarian or advisor. Apply 150 kg/ha to control marginal deficiency, 280 kg/ha for known deficiency (giving 420g Cobalt Sulphate/ha).

Copper Super 0 8 0 10

Contains 2.5% Copper Sulphate and is formulated to alleviate Copper deficiency in plants and animals. Where suspected consult your Veterinarian or advisor. Apply 224 kg/ha annually for known deficiency and 313 kg/ha every 2-3 years where marginal (this applies 7.847 kg Copper Sulphate/ha).

Molybdate Super 0 8 0 10

Molybdenum is an essential micronutrient for establishing legumes and brassicas. Use where deficiencies are known. If suspected, contact your advisor. Apply 280 kg/ha where marginally deficient and 420 kg/ha where known.

Weedophos 2,4-D Super 0 8 0 10

Formulated for control of crop weeds including willow weed redshank wire-weed and pasture weeds including buttercup, scotch winged and nodding and Californian thistles. Is likely to slightly check white clover but will seriously affect red clover in the leafy growth stage. Apply when weeds are moist with dew and temperatures are mild to warm. For application outside the period 1st May-31st August a permit is required. Apply when weeds are small and clover growth at a minimum. Grazing pasture will expose weeds and reduce clover growth which could be checked. Avoid contamination with seed and exercise care to avoid drift on to adjacent crops. Available in bags only. Apply 250 kg/ha.

GRANULATED AND GENERAL FERTILISERS

Superphosphate 0 9 0 11

Apply annually to Phosphate responsive soils in autumn, winter or spring months where micronutrients are not deficient. Apply 250 kg/ha low rainfall, 375-500 kg/ha high rainfall.

Serpentine Reverted Super 0 7 0 8

Becoming a widely used replacement for lime reverted mixtures because of better physical qualities. It is a useful source of Magnesium (5%). Serpentine based fertilisers should be used where Magnesium levels are marginal as a counter to "hypomagnasaemia" or grass staggers. Can be sown with seed which is normally susceptible to germination injury. Apply 312-500 kg/ha.

Turnip & Rape Fertiliser 2 6 0 10

Use on soils that are not Boron deficient. Best results are obtained when drills with separate seed and fertiliser tubes or drills with band placement ability are used. Apply 250 kg/ha low rainfall, 500 kg/ha high rainfall.

Boron Turnip & Rape Fertiliser 2 6 0 10

Use as above but where Boron is needed. Boron is essential for the control of "brownheart" in brassica crops. Contact with seed must be avoided, so broadcast fertiliser and drill seed. Apply 250 kg/ha low rainfall, 500 kg/ha high rainfall.

Lucerne Sowing Fertiliser 0 7 0 8

Based upon Serpentine Reverted Super with 0.10% Sodium Molybdate or its equivalent, to supply the essential micronutrient Molybdenum. Also suitable for sowing with peas, beans, clover or other legumes as it aids nodulation. Apply 250-375 kg/ha with inoculated or coated inoculated seed.

Lucerne High K Fertiliser 0 5 24 5

Based on 50% Potash Super with 2.5% Fertiliser Borate, a source of Boron. It is formulated for high producing, irrigated stands and/or where total removal takes place. Apply when foliage is dry to minimise leafburn and do not sow with seed. On low rainfall areas apply 250-500 kg/ha, 500-750 on high or irrigated areas (500 kg supplies 12.5 kg Fertiliser Borate).

Lucerne Fertiliser 0 6 14 7

Formulated to meet the needs of dry land lucerne which is periodically grazed and hayed during the season, maintaining production from annual applications. Contains 2.5% Fertiliser Borate and Magnesium. Where Phosphorus levels are low, Lime, Superphosphate or Sulphur Super may be necessary. Apply Lucerne Fertiliser at 250-500 kg/ha low rainfall, 375-625 kg/ha high rainfall. Do not sow with seed.

Note: this fertiliser replaces "Lucerne Trace Fertiliser 0 4 21 14 + Mo".

Canterbury Orchard Fertiliser 10 4 10 5

Formulated to supply the major nutrient needs of pip and stone fruit trees on Canterbury soils. Half the Nitrogen is in the immediately available Nitrate form and the other half is in the longer acting Ammonium form. Apply 750-1500 kg/ha, depending on variety of trees and potential of crop.

NITROGEN AND SPECIAL FERTILISERS

Ammonium Sulphate 21 0 0 24

Useful for topdressing pasture, seed crops and cereals in early and late spring and for potatoes. Apply 125-375 kg/ha.

Potassium Chloride 0 0 48 0

The cheapest form of potash available. Use on all crops with a high K requirement. Apply 125-375 kg/ha when foliage is dry. Keep away from small seed.

Urea 46 0 0 0

A useful Nitrogen fertiliser for applying to pasture and cereals in the cooler growth months. It may be drilled deep into the soil to minimise atmospheric loss through volatilisation. Apply 62-125 kg/ha during cool, moist conditions.

Calcium Ammonium Nitrate 26 0 0 0 (C.A.N. or Nitrolime)

A safe form of Nitrogen for drilling with grasses, cereals and legumes which supplies Nitrogen in both Ammonium and Nitrate forms, as well as Calcium. It is non-acidifying but, like Urea absorbs moisture. Apply 125-375 kg/ha.

Potassium Sulphate 0 0 40 17

Ideally suited to crops like tobacco and tomatoes. Favoured by market gardeners. Apply 125-375 kg/ha.

Liquid Nitrogen 20 0 0 1

A solution of Urea, Ammonium Sulphate and an anti-corrosive additive. Provides a readily available Nitrogen source acceptable through root and leaf.

Apply
112 litres/ha (equals 125 kg/ha Ammonium Sulphate)
168 litres/ha (equals 188 kg/ha Ammonium Sulphate)
222 litres/ha (equals 250 kg/ha Ammonium Sulphate)

IMPORTED COMPOUND FERTILISERS

Cropmaster "Premium" 15 17 50

A high analysis granular fertiliser for green forage crops and leafy market garden crops where strong growth is required. Apply 250 kg/ha base dressing and 375 kg/ha side dressing or alternatively broadcast 625 kg/ha.

Cropmaster "Extra" 12 15 10 0

A well balanced granular fertiliser for starting a wide range of crops like cereals, maize, vegetable and potatoes as well as pasture. Additional Nitrogen applied as a foliar spray or side dressing would be an advantage on lighter irrigated soils. Apply 125-250 kg/ha cereals and pasture and 375-625 kg/ha vegetables and potatoes.

Cropmaster "Hi Yield" 9 12 15 0

A high analysis granular material for cropping on soils with medium Nitrogen and low Potassium levels. Suitable for a wide range of cereals, forage grasses and vegetables. 125 kg is equivalent to 62 kg Ammonium Sulphate, 188 kg Superphosphate and 42 kg Potassium Chloride. Apply 375-750 kg/ha.

Cropmaster "Boost" 6 10 20 0

A concentrated granular fertiliser which, because of its high potash level is most suited for hay silage or any obvious K deficient pastures. This material should be broadcast when foliage is dry and never drilled in contact with seed. Apply 250-500 kg/ha.

Cropmaster D.A.P. 18 20 0 0

D.A.P. or Di-ammonium Phosphate is the most concentrated fertiliser available. It is granular, free flowing and is completely water soluble. The Nitrogen and Phosphorus contained within each granule results in quick uptake and efficient use of Phosphorus by the plant. It may be applied to a wide range of crops, new pasture, established pasture and spring and autumn cereal crops provided Potassium is not required. 125 kg D.A.P. equals nearly 125 kg of Ammonium Sulphate plus 282 kg of Superphosphate. Apply 125-250 kg/ha grasses and cereals, 375-500 kg/ha potatoes and vegetables.

(14) IRRIGATION AND WATER SUPPLY

Source—Farm Management Handbook—Queensland Department of Primary Industries.

Measurements

Units of volume

The units of volume commonly used are cubic foot (cu. ft.) gallon (gal), acre foot (ac. ft.) and acre inch (ac. in.). An acre inch is the volume necessary to cover 1 acre to a depth of 1 inch; an acre foot, to a depth of 1 foot. Some international authorities are 1 millard = 1 cu. km. = 810, 800 ac. ft.

Units of flow

The common units of flow in irrigation practice are cubic foot per second (cusec), gallon per minute (g.p.m.), gallon per hour (g.p.h.), million gallons per day (m.g.d.), and acre foot per (24-hour) day.

The cubic foot per second (cusec) is the generally accepted unit for surface flow, but the gallon per minute or gallon per hour is used for expressing flow from pumps and wells. The million gallons per day is used principally in connection with municipal water supplies and only occasionally for irrigation.

List of Equivalents

1 cubic foot per second
- = 374 gallons per minute
- = 1 acre inch in 1 hour and 30 seconds or 0.992 (approximately 1) acre inch per hour
- = 1.984 (approximately 2) acre feet day (24 hours)

1 gallon per minute (Imperial gallon)
- = 0.00267 cusecs
- = 0.0269 acre inch per hour
- = 0.00538 acre foot per day

1 million gallons per day
- = 1.85 cusecs
- = 694 gallons per minute
- = 1.86 acre inches per hour
- = 3.73 acre feet per day

1 acre inch	= 3,630 cubic feet
	= 22,688 gallons
	= 1/12 acre foot
1 acre foot	= 43,560 cubic feet
	= 1,613 cubic yards
	= 272,250 gallons
1 cubic foot	= 1,728 cubic inches
	= 6¼ gallons
	weighs approx. 62.4 lb
1 cubic yard	= 27 cubic feet
	= 169 gallons
1 gallon	= 277.2 cubic inches
	= 0.16 cubic foot
	weights 10 lb

Conversion Table for Units of Flow

Equivalent values are given in the same horizontal line

Cubic Feet per second (cusecs)	Gallons per minute (g.p.m.)	Gallons per hour	Million gallons per day (m.g.d.)	Acre feet per day
1.0	375	22,500	0.54	1.984
0.00267	1.0	60	0.00144	0.00538
0.0000445	0.0167	1.0	0.000024	0.0009
1.85	694	41,640	1.0	3.73
0.504	189.1	11,344	0.268	1.0

METRIC EQUIVALENTS

Linear dimensions	1 km = 1 000 m 1 m = 1 000 mm
Area	1 ha = 10 000 m^2 1 m^2 = 1 000 000 mm^2
Volume	1 m^3 = 1 000 1 1 1 = 1 000 ml
Mass	1 t = 1 000 kg
Volumetric flow rate	1 1/s = 86.4 m^3/day = 31 536 m^3/year
Consumption rate	1 1/day = 0.365 m^3/year

COMMONLY USED UNITS FOR FARM WATER SUPPLY PROJECTS

Quantity	Unit	Symbol	Typical Application
Volume	cubic metre	m^3	Storage capacity of farm dams, excavated tanks. Volumes of earthwork, concrete and solids generally.
	litre	l	Fluid volume, volumes of small tanks, pressure vessels, fluid containers generally.
Velocity	kilometre per hour	km/h	Vehicular speeds, wind speeds.
	metre per second	m/s	Stream flow velocity, velocity in pipes, drains, channels.
Volumetric flow rate	cubic metre per second	m^3/s	Flow rates in large pipes, channels, streams, drains.
	litre per second	l/s	Flow rates in pipes, bores, pumping rates.
	millilitre per second	ml/s	Flow rates for trickle irrigation outlets.
Mass	tonne	t	Mass of large quantities of materials.
	kilogram	kg	Mass of quantities of materials generally.
Pressure	kilopascal	kPa	Water and air pressure, sprinkler nozzle ratings.
Power	kilowatt	kw	Power of engines, pumps, electric motors, tractors.
Density	kilogram per cubic metre	kg/m^3	Mass per unit volume of materials such as concrete, earth, clay.
Rate of consumption of water	cubic metre per day	m^3/day	Irrigation draft from dams, bores, rivers. Stock draft at excavated tanks.
	litre per day	l/day	Water consumption per person or per head of cattle or sheep.
Linear Dimensions	kilometre	km	Stream lengths, catchment area lengths, large distances generally.
	metre	m	Pipe and channel lengths, reservoir and well depths, hydraulic head.
	millimetre	mm	Pipe diameters, depth of irrigation applied, rainfall, runoff, evaporation, thickness of materials, small dimensions generally.
Area	hectare	ha	Areas of land, catchment areas for small dams, ponded areas.
	square metre	m^2	Cross sectional area of channels, large pipes, embankments.
	square millimetre	mm^2	Cross sectional areas of small pipes, steel sections.

METRIC-IMPERIAL EQUIVALENTS

The units shown are those most commonly applied to Farm Water Supply projects, together with equivalents in metric and imperial units.

Quantity	Metric Unit	Symbol	Equivalents
Long distances	kilometre	km	1 km = 1 000 m = 0.62 miles
Dimensions generally, hydraulic head	metre	m	1 m = 3.280 8 feet = 1 000 mm 1 m head = 3.280 8 ft. head = 9.8 kPa = 1.42 lb/in^2
Small dimensions, rainfall run-off, irrigation applied	millimetre	mm	25.4 mm = 1 inch (1 mm water applied to 1 hectare = 10 m^3)
Large areas	hectare	ha	1 ha = 2.47 acres
Small areas	square metre	m^2	1 m^2 = 0.0001 ha = 10.76 sq. ft.
Volumes—Earthwork, concrete, water storage	cubic metre	m^3	1 m^3 = 35.3 cubic ft. = 1.31 cubic yds. (1 234 m^3 = 1 acre foot)
Fluid volumes, small containers for fluids	litre	l	1 *l* = 0.001 m^3 = 0.22 gallons
Water pressure, air pressure	kilopascal	kPa	1kPa = 0.145 lb/in^2 = 0.102 m head
Power	kilowatt	kW	1 kW = 0.746 Brake Horsepower
Flows in drains, channel streams, very large pipe	cubic metre per second	m^3/s	1 m^3/s = 35.3 cu. ft. per second = 2.91 ac. ft. per hour = 13 197 gallons per minute
Flow in pipes, pump rate	litre per second	l/s	1 *l*/s = 13.2 gallons per minute = 791 gallons per hour

Water Requirements

(a) Average rates of demand

Average consumption figures may be used as a basis for preliminary planning. They may also be used to calculate time patterns of demand for the design of minor storages, provided that these time patterns are computed for the appropriate critical storage period.

(b) Peak rates of demand

Peak consumption figures should be used for the design of pumps, distribution systems, and spray irrigation layouts. They should not be used for storage design, except in the case of trickle-inflow storages for irrigation use.

(c) Quantity and time patterns

In storage design, the use of average consumption figures for estimating reservoir demand may lead to under-design, particularly if the critical storage period is more than one year and includes two summers. A quantity-and-time pattern of demand must therefore be calculated. This is particularly important in the design of major irrigation storages, for which a detailed monthly analysis of irrigation requirements over a critical storage period of known severity is essential.

AVERAGE AND PEAK WATER REQUIREMENTS FOR FARM WATER SUPPLY (C. B. Judd)

1. Average Daily Stock Water Requirements

Investigations carried out in Britain and U.S.A. have resulted in the publication of observed rates of water consumption by livestock. Because of the nature of the factors influencing stock water consumption, there exists quite a divergence of opinion on this matter. The following figures are put forward as a reasonable basis for design. The figures are in litres per head per day.

Dairy cattle, in lactation dry	:	70
dry	:	45
Beef cattle	:	45
Calves	:	25
Horses, working	:	55
grazing	:	35
Sheep, dry pastures	:	7
irrigated pastures	:	3½
Lambs, dry pasture	:	2
irrigated pastures	:	1
Sows	:	25
Pigs	:	11
Poultry, per 100 birds per day	:	30
Turkeys, per 100 birds per day	:	55

2. Average Daily Domestic Consumption

The following figures are suggested as reasonable.

Household use including Septic system	:	180 litres per person per day
Household use excluding Septic system	:	135 litres per person per day

3. Average Daily Garden Consumption

(to be used for the design of pumping and reticulation equipment)

Lawns and gardens for the growing of flowers, fruit and vegetables are an essential part of every farm homestead and require much larger quantities of water than are used in the house.

The quantity of water used each day on the house garden can be obtained by relating the consumption to the evapotranspiration as given in the expression $C = 8000\ E_t$

Where C = consumption in litres per day per hectare

E_t = Daily evapotranspiration for pasture in millimeters for the month of January.

In deriving this relationship it was assumed that the quantity of water used on the average house garden would be only 60 per cent of the evapotranspiration for completely vegetated surfaces having a plentiful supply of water.

In view of the quantity of water used on a house garden it is most essential that the area of the garden that is actually watered be carefully measured.

4. Average Consumption on General Farming Activities

Water, in addition to being required for household and stock purposes, must also be provided for other farming activities. It is required in the dairy for the cleansing of equipment and the washing down of bails; in the piggery for washing down purposes; on the fruit farm for spraying; and on the grazing property for dipping purposes.

It should also be provided for use when required as a protection against fire. This important aspect is generally neglected and there is no doubt that if satisfactory supplies had been available, much of the loss in human lives, stock and farm buildings that has occurred from time to time could have been averted.

The quantities of water given below are suggested as being suitable for carrying out the above farming activities –

(1) Dairy	:	Cooling, cleansing of equipment and washing down of bails and other areas – 70 litres per head per day
(2) Piggery	:	Washing down of pens – 1500 litres per day per 100 sq. m of area to be cleaned
(3) Sheep Dip	:	The quantity used varies with the method of dipping and is generally carried out once a year. Spray Dip – 5 litres per 3 sheep for sheep 2 weeks off shears – 5 litres per 2 sheep for sheep 2 to 6 weeks off shears – 5 to 7 litres per sheep for sheep over 6 weeks off shears (capacity of sump 1000 to 2000 litres) Plunge Dip – Because of the greater wastage the above figures should be increased by 25 to 50 per cent (capacity of average dip 5000 to 7500 litres.)
(4) Insecticide spraying	:	Citrus – 18 litres per tree 4 to 5 times a year (average size of spraying vat 350 to 550 litres) Other fruit – 9 – 14 litres per tree 8 to 12 times a year (average size of spraying vat 350 to 550 litres)

(5) Fire fighting : 1200 litres per 10 m^2 of buildings

5. Long Term Demands in Domestic and Stock Supplies

The Source of supply for a stock and domestic scheme will be either a permanent watercourse, a well, a bore or a dam. Where the supply comes from a dam there must be sufficient capacity to meet the stock and domestic requirements for the longest period between replenishment from surface runoff. For most of New Zealand it can be assumed that the dam will be replenished once a year.

The average daily consumption of water in the house is more or less constant throughout this period as is to a certain extent the consumption of water in general farming activities. Consumption of water by livestock will vary to some extent because of changes in climatic conditions and the ages of the animals. It is suggested therefore that the long term requirements for stock be determined on the basis that the daily consumption for the period between replenishments is 75 to 80 per cent of the average daily requirements in the case of sheep and 80 to 85 per cent in the case of other stock.

The quantity of water used on the house garden over any period extending beyond several months and in different localities varies between wide limits and a greatly exaggerated figure is obtained for the long term demand if the total consumption for the period between replenishments is based solely on an average daily consumption.

It is considered therefore that the actual quantity of water needed to produce satisfactory growth of the garden during this period should be determined having regard to location and rainfall and this can be done by using the expression –

$$C = 10000\,(0.8\,E_t - R)$$

where C = total consumption in litres per hectare

E_t = monthly evapotranspiration for pasture in millimeters for each month of the growing season.

R = Three quarters of the sum of the average monthly rainfall for the particular locality and growing season

6. Storage Provision of Tanks and Dams Filled by Pumping Or Gravity From a Source of Supply

(a) For windmill operated pumps three to five days

(b) For pumps operated by other forms of power the storage to be provided in case of breakdown depends mainly on the interruption that the breakdown will cause to stock watering. If other water supplies are available and stock can be moved to these supplies without great inconvenience then no storage is necessary, on the other hand if no alternative supply exists at least two days supply should be kept in storage. This storage should be isolated from the main supply as often the breakdown is not noticed until all storage in the system is used and the troughs are dry.

7. Pumping Rates For Filling Storages From Supply

To determine the pumping rate to replenish a storage tank or dam, consideration should be given to:

(i) Type of pumping equipment to be used;

(ii) Nature of the supply, especially where withdrawal rates could approach low flows;

(iii) Accessibility of pumping equipment;

(iv) Possibility of using off-peak power at special rates.

The following points are listed for design purposes and as a general guide.

(1) For trunk mains to storage reservoirs, tanks etc. by power driven pump discharge rate to be based upon filling storage in approximately 12 hours. However, in the case of an electrically operated pump and a large storage tank there is no reason why a pumping period of 24 hours cannot be used.

(2) For trunk mains to storage reservoirs, tanks etc. by windmill driven pump.

Min. discharge litres/hour = 1/10 to 1/8 total daily demand in litres depending upon make of mill.

8. Maximum Rates of Consumption For Domestic and Stock Purposes

(1) Household Supplies

To calculate the maximum flow rate to a house it is first necessary to list all the outlet points in the house and then to make a rational estimation of how many of these points are likely to be used simultaneously during peak periods.

The discharges of various outlet points within a household are as follows:

Shower, bath, laundry	:	14 litres/min
Toilet cistern	:	7 litres/min
Kitchen sink	:	11 litres/min

For example in a household of two adults and two children it would be reasonable to assume that around tea time the shower, kitchen sink and toilet cistern could be in use simultaneously hence the total flow would be

Shower	14
Toilet	7
Kitchen Sink	11
	32 litres/min

(2) Stock Supplies

The lack of definite information on stock drinking habits makes any estimate of peak rate of demand to stock supply points open to argument.

It is suggested that peak demands be determined on the basis that the average daily consumption is used on a period 3 to 4 hours in case of set stocking in large area paddocks and 10 – 12 hours for intensive stocking on small sub-division paddocks.

(3) General Farm Supplies

Suggested values for the maximum rates at which water will be used in general farming activities are outlined below:

(i)	Dairy – cleansing	:	11 litres/min per outlet
	washing down	:	14 litres/min per outlet
(ii)	Piggery	:	14 litres/min per outlet

(iv) Insecticide spraying	:	70 to 90 litres/min into the spraying vat or at such a rate that this can be filled in a period of 5 to 7 minutes
(v) Fire fighting	:	100 to 150 litres/min at a head of 25 to 35 m.

(4) Garden Supplies

The maximum rate at which water is used on a house garden depends mainly upon the size of the garden. Most house gardens today are watered by garden sprinkler. A normal garden sprinkler on a 13 mm (½") garden hose has a flow rate of approximately 15 litres/min. For a very large garden it may be necessary to operate two sprinklers simultaneously, hence the required flow rate would then be 30 litres/min.

Water Requirements for Irrigation

RECOMMENDED DEGREES OF RELIABILITY FOR MAJOR STORAGE DESIGN

(Source: Queensland Department of Primary Industries)

Purpose of Storage	Recommended degree of reliability
Station homestead supply	95%
Stock water	90% to 95% depending upon likely consequences of failure.
Irrigation – permanent planting, e.g. citrus, vines	95%
Irrigation – permanent pastures	90%
Irrigation – annual crops or pastures	80%
Irrigation – fodder crops for sale or silage	66% to 75% depending upon degree of flexibility available

NOTE: 95% reliability implies 1 year in 20 with rationing or failure.
90% reliability implies 1 year in 10 with rationing or failure.
80% reliability implies 1 year in 5 with rationing or failure.
75% reliability implies 1 year in 4 with rationing or failure.
66% reliability implies 1 year in 3 with rationing or failure.

A minor storage is one which is not important in a hydrologic or economic sense and where alternative sources of water are available in the

Factors Influencing Cost of Irrigation System:—

(a) The soil type and depth
(b) The crop to be grown
(c) The shape and dimensions of the area to be irrigated
(d) The distance from the water source to the edge of the irrigated area
(e) The maximum height of the area above the level of the water source
(f) The topography of the irrigated area
(g) The existence of any restriction on daily pumping time
(h) The availability of electricity

Establishing the Watering Cycle

In establishing the watering cycle, several factors must first be accounted for.

(i) The frequency of irrigation
(ii) Maximum net application (inches)
(iii) Efficiency of application
(iv) Application rate

Frequency of Irrigation

The frequency of irrigation is the maximum interval between irrigations under peak crop requirements for the crop and soil type under consideration, assuming that no natural precipitation occurs in that interval. If the irrigation plant is adequate to cope with this situation, it should be more than adequate to cope with crop requirements at all other stages.

Frequency of irrigation is obtained by dividing the net available water in the crop root zone by the peak daily water usuage of the crop. To allow for a safety margin, approximately 70 to 80 per cent. of this time is taken as the maximum cycle under peak conditions.

Net Available Water

This ranges from 40 to 60 per cent. of the total available moisture, the higher figure in general applying to the light soils. The figure normally used is 50 per cent.

Total Available Water

This is obtained by multiplying the total available water per foot of soil by the depth of the effective root zone.

Total Available Water per Foot of Soil

A table of total available water capacities per foot of soil for various typical irrigation soil types is given. These figures are for soils of uniform texture throughout the effective root zone of the crop being considered. No allowance is made for the presence of a permanent or perched water table within this root zone.

SPRINKLER IRRIGATION DESIGN DATA TABLE 1

Mean Available Water-Holding Capacities of Soils of Various Textural Classes

Textural			Water available Millimeters per decimetre Inches per foot depth of soil	
	Up to .3 metres (12in)			
	Millimeters per metre	Inches per foot	Millimetres per metre	Inches per foot
Sand	150	1.8	50	0.6
Loamy Sand	180	2.2	110	1.3
Sandy Loam	230	2.7	150	1.8
Fine sandy loam	220	2.6	150	1.8
Silt loam	220	2.6	150	1.8
Clay loam	180	2.2	110	1.3
Clay	175	2.1	110	1.3
Peat	200 to 250	2.4 to 3	At least 200 to 250	At Least 2.4 to 3

NOTE 1 – Before Table 1 is applied to the soils of an area a sufficient number of earth auger test holes shall be put down to determine variations in the depth and textural class of the soil within the effective crop root depth.

NOTE 2 – Where detailed determinations of the water-holding capacities of soils have been made, the values so obtained shall be used in place of table 1.

Where no determinations have been made but the classification of the soil to be irrigated is known in terms of the main soil groups defined by the New Zealand Soil Bureau, the available water-holding capacity of the soil may be predicted from the known properties of these groups rather than from table 1. Mean values of measured available water-holding capacities for several of these soil groups are set out in table 2. The use of table 2 as soils formed on volcanic ash, pumice or basalt.

TABLE 2

Mean Available Water-Holding Capacities of Soil Groups in New Zealand

Soil Group	Water available			
	Millimetres per decimetre depth soil		Inches per foot depth soil	
	Depth from surface		Depth from surface	
	Up to .3m	Below .3m	Up to 12in	Below 12in
Northern yellow brown earths	17.5	11	2.1	1.3
Northern podzols and podzolized soils	22	9	2.6	1.1
Brown loams on basalt	13	7.5	1.6	0.9
Brown Granular clays (North Auckland)	17.5	15	2.1	1.8
Brown Granular loams (South Auckland)	16	7.5	1.9	0.9
Yellow brown loams	20	12	2.4	1.4
Yellow brown pumice soils	26	22	3.1	2.6
Central and Southern yellow brown earths	20	11	2.4	1.3
Yellow grey earths	22	11	2.6	1.3
Brown grey earths	18		2.2	
Organic soils (peat)	20 to 25	At least 20 to 25	2.4 to 3	At least 2.4 to 3

A Guide to Soil Textures

Coarse Sand Many of the individual grains are 1/12 in. in diameter or larger and can be easily seen and felt. When moist, the cast crumbles easily.

Sand. This is similar to a coarse sand in texture and appearance, except that the individual grains are much smaller.

Sandy loam. The individual sand grains can be seen and felt but the silt and clay content is sufficient to give some stability to a cast made from the moist soil.

Fine sandy loam. This is intermediate in texture and appearance between a sandy loam and a loam.

Loam. This contains sand, silt and clay in such proportions that none of the fractions is easily distinguished by sight or feel. The dry soil slips easily through the fingers, but the moist soil feels smooth (not sticky) and a cast can be handled quite freely without breaking.

Sandy clay loam. This is intermediate between a loam and a clay loam.

Clay loam. When dry, a clay loam is inclined to be cloddy unless the organic matter is high. When moist, it is slightly sticky and a thin ribbon, formed under pressure between the fingers, breaks easily. The cast of moist soil is quite stable.

Light clay. This is intermediate between a clay loam and a clay.

Clay. Clay soils are usually lumpy when dry and sticky when wet. A thin ribbon of moist soil is quite flexible and can frequently be bent into a circle without breaking.

Crop Root Zone

Crop root zone is the depth of soil which contains the bulk of the roots (80 to 90 per cent.) of a crop. The table that follows is a guide to these depths for some selected crops and while the roots of some may be traced to much greater depths, the contribution made by the deeper roots to the plant's water requirements may be neglected.

TABLE 3
Effective Crop Root Depths Under Irrigation

Crop	Root depth Metres	Root depth Feet
Fruit Crops		
Apples	.76–1.22	2½–4
Apricots	.61–1.37	2–4½
Berry Fruits	.31–.76	1–2½
Cherries	.76–1.22	2½–4
Chinese gooseberries	.31–.46	1–1½
Citrus	.61–1.22	2–4
Grapes	.46–.91	1½–3
Passion fruit	.31–.46	1–1½
Peaches	.61–1.22	2–4
Pears	.61–1.22	2–4
Plums	.76–1.22	2½–4
Strawberries	.31–.46	1–1½
Vegetables		
Asparagus	1.83	6
Beans	.46–.61	1½–2
Beetroot	.31–.46	1–1½
Broccoli	.46–.61	1½–2
Brussels sprouts	.46–.61	1½–2
Cabbages	.46–.61	1½–2
Carrots	.46–.61	1½–2
Cauliflowers	.46–.61	1½–2
Celery	.61	2
Cucumbers	.46–.61	1½–2
Globe artichokes	.61–.91	2–3
Lettuces	.15–.46	½–1½
Onions	.31	1
Parsnips	.62–.91	2–3
Peas	.46–.61	1½–2
Potatoes	.61–.91	2–3
Potatoes (sweet)	.61–.91	2–3
Pumpkins	.91–1.22	3–4
Vegetables		
Radish	.31	1
Rock melons or canteloups	.61	2
Spinach (silver beet)	.46–.61	1½–2
Squash	.61–.91	2–3
Swedes	.61–.91	2–3
Sweet Corn	.61–.91	2–3
Tomatoes	.61–1.22	2–4
Turnips (white)	.31–.61	1–2
Water melons	.61–.91	2–3
Field Crops		
Barley	.91–1.1	3–3½
Lucerne	1.22–1.83	4–6
Maize	.61–.91	2–3
Oats	.61–.76	2–3
Rice – sprinkler irrigated	.61–.91	2–3
Sorghum (grain & sweet)	.61–.91	2–3
Tobacco	.61–1.22	2–4
Wheat	.76–1.1	2½–3½
Pasture and fodder crops		
Choumoellier	.46–.61	1½–2
Fodder beet	.46–.61	1½–2
Lucerne	1.22–1.83	4–6
Millett – fodder	.31–.61	1–2
Pastures – annual	.31–.76	1–2½
Pastures – perennial	.31–.76	1–2½
Rape	.46–.61	1½–2
Sorghum alum	.91–1.22	3–4

(ii) Maximum Net Application

Maximum net application is the amount of water required to replace that removed from the soil by the crop under peak water conditions during the irrigation cycle.

In quantity, it is equivalent to the net available water.

(iii) Efficiency of Application

For sprinkler irrigation systems, efficiencies within the range 80 to 90 per cent. can be achieved with good equipment correctly used.

For high temperature, low humidity and moderate wind conditions (5 to 10 m.p.h.), the figure of 80 per cent. should be used. For low temperature, high humidity and light wind conditions (less than 5 m.p.h.), the figure of 90 per cent. should be used. Efficiency of sprinkler systems should be estimated for the peak use period.

For surface irrigation, lower efficiencies of application than those quoted for spray irrigation are usual, due mainly to water distribution losses in head ditches, and, particularly in lighter soils, to deep percolation below the crop root zone. Evenness of wetting depth is more difficult to achieve with coarser-textured soils, and for these the efficiency of application may fall as low as 60 per cent. For heavier (finer textured) soils, it is possible to achieve efficiencies of the order of 70 to 80 per cent.

EFFICIENCY OF APPLICATION FOR VARIOUS IRRIGATION METHODS

	Method of Application	Application Efficiency
(a)	*Spray* –	
	(i) Night watering	0.90
	(ii) Average day watering	0.80
	(iii) Day watering in hot, windy weather	0.60
(b)	*Control flooding* –	
	(i) Border check	0.75
	(ii) Border ditch	0.70
(iii	(iii) Contour check	0.75
(c)	*Semi-controlled flooding* –	
	(i) Contour ditch	0.60
	(ii) Keyline system	0.65
	(iii) Wild flooding, little or no land preparation and no spreader banks	0.50

(iv) Application Rate

Application rate should be varied according to the infilitration rate of the soil, the average slope of the irrigated area, the degree of plant cover, the soil surface phenomena and the total application.

For spray irrigation systems, application rate determines the time necessary to apply the required depth of water. Thus, in turn, will govern the interval between shifts and thus the number of shifts possible per day. The greater the daily pumping time that can be utilized, the smaller the discharge rate required from a pumping unit for a particular gross application, area and irrigation cycle. Therefore, wherever it is suitable, select the rate which will require the highest possible daily pumping time, but which still allows two shifts to be made per day. For medium pressure systems, rates from 25 to 40 p.p.h. are normally recommended. The rate used should not exceed the maximum rates specified in the table that follows.

Estimated Maximum Water Application Rates for Design

Soil groups based on texture and profile	Slopes* $0-8^{0}$		Slopes** $9^{0}-12\frac{1}{2}^{0}$		Slopes*** over $12\frac{1}{2}^{0}$	
	mm per hr	in per hr	mm per hr	in per hr	mm per hr	in per hr
Sands and light sandy loams uniform in texture to 6ft (1.82m) pumice	31.8	1.25	25.4	1.00	20.3	.80
Sandy loams to 2ft (.61m) overlaying a heavier subsoil	20.3	.80	16.5	.65	12.7	.50
Medium loams to sandy clays over a heavier subsoil	16.5	.65	12.7	.50	10.2	.40
Clay loams over a clay sub-soil	12.7	.50	10.2	.40	7.6	.30
Silt loams and silt clays	10.2	.40	7.6	.30	5.1	.20
Clays	6.4	.25	5.1	.20	3.8	.15
Peat	16.5	.65				

* $0-8^{0}$ slope – level to undulating.

** $9^{0}-12\frac{1}{2}^{0}$ slope – undulating to low hills.

*** Over $12\frac{1}{2}^{0}$ slope – low to steep hills.

NOTE 1 – The above figures are intended for guidance only. Where detailed soil surveys and infiltration experiments have been carried out or, where reliable application rate data are available for a similar soil, the figures so established for application rates shall be used.

NOTE 2 – For bare cultivation such as undertree watering of orchards and watering of vegetables, the above rates shall be reduced by up to 50 percent (to avoid soil loss or damage to structure).

NOTE 3– Lighter application rates shall be used when pastures and crops are being established.

For flood irrigation, the amount applied per watering, rather than application rate, will determine the area which can be watered in the irrigation cycle from a given water supply or with a given size of pumping plant. This is because infiltration rates are relatively high in the initial stages of application, but as watering continues, a more or less steady, much lower, rate of infiltration occurs. Thus for a particular soil, it may take 1 hour to apply 1 in. but 3 or 4 hours to apply 2 in.

Factors Affecting Pump Size

Total Head

The total head involves three factors –

Suction head
Delivery head
Friction head

and is expressed in metres.

The Suction Head is the vertical distance between the water level and the pump centre. To this must be added the losses due to friction in pumping a given quantity of water.

The Delivery Head is the vertical distance from the pump centre to the point of discharge.

The Friction Head is the loss due to friction caused by the flow of water in the system. These losses vary with the size and nature of the pipe and the rate of flow through the pipe.

In any system there must of necessity be various fittings such as valves, elbows and tee pieces. In calculating the friction loss it is necessary to equate these in terms of equivalent lengths of straight pipe. In computing the total friction loss, the sum of these equivalents must be added to actual length of pipe.

Water Power (W.P.)

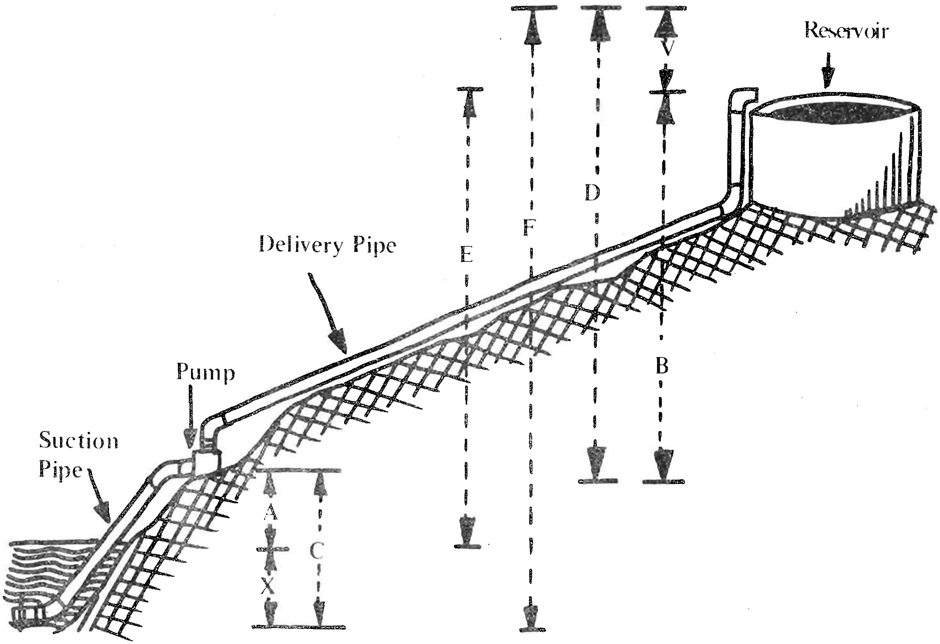
Once the total head against which the pump must operate has been determined, the calculation of water power is the next step in the process of arriving at the motor power required.

Water power is the power required to deliver a given quantity of water against a given head or pressure in a given time.

If then the flow in litres per minute Ql and the pump pressure in kPa are known, then water power can be determined by multiplying the flow in litres per second (Ql/60) the head in metres (i.e. pressure in kPa x .1019) and the weight per litre of water, to give the answer in watts.

$$\text{W.P.} = 9.89 \times \frac{Ql}{60} \times .1019\,P \qquad = \left(\frac{1}{60} \times Ql \times P\right) \text{Watts}$$

DIAGRAM PORTRAYING VARIOUS DEFINITIONS



Definitions of Head in Pumping

A Static suction head or lift
B Static delivery head
X Friction head loss in suction pipe
Y Friction head loss in delivery pipe
C Total suction head (A + X)
D Total delivery head (B + Y)
E Static head (A + B)
F Working or total head (A + B + X + Y)

Pump Efficiency

The power delivered by an electric motor or engine to the shaft it turns is known as the brake power. Pump efficiency is the ratio of the useful water power delivered by a pump (the output) to the brake power (the input to the pump).

Centrifugal pumps are designed for specific types of work. One cannot expect, for example, a pump designed for large volume but low lift work to perform efficiently in a position where it is required to pump a low volume to a great height.

A good practical suggestion is to assume the efficiency of a centrifugal pump at 65 per cent. This allows a fair margin of safety for pump wear.

The formula for pump efficiency:–

$$\text{Efficiency} = \frac{\text{Water Power}}{\text{Brake Power}}$$

can be used in its other two forms:–

$$\text{B.P.} = \frac{\text{W.P.}}{\text{Efficiency}} \text{ or W.P.} = \text{Efficiency} \times \text{B.P.}$$

It is of practical value always to keep some reserve "up your sleeve" to allow some margin for wear and tear in the unit supplying the power. Centrifugal pumps must run at recommended speeds and any fall in revolutions will seriously impair the pump's efficiency – even to the level where it could fail to pump at all.

Selection of Pump Size

For a given centrifugal pump, the delivery, head and power used will all increase as speed is increased.

All centrifugal pumps operate within the following laws –

1. The quantity of fluid discharged varies directly as the speed.
2. The head or pressure developed by the pump varies as the square of the speed.
3. The power required varies as the cube of the speed.

It is most undesirable to drive the pump at speeds higher than recommended because the wear on impeller and bearings becomes very great.

Manufacturers' tables should be referred to when selecting a suitable size pump. They are designated by the size of the discharge pipe. For example, a 2-in. pump has a 2-in. discharge pipe. A 2:3 pump has a 2-in. delivery and a 3-in. suction.

There is no power loss when pump and engine are directly coupled. In the case of belt drives, however, an additional margin must be added to both engine H.P. and pump speed to allow for slip. This is 5 per cent. for V belts and 10 per cent. for flat belts.

Working lives for Farm Water Supply Equipment

Storages:

Wells and bores	25 years
Windmill	20 years
Pumphouse or shed	20 years

Pumps:		
Deep-well turbine pump:		
Bowl		16,000 hours or 8 years
Column etc.		32,000 hours or 16 years
Centrifugal pump		30,000 hours or 15 years
Low lift high discharge axial flow pump		30,000 hours or 15 years
Motors:		
Electric motor		50,000 hours or 25 years
Diesel engine	900 rpm or more	28,000 hours or 14 years
	less than 600 rpm	50,000 hours or 25 years
Petrol engine	air cooled	8,000 hours or 4 years
	water cooled (1200 rpm +)	28,000 hours or 14 years
	water cooled (< 1200 rpm)	20,000 hours or 20 years

Asbestos-cement pipeline	20 years
Aluminium sprinkler line	15 years
Galvanized sprinkler line	15 years
Sprinkler head	8 years
Earth irrigation ditches	15 years
Concrete irrigation ditches	20 years
Catch drains	15 years

15 WEED AND PEST CONTROL

Insecticides

(Source: F. B. Thompson – N.Z.J.Ag.)

Insecticides are used widely in New Zealand by farmers on cropping farms, pastoral farms and dairy farms alike.

Many farmers remain unaware of, or perhaps consider negligible, the dangers involved in using certain insecticides.

Toxicity is expressed briefly, but incompletely, as the LD50 in Mg/kg. This is the lethal dose to 50% of the test animals (usually rats) expressed as milligrams of chemical per kilogram of the animal's liveweight (1 mg/kg is one part per million). The LD50 for very toxic materials is thus lower than that for less toxic chemicals, e.g. Malathion, with an oral LD50 of 1,400 mg/kg is much less toxic than TEPP, LD50 0.5–1 mg/kg, which is the most hazardous chemical in New Zealand.

Other information given in the table is:

–Waiting periods:

Recommended periods between the application of the chemical and the harvesting of horticultural crops.

–Withholding periods:

Period that must elaspse between last application of an agricultural chemical and grazing by livestock.

PEST CONTROL GUIDE

Insecticide	For Control of	Rates per Hectare	LD50	Characteristics
ORGANOCHLORINE INSECTICIDES				
Aldrin	Wireworm in maize, sweetcorn, tobacco and potatoes.	1121 - 3586 gm a.i.	Oral - 40-60 Dermal - > 200	Highly hazardous, permit required. Waiting period - crops where edible parts exposed - 6 weeks, where not - 3 weeks.
DDD	Chewing insects in horticultural crops and ornamentals.	830 gm a.i./1128 litres	Oral - 400-3400 Dermal - > 5000	Toxic to bees, cucurbits, tomatoes (at an excessive rate). Waiting period - tomatoes - 1 day, other crops - 3 wks
DDT	Wide range of chewing and sucking insects, in hort. crops and grassed areas not grazed.	Spray 279 gm a.i./1128 litres Dust 224 - 1345 gm a.i./ ha Pellets 3362 gm	Oral - 300-500 Dermal - 2500	Toxic to fish and bees. Waiting period - tomatoes - 7 days, berry fruits - before flowering, other crops - 4 wks. Permit required.
Dieldrin	Crickets, soil insects. No permits issued for agricultural land.		Oral - 40 Dermal - > 100	Permit required. Very hazardous. Toxic to fish and bees. Not phytotoxic. Waiting period - edible parts exposed - 6 wks, where not - 4 wks.
Endosulfan	Broad spectrum - black currant gall mite, aphides, bronze beetle, thrips, earthworms, cyclamen mites, potato tuber moth, looper caterpillars.	448 - 1008 gm/1128 litres	Oral - 35 Dermal - 74-130	Permit required. 14 wk withholding period. Inflammable. Highly hazardous. Toxic to fish and bees.
Endrin	Big bud mite, raspberry bud moth and flax grub.	448 gm a.i./1128 litres Flaxgrub 897 gm a.i.	Oral - 3-6 Dermal - 6-120	Very toxic. Toxic to fish and bees. Permit required for use. 14 wk withholding period. Pip fruit - apply pre-blossom only.
Heptachlor	Long term control of soil insects in grassed, non-grazed areas.	1120 gm a.i. Pellets 2241 gm a.i.	Oral - 40 Dermal - 200-250.	Highly hazardous, toxic to fish and bees. Phytotoxic to hops. Permit required.
Lindane	Chewing and sucking insects in horticultural, agricultural crops and gardens.	Hort. 335 - 560 gm a.i. per 1128 litres Agri. 2240 gm/ha (grass grub) 1120 gm/ha (black Beetle)	Oral - 200 Dermal - 500-1000	Toxic to bees. Do not use on crops where root crops will be grown in next 2 yrs. Permit required. Withholding period - 4 wks. Waiting per-

Insecticide	For Control of	Rates per Hectare	LD50	Characteristics
Lindane (cont.)				iod - tomatoes & smooth skinned fruits - 3 wks. On other crops - do not apply after edible parts start to form.
ORGANOPHOSPHOROUS INSECTICIDES				
Azinphos-ethyl	Biting and chewing insects, springtails, white butterfly, potato tuber moth, red-legged mite, blue oat mite, pasture weevils, horticultural and agricultural crops.	335 - 450 gm a.i./1130 litres Springtails 130 gm a.i./ 1130 litres	Oral - 9 Dermal - 280	Very hazardous. Toxic to bees. Waiting period - 2 wks for smooth skinned fruits and root vegetables. All others - 3 wks.
Azinphos-methyl	Insect pests in pip, stone and citrus fruits, potato tuber moth.	335 - 560 gm a.i./1130 litres	Oral - 7-13 Dermal - 280	Highly hazardous. 3 weeks withholding period. 2 weeks waiting period for smooth skinned fruit & root vegetables. Others - 3 weeks.
Bromophos	Clover case bearers & springtail. Leaf chewing insects, thrips, midges, aphides.	600 gm a.i.	Oral - 3750-6100 Dermal - 2181	Toxic to bees. Permit required. Toxic to certain susceptible varieties of grapes, pears, melons, cucumbers. Waiting period - 7 days. Withholding period - 7 days.
Carbophenothion	European red & two spotted mites, woolly aphides and scale insects on orchard trees.	335 - 670 gm a.i./1130 Litres	Oral - 7-30 Dermal - 800	Highly hazardous. Toxic to fish. Waiting period - 3 wks. Young foliage may be susceptible to damage.
Chlorfenvinphos	Phorid and Sciarid fly larvae in mushroom compost.	225 - 335 gm per 2.5 tonnes	Oral - 19 Dermal - 69	Highly hazardous. Toxic to fish. For field assessment only. Do not feed treated crops to animals or humans.
Demeton-S-methyl	Cereal aphid, cabbage aphid. Sucking insects and mites.	225 - 355 gm a.i./1130 litres	Oral - 40 Dermal - 85	Highly hazardous. Toxic to bees and fish. Do not spray plants within 10 days of flowering. Waiting period - 3-5 weeks. Withholding period - 2 weeks.

Insecticide	For Control of	Rates per hectare	LD50	Characteristics
Diazinon	Aphides, leaf hopper, leaf curling midge, scale insects, codling moth, mealy bug, leaf roller, thrips, caterpillars, grass grub, porina, army caterpillar, diamond back moth, springtails, crickets, carrot rust fly.	Agri. 920 gm a.i. Hort. 570 gm a.i./1130 litres (high vol.) 900 gm a.i./225 - 4380 litres	Oral - 300-600 Dermal - 500-1200	Toxic to bees. Grassgrub - apply March-May when grubs small and actively feeding. Phytotoxic to cineraria, foliage damage to azaleas and linums. Waiting period: tomatoes - 3 days, other crops - 2 weeks. Withholding period - up to 7 days (nil for concentrates up to 1 lb ai/acre.
Dichlorvos	Aphids, diamond backed moth, white butterfly, clover case bearer moth.	110 - 225 gm a.i. (case bearer) 225 - 335 gm a.i. (crickets) 336 - 785 gm a.i. (field crops & horticulture)	Oral - 25-30 Dermal - 75-900	Highly hazardous. Toxic to bees. Waiting period - 3 days. Withholding period - 12 hours. Permit required.
Dicrotophos	Cereal and potato aphids.	225 - 335 gm a.i.	Oral - 22 Dermal - 127	Highly hazardous. Toxic to bees. Withholding period - 4 wks, waiting period: potatoes, cereals, grapes - 6 wks, vegetable & fodder crops - 4 wks.
Dimethoate	Aphides, spider mites, mealy bug, scale insects, leaf miners, leaf hoppers, springtails, white & fruit flies, thrips. Contact & systemic insecticide for field crops, cereals, orchards, market gardens, nurseries.	225 - 448 gm a.i.	Oral - 200-300 Dermal - 700-1150	Toxic to bees. Do not spray rough lemons, meyer lemons, unbudded rough stock, seville oranges, apricots, early ripening peaches or ornamentals. Waiting period - 2 weeks. Withholding period - 7 days.
Disulfoton	Potato aphid, green peach aphid. Persistent systemic insecticide.	900 - 1680 gm a.i.	Oral - 4 Dermal - 50	Highly hazardous, toxic to bees. Waiting periods: potatoes - 13 wks, Brassicas - 6 wks, others - 8 wks. Withholding period - 8 wks. Restricted Poison.
Ethion	European red mites and two spotted mites on apples and pears.	335 gm a.i./1130 litres	Oral - 13-34 Dermal - 1600	Highly hazardous. Toxic to bees. Waiting period: fruit crops - 4 wks, others - 6 weeks.
Ethoate-methyl	Insects and mites including aphides, mealy bugs, leaf miners, European clover and two spotted mites attack-	335-450 gm a.i. per 450 - 1130 litres	Oral - 125 Dermal - 2000	Toxic to bees. Waiting period - 3 wks. Withholding period - 4 weeks.

Insecticide	For Control of	Rates per Hectare	LD50	Characteristics
Ethoate-methyl (contd.)	ing fruit, vegetable & ornamental plants.			
Fenitrothion	Porina caterpillar and army caterpillar.	450 - 1230 gm a.i.	Oral - 250-673 Dermal - 1500-3000	Toxic to bees. Waiting period: pellets - 7 days, wettable powder & emulsifiable concentrates - 2 wks. May cause injury to fruit.
Fensulfothion	Grass grub.	2240 gm a.i.	Oral - 2-10 Dermal - 9-30	Very hazardous. Permit required. Withholding period: pellets - 4 wks, but dairy cows should not be grazed on areas for more than 8 hrs per day for a further 2 weeks.
Fenthion	Diamond back moth, wheat bug, aphids, earwigs, flies, mosquitoes.	560 gm a.i./1130 litres Flies & mosquitoes 70 - 105 gm a.i./10 litres	Oral - 200 Dermal - 1300	Toxic to bees. Waiting period - 3 wks. Withholding period - 3 weeks.
Formothion	Contact and systemic control of aphids on lettuce and brassicas.	450 gm a.i	Oral - 400 Dermal - 400-1680.	Toxic to bees. Waiting period - 2 wks.
Maldison	Many insects and mites in horticultural and agricultural crops.	Hort. & Field crops Sprays 112 - 340 gm a.i./ha Dusts 450 - 1350 gm a.i.	Oral - 1400-1900 Dermal - 4000	Toxic to bees. Waiting period - 3 days. Withholding period - 7 days.
Menazon	Control of aphids on fruit trees and vegetables.	70 gm a.i./56 litres	Oral - 1200-1600 Dermal -> 500	Toxic to bees. Waiting period - 3 wks. Withholding period - 3 weeks.
Mevinphos	Cereal aphides, diamond back moth, aphides, thrips, green vegetable bug, white butterfly caterpillar.	220 - 450 gm a.i.	Oral - 3-5 Dermal - 90	Waiting period: strawberries - 2 days, other crops - 3 days. Highly hazardous but short lived systemic insecticide, toxic to fish and bees.
Monochrotophos	Army caterpillar.	450 - 1350 gm a.i.	Oral - 17-21 Dermal - 354	Highly hazardous. Toxic to bees. Withholding period - 3 weeks.

Insecticide	For Control of	Rates per Hectare	LD50	Characteristics
Naled	Late season mite control on pip fruit and strawberries. Tentative claims for control of sucking and chewing insects on some hort. crops and grass grub beetle.	Pip Fruit 560 gm/1130 litres Strawberries 1230 gm a.i./1700 litres	Oral - 430 Dermal - 800-1100	Toxic to bees. Waiting period - 4 days.
Omethoate	Mites, aphides, leaf hoppers and mealy bugs on apples and pears. Systemic insecticide.	670 gm/1130 litres	Oral - 50 Dermal - 700-1400	Highly hazardous. Toxic to bees. Waiting period - 2 wks. Withholding period - 3 weeks.
Oxydemeton-methyl	Control of sucking insects in agriculture and horticulture.	110 - 335 gm/ha	Oral - 57 Dermal - 100	Highly hazardous. Toxic to bees. Waiting period - 3 weeks. Withholding period - 2 weeks.
Parathion	Wide range of sucking and chewing insects. Tentatively recommended for control of grassgrub, porina caterpillar, wireworm and soldier fly.	Fruit trees & vegetables 225-450 gm a.i./1130 litres Tentative uses on pasture & field crops. 2240 - 4500 gm a.i.	Oral - 3-6 Dermal - 4-200	Highly hazardous. Toxic to bees and fish. Restricted - must not be applied from the air, over water, or near bush. Waiting period - 2-3 wks. Withholding - 2-4 wks.
Parathion-methyl	Sucking and chewing insects in agricultural and horticultural crops.	110 - 670 gm a.i./1130 litres	Oral - 12-16 Dermal - 67	Use during post-blossom period on apples. Repeated applications may cause russet. Highly hazardous. Toxic to bees and fish. Waiting period - 2-3 wks. Withholding - 2 wks.
Phenthoate	Lepidopterous larvae & scale insects - some activity against thrips and pyslids.	450 - 1120 gm a.i./1130 litres	Oral - 250-300	Toxic to bees. Do not use on early ripening peaches. Waiting period - 2 weeks. Withholding - 2 weeks.
Phorate	Virus bearing aphides during establishment.	900 - 2240 gm a.i.	Oral - 2-3 Dermal - 70-300.	Highly hazardous systemic insecticide. Toxic to fish and bees. Bird deaths when applied aerially. Waiting period - 8 wks (cereals). Withholding period - 13 wks. May depress yields in heavy soils.
Phosalone	Leaf rollers, codling moth and red spider mites in apples and pears.	670 gm a.i./1130 litres	Oral - 120-170 Dermal - 390	Toxic to bees and fish. Waiting period 3 wks, withholding period - 4 wks.

Insecticide	For Control of	Rates per Hectare	LD50	Characteristics
Phosmet	Codling moth, leaf roller, woolly aphides, scale.	110 - 1120 gm a.i./1130 litres	Oral - 147 Dermal - 160	Toxic to bees and fish. Waiting period 4 weeks.
Phosphamidon	Cereal, grey cabbage, and other aphides in agriculture and horticulture.	225 – 280 gm *a.i.* (high vol) 1800 – 3360 gm *a.i.*/ 1130 litres	Oral - 15 Dermal - 125	Highly hazardous systemic insecticide Toxic to bees. Waiting period - 3 weeks. Witholding period - 2 weeks. Some varieties of cherries are susceptible. When used on fodder crops for consumption by livestock do not exceed 0.25 lb ai.
TEPP	European red mites, aphides and caterpillars on strawberries.	110 gm/1130 litres	Oral - 0.5 Dermal - 20	Phytotoxic to tomatoes and some varieties of chrysanthemums. The most toxic registered insecticide in N.Z. Toxic to bees and fish.
Thiometon	Selective systemic control of aphides and spider mites on many plants - fruit trees, brassicas and cereals.	280 gm a.i./1130 litres Cereals: 225 gm a.i./70 - 170 litres	Oral - 100 Dermal - 200	Toxic to bees and fish. Waiting period - 4 weeks. Withholding period - 3 wks if not more than 0.4 lb ai is applied.
Thionazin	Systemic and contact action. Control of bulb stem and leaf eelworm in tulips, daffodils and chrysanthemums. Controls other nematodes and chewing and sucking insects such as aphides and bulb scale mite.	2580 gm (dip for bulbs) 3920 gm/1130 litres 35 gm/110 litres (soil drench)	Oral - 9-16 Dermal - 8-15	Highly hazardous. Toxic to bees and fish.
Trichlorfon	Army worm, corn ear worm, clover case-bearer, porina, thrips, cutworm, diamond-back moth, wheat bug.	560 - 1680 gm a.i.	Oral - 650 Dermal - 2800	Toxic to bees. Permit required under Apiaries Act. Waiting period: canning tomatoes - 1 day, all other crops - 2 weeks. Withholding period - 5 days.

Insecticide	For Control of	Rates per Hectare	LD50	Characteristics
Trichloronate	Porina caterpillar (with emulsifiable concentrate). Tentative claims for control of army caterpillar, black beetles, porina, grassgrub with pellets. Insects attacking emerging brassica seedlings controlled by the liquid.	785 - 1120 gm a.i. (emulsifiable concentrate) Pellets: 1120 gm (black beetle) 2240 gm (grass grub)	Oral - 16 Dermal - 135	Highly hazardous material. Soil applications may give up to 5 months residual activity. Waiting period - 6 weeks for emulsifiable concentrate, 4 weeks for pellets. Withholding period - the same.
Vamidothion	Systemic insecticide for control of woolly aphis, mites and sucking insects on apples and pears.	560 - 1120 gm a.i./ 1130 litres	Oral - 64-100 Dermal - 1160	Highly hazardous. Very effective against woolly aphides. Good residual activity, only one application per season. Toxic to bees. Waiting period - 6 wks. Withholding period - 4 wks.
CARBAMATES				
Aminocarb	Codling moth, leaf roller, leaf hopper and mealy bug on pip fruit. Reduces mite populations.	900 - 1350 gm a.i./ 1130 litres	Oral - 30-60 Dermal - 1000	Highly hazardous. Toxic to bees. Waiting and withholding period - 3 weeks.
Carbaryl	Army worm, white butterfly, corn earworm, green vegetable bug, silver Y moth. Used for thinning apples.	560 - 1700 gm 450 - 1350 gm a.i./ 1130 litres 1200 - 1700 gm a.i. Aerial application	Oral - 400 Dermal - 500	Toxic to bees. Waiting period: tomatoes, nil, other crops - 1 day. Withholding period - 3 days. Compatible with most other insecticides and combined products can be obtained.
Methiocarb	Sucking and chewing insects on apples - slugs and snails.	1000 - 1230 gm a.i./ 1130 litres	Oral - 100-135 Dermal - 350-700	Toxic to bees. Waiting period - 3 wks, but nil if slug and snail baits do not touch edible portions of plant. Withholding period - 3 weeks.
Methomyl	Systemic insecticide for control of army caterpillar on pasture, cereals, maize and sweetcorn.	225 - 335 gm a.i.	Oral - 17-24 Dermal - 1500	Highly hazardous material. Toxic to bees. May also be toxic to earthworms. Waiting and withholding period - 7 days.

Insecticide	For Control of	Rates per Hectare	LD50	Characteristics
PLANT DERIVATIVES				
Nicotine	Aphids, thrips and sucking insects	560 gm a.i./1130 litres	Oral - 50 Dermal - 300	Waiting period - 2 days. Do not use on spinach, kale or mustard. Withholding period - 7 days. Contact and stomach poison.
Pyrethrin	Aphids, caterpillars and leaf hoppers.		Oral - 200 Dermal - 1900	Break down rapidly. No waiting or withholding periods.
Rotenone	Aphids, beetles, caterpillars, diamond back moth and white butterfly.		Oral - 130	Extremely toxic to fish. Waiting period - 1 day.
INORGANIC CHEMICALS				
Lead Arsenate	Control of chewing insects such as caterpillars and codling moth.	1120 - 3400 gm/1130 litres	Oral - 100	Waiting period: pip fruits - 6 wks but last applicationnot after Dec. 31st. Vegetables - not after edible parts start to form.

WEED CONTROL (Source: F. B. Thompson, N.Z.J.Ag.)

Crop	Weedicide	For Control of	Rates of Application per Hectare	Time of Application	Other Characteristics
Brassicas	Trifluralin	A wide range of annual broadleaf and grass weeds.	Depend on soil type and locality.	Pre-emergent spray. Immediate incorporation into soil necessary.	Will not control wild turnip, shepherd's purse, black nightshade, mallow, storksbill or perennial weeds.
	Nitrofen	Annual weeds, e.g. fathen spurrey, willow weed.	8 to 11 litres in 225 litres of water.	When weeds are small seedlings. 10-14 days after crop has struck.	Can be used on all varieties of brassicas.
	Picloram + Trichlorophenyl nitro phenyl ether	Californian Thistle	4 to 8 litres	Best results with low rates of application to young weeds.	Toxic to legumes. Will not control storksbill. Rates above 4 pts may distort soft turnips and swedes.
	Desmetryne	Fathen, red root, willow weed at later stages of growth than nitrofen.	1120 to 2000 gm in 225 litres of water.	When crop has at least 4 true leaves.	Only used in choumoellier. Do not spray in drought or heat, or where crop undersown with pasture species.
	Dicamba	Californian thistle, fathen, willow weed.	140 to 420 gm in 110 litres of water	Not before crop has 2-3 true leaves.	Toxic to clovers.
Wheat, Oats, Barley, Ryecorn.	MCPA	Black nightshade, Californian thistle, docks, fathen, hedge mustard, penny cress, shepherds purse, stinging nettle, tares, wild turnip.	560 - 1120 gm a.i. in 56 litres of water	Oats: after the 3 leaf stage. Barley & Ryecorn: after the 4 leaf stage. Wheat: after the 5 leaf stage. Don't spray after the first sign of ear swelling.	Toxic to legumes, but safe to use on all varieties of cereals.
	2,4-D	All MCPA weeds plus cornbind or willow weed	840 - 1120 gm in 110 litres or more of water.	Wheat barley & ryecorn between 5-leaf & early boot stage.	Use only salt formulations, do not use on oats.

Crop	Weedicide	For Control of	Rates per Hectare	Time of Application	Other Characteristics
Wheat, Oats, Barley, Ryecorn (cont.)	MCPB	Black nightshade, Californian thistle, docks, fathen, hedge mustard, penny cress, stinging nettle.	840 - 1400 gm	After 2 leaf stage and before the third joint is easy to detect.	Use where crop is undersown with legumes. Less effective against shepherds purse, tares, wild turnip.
	2,4-DB	Cornbind, willow weed, docks, broadleafed weeds.	840 - 1400 gm	After two leaf stage and before the third joint is easy to detect.	Where the crop is undersown with clovers or lucerne but not peas.
	MCPA + Bromoxynil	MCPA- susceptible weeds, plus daisy weeds, cornbind, willow weed, wire weed.	1.5 litres in 170 litres of water	From 4 leaf stage to early jointing. Best results on seedling weeds.	Cereals tolerate mixture better than MCPA + dicamba.
	MCPA + Dicamba	MCPA-susceptible weeds, chickweed, cornbind & spuricy. Use when willow weed & wire weed predominate.	560 - 840 gm MCPA 105 - 140 gm dicamba	Between the 5 leaf stage & jointing.	Toxic to legumes. Wash all equipment after use.
	MCPA + TBA	MCPA-susceptible weeds plus cleavers and mayweed.	5.6 litres	Between the 5 leaf stage & jointing.	Safe in wheat and barley. Clean as for MCPA + dicamba.
	Mecoprop	MCPA-susceptible weeds plus chickweed, cleavers, mayweed.		Between the 2 leaf stage and jointing.	Safe on all cereals. Toxic to legumes.
	Dichlorprop	MCPA-susceptible weeds plus spurrey, cornbind, wireweed, willow weed.		On all cereals between 3 leaf stage and early jointing.	Toxic to legumes.
	Prometryme	Annual weeds only, including willow weed, wire weed, spurrey, fumitory.	560 - 840 gm in 225 or more litres of water	3-4 leaf stage when weeds are small.	If Californian thistle is present, 8 oz Prometryme + ½ lb MCPA is effective.

Crop	Weedicide	For Control of	Rates per Hectare	Time of Application	Other Characteristics
Grass Seed	MCPA	Thistles, docks, hedge mustard, wild turnip & other susceptible weeds.	840 - 1400 gm a.i. in 110 or more litres water.	Seedling docks & annuals: 6-8 wks past drilling. Scotch & nodding thistle: autumn. Cal. thistle & estb. docks: 1-2 wks after closing.	In crops such as fescue where clover is regarded as a weed, add 2 oz ai dicamba.
	MCPB or 2,4-DB	Susceptible weeds (see prev.)	1120 - 1680 gm a.i.	As for MCPA	Substitute for MCPA when clover is required.
Linseed	MCPA	Susceptible annual weeds, docks, Californian thistle.	840 - 1120 gm a.i.	After the 6 true leaf stage & before the first signs of flower buds.	Toxic to clovers and lucerne.
	MCPA + Atrazine	MCPA-susceptible weeds, plus cornbind, daisy weeds, fumitory, spurrey, willow weed, wireweed.	560 gm MCPA and 420 gm Atrazine (a.i.)	When weeds are small and linseed is at the 10-20 leaf stage.	Toxic to clovers and lucerne.
	MCPA + Bromoxynil	MCPA-susceptible weeds plus cornbind, may weeds, wire weed.	1.5 to 1.75 litres	When weeds are small and linseed at the 10-20 leaf stage.	
	MCPA + Dicamba	MCPA-susceptible weeds, cornbind, spurrey. Where willow weed and wire weed predominate.	560 gm MCPA, 105 gm a.i. dicamba	When crop is 2-4" high, and conditions are suitable for growth.	Do not treat undersown crops.
	Linuron	Spurrey, other annual weeds and grasses.	1120 to 1680 gm	When linseed 2-4" high.	Do not treat undersown crops.
	MCPB	MCPA-susceptible weeds.	1120 gm a.i.	After the 6 true leaf stage and before signs of flowering.	Use when crop is undersown with white clover.

Crop	Weedicide	For Control of	Rates of Application per ha	Time of Application	Other Characteristics
Wheat, Oats, Barley, Ryecorn (cont.)	Barban	Wild oats and annual canary grass.	3 litres low volume (110 litres) and high pressure is best.	When the oldest of the oat seedlings reaches the 2½ leaf stage.	Use in wheat, barley, ryecorn, not oats. Can be used where crop is undersown with a legume, but not with grass seed.
	Tri-Allate	Wild oats.	1400 gm	Pre emergent spray.	Thorough mixing into the soil required. Use in spring sown wheat and barley.
Clover Seed	Paraquat	Grass competition, annual weeds.	1 to 2 litres plus wetting agent in 225 litres of water	Short graze pastures and apply in dull humid conditions. Fortnight before shutting up.	Used on white clover, and less frequently on red clover. May be inactivated if mixed with dirty water or sprayed on soiled foliage.
	MCPB and 2,4-DB	Thistles, docks, plantains or susceptible annual weeds.	840 - 1680 gm	Spray biennial thistles as small as possible. Allow Californian thistle and docks to develop fresh foliage, before the crop is shut, and spray before clover buds show in base of crop.	Don't spray red clover after mid December, use MCPB rather than 2,4-DB.
Fodder Beet and Mangolds	Pyrazon		3360 - 4500 gm	Pre-emergent or after the beet have formed the first true leaf.	Is reliable post-E when applied in good growing conditions. Grass weed control improved by addition of 2,2-DPA to Post E treatments.
	Phenmedipham	Wide range of annual weeds.	1120 - 1680 gm	While the weeds are seedlings.	Does not control redroot, willow weed, wire weed.
	Lenacil	Wide range of annual weeds.	1120 gm a.i.	Pre emergent.	Lenacil followed by pyrazon or phenmedipham has increased control.

Crop	Weedicide	For Control of	Rates of Application per Hectare	Time of Application	Other Characteristics
Linseed (cont.)	2,4-DB	Where cornbind and willow weed predominate (also MCPA weeds).	1120 - 1680 gm a.i.	When weeds are small and lucerne is in the 6-20 leaf stage.	Use when crop is undersown with clovers or lucerne.
Lucerne	2,2-DPA Dalapon	Barley grass, brown top, creeping bent, fog and other weed grasses.	3900 - 5600 gm	Early spring after growth has commenced.	Must not be used when grasses sown with the lucerne. Treatment will delay or reduce the following cut, but subsequent growth will offset loss.
	2,2-DPA + Atrazine	Annual grassy weeds and annual broadleaf weeds.	1120 gm dalapon & 900 gm atrazine	Late winter before fresh lucerne growth starts.	Spray carefully to avoid overlap or underlap.
	Paraquat	Yorkshire fog, poa annua and other annual grasses. Effective against annual weeds - chickweed, storksbill.	1.5 to 3 litres in 225 litres of water plus wetting agent.	Winter or early spring while weeds are small.	Only effective against small seedlings of barley grass. Checks brown top. Spray in dull, humid weather, avoiding dust and dirt contamination of water or foliage.
	Paraquat + Simazine or Terbacil.	Browntop, barley grass, shepherds purse (improved control).	1120 gm sumazine or terbacil	Application as with paraquat.	
	Benfluralin or Benefin	Germinating grasses, fathen, redroot, polygonaceous weeds - cornbind, willowweed, wire weed.	1120 - 1680 gm	Pre-emergent.	Will not control brassica weeds or storksbill.
	2,4-DB	2,4-DB-susceptible annual weeds and thistles.	1400 - 1680 gm a.i.	Spray as soon as lucerne has its first trifoliate leaf.	Do not spray autumn sown lucerne if resistant winter growing weeds present.
	MCPB	Where nodding thistle is principal weed.	1120 gm a.i.	As for 2,4-DB.	Use instead of 2,4-DB where seedling lucerne undersown with peas. Special advice required if spraying mature lucerne.

Crop	Weedicide	For Control of	Rates of Application per Hectare	Time of Application	Other Characteristics
Lucerne (cont.)	Asulam	Established docks.	3 to 4 litres	September or following the last cut in autumn.	
Maize and Sweetcorn	2,4-D Amine	Susceptible annual weeds.	840 - 1120 gm a.i.	When maize 6-10” high.	Use where no grass weeds present although atrazine is to be preferred.
	Atrazine	Annual broadleafed weeds.	1120 gm a.i.	Post emergence to seedling weeds.	
	Atrazine + Propachlor	Grass weeds.	2240 gm atrzaine 3360 gm proptachlor	Post emergence while weeds are very small.	Better results if soil surface is moist at time of application.
	Linuron or Cypromid	Linuron - broadleafed weeds, some grass. Cypromid - predominantly grass weeds.	2240 gm a.i. 3360 gm a.i.	When weeds are larger, i.e. if weed growth has got away.	Avoid contact with the maize as much as possible.
Peas	Dinoseb (DNPB) Available as: Ammonium Amine Acetate	Annual weeds esp. black nightshade, wild turnip, fumitory and fathen.	840 - 1120 gm 1120 - 1680 gm 1680 - 2240 gm all in 225 or more litres of water	Spray as soon as possible after the weeds have struck. Kill is better if growing conditions are good.	Not satisfactory for redroot. Poisonous, requires care in handling. - can cause severe scorch at high temp. - effectiveness reduced at $<65^{\circ}$F. - more selective towards peas. Safer. Can be used in clover or lucerne undersown crops.
	MCPB	Californian thistle, redroot, other susceptible weeds.	840 - 1400 gm a.i. in 170 or more litres water.	Seedling weeds.	Not effective against willowweed, fumitory, nightshade. Can be sprayed on lucerne and clover undersown crops.
	MCPB + Dinoseb	Redroot and black nightshade mixture plus others.	840 gm a.i. MCPB & 650 - 840 gm a.i. Dinoseb 1600 gm a.i.	Seedling weeds.	Observe precautions for dinoseb. Add ingredients to water separately.
	Methabenzthiazuron	Fathen, black nightshade, cornbind, willow weed, redroot, wireweed.		Seedling weeds.	Cannot be mixed with MCPB.

Crop	Weedicide	For Control of	Rates of Application per Hectare	Time of Application	Other Characteristics
Peas (cont.)	Barban	Wild oats.	3 litres	When oldest oat seedling is at 2½ leaf stage.	All varieties of peas.
	Triallate	Wild oats.	3 litres	Pre emergent.	Mix in thoroughly.
	Trifluralin	Wide range of annual broadleaf and grass weeds.	3 litres	Pre emergent.	Incorporate well.
Potatoes	Linuron	Broadleafed weeds, some grass weeds.	1120 - 1680 gm a.i.	After moulding, before haulms have emerged.	Will not control fumitory or perennial weeds.
	Monolinuron	Seedling grasses, less effective than linuron against broadleafed weeds.	1120 - 1680 gm a.i.	As for linuron.	A mixture of linuron and monolinuron. May give more effective control.
	Metabromuron	Annual weeds.	1120 - 1680 gm a.i.	Pre emergent.	No post-emergent effect.
	Prometryne	Annual weeds and perennial weeds.	1120 - 1680 gm a.i.	Pre emergent.	Some post emerge effect on small seedlings.
	Propanil				Only chemical other than MCPA that can be applied post emergent.
Potato-top Killing and Weed Dessication	Arsenical Compounds	Grasses, hedge mustard, red dead nettle, fumitory.	9 kg - 11 kg arsenic trioxide equiv. in 225 litres water	3 wks preharvest for top destruction. 10-14 days for effect on weeds.	Highly toxic. 3 wks nec. after haulm destruction before harvesting.
	Diquat	Fumitory, red dead nettle, cruciferae. Haulm destruction.	3 litres & wetting agent in 340 litres or more of water.	Pre harvest.	Some tuber damage may occur in hot dry conditions.
	Paraquat	Grass and broad leaf weeds.	1.5 to 2.0 litres and wetting agent in 225 litres or more of water.	After haulm destruction.	Do not apply to live haulm.

16. FARM STRUCTURES

Haybarns

Capacity allowing 5 bales per cubic metre i.e. (7 cu.ft. per bale.)

1 m^3 = 35.32 cubic feet.

Eave Height metres	(ft.)	Length metres	(ft.)	6m(20ft) Gable Building Capacity (bales)	9m(30ft) Gable Building Capacity (bales)
2.438	(8)	9.144	(30)	800	1400
		13.716	(45)	1200	2100
		18.288	(60)	1700	2800
		22.860	(75)	2100	3500
		27.432	(90)	2500	4200
3.048	(10)	9.144	(30)	1000	1600
		13.716	(45)	1500	2500
		18.288	(60)	2000	3300
		22.860	(75)	2500	4200
		27.432	(90)	3100	5000
3.658	(12)	9.144	(30)	1200	1900
		13.716	(45)	1800	2900
		18.288	(60)	2400	3800
		22.860	(75)	3000	4800
		27.432	(90)	3600	5700
4.267	(14)	9.144	(30)	1300	2100
		13.716	(45)	2000	3300
		18.288	(60)	2700	4300
		22.860	(75)	3500	5400
		27.432	(90)	3900	6500

Grain Storage Buildings

Capacities (Pre-fabricated Galvanized Steel Grain Silos)

Diameter Metre	(ft.)	Overall Height meter	(ft.)	Capacity tonnes of wheat	(tons)
4.572	(15)	3.658	(12)	59	(58)
4.572	(15)	4.877	(16)	76	(75)
5.486	(18)	4.877	(16)	112	(110)
6.401	(21)	4.267	(14)	137	(135)
6.401	(21)	4.877	(16)	154	(152)
7.315	(24)	4.267	(14)	183	(180)
7.315	(24)	4.877	(16)	205	(202)
7.315	(24)	7.315	(24)	299	(294)

Plywood bins (kitset) available in 20 or 30 tonne capacity Prefab' Steel Granary.

18.3m x 6.1m x 3.0m stud – capacity = 244 tonnes
(60' x 20' x 10' stud – capacity = 240 tons)

METRICATION IN BUILDING

CONCRETE BLOCKS

Dimensions — Imperial	Equivalent Conversions — Metric	Metric Dimensions
4″ units 15-5/8″ x 7-5/8″ x 3-5/8″	396.8 x 193.7 x 92.0 mm	390 x 190 x 90 mm
6″ units 15-5/8″ x 7-5/8″ x 5-5/8″	396.8 x 193.7 x 142.9 mm	390 x 190 x 140 mm
8″ units 15-5/8″ x 7-5/8″ x 7-5/8″	396.8 x 193.7 x 193.7 mm	390 x 190 x 190 mm
10″ units 15-5/8″ x 7-5/8″ x 9-5/8″	396.8 x 193.7 x 244.5 mm	390 x 190 x 240 mm

EXTERIOR SHEATHING — WOODFIBRE BOARD (WEATHERSIDE)

Dimensions — Imperial	Equivalent Conversions — Metric	Metric Dimensions
16 ft. x 11.75 ins.	4876.8 x 298.45 mm	4800 x 300 mm

EXTERIOR AND INTERIOR SHEATHING — ALUMINIUM SHEET

Dimensions — Imperial	Equivalent Conversions — Metric	Metric Dimensions
First sheet — up to 48 in. wide, 20 ft. long	Up to 1219.2 mm wide, 6096 mm long.	Up to 1250 mm wide 6100 mm long Proposed standard sheet sizes: 2400 mm x 1200 mm 2400 mm x 900 mm 1800 mm x 900 mm

INTERIOR LINING MATERIALS — TEMPERED HARDBOARD AND SOFT BOARD – SHEETS

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
6 x 4 ft.	1828.8 x 1219.2 mm	1800 x 1200 mm
8 x 4 ft.	2438.4 x 1219.2 mm	2400 x 1200 mm
9 x 4 ft.	2743.2 x 1219.2 mm	2700 x 1200 mm
10 x 4 ft.	3048.0 x 1219.2 mm	3000 x 1200 mm
12 x 4 ft.	3657.6 x 1219.2 mm	3600 x 1200 mm
8 x 3 ft.	2438.4 x 914.4 mm	2400 x 900 mm

INTERIOR LINING MATERIALS — PLYWOOD – INTERIOR AND EXTERIOR

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
8 x 4 ft.	2440 x 1220 mm	2400 x 1200 mm
8 x 3 ft.	2440 x 914 mm	2400 x 900 mm
7 x 4 ft.	2130 x 1220 mm	2100 x 1200 mm
7 x 3 ft.	2130 x 914 mm	2100 x 900 mm
6 x 4 ft.	1830 x 1220 mm	1800 x 1200 mm
6 x 3 ft.	1830 x 914 mm	1800 x 900 mm

MEDIUM DENSITY PARTICLE BOARD
– SHEETS – INTERIOR WALL LINING AND FURNITURE MANUFACTURING

Dimensions – Imperial		Equivalent Conversions – Metric		Metric Dimensions	
	Thickness		Thickness		Thickness
24 x 6 ft.	¾, 5/8, ½, 3/8 in.	7315.2 x 1828.8 mm	19, 15.9, 12.7, 9mm	7200 x 1800 mm	19, 16, 12.5, 9mm
12 x 6 ft.	¾, 5/8, ½, 3/8 in.	3657.6 x 1828.8 mm	19, 15.9, 12.7, 9mm	3600 x 1800 mm	19, 16, 12.5, 9mm
8 x 6 ft.	¾, 5/8, ½, 3/8 in.	2438.4 x 1828.8 mm	19, 15.9, 12.7, 9mm	2400 x 1800 mm	19, 16, 12.5, 9mm
8 x 4 ft.	¾, 5/8, ½, 3/8 in.	2438.4 x 1219.2 mm	19, 15.9, 12.7, 9mm	2400 x 1200 mm	19, 16, 12.5, 9mm

INTERIOR SHEATHING **GIBRALTAR BOARD – SHEETS**

Dimensions – Imperial		Equivalent Conversions – Metric	Metric Dimensions
Width Length	4 ft. and 3 ft. 6 ft. to 16ft. (in foot intervals)	Width 1220 mm & 915 mm Length 1829 mm to 4877 mm	1200 mm 1800 mm to 4800mm (Intervals to be decided).

INTERIOR LINING **FIBROUS PLASTER – SHEETS**

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
Common size: 8 ft. x 6 ft.	2438 x 1829 mm	2400 x 1800 mm

ROOFING MATERIALS **ALUMINIUM – CORRUGATED SHEETS**

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
Circular pitch 3 inches. Other pitches 5 inches and 5-1/8 in. covering widths dependent on pitch and method of fixing. Length of sheet cut to order up to 18 feet.	Circular pitch 76.2 mm. Others 127 mm, 130.2 mm. Length up to 5486 mm.	Change in gauge and length only to ordered dimensions in metric measure. Pitch (and thus covering width) to be specified as a straight conversion.

BRICKS

BRICKS AND QUARRY TILES	Dimensions — Imperial	Equivalent Conversions — Metric	Metric dimensions	Metric course equivalents (laid height concrete block = 200 mm)	
	inches	millimetres	millimetres	Courses of brick	Courses concrete block
Auckland produced					
Roman	11-5/8 x 3-13/16 x 2	295.275 x 96.837 x 50.8	290 x 95 x 50	10	3
B3	11-5/8x3-13/16x3-5/8	295.275x96.837x92.075	290 x 95 x 90	2	1
Standard	8-5/8x4-1/8x2-13/16	219.075x104.775x71.437	215 x 102.5 x 70	5	2
American	8 x 3-13/16 x 2-5/8	203.2x96.837x66.675	200 x 95 x 65		
Quarry Tiles	8 x 8	203.2x203.2	200 x 200	Not applicable	
Huntly produced					
Roman	11-3/5 x 3¾ x 2¼	294.64 x 95.25 x 57.15	295 x 95 x 57	3	1
Standard	8¾ x 4½ x 2-7/8	222.25x104.775x73.025	222 x 105 x 73	5	2
Welligtn. pr'd'ced					
Roman	12 x 3¾ x 2	304.8 x 95.25 x 50.8	290 x 90 x 57	3	1
Grecian	12 x 3¾ x 3-5/8	304.8 x 95.25 x 92.075	290 x 90 x 90	2	1
Standard	8-7/8x4¼x2-15/16	222.425x107.95x74.612	230 x 110 x 70	5	2
Quarry Tiles	5-15/16 x 5-15/16	150.712 x 150.712	145 x 145	Not applicable	
Otago produced					
Roman	11-5/8x3-5/8x2¼	295.275x92.075x57.15	290 x 90 x 57	3	1
Colonial	11-5/8x3-5/8x3-5/8	295.275x92.075x92.075	290 x 90 x 90	2	1
Standard	8-5/8 x 4¼ x 2-5/8	219.075x107.95x66.675	230 x 110 x 70	5	2
Quarry Tiles	7½ x 7½	190.5 x 190.5	190 x 190	Not applicable	

NOTE: The above sizes are for typical bricks and tiles produced. 10 mm should be added for the mortar joint thickness when laid. Manufacturers make a considerable variety of brick and tile products outside the sizes shown in the table. For specific needs the manufacturer should be contacted.

PAINT – CAN SIZES

Dimensions – Imperial	Equivalent Dimensions – Metric	Metric Dimensions
1 gallon	4.55 litres	4 litres
½ gallon	2.28 litres	2 litres
1 quart	1.14 litres	1 litre
1 pint	568 ml	500 ml
½ pint	284 ml	250 ml
¼ pint	142 ml	125 ml

PAINT – DRUM SIZE: metric dimension, 20 litres. Further Information: NZ Paint Manufacturer's Association.

CEMENT – BAGGED

Dimensions – Imperial	Equivalent Dimensions – Metric	Metric Dimensions
93-1/3 lb. (24 per ton)	42.3 kg	40 kg
112 lb. (20 per ton)	50.8 kg	(25 per tonne)

Further Information: New Zealand Portland Cement Association.

GLASS

Dimensions – Imperial	Equivalent Dimensions Metric	Metric Dimensions
24 oz. sheet and ½ in. figured	680 g sheet & 3.2 mm figured	3 mm
32 oz. sheet	907 g	4 mm
3/16 in. sheet, figured and float	4.8 mm	5.5 mm
7/32 in. sheet and figured	5.55 mm	6 mm
¼ in. sheet, figured and float	6.35 mm	
18 oz. thin glass (for picture frames).	510 g	2 mm

UNPLASTICICISED PVC PRESSURE AND NON-PRESSURE PIPES

Dimensions (Imperial)	Metric Dimensions
Length 20 ft. Diameter (Nominal bore) ½ in., ¾ in., 1 in., 1¼ in., 1½ in., 2 in., 2½ in., 3 in., 4 in., 5 in., 6 in., 8 in., 9 in., 10 in., 12 in., 14 in.	Length 6 m Diameter (Nominal bore) 13 mm, 19 mm, 25 mm, 32 mm, 38 mm, 51 mm, 63 mm, 76 mm, 102 mm, 127 mm, 152 mm, 203 mm, 229 mm, 254 mm, 305 mm, 356 mm.

Further Information: Plastics Institute of New Zealand.

TIMBER

Dimensions - Imperial
TABLE 1 – Minimum Sizes in Inches

Nominal Sawn Size	Minimum Gauged Size Unseasoned for Framing Timbers	Minimum Dressed Size Seasoned
1	NA	13/16
1¼	NA	1
1½	NA	1¼
2	1-7/8	1¾
3	2¾	2-5/8
4	3¾	3-5/8
5	4¾	4-5/8
6	5¾	5-5/8
7	6¾	6½
8	7¾	7½
9	8¾	8½
10	9¾	9-3/8
12	11¾	11¼

Length increments (no Standard applicable): in 1 ft. increments, generally from 6′ 0″ minimum to 16′ 0″ for run-of-mill production.

METRIC DIMENSIONS (Table 2)
Preferred Range of Call Sizes in mm

Call Dimensions THICKNESS	Call Dimensions – WIDTH								
	50	75	100	125	150	200	225	250	300
25	X	X	X	X	X	X	X	X	X
30			X		X				
40	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X
75			X	X	X	X	X	X	X
100			X	X	X	X	X	X	X

(Table 3) – PREFERRED LENGTHS (in metres)

1.8	3.3	4.8
2.1	3.6	5.1
2.4	3.9	5.4
2.7	4.2	5.7
3.0	4.5	6.0

(Table 4) Finished Dimensions in mm

Call Dimension	Finished Dimension	
	Green Gauged Timber	Dry Dressed Timber
25	–	19
30	–	25
40	37	35
50	47	45
75	69	65
100	94	90
125	119	115
150	144	140
200	194	180
225	219	205
250	244	230
300	294	280

Further information: The New Zealand Sawmillers' Federation Inc., NZ Timber Merchants' Fed. Inc.

DOORS – TIMBER

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
6′ x 1′6″, 6′ x 2′, 6′6″ x 2′, 6′6″ x 2′2″, 6′6″ x 2′4″, 6′6″ x 2′6″, 6′6″ x 2′8″, 6′6″ x 2′10″, 6′6″ x 3′, 6′8″ x 2′6″, 6′8″ x 2′8″, 6′8″ x 2′11″, 6′8″ x 3′.		As demand requires. viz module trim sizes.

DOORS – JOINERY

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
6ft. 6in. – standard height.	2 metres	Joinery manufacturers work to specified sizes on architectural drawings.

WINDOWS – JOINERY

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
Large variety of sizes – no standard sizes.		

ALUMINIUM WINDOWS

Dimensions – Imperial	Equivalent Conversions – Metric	Metric Dimensions
Feet and inches. Dimensioned to suit concrete block modules in both width and height.	Direct conversion	To suit concrete block modules. No change in that 'sizing' used at present.

The foregoing information was supplied by the Divisional Committee on Building Materials, Metric Advisory Board. Further information on the change to metric in the building and construction industry may be obtained from the Secretary of the Committee, Mr R. Holdsworth, P.O. Box 10-243, Wellington.

Fencing Materials – Plain and Barbed Wire

Specifications for Wire

	No. 12½ Steel	No. 8	150 mm Barb	75 mm Barb
Length per 100 kg Metres	2782	1025	1104	983
Length per 25 kg Metres	695	254	276	245
Breaking Strain kg.	249	317	181	181
Tension Loss for 2.5 cm movement kg.	12.7	33		
Cost per 100 m	$1.88	$4.76	$4.93	$5.55

Cattle Yards

The main purpose for which the yard will be used will influence the design. For example, on breeding properties good facilities are required for calf marking – drafting, drenching and spraying of weaners, innoculating and dehorning. Where the main enterprise consists of buying stores and fattening, then drafting, loading and holding facilities will receive top priority.

Yard size is determined by the number of stock which require handling at one time. The size of the receiving yard should allow not less than 2.33 sq. metres of space for every adult animal.

The forcing yard should be designed to hold about one third of the number accommodated in the holding yard, allowing about 1.86 sq. metres each adult animal.

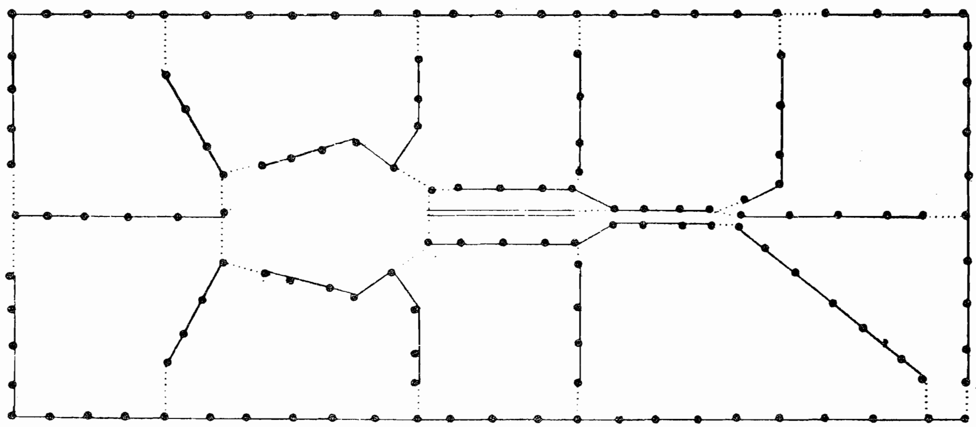
Crush length should provide about 1.676m for each adult animal.

Sheep Yards

The number of sheep and the number of separate mobs likely to be yarded at any one time is the first consideration in determining size of sheep yards.

An allowance of an average .465 sq. metres, say .5m^2 (5 sq. ft.) per sheep should allow ample room to work any but the largest sheep.

SHEEPYARD AS DESIGNED BY DEPT. OF AGRICULTURE, DUNEDIN



LIST OF MATERIALS

Length	142 feet	(43.28m)	Area per sheep	8.5 sq. ft. (.8m^2)
Width	60 feet	(18.3 m)	Fencing per sheep	.9 ft. (.27m)
Area	8520 sq.ft.	(791.5m^2)	Posts per sheep	.14
Capacity	1000 sheep			

Length of fencing	686 feet (209 metres)
Length of fencing carrying extra board	23 feet (7 metres)
Length of fencing close boarded	41 feet (12.5 metres)
Number of Posts	145

Gates	**SIZE**	**No.**
	2.4 m	4
	1.8 m	14
	1.95 m	2
	1.35 m	1
	.9 m	2
	.75 m	3
Drafting	1.2 m	3
TOTAL		28

17 FARM MACHINERY

SOURCE–FARM MANAGEMENT HANDBOOK, QUEENSLAND DEPT. OF PRIMARY INDUSTRIES.

POWER TERMS

Kilowatt (kW) is a unit of power measurement. It expresses the amount of work a machine will do in a given time and equals 1 000 joules per second. (1 kW = 1.34 horse power).
Indicated Power (theoretical determination) is the power available at the piston heads of an engine and equals the brake power plus the friction power.
Friction Power accounts for the power used by an engine to overcome the friction of moving parts plus pumping losses. These power losses occur even at no load and increase with speed and added load.
Brake Power generally means the engine power available for productive work at the crankshaft or flywheel. It equals the gross power available when the engine is not driving power-consuming ancillary equipment such as hydraulic pumps, generators, water pumps, and net power when this equipment is functioning. Belt and P.T.O. power are 2 to 4 per cent less than net power.

Drawbar Power is the power available at the hitch or drawbar to pull loads. With ballast, drawbar power is generally higher than without ballast because extra weight permits greater pull at nearly the same speed.

Rated Power is the power generated under a particular condition and engine speed as quoted by the manufacturer, or is some quoted percentage of the maximum power. (Usually about 85% maximum power and 75% drawbar power.)

Maximum Power is an arbitrary percentage of brake power. The resulting rating is a compromise between low efficiency and rapid wear at medium power and the higher efficiency and reduced wear at lower speeds and lower power.
P.T.O. Power is the power available at the P.T.O. When tractors have a completely separate belt and P.T.O. drives, the P.T.O. drive is usually designed to transmit 95% of the maximum power.
Maximum P.T.O. Power is the maximum power, more or less continuously available at the P.T.O.
P.T.O. Power at standard speeds is the power at S.A.E. and A.S.A.E. standard speed of 540 r.p.m. and 1 000 r.p.m. For some tractors, maximum P.T.O. power and power at standard speeds are identical.

Formulae

Work = Force (newton) (N) X Distance moved in metres (m)
= joules (J)

$$\text{Power} = \frac{\text{work}}{\text{time}} = \frac{\text{joules}}{\text{second}} = \text{watts (W) or divided by}$$

1 000 to obtain (kW)

Torque = Force (newtons) (N) X Distance to centre of rotation (metres) (m) = N.m (1 newton (N) = 0.2248 pounds force)

$$\text{Power (kW)} = \frac{\text{work}}{\text{time}} = \frac{\text{Pull (N)} \times \text{Distance (m)}}{1\,000 \times \text{time (seconds)}}$$

$$= \frac{\text{Pull (N)} \times \text{Speed (km/h)}}{3600}$$

Power in a shaft is the product of torque* and rotational speed.

$$\text{Shaft power (kW)} = \frac{\text{Torque (N.m)} \times \text{Speed (r.p.m.)}}{9\,549}$$

example:– Torque 400 N.m at 1 200 r.p.m.

$$\text{power (kW)} = \frac{400 \times 1\,200}{9\,549} = 50 \text{ kW}$$

*Maximum torque usually occurs at 60-75% of rated engine speed.

Belt Power (kW) = Shaft power as above for equivalent shaft speed and torque.

Rated Belt Power = 85% of maximum belt power at rated engine speed.

$$\text{Drawbar Power (kW)} = \frac{\text{Pull (N) X Speed (km/h)}}{3\,600}$$

= 10-15% below the maximum brake power (a rough guide).

Rated Drawbar Power = 75% maximum drawbar power.

*Wheelslip*** is limited to 16% for a wheeled tractor and 17% for a crawler.

**When considering maximum drawbar pull.

Speed of an implement (km/h) = Number of paces per minute ÷ 20 (as a rough guide).

Wheel Slip

Loss of forward motion due to wheel slippage results in power loss.

Estimated Fuel and Oil Consumption of Tractors

The average fuel consumption per kW/hour shown in the table is for new tractors. The rate for older tractors may be higher. The average load on the engine varies according to the way the machine is used, the size and type of the implement attached, speed of travel and condition of the soil.

The fuel consumption per kW/hour increases as the load on the engine decreases.

Average Specific Fuel Consumption per kW/hour for a Sample of New Tractors

	Type of Engine and Fuel	
Engine Loading % of max. power	Petrol litres/kWh.	Diesel litres/kWh.
100	.261	.180
75	.292	.193
50	.366	.217
35	.468	.254
25	.573	.319

Approximate fuel consumption in litres per hour can be estimated by multiplying S.F.C. by power in kW produced at a particular engine loading.

Fuel Consumption in Litres/Hr for Different Sizes and Loads of Tractor Engines

Type of Engine	Maximum Engine Power (H.P.)	(kW)	75% gals/hr	75% litre/hr	50% gals/hr	50% litre/hr	35% gals/hr	35% litre/hr	25% gals/hr	25% litre/hr
Petrol	30	22.4	1.93	8.77	1.62	7.36	1.45	6.59	1.27	5.77
	35	26.1	2.26	10.27	1.89	8.59	1.69	7.68	1.48	6.81
	40	29.8	2.58	11.73	2.16	9.82	1.93	8.77	1.69	7.68
	45	33.5	2.90	13.18	2.43	11.05	2.17	9.91	1.90	8.63
	50	37.3	3.22	14.64	2.70	12.27	2.42	11.01	2.11	9.59
	55	41.0	3.55	16.14	2.97	13.50	2.66	12.09	2.32	10.54
	60	44.7	3.87	17.59	3.24	14.73	2.90	13.18	2.54	11.55
	65	48.5	4.19	19.05	3.51	15.96	3.14	14.27	2.75	12.50
	70	52.2	4.52	20.55	3.78	17.18	3.38	15.37	2.96	13.45
	75	55.9	4.84	22.00	4.05	18.42	3.62	16.46	3.17	14.41
	80	59.6	5.16	23.46	4.32	19.64	3.86	17.54	3.38	15.37
	85	63.4	5.48	24.91	4.59	20.88	4.12	18.73	3.59	16.32
	90	67.1	5.80	26.37	4.86	22.09	4.35	19.78	3.80	17.27
Diesel	30	22.4	1.28	5.82	0.96	4.36	0.79	3.59	0.71	3.23
	35	26.1	1.50	6.82	1.12	5.09	0.92	4.18	0.82	3.73
	40	29.8	1.71	7.77	1.28	5.81	1.05	4.78	0.94	4.27
	45	33.5	1.92	8.73	1.44	6.55	1.18	5.36	1.06	4.82
	50	37.3	2.14	9.73	1.60	7.27	1.31	5.95	1.18	5.36
	55	41.0	2.35	10.68	1.76	8.00	1.44	6.55	1.29	5.86
	60	44.7	2.56	11.64	1.92	8.73	1.58	7.18	1.41	6.41
	65	48.5	2.78	12.64	2.08	9.45	1.71	7.77	1.53	6.96
	70	52.2	2.99	13.59	2.24	10.18	1.84	8.36	1.65	7.50
	75	55.9	3.21	14.59	2.40	10.91	1.97	8.95	1.76	8.00
	80	59.6	3.42	15.55	2.56	11.64	2.10	9.55	1.88	8.55
	85	63.4	3.63	16.50	2.72	12.36	2.23	10.13	2.00	9.09
	90	67.1	3.85	17.50	2.88	13.09	2.36	10.72	2.12	9.64
	95	70.8	4.06	18.46	3.04	13.82	2.49	11.32	2.23	10.14
	100	74.6	4.28	19.46	3.20	14.55	2.63	11.95	2.35	10.68
	105	78.3	4.49	20.41	3.36	15.28	2.76	12.54	2.47	11.23
	110	82.0	4.70	21.37	3.52	16.00	2.89	13.14	2.59	11.77
	115	85.7	4.92	22.37	3.68	16.73	3.02	13.73	2.70	12.27
	120	89.5	5.13	23.32	3.84	17.46	3.15	14.31	2.82	12.82
	125	93.2	5.34	24.27	4.00	18.18	3.28	14.91	2.94	13.36
	130	96.9	5.56	25.27	4.16	18.91	3.41	15.51	3.06	13.91
	135	100.7	5.77	26.23	4.32	19.64	3.54	16.10	3.17	14.41
	140	104.4	6.00	27.28	4.48	20.37	3.68	16.73	3.29	14.95

Oil Consumption

Average oil consumption in tractors is 2.5 to 3 per cent.of the fuel consumption. The engine oil may be changed every 250 hours, and transmission oil may be changed every 1,000 hours. Oil filters are usually changed at each oil change.

WORK CAPACITY OF FARM MACHINERY AND IMPLEMENTS

(a) Cultivation
(b) Harvesting

(a) Area covered by cultivation implements in a given time depends on:

1. size of implement
2. size of traction unit
3. nature of country – general steepness of the contour
4. type and condition of soil – compare light, stony, heavy and clay soil. In wet or dry condition
5. type of work
6. breakage and general skill of operator. An experienced man knows the speed at which he gets maximum use out of the implement.
7. size and shape of paddock

(b) Area covered by harvesting machinery in a given time depends on:

1. bulk of the crop – heavy or light yields
2. type of crop – wheat or peas, or clovers etc.
3. condition of crop – ease of threshing – lodged oats or ryegrass
4. weather – hot, dry, vs. damp and cool
5. whether the crop has been windrowed (e.g. peas, ryegrass, clover, oats) or is being direct headed
6. nature of ground surface – flat or sloping, smooth or rough.

FIELD CAPACITY AND EFFICIENCY

(a) Field capacity is a measure of the relative productivity of a machine under field conditions. It accounts for failure to utilize the theoretical operating width of the machine, operator capability and habits, operating policy and field characteristics. The following activities account for a majority of the time loss in the field:

- turning and idle travel
- materials handling (e.g. seed, fertilizer, chemicals, water, harvested material)
- cleaning clogged equipment

- machine adjustment
- lubrication and refuelling over daily service
- waiting for other machines
- other field time interruptions

Travel to or from a field, major repairs, preventative maintenance, and daily service activities are not included in field time or field efficiency. Field efficiency is not a constant for a particular machine, but varies with size and shape of the field, pattern of field operation, crop yield, moisture and crop conditions.

(b) Effective field capacity may be determined from the following equation :

$$C = \frac{S.W.E.}{10}$$ where

C = effective field capacity, hectares per hour
S = field speed, km per hour
W = theoretical machine width in metres
E = field efficiency

Theoretical field capacity can be determined from the above equation by using a field efficiency of 100%. Typical ranges of field efficiency and operating speed are listed below:–

Machine	Range in Field Efficiency (%)	Speed m.p.h.
Cultivator, field	75 – 90	3.0 – 5.0
Cultivator, row crop	75 – 90	1.5 – 5.0
Disc Harrow	75 – 90	3.5 – 6.0
Plough	75 – 90	3.5 – 5.0
Rotary Hoe	75 – 90	5.0–10.0
Harrow (spike-tooth)	70 – 85	3.0 – 6.0
Grain Drill	60 – 80	2.5 – 4.0
Maize Planter	60 – 80	3.5 – 6.0
Combine Header	65 – 80	2.0 – 3.5
Maize Picker	55 – 70	2.5 – 3.5
Mower	75 – 80	3.5 – 5.5
Rake	75 – 90	3.5 – 5.0
Hay baler	55 – 80	2.0 – 5.0
Forage Harvester	50 – 75	2.0 – 4.0
Sprayer	55 – 65	3.0 – 6.0

Examples of Working Out Tractor Hours (Typical Mixed Cropping Farm implements and 50 – 60 b.h.p. Tractor) :

(1) Heavy Soils:

(a) Preparation for Peas:

August	hrs/ha
Grub	.6
Grub, Harrow and Roll	.7
Plough	1.7
Roll	.5
Harrow and Roll	.3
Disc, Roll and Harrow	.7
Disc and Roll	.6
Harrow and Roll	.3
Dutch Harrow	.4
Drill	.9
TOTAL Cultivation	6.7
Harvesting (Yield 45 bus.) 3000 Kg/ha	2.0

(b) Preparation for Wheat:

January	hrs/ha
Plough	2.8
Roll	.5
Disc	.6
Grub and Harrow	.5
Grub	.4
Harrow and Roll	.4
Drill	.6
TOTAL Cultivation	5.8
Harvesting (Yield 50 bus.) 3300 Kg/ha	1.5

(c) Preparation for Barley:

August	hrs/ha
Grub	.4
Grub, Harrow and Roll	.4
Harrow and Roll	.2
Plough	1.4
Roll and Disc	.6
Harrow and Roll	.3
Harrow and Roll and Disc	1.7
Harrow and Roll	.3
Drill	.8
TOTAL Cultivation	6.1
Harvesting	1.5
Plough headland	.1

(d) Preparation for Grass:

March	hrs/ha
Disc	1.2
Harrow and Roll	.5
Drill	1.1
Spread Fertilizer	.5
TOTAL Cultivation	3.3

This paddock is sown for 3 years, so cost of establishment is divided by 3 to find the annual cost.

(e) Preparation for Tama Ryegrass

	hrs/ha
Disc and Harrow	.6
Roll and Disc	.2
Roll	.4
Disc	.6
Harrow and Roll	.4
Disc and Harrow	.6
Roll	.3
Disc and Harrow	.5
Harrow and Roll	.4
Drill	1.0
Spread Fertilizer	1.5
TOTAL Cultivation	6.5

(f) Preparation for Clover Seed

	hrs/ha
Spray	.4
Heavy Roll	.8
Mow	1.5
TOTAL	2.7
Thresh	2.5

(2) Medium Soils :

(a) Old Grass/Peas

	hrs/ha
Deep Plough	3.3
Roll	.8
Disc (2 x)	2.0
Grub (3 x)	2.5
Harrow (2)	1.0
Roll (2)	1.6
Drill	1.0
Roll	.8
Harrow	.5
TOTAL Cultivation	13.5
Harvest – Mow	1.6
Head	1.3

(b) Peas – Wheat

	hrs/ha
Disc (2)	2.0
Deep Plough	3.3
Grub (3)	2.5
Drill	1.0
Roll	.8
Harrow	.5
TOTAL Cultivation	10.1
Harvesting	.9

(c) Wheat – Barley	hrs/ha
Disc (2)	2.0
Deep Plough	3.3
Grub (2)	1.6
Harrow (2)	1.0
Roll (2)	1.6
Drill	1.0
Harrow	.5
TOTAL Cultivation	11.0
Harvesting	1.2

(d) Barley–Greenfeed–Summer fallow–new grass	hrs/ha
Grub	2.5
Roll	.8
Drill	1.0
Plough (Oct.)	3.3
Grub (4)	3.3
Harrow (4)	2.0
Roll (4)	3.3
Drill	1.0
Roll	.8
TOTAL Cultivation	18.0
Harvesting Ryegrass	1.6

Feeding Out

1 hour per day 100 days 100 hours

(18) WEIGHTS AND MEASURES

Measures of Length.

British System.

12 inches	=	1 foot
3 feet	=	1 yard
22 yards	=	1 chain
80 chains	=	1 mile
1,760 yards	=	1 mile
7.92 inches	=	1 link
25 links	=	1 pole, rod or perch (5½ yards)
100 links (4 perches)	=	1 chain
40 perches (10 chains)	=	1 furlong
8 furlongs (80 chains)	=	1 mile
The hand	=	4 inches (used in measuring the height of a horse at the withers)
The span	=	9 inches) rough measurements
The palm	=	3 inches) using the human hand
The cubit	=	18 inches
The fathom	=	6 feet
Mile	=	5,280 feet
Nautical mile	=	6,080 feet
League	=	3 miles
1 Degree	=	69-1/8 miles

Metric System.

10 millimetres	=	1 centimetre
100 centimetres	=	1 metre
1,000 metres	=	1 kilometre

Surveyors Measure (Lineal).

Inches	Links	Feet	Yards	Chains	Mile
1.00	0.126	0.0833	0.0278	0.00126	0.0000158
7.92	1.000	0.6600	0.2200	0.01000	0.0001250
12.00	1.515	1.0000	0.3333	0.01515	0.0001894
36.00	4.545	3.0000	1.0000	0.04545	0.0005682
793.00	100.000	66.0000	22.0000	1.00000	0.0125159
63360.00	8000.000	5280.0000	1760.0000	80.00000	1.0000000

Measures of Area.

British System.

144 square inches	=	1 square foot
9 square feet	=	1 square yard
30.25 square yards	=	1 square perch
40 square perches	=	1 rood
4 roods	=	1 acre
640 acres	=	1 square mile
1 acre	=	700,000 square links
1 acre	=	160 square perches
1 acre	=	4,840 square yards
1 acre	=	43,560 square feet

Metric System.

100 square millimetres	=	1 square centimetre
10,000 square centimetres	=	1 square metre
100 square metres	=	1 are
100 ares	=	1 hectare

Surveyors Measure (Square)

Square inches	Square feet	Square yards	Square perches	Square roods	Acres
1	0.00694	0.000772	0.0000255	0.00000064	0.000000159
144	1.00000	0.1110	0.00367	0.0000918	0.000023
1,296	9.000	1.00	0.0331	0.000826	0.0002062
39,204	272.25	30.25	1.00	0.025	0.00625
1,568,160	10,890.0	1,210.0	40.0	1.00	0.25
6,272,640	43,560.0	4,840.0	160.0	4.0	1.00

Measures of Volume.

British System.

a) Solid Measure.

16.387 cubic centimetres	=	1 cubic inch
1,728 cubic inches	=	1 cubic foot
27 cubic feet	=	1 cubic yard
1.307954 cubic yards	=	1 cubic metre

b) Dry Measure.

2 gallons	=	1 peck
4 pecks	=	1 bushel
8 bushels	=	1 quarter
8 gallons	=	1 bushel

c) Fluid Measure.

1 fluid ounce	=	28.4 cubic centimetres
20 fluid ounces	=	1 pint (568 cc)
4 gills	=	1 pint
1 litre	=	1.75 pints
2 pints	=	1 quart
4 quarts	=	1 gallon

Metric System.

1,000 cubic millimetres	=	1 cubic centimetre
1,000 cubic centimetres	=	1 cubic decimetre (1 litre)
1,000 cubic decimetres	=	1 cubic metre

1 litre = 1000 cc = 1000 gms water

Measures of Weight.

British System.

27.34375 grains	=	1 dram
16 drams	=	1 ounce
16 oz	=	1 pound
14 lb	=	1 stone
2 stones	=	1 quarter
4 quarters	=	1 hundred weight (112 lbs)
20 cwt	=	1 ton
1 short ton	=	2,000 lb
1 long ton	=	2,240 lb
1 metric tonne	=	2,205 lb

Metric System.

1,000 milligrams	=	1 gram
1,000 grams	=	1 kilogram
1,000 kilograms	=	1 tonne

Conversion from British to Metric System (and Vice Versa)

To Convert	British to Metric Multiply by	Metric to British Multiply by
Inches – Millimetres	25.4000	0.0394
Inches – Centimetres	2.5400	0.394
Inches – Metres	0.0254	39.37
Feet – Centimetres	30.48	0.032808
Feet – Metres	0.3048	3.2808

To Convert	British to Metric Multiply by	Metric to British Multiply by
Yards – Centimetres	91.44	0.010936
Yards – Metres	0.9144	1.0936
Chains – Metres	20.11678	0.04971
Furlongs – Metres	201.1678	.004971
Furlongs – Kilometres	.20116	4.971
Miles – Metres	1609.3	0.0006214
Miles – Kilometres	1.6093	0.6214
Sq. inches – Sq. centimetres	6.4516	0.1550
Sq. feet – Sq. metres	0.0929	10.7639
Sq. yards – Sq. metres	0.836126	1.196
Acres – Hectares	0.40468	2.4711
Sq. miles – Hectares	259	0.003861
Cu. inches – Cu. centimetres	16.3870	0.0610
Cu. feet – Cu. metres	0.0283	35.3148
Cu. feet – Litres	28.32	0.03531
Cu. yards – Cu. metres	0.76455	1.307954
Fluid ounces – Cu. centimetres	28.4	0.0352
Pints – Litres	0.5714	1.75
Quarts – Litres	1.143	0.8749
Gallons – Litres	4.5459	0.2199
Ounces (av.) – Grams	28.3500	0.0350
Pounds (av.) – Grams	453.6	0.002204
Pounds (av.) – Kilograms	0.4536	2.2046
Stones (av.) – Kilograms	6.3504	0.1575
Hundredweights – Kilograms	50.803	0.01968
Long tons (av.) – Kilograms	1016.06	0.000984
Short tons (av.) – Kilograms	907.20	0.0011
Tons (av.) – Tonnes	1.0160	0.9842
British H.P. (746 watts) – Metric H.P. (736 watts)	1.0136	0.9865
Foot pounds – Kg metres	0.1383	7.2340
lb per sq. inch – Kg per sq. cm.	0.0703	14.2230
Tons per sq. inch – Kg. per sq. mm.	1.5749	0.6349
Gallons per minute – Cu. metres per hour	0.2728	3.6662
Cubic ft. per minute – Cubic metres per hour	1.6990	0.5886
Cubic ft. per minute – Litres per second	0.4719	2.1190

To Convert	British to Metric Multiply by	Metric to British Multiply by
Inches Hg – Kg per sq. cm.	0.0344	29.0427
B.t.u. per lb – K cal per kg.	0.5555	1.8000
Cu. ft. per sec. – Cu. metres per sec.	35.3148	0.02832
Cu. ft. per sec. – litres per sec.	28.3167	0.035314

Useful Equivalents

One Imperial Gallon	=	277.46 cubic inches
	=	0.1605 cubic feet
	=	1.2 United States gallons
	=	10 lb of fresh water
	=	10.272 lb of salt water
	=	4.54 litres or kilograms
One litre of water	=	61 cubic inches
	=	0.264 U.S. gallons
	=	2.2 lb
	=	0.22 Imp. gallons
	=	1 kilogram
One pound of water	=	27.69 cubic inches
	=	0.1 Imp. gallons
	=	0.12 U.S. gallons
	=	0.4536 litres or kilos
One U.S. gallon	=	0.83 Imp. gallons
	=	231 cubic inches
	=	3.8 litres or kilos
One Cubic Metre of Water	=	2,200 lbs
	=	220 Imp. gallons
	=	264 U.S. gallons
	=	35.31 cubic feet
	=	1000 litres or kilos
1 large drink bottle	=	26 fluid ounces
1 teaspoonful	=	1/8 fluid oz.
1 dessertspoonful	=	¼ fluid oz.
1 tablespoonful	=	½ fluid oz.
1 kilogram per hectare	=	0.89 lbs per acre

Metric Equivalents of Power, Force and Energy

Power is the measure of work done per unit time.

The metric unit is 1 watt (W)

1 watt	=	1 joule per sec.
	=	1 newton metre per sec.
	=	.101972 kilogram-force metre per second.
1 kw	=	1.341 horsepower.

Force is measures in newtons (N) and moment of force or torque in newton metres (Nm).

Energy or Work is measured in 'joules', the special name for newton metres.

1 kJ	=	0.2388 kilocalorie
1 kilogram-force metre	=	9.80665 joules.

Miscellaneous Measures.

Water pressure lb/sq. in. = Height in feet x 0.434.
A column of water 2.31 ft. high = 1 lb/sq. in.
A column of water 1 metre high = 1.43 lb/sq. in.
1 in. water gauge = 0.036 p.s.i.
One atmosphere = 14.7 psi = 30 in. of mercury = 34 ft. of water
Barometric pressure varies from 0.1 in. for each 90 ft. change of altitude
Miles per hour x 88 = feet per second
1 knot = 1 nautical mile (1.1515 statute miles) per hour
One billion (British) = 1 million millions
One billion (U.S.A.) = 1 thousand millions

Measurement of Timber.

To ascertain the superficial contents of a log, multiply the square of a quarter of the centre girth by the length of the log, and divide the result by 12 (length in feet, girth in inches).

i.e. $$\frac{\left(\frac{G\text{ (in.)}}{4}\right)^2 \times L\text{ (ft)}}{12} = \text{super feet}$$

Belting Facts.

To find the circumference of a pulley.

Circumference = 3.14 x Diameter (D)

Belt speed in ft per minute.

$$\text{Belt Speed} = 3.14 \times \frac{D}{12} N \quad \text{ft per min.}$$

Where N = number of revolutions of the pulley per minute.

The length of a belt.

$$\text{Length} = 2 \times \text{Length (in feet between centres of pulleys)} + \frac{3.14}{24} \times \text{Diameter (in inches) of driving pulley} + \frac{3.14}{24} \times \text{Diameter (in inches) of driven pulley}$$

$$\text{Diameter of Driving Pulley} = \frac{\text{Dia. of Driven Pulley} \times \text{rpm of Driven Pulley}}{\text{rpm of Driving Pulley.}}$$

Centigrade – Fahrenheit Temperatures.

The formula to convert temperature from one scale to another is –

$$°F = (°C \times \frac{9}{5}) + 32 \qquad °C = (°F - 32) \times \frac{5}{9}$$

Description	Degrees Centigrade	Degrees Fahrenheit
Freezing Point	0	32
Blood Heat	36.6	98.4
Silage Curing	37.7	100
Warm Water	49	120
	60	140
Hot Water	71	160
	82	180
Boiling Water	100	212

Absolute temperature (deg. K) = Centigrade temp. + 273.16

Standard Bushel Weights.

Produce	lb per bushel
Barley	50
Beans	60
Beans (fresh)	20
Bran	20
Buckwheat	50
Canary Seed	56
Clovers	60
Flax	60
Grass seed	20
Linseed	56
Lucerne	60
Lupins	60
Maize	56
Millets	50
Oats	40
Peas	60
Peas (in pod)	28
Pollard	20
Rice	45
Rye corn	60
Safflower	40
Sorghum grain	60
Sudan grass	50
Sunflower	35
Wheat	60

Average Bag Weights of Feeds. (lbs.)

Barley	150
Barley Meal	120
Beans	180
Blood meal	160
Bran	110
Buck wheat	150
Buttermilk	112
Canary seed	150
Epsom salts	92
Fish meal	100
Grit	82
Linseed	140
Linseed meal	125
Liver meal	140
Lucerne chaff	84
Lucerne meal	100
Maize	170
Maize meal	120
Meat meal	140
Millet (Japanese)	112
Millet (French)	140
Oats	120
Oats (hulled)	180
Peas	160
Pollard	140
Rape	112
Ryecorn	170
Ryegrass	112
Safflower	110
Salt (coarse)	184
Salt (fine)	112
Sorghum	177
Sorghum meal	140
Sunflower	100
Turnips	112
Wheat	180
Wheat germ	110
Wheat meal	140

Wool Metric Conversion Chart.

1 Kg = 2.2046213 lb.
Rough Rule – half kilo price less one-tenth = cents per lb.

¢/kg	¢/lb.	¢/kg	¢/lb	¢/kg	¢/lb	¢/kg	¢/lb	¢/kg	¢/lb
30	13.61	54	24.49	78	35.38	102	46.27	126	57.15
31	14.06	55	24.95	79	35.83	103	46.72	127	57.61
32	14.52	56	25.40	80	36.29	104	47.17	128	58.06
33	14.97	57	25.85	81	36.74	105	47.63	129	58.51
34	15.42	58	26.31	82	37.19	106	48.08	130	58.97
35	15.88	59	26.76	83	37.65	107	48.53	131	59.42
36	16.33	60	27.22	84	38.10	108	48.99	132	59.88
37	16.78	61	27.67	85	38.56	109	49.44	133	60.34
38	17.24	62	28.12	86	39.01	110	49.90	134	60.78
39	17.69	63	28.58	87	39.46	111	50.35	135	61.24
40	18.14	64	29.03	88	39.92	112	50.80	136	61.69
41	18.60	65	29.48	89	40.37	113	51.26	137	62.14
42	19.05	66	29.94	90	40.82	114	51.71	138	62.60
43	19.50	67	30.39	91	41.28	115	52.16	139	63.05
44	19.96	68	30.84	92	41.73	116	52.61	140	63.50
45	20.41	69	31.30	93	42.18	117	53.07		
46	20.87	70	31.75	94	42.64	118	53.52		
47	21.32	71	32.21	95	43.09	119	53.97		
48	21.77	72	32.66	96	43.54	120	54.43		
49	22.23	73	33.11	97	44.01	121	54.88		
50	22.68	74	33.57	98	44.45	122	55.34		
51	23.13	75	34.02	99	44.91	123	55.79		
52	23.59	76	34.47	100	45.36	124	56.25		
53	24.04	77	34.97	101	45.81	125	56.70		

METRIC NOTES

Useful metric data taken from the handbook 'Hydraulics for Firemen', edited by the Christchurch Technical Institute.

2.0 Fundamental Units

The initials "S.I." stand for "Systeme International d'Unites" (International System of Units) which is a system of units based on the old metric units.

The units are based on multiples of 10 so that awkward conversions are eliminated. This simplifies calculations and also reduces the possibility of making mistakes.

2.1 Multiple and Submultiple Units:

The S.I. is based on several basic and derived units. However, these units do not generally satisfy the requirements of every situation in that they may give answers with a large number of figures. To overcome this situation a series of multiple and submultiple units may be used.

The multiple and submultiple units are formed by combining a prefix with the name of the basic unit. The prefix means that the basic unit is multiplied by a certain number.

Table 2.1 shows the most commonly used prefixes which have been adopted, and the symbols and multiplication factors specified for each.

Prefix	Symbol	Basic Unit multiplied by:
Giga	G	1000 000 000
Mega	M	1 000 000
kilo	k	1 000
hecto	h	100
deca	da	10
ORIGINAL UNIT		1
deci	d	$\frac{1}{10}$
centi	c	$\frac{1}{100}$
milli	m	$\frac{1}{1000}$
micro	μ	$\frac{1}{1000\ 000}$
nano	n	$\frac{1}{1000\ 000\ 000}$

The prefix is combined with the unit name and the combination is written as one word, e.g. millimetre.

2.2 Base Units:

The S.I. is founded on a small number of base units which may be combined to form other units called derived units.

The base units which will be most frequently used in hydraulics are shown in Table 2.2 with the recommended multiple and submultiple units.

Quantity	Name of Basic Unit	Symbol	Multiple Unit	Submultiple Unit
Length	Metre	m	Kilometre (km) = 1000 m	millimetre mm = $\frac{1}{1000}$ m
Mass	Kilogram	kg	Megagram Mg = 1000 kg = 1 Tonne	gram g = $\frac{1}{1000}$ m
Time	Second	s	1 minute * 1 hour	

* The multiple units of the second, i.e., the minute and the hour as at present in use, are to be retained in the S.I.

Table 2.2 Base Units

2.2.1 Mass

The quantity Mass is perhaps the only base unit which may be unfamiliar to readers.

The mass of an object is a measure of the quantity of matter of substance in the object. The mass of any object is constant and is independent of position on earth or in the universe, and is also independent of its acceleration.

2.3 Derived Units:

Base units may be combined to form "Derived Units" to suit the particular application.

Table 2,3 shows the derived units which are used most frequently in hydraulics.

Quantity	Unit Name	Symbol
Force	Newton	N
Pressure	Pascal	Pa
Energy	Joule	J
Power	Watt	W

Table 2.3 Derived Units

2.3.1 Force:

The presence of a force can be determined by its effect. For example, an earthquake is seen to produce a force because it is capable of damaging buildings, etc.

If a piece of cast iron having a mass of 1 kg is rested on one's hand a certain force is required to prevent it falling to the floor. On the other hand if the same piece of cast iron is dropped onto one's foot, it is obvious that the force produced is different, even though the mass of the object is unchanged.

The force produced by a certain mass depends upon the acceleration of the object and is measured in units called NEWTONS, thus:–

Force (in Newtons) = Mass (in kilograms) X Acceleration (in metres per sec.^{2}).

2.3.2 Weight:

Between any two objects in space there exerts a force of attraction. For example, there is a force of attraction between the earth and the moon which keeps the moon in orbit around the earth and prevents it flying off into space. This same force of attraction is exerted upon every object on or near the earth; the larger the object the greater is the force of attraction. This special force of attraction is normally referred to as the force of Gravity, or gravitational force.

When an object having some particular mass is held above the earth's surface, a force must be applied to the object to prevent it falling to earth under the influence of the earth's gravitational force. This force applied to the object is called the WEIGHT of the object.

The weight of an object may be defined as the FORCE applied to a mass due to its presence within the earth's gravitational field.

Since weight is a force is should be expressed in NEWTONS, thus:

Weight in Newtons = Mass in kilograms x 9.81

It is likely that weight will continue to be expressed in kilograms. For all practical purposes, therefore, a weight of 5 kilograms measured by a spring balance actually measuring force but calibrated in kilograms instead of Newtons.

2.3.3 Pressure:

Pressure is defined as a force divided by the area over which the force acts.

$$\text{Thus:— Pressure} = \frac{\text{Force (in Newtons)}}{\text{Area (in metres squared)}}$$

It is clear that the unit of pressure is therefore the N/m^2 which is given the name "Pascal", symbol Pa = 1 N/m^2.

It is permissable to combine prefixes with this unit to give :

Kilopascals kPa = 1000 N/m^2
and Megapascals MPa = 1000 000 N/m^2, etc.

An additional unit called the BAR is in widespread use. It is easily converted to basic units using the relationship

1 BAR = 100 000 Pa

1 Bar is almost exactly equal to atmospheric pressure at M.S.L.

2.3.4 Energy:

Energy is the ability of a force to perform work. For example, if a certain amount of energy is required to push a motor-car 1 m along level ground, it will require twice the energy to move it 2 m, and if the car does not move, no energy is used.

The unit of energy is called the JOULE (symbol J) which is the energy expended when 1 Newton of force moved through 1 m.

Energy (in Joules) = Force (in Newtons) x Distance (in metres)

1 J = 1N x 1 m

2.3.5 Power

Power is the quantity which defines the rate at which energy is supplied, or is used by a system. For example, if a motor car is pushed a distance of 10 m along the road in 1 minute a certain amount of power is expended. If the car is moved over the same distance in 0.5 minutes, twice the power will be required.

The unit of power is called the WATT (symbol W) which is the amount of power delivered when 1 joule of energy is supplied per second.

i.e. Power (in Watts) = Energy (in Joules) ÷ Time (in Seconds)

i.e. $1W = \frac{1J}{1s} = 1 \frac{Nm}{s}$

Prefixes may be combined to give larger units, e.g. kilowatts (kW) and megawatts (MW).

3.0 Properties of Water

Any material may exist in three states, i.e., as a gas, a liquid or a solid.

Water is a liquid which may be converted to a solid (i.e., ice) by freezing, and into a gas (i.e.,steam) by boiling.

A liquid is a substance which has definite volume, but is incapable of resisting change in shape, i.e., when poured into a container it will adjust itself to the shape of the container, and will come to rest with a level surface.

Pure water is colourless, odourless and tasteless. However, impurities will normally modify these properties in varying degrees. Under normal circumstances water will boil at 100^oC and will freeze at 0^oC.

3.1 Density:

The density of a liquid is defined as its mass per unit volume.

Water has a density at 4^oC of $1000\ kg/m^3 = 1\ Tonne/m^3$

Since 1 litre = $\frac{1}{1000}\ m^3$, one litre of water at 4^oC will have a mass of 1 kg.

3.2 Specific Weight:

The specific weight of a liquid is defined as the weight of unit volume of a liquid.

i.e. Specific weight of water $= 9.81\ \text{kN/m}^3$

$\qquad\qquad\qquad\qquad\qquad\quad \doteq 10\ \text{kN/m}^3$

3.3 Compressibility:

For all practical purposes water is incompressible. If one metre cube of water was subjected to a pressure increase of 1 atmosphere its volume would be reduced by 500 mm^3 or about $\frac{1}{200}$% of its original volume.

New Zealand Meteorological Service
Summaries of Climatological Observations at New Zealand Stations to 1970

Introduction

This volume contains summaries of the climatological observations made at stations administered by the New Zealand Meteorological Service in New Zealand, the Cook Is., Raoul Is., Chatham Is., and Campbell Is.

In most cases the tables are based on observations made once a day. The observation hour since 1 January 1950 in New Zealand, Raoul Is. and Campbell Is. has normally been 0900 hours New Zealand Standard Time (NZST) but prior to this was 0930 hours NZST. Any deviations from these times are noted in the tables. NZST is 12 hours ahead of GMT.

In the Cook Is. observations are now made at 0730 hours local time (1800 hours GMT the previous day). Past deviations from this time are noted in the tables. Chatham Is. observations are now made at 0915 hours local time (2030 GMT).

The summaries relate to the present sites of most currently operating stations. Unless the tables specify otherwise, site changes involving little if any discontinuity are ignored in compiling the data. When for a particular station sites not strictly comparable have been used, the data for the extremes of temperature, rainfall and sunshine are usually taken from observations made at all sites.

Notes on the Tables

Station Details

The latitude and longitude of each station are given in degrees and minutes and the height in metres.

The code number listed before each station name is allocated by the New Zealand Meteorological Service for its own purposes.

Rainfall

The standard New Zealand Meteorological Service raingauge has a funnel diameter of 12.7 cm and is installed with the rim 30 cm above ground. Rainfall is measured to 0.1 mm.

Highest monthly/annual total: The highest rainfall recorded during the period indicated.

Normal: The normal refers to the standard 30 year period 1941–70, and is the average rainfall over this period. At many stations the observations are not complete over this period and the normal is obtained by adjusting the actual rainfall recorded to the standard 1941–70 period. This is done by comparing the actual rainfall at the station with the rainfall at nearby stations for which a true 1941–70 normal is available. The normal rainfalls are adjusted for changes in the observation site (where applicable) and relate to the current observation site.

Lowest monthly/annual total: The lowest rainfall recorded during the period indicated.

Average number of days with rain: The average number of days (0900 hours NZST to

0900 hours NZST) during which at least 1.0 mm of rain was recorded.

Maximum 1-day rainfall: The highest rainfall recorded in the 24 hours ending at 0900 hours NZST during the period indicated.

Water Balance

The data on water balance are based on the relationship between the estimated daily potential evapotranspiration (assessed from the mean monthly evapotranspiration) and the daily rainfall, assuming that the soil is capable of holding a maximum of 75 mm of water.

Average runoff: Runoff occurs when the rainfall less the potential evapotranspiration exceeds the moisture capacity of the soil which is assumed to be not more than 75 mm. The average runoff during the period indicated is the average runoff per month or year, after allowance is made for the soil moisture capacity of 75 mm.

Average deficit: A deficit occurs when the combined rainfall and available soil moisture is less than the potential evapotranspiration. The average deficit during the period indicated is the average deficit per month or year after allowance has been made for the available soil moisture.

Temperatures

Dry and wet bulb, maximum and minimum thermometers are exposed in screens 1.3 metres above a grassed surface. The thermometers used are mainly of the sheathed pattern.

Highest maximum: The highest temperature recorded during the period indicated.

Mean monthly/annual maximum: The average of the highest temperature recorded in each month or year during the period indicated.

Mean daily maximum: The average of the highest temperature recorded each day during the period indicated. This is approximately the average early afternoon temperature.

Normal: The normal refers to the standard 30 year period 1931–60, and is obtained by averaging the mean daily maximum and mean daily minimum temperatures for this period. At many stations the observations started after 1931, and in these cases the normal is obtained by adjusting the actual temperatures to the standard 1931–60 period. This is done by comparing the actual temperature with the temperature at nearby stations for which a true 1931–60 normal is available. The normal temperatures are adjusted for changes in the observation site (where applicable) and relate to the current observation site. The normal temperatures given here are slightly different from those which would be obtained using hourly observations over the 24 hour day. Such temperatures are available on request.

Mean daily minimum: The average of the lowest temperature recorded each day during the period indicated. This is approximately the average early-morning temperature.

Mean monthly/annual minimum: The average of the lowest temperatures recorded in each month or year during the period indicated.

Lowest minimum: The lowest temperature recorded during the period indicated.

Mean daily grass minimum: The average of the lowest grass temperatures recorded each day during the period indicated. The grass minimum thermometer is exposed horizontally 2.5 cm above a level grass surface.

Days with Frost

Ground frost: Data on ground frost are obtained from the readings of grass minimum thermometers which are exposed horizontally 2.5 cm above a level grass surface. A day with ground frost occurs when the grass minimum temperature is $-1.0^{o}C$ or lower. The data given are the average number of days with ground frost in a month or year, during the period indicated.

Frost in screen: A day with screen frost occurs when the temperature in the screen (1.3 metres above a grassed surface) is below $0^{o}C$. The data given are the average number of days with screen frost in a month or year, during the period indicated.

Earth Temperature

Earth temperatures are measured at 0900 hours NZST. Bent-stem thermometers with the bulbs sunk into bare soil are used at depths of 0.10 and 0.20 metres. At depths of 0.30 and 0.91 metres lagged thermometers are used, these being suspended inside steel tubes sunk into the ground. At shallow depths the 0900 hours earth temperature is close to the minimum earth temperature for the day, but at depths of 0.30 metres or more the diurnal range is negligible, and such earth temperatures at 0900 hours are close to the mean daily earth temperatures at these depths. The data give the average 0900 hours earth temperature for various depths during the period indicated.

Relative Humidity

The average relative humidity at 0900 hours NZST is calculated from the average dry and wet bulb temperature observations made at 0900 hours. At the stations equipped with hygrographs a mean relative humidity over 24 hours is also given. This is found by averaging the value for each hour scaled from the hygrograph charts. The data given are over the period indicated.

Vapour Pressure

The vapour pressure is a measure of the water vapour content of the air. The average vapour pressure at 0900 hours NZST is calculated from the average dry bulb temperature observations made at 0900 hours and the average relative humidity calculated (as above) for 0900 hours. The data given are averages over the period indicated. Note: Water vapour, like other gases, exerts a pressure, which is called the vapour pressure. Near the ground water vapour can exert a pressure of about 5 to 30 millibars and in New Zealand average vapour pressures vary from about 7 millibars to 18 millibars. The relative humidity at a specific time may be expressed as the actual vapour pressure at that time divided by the vapour pressure necessary for saturation.

Sunshine

The duration of "bright sunshine" is given for stations equipped with Campbell-Stokes pattern sunshine recorders. Owing to topographical features there are few stations at which all possible sunshine would be recorded.

Highest: The highest duration of bright sunshine for the month or year during the period indicated.

Average: The average duration of bright sunshine for the month or year during the period indicated.

% of possible: The highest/average/lowest duration of bright sunshine expressed as a percentage of the total possible bright sunshine, i.e. the astronomically possible sunshine, less half an hour for each day.

Lowest: The lowest duration of bright sunshine for the months or years during the period indicated.

Wind

The daily wind run in km per day is given for those stations equipped with a Robinson Cup anemometer, the cups of which are usually exposed 6 metres above the ground. For an open exposure the wind run recorded at 6 metres is approximately 10 percent less than the wind run at 10 metres.

Wind gusts: At stations equipped with Dines or Munro recording anemometers, detailed information about fluctuations in wind speed and direction are available. From these records are given the average number of days in the month or year with gusts of 34 knots or more, and 52 knots or more.

Special Phenomena

The frequency of special phenomena is given as the average number of days per month or year on which they are observed. Note: It is difficult to obtain reliable data on some special phenomena because some observers fail to record all occurrences especially when they happen at night. The data should therefore be treated with caution. Data given are the average number of days per month or year, over the period indicated, of snow, hail and thunder.

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

G23021 MOLESWORTH LAT. 42 5S LONG. 173 16E HT. 893 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1944-1970	163	130	125	154	169	106	143	127	128	147	157	119	881
NORMAL	1941-1970	53	46	48	58	69	48	61	58	53	58	58	56	666
LOWEST MONTHLY/ANNUAL TOTAL	1944-1970	16	5	3	4	6	11	9	11	9	10	3	12	480
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1944-1970	6	6	6	7	8	7	8	8	7	8	8	8	86
MAXIMUM 1-DAY RAINFALL MM.	1944-1970	68	40	38	67	78	54	53	39	39	46	49	42	78
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1944-1970	3	.	.	5	23	30	48	38	18	18	13	5	201
AVERAGE DEFICIT (MM)	1944-1970	28	33	18	8	.	.	.	.	.	.	.	13	100
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1944-1970	31.9	32.8	30.6	26.1	20.7	18.4	14.9	15.8	21.1	26.1	27.2	29.7	32.8
MEAN MONTHLY/ANNUAL MAXIMUM	1944-1970	28.0	28.3	25.7	21.7	16.8	13.1	11.9	13.2	17.8	21.3	23.2	25.9	29.5
MEAN DAILY MAXIMUM	1944-1970	20.9	21.0	18.5	14.7	10.4	7.4	6.5	8.2	11.7	14.2	16.5	18.7	14.1
NORMAL	1931-1960	13.9	13.6	11.7	8.6	4.7	2.2	1.2	2.7	5.7	8.1	10.1	12.3	7.9
MEAN DAILY MINIMUM	1944-1970	7.0	6.9	5.3	2.3	-0.3	-2.8	-3.6	-2.3	-0.1	2.1	3.8	5.8	2.0
MEAN MONTHLY/ANNUAL MINIMUM	1944-1970	0.5	0.0	-1.5	-3.9	-7.1	-8.5	-9.9	-8.4	-6.0	-4.1	-2.3	-0.3	-10.8
LOWEST MINIMUM	1944-1970	-2.8	-2.8	-6.9	-7.2	-11.9	-12.8	-12.8	-12.7	-11.2	-8.3	-6.7	-6.0	-12.8
MEAN DAILY RANGE	1944-1970	13.9	14.1	13.2	12.4	10.7	10.2	10.1	10.5	11.8	12.1	12.7	12.9	12.1
MEAN DAILY GRASS MINIMUM	1944-1970	2.9	2.3	1.0	-2.5	-4.7	-7.0	-7.3	-5.9	-4.2	-2.4	-0.5	2.0	-2.2
DAYS WITH FROST														
GROUND FROST AVERAGE	1944-1970	6.2	7.7	11.9	19.5	24.2	27.5	28.1	27.2	23.0	19.0	15.7	7.8	217.8
FROST IN SCREEN AVERAGE	1944-1970	0.5	0.5	2.0	7.7	16.7	23.5	25.7	23.0	22.0	7.8	3.6	0.9	133.9
EARTH TEMPERATURES (DEGREES C)														
AVERAGE AT 0.10 METRES	1944-1970	15.8	15.0	11.7	7.3	3.6	0.8	0.0	0.9	3.7	7.7	11.6	14.5	7.7
AVERAGE AT 0.30 METRES	1944-1970	16.2	16.2	13.6	9.7	5.6	2.5	1.2	1.8	4.0	8.4	10.6	14.6	8.7
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1944-1970	56	60	67	67	75	80	82	75	65	60	59	58	67
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1944-1970	10.0	10.2	9.7	7.8	6.2	5.4	5.2	5.4	6.1	7.1	8.3	9.3	7.6
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1944-1970	.	0.2	0.1	0.4	1.4	1.4	2.1	1.9	1.4	0.3	.	0.2	9.4
AVERAGE NO. OF DAYS WITH HAIL	1944-1970	.	.	.	.	.	.	.	.	.	.	0.2	0.2	0.4
AVERAGE NO. OF DAYS WITH THUNDER	1944-1970	0.5	0.2	.	.	.	.	.	.	.	.	0.4	0.4	1.5

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

H22871 BALMORAL FOREST LAT. 42 52S LONG. 172 45E HT. 198 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1921-1970*	134	222	214	154	382	181	221	183	207	149	150	246	1066
NORMAL	1941-1970	46	51	51	61	61	51	64	58	46	53	51	64	657
LOWEST MONTHLY/ANNUAL TOTAL	1921-1970*	9	0	3	8	9	10	6	8	3	9	9	4	380
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1928-1970	35.6	35.0	32.8	29.4	25.6	23.9	20.0	22.8	23.3	27.2	31.1	33.7	35.6
MEAN MONTHLY/ANNUAL MAXIMUM	1928-1970	30.8	30.5	28.8	25.0	20.7	17.3	16.4	18.1	21.0	24.1	26.4	28.8	32.2
MEAN DAILY MAXIMUM	1928-1970	22.8	22.9	20.8	17.4	13.5	10.7	9.9	11.8	14.6	17.2	19.4	21.3	16.9
NORMAL	1931-1960	15.8	15.8	13.9	11.1	7.4	4.7	4.0	5.7	8.1	10.5	12.7	14.7	10.4
MEAN DAILY MINIMUM	1928-1970	9.6	9.6	7.9	5.2	1.9	-0.7	-1.2	0.1	2.2	4.6	6.5	8.5	4.5
MEAN MONTHLY/ANNUAL MINIMUM	1928-1970	2.5	2.2	0.3	-2.1	-4.7	-6.5	-7.3	-5.9	-3.9	-2.1	-0.6	1.8	-7.9
LOWEST MINIMUM	1928-1970	-0.6	-0.3	-1.8	-5.6	-8.3	-9.4	-13.3	-9.2	-6.7	-5.3	-3.3	-1.2	-13.3
MEAN DAILY RANGE	1928-1970	13.2	13.3	12.9	12.2	11.6	11.4	11.1	11.7	12.4	12.6	12.9	12.8	12.4
MEAN DAILY GRASS MINIMUM	1928-1970	6.8	6.9	5.3	2.5	-0.6	-3.1	-3.4	-2.4	-0.3	2.0	3.7	5.9	1.9
DAYS WITH FROST														
GROUND FROST AVERAGE	1950-1970	0.9	1.0	1.8	7.9	15.7	22.4	23.9	20.0	14.3	8.3	3.0	1.0	120.2
FROST IN SCREEN AVERAGE	1950-1970	.	0.4	0.6	4.3	11.6	19.0	20.7	17.5	10.5	4.9	1.2	0.1	90.8
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1950-1970	57	61	69	76	80	83	84	76	69	60	55	58	69
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1950-1970	11.6	11.8	11.5	9.8	7.8	6.3	6.1	6.6	8.0	8.8	9.4	11.0	9.1
WIND														
DAILY WIND RUN (KILOMETRES)	1950-1970	185	166	137	126	105	92	89	103	134	164	198	180	140
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1950-1970	.	.	.	.	0.2	0.5	0.7	0.2	0.3	0.3	.	.	2.2
AVERAGE NO. OF DAYS WITH HAIL	1950-1970	.	.	.	.	0.1	0.1	.	.	.	0.1	0.1	0.1	0.5
AVERAGE NO. OF DAYS WITH THUNDER	1950-1970	0.2	.	.	.	.	.	0.1	.	0.1	0.1	0.1	0.2	0.8

* includes observations at rainfall station

H31572 HIGHBANK POWER STN LAT. 43 35S LONG. 171 44E HT. 336 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1953-1970	161	125	179	197	219	150	255	135	100	154	187	185	1195
NORMAL	1941-1970	89	81	86	91	81	61	79	74	66	86	97	94	985
LOWEST MONTHLY/ANNUAL TOTAL	1953-1970	36	24	32	13	29	5	15	14	21	16	25	34	665
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1953-1970	9	8	10	9	10	7	9	8	7	8	10	10	104
MAXIMUM 1-DAY RAINFALL MM.	1953-1970	62	52	59	102	75	34	62	43	40	58	54	61	102
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1954-1970	10	3	13	25	56	38	76	41	23	18	23	18	344
AVERAGE DEFICIT (MM)	1954-1970	13	10	5	.	.	.	.	.	.	.	.	3	31
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1953-1970	35.7	32.2	30.1	25.8	21.6	18.8	18.3	19.7	22.9	25.7	30.4	30.0	35.7
MEAN MONTHLY/ANNUAL MAXIMUM	1953-1970	29.3	28.8	27.0	23.3	19.1	16.6	15.9	17.1	19.4	22.4	24.2	26.9	30.6
MEAN DAILY MAXIMUM	1953-1970	21.4	21.0	18.9	16.1	12.6	10.7	9.4	11.0	13.3	15.7	17.5	19.5	15.6
NORMAL	1931-1960	15.2	15.1	13.7	11.4	8.2	7.0	5.3	6.4	8.9	10.7	12.3	13.9	10.7
MEAN DAILY MINIMUM	1953-1970	10.6	10.4	9.4	7.0	4.4	2.7	1.9	2.8	4.5	6.4	7.8	9.2	6.4
MEAN MONTHLY/ANNUAL MINIMUM	1953-1970	5.1	4.7	4.2	1.5	-0.6	-1.6	-2.3	-1.2	-0.2	0.9	2.1	3.9	-2.9
LOWEST MINIMUM	1953-1970	1.9	1.2	1.3	0.0	-4.2	-5.6	-4.4	-3.9	-3.2	-1.1	0.1	1.6	-5.6
MEAN DAILY RANGE	1953-1970	10.8	10.6	9.5	9.1	8.2	8.0	7.5	8.2	8.8	9.3	9.7	10.3	9.2
MEAN DAILY GRASS MINIMUM	1953-1970	8.7	8.7	7.1	4.4	1.2	-0.7	-1.3	-0.2	2.0	3.9	5.7	7.4	3.9
DAYS WITH FROST														
GROUND FROST AVERAGE	1953-1970	.	0.1	0.5	2.5	9.5	15.6	18.1	13.7	7.8	4.1	1.5	0.3	73.7
FROST IN SCREEN AVERAGE	1953-1970	.	.	.	.	2.1	4.7	8.9	4.0	0.9	0.4	.	.	21.0
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1953-1970	71	73	77	73	76	68	72	71	69	64	65	68	71
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1953-1970	12.2	11.8	11.3	9.1	7.6	6.1	5.9	6.3	7.3	8.2	9.4	10.0	8.8
SUNSHINE. HOURS														
HIGHEST	1954-1970	279	235	189	195	164	173	170	224	243	246	264	267	2198
AVERAGE	1954-1970	220	181	160	160	136	135	136	164	174	206	212	209	2093
% OF POSSIBLE	1954-1970	48	47	42	50	46	51	48	52	50	51	49	44	49
LOWEST	1954-1970	163	129	111	102	98	96	108	127	111	164	167	123	1867
WIND														
DAILY WIND RUN (KILOMETRES)	1954-1970	306	288	269	274	256	253	246	275	298	332	351	309	288
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1953-1970	.	.	.	0.2	0.5	0.6	1.8	0.8	0.9	0.5	0.3	0.1	5.7
AVERAGE NO. OF DAYS WITH HAIL	1953-1970	0.1	0.1	0.2	0.1	.	0.2	0.2	0.1	0.3	0.2	0.5	0.1	2.1
AVERAGE NO. OF DAYS WITH THUNDER	1953-1970	0.9	0.3	0.3	0.2	0.2	0.1	.	0.1	0.1	0.5	0.6	0.3	3.6

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

H31883 WINCHMORE — LAT. 43 48S LONG. 171 48E HT. 160 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1947-1970	144	134	158	219	243	143	175	132	87	120	253	150	948
NORMAL	1941-1970	61	64	74	66	74	56	61	61	51	61	66	76	771
LOWEST MONTHLY/ANNUAL TOTAL	1947-1970	18	7	20	5	20	3	14	12	11	9	13	12	491
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1947-1970	8	6	8	7	8	6	8	7	6	7	8	8	86
MAXIMUM 1-DAY RAINFALL MM.	1947-1970	49	95	84	73	58	49	62	51	50	53	62	56	95
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1947-1970	3	5	5	18	20	18	48	33	13	15	13	5	196
AVERAGE DEFICIT (MM)	1947-1970	33	28	13	10	.	.	.	.	.	.	5	13	102
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1949-1970	35.9	34.0	31.4	27.9	23.9	19.3	19.7	21.1	23.2	26.4	31.6	31.1	35.9
MEAN MONTHLY/ANNUAL MAXIMUM	1949-1970	30.8	30.4	28.1	23.9	19.6	16.6	16.4	18.2	21.0	23.7	26.2	28.5	31.8
MEAN DAILY MAXIMUM	1949-1970	21.8	21.5	19.2	16.2	12.7	10.4	9.8	11.4	13.9	16.4	18.7	20.1	16.0
NORMAL	1931-1960	15.4	15.3	13.4	10.7	7.6	5.1	4.7	6.1	8.2	10.4	12.4	14.2	10.3
MEAN DAILY MINIMUM	1949-1970	9.9	9.9	8.5	5.7	2.7	0.3	-0.2	1.1	3.1	5.2	6.7	8.8	5.1
MEAN MONTHLY/ANNUAL MINIMUM	1949-1970	3.8	3.6	1.8	-0.4	-3.5	-4.9	-5.2	-4.5	-2.7	-0.8	0.4	3.0	-6.0
LOWEST MINIMUM	1949-1970	1.7	1.6	-0.4	-3.1	-8.4	-7.8	-7.7	-7.2	-6.2	-4.2	-2.1	0.7	-8.4
MEAN DAILY RANGE	1949-1970	11.9	11.6	10.7	10.5	10.0	10.1	10.0	10.3	10.8	11.2	12.0	11.3	10.9
MEAN DAILY GRASS MINIMUM	1949-1970	7.8	7.7	6.2	3.4	0.3	-2.5	-3.0	-1.9	0.3	2.5	4.2	6.7	2.6
DAYS WITH FROST														
GROUND FROST AVERAGE	1949-1970	0.3	0.2	1.4	6.2	13.7	21.0	22.8	19.9	13.2	7.7	3.9	0.9	111.2
FROST IN SCREEN AVERAGE	1949-1970	.	.	0.1	1.1	6.6	14.5	16.8	12.2	4.7	2.0	0.3	.	58.3
EARTH TEMPERATURES (DEGREES C)														
AVERAGE AT 0.10 METRES	1949-1970	16.6	15.7	13.3	10.1	6.4	3.6	2.8	3.9	6.7	10.2	13.3	15.4	9.8
AVERAGE AT 0.30 METRES	1949-1970	17.4	17.2	15.3	12.3	8.8	5.7	4.6	5.6	8.1	11.0	13.7	15.8	11.3
AVERAGE AT 0.91 METRES	1949-1970	16.7	16.9	15.9	13.7	10.7	7.8	6.1	6.4	8.2	10.6	13.1	15.1	11.8
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1949-1970	65	69	77	80	83	81	81	80	73	68	62	66	74
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1949-1970	12.4	12.6	12.1	10.5	8.2	6.4	6.2	7.2	8.3	9.6	10.1	11.6	9.6
WIND														
DAILY WIND RUN (KILOMETRES)	1949-1970	330	311	283	269	253	230	241	264	296	330	357	346	293
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1949-1970	.	.	.	.	0.2	0.4	0.8	0.5	0.7	0.2	0.1	.	2.9
AVERAGE NO. OF DAYS WITH HAIL	1949-1970	0.1	0.1	.	.	0.1	0.1	0.2	.	0.3	0.4	0.5	0.4	2.2
AVERAGE NO. OF DAYS WITH THUNDER	1949-1970	0.6	0.3	0.3	0.1	.	.	.	.	0.1	0.4	0.6	0.7	3.1

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

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H31971 ASHBURTON — LAT. 43 54S LONG. 171 45E HT. 101 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1909-1970*	182	255	256	224	248	166	229	204	182	154	257	243	1147
NORMAL	1941-1970	64	66	76	66	71	56	61	61	51	61	69	74	776
LOWEST MONTHLY/ANNUAL TOTAL	1909-1970*	8	3	6	5	8	2	7	9	2	4	16	5	382
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1927-1970	7	7	8	7	8	7	8	7	7	7	8	8	90
MAXIMUM 1-DAY RAINFALL MM.	1927-1970	56	121	105	67	71	61	62	72	59	56	74	66	121
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1927-1970	5	8	10	10	20	30	43	36	23	13	10	10	218
AVERAGE DEFICIT (MM)	1927-1970	33	28	15	10	.	.	.	.	.	.	5	18	109
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1930-1970	38.4	36.4	36.0	30.7	26.2	23.0	21.2	22.3	26.0	29.1	33.8	33.3	38.4
MEAN MONTHLY/ANNUAL MAXIMUM	1930-1970	31.5	31.6	29.2	25.3	21.1	17.3	17.1	19.4	22.4	25.4	27.5	29.5	32.9
MEAN DAILY MAXIMUM	1930-1970	22.4	22.2	20.2	17.0	13.4	10.7	10.1	12.0	14.7	17.4	19.6	21.2	16.7
NORMAL	1931-1960	16.6	16.5	14.7	11.9	8.4	5.9	5.2	6.9	9.3	11.7	13.8	15.4	11.3
MEAN DAILY MINIMUM	1930-1970	10.4	10.4	8.9	6.1	2.9	0.5	-0.2	1.2	3.4	5.6	7.3	9.4	5.5
MEAN MONTHLY/ANNUAL MINIMUM	1930-1970	4.1	3.9	1.8	-0.4	-3.2	-4.7	-5.6	-4.4	-2.2	-0.5	0.9	3.2	-6.0
LOWEST MINIMUM	1930-1970	0.3	-0.4	-0.9	-2.8	-6.0	-7.1	-11.6	-7.8	-4.8	-3.0	-2.6	-1.5	-11.6
MEAN DAILY RANGE	1930-1970	12.0	11.8	11.3	10.9	10.5	10.2	10.3	10.8	11.3	11.8	12.3	11.8	11.2
MEAN DAILY GRASS MINIMUM	1930-1970	7.9	7.7	6.1	3.2	0.2	-2.7	-3.2	-1.8	0.3	2.7	4.8	6.9	2.7
DAYS WITH FROST														
GROUND FROST AVERAGE	1929-1970	0.3	0.5	1.7	6.0	14.3	21.3	22.8	19.1	12.7	6.5	2.6	0.8	108.6
FROST IN SCREEN AVERAGE	1927-1970	.	.	0.1	1.4	7.0	14.6	16.7	11.8	5.3	1.4	0.4	.	58.7
EARTH TEMPERATURES (DEGREES C)														
AVERAGE AT 0.10 METRES	1951-1970	18.9	17.8	14.7	10.9	6.6	3.4	2.6	4.3	7.7	11.9	15.4	17.8	11.0
AVERAGE AT 0.30 METRES	1951-1970	19.3	18.8	16.4	12.9	8.9	5.8	3.7	6.0	8.8	12.3	15.3	17.8	12.2
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1928-1970	64	68	74	77	79	79	79	74	69	64	61	64	71
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1931-1970	12.5	12.8	12.3	10.6	8.2	6.7	6.4	7.0	8.4	9.5	10.5	11.6	9.7
SUNSHINE. HOURS														
HIGHEST	1935-1970	265	218	243	186	164	168	178	192	230	238	263	254	2039
AVERAGE	1935-1970	200	166	157	140	121	115	124	145	157	182	188	191	1886
% OF POSSIBLE	1935-1970	43	43	41	44	41	44	44	46	45	45	43	40	44
LOWEST	1935-1970	136	107	82	97	85	81	89	81	97	138	111	106	1647
WIND														
AVERAGE NO. OF DAYS WITH														
GUSTS 34 KNOTS OR MORE	1943-1954**	3.8	3.9	3.4	3.4	2.4	4.2	2.9	1.7	3.7	4.9	4.8	3.6	42.7
GUSTS 52 KNOTS OR MORE	1943-1954**	0.1	0.2	0.2	0.3	.	0.2	0.1	0.1	0.3	0.1	0.4	.	2.0
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1929-1970	.	.	.	.	0.1	0.3	0.8	0.4	0.5	0.3	.	.	2.4
AVERAGE NO. OF DAYS WITH HAIL	1929-1970	0.2	0.2	0.1	0.3	0.1	0.1	0.2	0.1	0.2	0.4	0.3	0.2	2.4
AVERAGE NO. OF DAYS WITH THUNDER	1929-1970	0.5	0.3	0.2	0.2	.	.	.	.	0.1	0.2	0.5	0.5	2.5

* includes observations at rainfall station
** refers to observations at Ashburton Aerodrome

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973".

H32252 ASHLEY FOREST LAT. 43 15S LONG. 172 35E HT. 107 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1941-1970	172	271	190	141	238	176	221	240	191	138	195	250	1343
NORMAL	1941-1970	64	66	71	74	84	53	71	74	53	58	66	86	820
LOWEST MONTHLY/ANNUAL TOTAL	1941-1970	15	12	14	13	15	9	10	5	11	2	5	10	473
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1950-1970	7	7	8	7	9	7	8	7	6	7	8	8	90
MAXIMUM 1-DAY RAINFALL MM.	1950-1970	45	108	61	54	55	60	63	64	80	52	55	78	108
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1951-1970	5	.	8	15	28	15	46	41	15	10	13	10	206
AVERAGE DEFICIT (MM)	1951-1970	25	28	13	5	3	.	.	.	.	.	5	15	94
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1942-1970	34.4	32.8	33.9	28.3	26.7	21.5	20.9	22.2	29.4	30.0	30.1	31.7	34.4
MEAN MONTHLY/ANNUAL MAXIMUM	1942-1970	30.2	30.0	28.5	24.5	21.1	17.5	17.4	18.8	21.7	24.6	26.6	28.0	31.4
MEAN DAILY MAXIMUM	1942-1970	21.2	21.3	19.2	16.5	13.1	10.8	10.2	11.5	13.9	16.4	18.5	19.8	16.0
NORMAL	1931-1960	15.9	15.8	14.1	12.0	8.8	6.7	5.7	7.0	8.9	11.2	13.1	14.7	11.2
MEAN DAILY MINIMUM	1942-1970	11.0	11.0	9.7	7.7	5.2	2.8	2.1	2.9	4.4	6.4	8.0	9.8	6.8
MEAN MONTHLY/ANNUAL MINIMUM	1942-1970	5.5	5.4	4.4	2.4	0.3	-1.5	-2.3	-1.5	-0.6	1.0	2.3	4.9	-2.7
LOWEST MINIMUM	1942-1970	1.7	3.0	0.6	0.0	-2.2	-5.6	-4.2	-3.4	-2.2	-1.1	-2.0	2.6	-5.6
MEAN DAILY RANGE	1942-1970	10.2	10.3	9.5	8.8	7.9	8.0	8.1	8.6	9.5	10.0	10.5	10.0	9.2
MEAN DAILY GRASS MINIMUM	1942-1970	9.0	8.9	7.6	5.4	2.9	0.6	-0.1	0.4	1.9	4.1	5.8	7.7	4.5
DAYS WITH FROST														
GROUND FROST AVERAGE	1942-1970	.	.	0.1	0.3	3.7	10.9	13.8	11.8	5.8	1.4	0.4	.	48.2
FROST IN SCREEN AVERAGE	1942-1970	.	.	.	.	0.6	3.7	7.0	4.3	1.4	0.2	0.2	.	17.4
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1952-1970	68	70	76	75	77	75	78	74	70	66	65	69	72
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1952-1970	13.6	13.5	13.0	10.8	8.9	7.2	7.1	7.6	8.6	9.8	11.1	12.9	10.3
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1951-1970	.	.	.	0.1	0.1	0.2	0.5	0.3	0.4	0.1	.	.	1.7
AVERAGE NO. OF DAYS WITH HAIL	1951-1970	0.1	.	.	0.1	.	0.1	0.1	0.2	0.1	0.2	0.1	.	1.0
AVERAGE NO. OF DAYS WITH THUNDER	1951-1970	0.2	0.1	0.2	.	0.1	0.1	.	.	0.1	0.1	0.3	0.2	1.4

H32412 DARFIELD LAT. 43 29S LONG. 172 8E HT. 195 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1919-1970	180	242	195	221	336	203	245	228	178	178	178	189	1100
NORMAL	1941-1970	69	66	74	69	81	58	66	64	56	66	69	76	814
LOWEST MONTHLY/ANNUAL TOTAL	1919-1970	17	1	6	6	18	11	12	8	10	5	8	5	499
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1939-1970	8	6	8	7	9	7	8	8	7	8	8	8	93
MAXIMUM 1-DAY RAINFALL MM.	1939-1970	48	84	117	65	88	61	51	56	75	57	45	77	88
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1939-1970	3	8	8	15	33	28	48	43	25	23	13	10	257
AVERAGE DEFICIT (MM)	1939-1970	23	25	13	8	3	.	.	.	.	.	3	13	88
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1939-1970	36.3	36.1	33.6	28.4	23.9	19.3	19.9	22.4	25.7	29.1	31.9	33.9	36.3
MEAN MONTHLY/ANNUAL MAXIMUM	1939-1970	31.4	32.0	29.2	24.9	20.2	16.5	16.5	18.6	21.9	25.3	27.6	30.3	32.9
MEAN DAILY MAXIMUM	1939-1970	22.9	22.9	20.5	17.1	13.2	10.4	9.9	11.9	14.9	17.3	19.7	21.5	16.9
NORMAL	1931-1960	16.2	16.2	14.3	11.6	7.9	5.6	4.8	6.4	9.0	11.1	13.1	14.9	10.9
MEAN DAILY MINIMUM	1939-1970	10.0	10.0	8.5	5.8	3.0	0.7	0.1	1.2	3.2	5.2	6.9	8.8	5.3
MEAN MONTHLY/ANNUAL MINIMUM	1939-1970	4.0	3.4	2.0	-0.3	-2.4	-3.7	-4.4	-3.7	-2.1	-0.8	0.5	2.9	-5.0
LOWEST MINIMUM	1939-1970	0.9	-0.4	-0.4	-2.6	-5.3	-7.4	-9.0	-6.1	-4.8	-3.5	-2.6	0.1	-9.0
MEAN DAILY RANGE	1939-1970	12.9	12.9	12.0	11.3	10.2	9.7	9.8	10.7	11.7	12.1	12.8	12.7	11.6
MEAN DAILY GRASS MINIMUM	1944-1970	8.1	8.2	6.4	3.0	0.2	-2.3	-2.9	-2.0	0.2	2.6	4.4	6.7	2.7
DAYS WITH FROST														
GROUND FROST AVERAGE	1944-1970	.	0.1	0.9	5.5	14.0	21.2	22.8	19.1	13.3	6.4	2.9	0.4	106.6
FROST IN SCREEN AVERAGE	1939-1970	.	.	0.1	1.2	5.7	12.8	16.1	11.9	5.1	1.7	0.5	.	55.1
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1939-1970	67	70	78	82	85	84	84	82	77	70	65	66	76
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1939-1970	12.6	12.6	12.2	10.3	8.3	6.8	6.5	7.2	8.4	9.7	10.6	11.9	9.8
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1939-1970	.	.	.	0.1	0.4	0.7	1.3	0.7	0.6	0.5	0.1	.	4.4
AVERAGE NO. OF DAYS WITH HAIL	1939-1970	0.2	0.1	0.1	0.1	0.1	.	0.1	0.1	0.2	0.3	0.2	0.1	1.6
AVERAGE NO. OF DAYS WITH THUNDER	1939-1970	0.4	0.3	0.1	0.1	.	.	.	.	0.1	0.3	0.6	0.5	2.4

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

H32424 EYREWELL FOREST LAT. 43 24S LONG. 172 17E HT. 158 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL, MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1942-1970	154	269	144	228	260	191	230	178	229	197	194	315	1224
NORMAL	1941-1970	76	74	79	71	81	58	66	69	58	74	74	91	871
LOWEST MONTHLY/ANNUAL TOTAL	1942-1970	14	20	15	6	23	14	12	10	9	6	9	16	468
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1942-1970	8	7	8	8	9	8	8	8	7	8	8	9	95
MAXIMUM 1-DAY RAINFALL MM.	1942-1970	54	90	80	69	104	61	52	76	77	50	54	73	104
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1942-1970	3	10	5	18	38	36	53	48	28	25	15	18	297
AVERAGE DEFICIT (MM)	1942-1970	23	25	13	8	.	.	.	.	.	.	3	10	82
TEMPERATURE, DEGREES CELSIUS														
HIGHEST MAXIMUM	1951-1970	34.4	36.9	33.3	28.7	25.0	21.7	19.4	22.8	25.6	28.3	30.9	33.2	36.9
MEAN MONTHLY/ANNUAL MAXIMUM	1951-1970	31.2	31.6	29.2	25.2	20.5	17.3	16.7	18.4	21.7	24.7	27.1	29.4	32.4
MEAN DAILY MAXIMUM	1951-1970	22.7	22.6	20.1	17.1	13.1	10.7	9.9	11.7	14.6	17.4	19.7	21.2	16.7
NORMAL	1931-1960	15.9	15.7	13.6	11.1	7.4	5.1	4.1	5.8	8.2	10.8	12.8	14.7	10.4
MEAN DAILY MINIMUM	1951-1970	10.2	10.1	8.4	5.6	2.7	0.3	-0.5	0.7	2.7	5.1	7.1	9.2	5.1
MEAN MONTHLY/ANNUAL MINIMUM	1951-1970	3.7	3.4	1.8	-0.9	-3.4	-4.5	-5.2	-4.6	-2.7	-1.6	0.7	3.2	-5.7
LOWEST MINIMUM	1951-1970	0.9	0.8	-2.8	-2.3	-5.9	-6.1	-7.0	-6.7	-4.7	-3.3	-2.3	1.1	-7.0
MEAN DAILY RANGE	1951-1970	12.5	12.5	11.7	11.5	10.4	10.4	10.4	11.0	11.9	12.3	12.6	12.0	11.6
MEAN DAILY GRASS MINIMUM	1951-1970	8.6	8.4	6.8	3.5	0.4	-2.1	-3.0	-1.7	0.1	2.8	4.9	7.3	3.0
DAYS WITH FROST														
GROUND FROST AVERAGE	1951-1970	.	0.1	0.7	4.5	12.7	19.8	22.2	18.7	12.1	6.3	2.3	1.2	100.6
FROST IN SCREEN AVERAGE	1951-1970	.	.	0.4	2.0	7.8	15.5	17.9	14.0	7.2	3.0	0.5	.	68.3
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1951-1970	66	68	76	79	84	82	84	79	74	67	63	65	74
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1951-1970	13.0	13.1	12.6	10.6	8.4	6.8	6.4	7.2	8.7	9.7	10.7	12.2	10.0
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1951-1970	.	.	.	.	0.2	0.2	0.9	0.3	0.5	0.3	0.1	.	2.5
AVERAGE NO. OF DAYS WITH HAIL	1951-1970	0.1	0.1	0.1	0.2	0.2	.	0.2	0.1	0.3	0.2	0.1	0.1	1.7
AVERAGE NO. OF DAYS WITH THUNDER	1951-1970	0.6	0.3	0.4	0.3	0.2	0.3	0.1	0.1	0.3	0.1	0.4	0.5	3.6

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

H32451 CHRISTCHURCH AIRPORT 58 LAT. 43 29S LONG. 172 32E HT. 30 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1943-1970	99	144	147	188	198	168	140	136	123	138	140	148	861
NORMAL	1941-1970	46	45	53	56	81	56	61	53	43	43	43	48	626
LOWEST MONTHLY/ANNUAL TOTAL	1943-1970	8	7	8	13	13	6	5	5	8	3	8	5	382
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1945-1970	6	5	7	6	8	7	8	6	6	6	7	6	81
MAXIMUM 1-DAY RAINFALL MM.	1945-1970	30	31	51	74	62	41	43	51	73	33	35	80	80
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1946-1970	.	.	3	10	20	20	30	23	13	8	3	.	130
AVERAGE DEFICIT (MM)	1946-1970	51	43	25	10	3	.	.	.	.	.	15	36	183
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1953-1970	35.4	34.3	33.3	29.7	26.1	21.7	21.2	22.8	24.8	28.6	32.0	32.6	35.4
MEAN MONTHLY/ANNUAL MAXIMUM	1953-1970	32.3	31.7	29.0	25.7	20.8	17.8	17.2	20.1	21.7	25.3	28.0	29.9	33.1
MEAN DAILY MAXIMUM	1953-1970	22.3	22.0	19.7	17.2	13.6	11.2	10.3	12.1	14.3	17.0	19.5	20.6	16.7
NORMAL	1931-1960	16.2	16.1	14.1	11.6	8.3	5.7	4.9	6.5	8.8	11.0	13.2	15.0	10.9
MEAN DAILY MINIMUM	1953-1970	12.0	11.7	10.3	6.9	4.0	1.1	0.6	1.8	4.0	6.4	8.4	10.7	6.5
MEAN MONTHLY/ANNUAL MINIMUM	1953-1970	5.8	5.8	3.8	0.6	-2.1	-3.8	-4.5	-3.4	-1.8	0.1	2.4	4.9	-4.6
LOWEST MINIMUM	1953-1970	3.1	3.5	-0.1	-2.2	-4.2	-5.2	-6.7	-5.1	-3.7	-4.1	-0.3	2.8	-6.7
MEAN DAILY RANGE	1953-1970	10.3	10.3	9.4	10.3	9.6	10.1	9.7	10.3	10.3	10.6	11.1	9.9	10.2
MEAN DAILY GRASS MINIMUM	1953-1970	9.8	9.7	8.3	4.6	1.9	-1.3	-1.7	-0.6	1.2	3.5	5.4	8.5	4.1
DAYS WITH FROST														
GROUND FROST AVERAGE	1953-1970	.	.	0.6	3.6	8.7	17.5	19.1	15.8	10.1	5.6	2.3	0.3	83.6
FROST IN SCREEN AVERAGE	1953-1970	.	.	0.1	0.3	4.0	12.0	14.3	9.5	3.9	1.1	0.1	.	45.3
EARTH TEMPERATURES (DEGREES C)														
AVERAGE AT 0.10 METRES	1959-1970	18.1	17.1	14.6	11.0	7.5	4.4	3.9	4.8	7.4	11.0	14.3	17.1	10.9
AVERAGE AT 0.30 METRES	1959-1970	19.2	18.7	16.4	13.2	9.6	6.4	5.4	6.5	8.8	11.9	14.9	17.7	12.4
AVERAGE AT 0.91 METRES	1959-1970	18.0	18.1	16.9	14.6	11.5	8.5	6.9	7.3	8.9	11.3	13.9	16.3	12.7
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1953-1970	68	73	80	81	86	86	87	85	79	71	64	68	77
MEAN OVER 24 HOURS	1960-1969	72	74	78	80	83	83	84	80	78	72	70	73	77
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1953-1970	13.5	13.6	13.1	10.1	8.7	7.0	6.8	7.6	9.0	10.1	10.8	12.3	10.2
SUNSHINE. HOURS														
HIGHEST	1949-1970	288	228	227	192	143	160	172	195	220	236	265	264	2198
AVERAGE	1949-1970	211	180	160	147	121	119	123	150	164	198	206	205	1984
% OF POSSIBLE	1949-1970	46	46	42	46	41	45	44	48	47	49	48	43	46
LOWEST	1949-1970	167	112	92	95	93	83	98	114	90	149	151	124	1846
WIND														
AVERAGE NO. OF DAYS WITH														
GUSTS 34 KNOTS OR MORE	1942-1970	5.7	4.9	4.4	4.1	4.1	3.2	3.2	2.6	4.4	6.0	6.6	5.0	54.2
GUSTS 52 KNOTS OR MORE	1942-1970	0.2	0.2	0.3	0.4	0.2	0.2	0.2	.	0.3	0.4	0.3	0.1	2.8
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1953-1970	.	.	.	.	0.3	0.1	0.6	0.3	0.5	0.2	.	.	2.0
AVERAGE NO. OF DAYS WITH HAIL	1953-1970	0.4	0.2	0.1	0.3	0.3	0.4	0.7	0.3	0.6	0.5	0.4	0.1	4.3
AVERAGE NO. OF DAYS WITH THUNDER	1953-1970	0.4	0.2	0.3	0.1	0.1	0.1	.	.	0.1	0.2	0.5	0.2	2.2

H32552 WIGRAM, CHRISTCHURCH LAT. 43 33S LONG. 172 33E HT. 22 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1938-1969	112	141	161	188	203	145	204	232	135	117	138	138	926
NORMAL	1941-1970	46	43	53	56	79	56	61	53	41	43	43	48	622
LOWEST MONTHLY/ANNUAL TOTAL	1938-1969	9	5	11	13	11	5	6	7	5	2	11	5	390
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1937-1969	6	5	6	8	8	8	9	7	7	6	6	7	84
MAXIMUM 1-DAY RAINFALL MM.	1937-1969	85	85	51	60	81	38	38	66	55	37	45	39	85
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1937-1968	35.8	34.7	33.7	29.3	27.3	22.1	20.9	22.6	25.4	28.1	31.2	32.8	35.8
MEAN MONTHLY/ANNUAL MAXIMUM	1937-1968	30.9	30.9	28.6	25.4	21.4	17.6	17.2	19.0	22.1	24.8	27.3	29.0	32.1
MEAN DAILY MAXIMUM	1937-1968	22.0	22.2	19.9	17.2	13.9	11.2	10.5	11.9	14.4	16.9	19.3	20.6	15.7
NORMAL	1931-1960	16.3	16.4	14.6	12.1	8.7	6.1	5.4	6.9	9.1	11.4	13.5	15.2	11.3
MEAN DAILY MINIMUM	1937-1968	11.2	11.4	9.8	6.9	4.0	1.3	0.8	2.1	4.1	6.2	8.1	10.1	6.3
MEAN MONTHLY/ANNUAL MINIMUM	1937-1968	5.3	4.7	2.8	0.3	-2.4	-3.7	-4.3	-3.5	-1.7	0.2	1.7	4.3	-4.8
LOWEST MINIMUM	1937-1968	2.8	1.9	-0.1	-2.4	-5.3	-5.9	-9.4	-5.3	-4.8	-4.0	-2.2	-0.1	-9.4
MEAN DAILY RANGE	1937-1968	10.8	10.8	10.1	10.3	9.9	9.9	9.7	9.8	10.3	10.7	11.2	10.5	10.4
MEAN DAILY GRASS MINIMUM	1937-1968	8.6	8.7	7.1	3.9	1.2	-1.4	-1.8	-1.1	0.8	3.1	4.8	7.3	3.4
DAYS WITH FROST														
GROUND FROST AVERAGE	1937-1969	0.2	0.2	1.6	5.2	10.1	15.9	16.8	15.9	10.4	5.7	2.8	0.4	65.2
FROST IN SCREEN AVERAGE	1937-1969	.	.	.	0.7	3.9	9.7	12.1	8.3	2.8	0.6	0.3	.	38.4
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1937-1969	65	70	77	82	85	87	87	83	76	68	65	67	76
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1937-1969	13.2	13.5	13.0	11.2	9.1	7.4	7.1	7.9	9.1	9.9	10.9	12.3	10.4
WIND														
AVERAGE NO. OF DAYS WITH														
GUSTS 34 KNOTS OR MORE	1937-1957	6.0	5.8	5.0	3.4	4.0	3.7	3.1	2.4	4.1	5.9	6.7	6.3	56.4
GUSTS 52 KNOTS OR MORE	1937-1957	0.2	0.2	0.1	0.4	0.1	0.1	0.2	0.1	0.1	0.1	0.2	.	1.8
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1937-1969	.	.	.	.	0.2	0.4	1.0	0.4	0.5	0.2	.	.	2.7
AVERAGE NO. OF DAYS WITH HAIL	1937-1969	0.1	0.2	0.2	0.3	0.4	0.7	0.8	0.4	0.6	0.6	0.6	0.2	5.1
AVERAGE NO. OF DAYS WITH THUNDER	1937-1969	0.6	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.2	0.1	0.5	0.7	3.4

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

H32561 CHRISTCHURCH 59 LAT. 43 32S LONG. 172 37E HT. 7 M.

	Period	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1894-1970*	139	176	172	226	233	191	221	197	156	158	166	203	999
NORMAL	1941-1970	51	46	58	58	84	56	58	53	46	46	46	56	658
LOWEST MONTHLY/ANNUAL TOTAL	1894-1970*	5	1	3	6	10	4	6	2	4	1	8	1	579
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1902-1970*	7	5	7	7	8	8	9	7	7	7	7	7	85
MAXIMUM 1-DAY RAINFALL MM.	1873-1970*	82	78	80	120	102	75	71	83	56	69	46	108	120
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1946-1970**	.	.	3	10	20	20	30	23	13	8	3	.	130
AVERAGE DEFICIT (MM)	1946-1970**	51	43	25	10	3	.	.	.	.	.	15	36	183
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1864-1970*	36.2	35.6	33.4	30.1	26.5	21.1	22.8	23.2	27.3	31.0	32.2	33.5	36.2
MEAN MONTHLY/ANNUAL MAXIMUM	1905-1970	30.5	29.4	28.0	24.9	20.7	17.3	16.9	18.4	21.9	24.8	26.7	29.2	31.8
MEAN DAILY MAXIMUM	1905-1970	21.3	21.0	19.3	16.8	13.4	10.8	10.2	11.7	14.2	16.9	18.8	20.4	16.2
NORMAL	1931-1960	16.5	16.4	14.6	12.1	8.7	6.1	5.5	7.1	9.4	11.7	13.8	15.4	11.4
MEAN DAILY MINIMUM	1905-1970	11.5	11.4	10.1	7.3	4.2	1.7	1.3	2.4	4.6	6.8	8.3	10.4	6.7
MEAN MONTHLY/ANNUAL MINIMUM	1905-1970	5.4	4.9	3.3	0.5	-1.7	-3.3	-3.4	-2.9	-1.2	0.6	2.2	4.4	-4.1
LOWEST MINIMUM	1864-1970*	1.1	1.2	-0.9	-3.6	-5.9	-5.8	-7.1	-5.0	-4.8	-3.3	-1.2	0.6	-7.1
MEAN DAILY RANGE	1905-1970	9.8	9.6	9.2	9.5	9.2	9.1	8.9	9.3	9.6	10.1	10.5	10.0	9.5
MEAN DAILY GRASS MINIMUM	1905-1970	8.8	8.6	7.0	3.9	1.0	-1.4	-1.7	-1.0	1.1	3.2	5.0	7.5	3.5
DAYS WITH FROST														
GROUND FROST AVERAGE	1905-1970	0.2	0.2	1.1	4.6	11.0	17.7	19.1	17.0	9.8	5.5	2.4	0.5	89.1
FROST IN SCREEN AVERAGE	- *	.	.	.	0.6	3.5	10.0	11.5	8.1	2.3	0.4	0.1	.	36.5
EARTH TEMPERATURES (DEGREES C)														
AVERAGE AT 0.10 METRES	1959-1970**	18.1	17.1	14.6	11.0	7.5	4.4	3.9	4.8	7.4	11.0	14.3	17.1	10.9
AVERAGE AT 0.30 METRES	1936-1970	19.8	19.2	16.9	13.6	9.9	6.4	5.4	6.8	9.4	12.8	16.2	18.4	12.9
AVERAGE AT 0.91 METRES	1936-1970	18.7	18.8	17.7	15.0	11.8	8.7	7.1	7.6	9.6	12.1	15.1	17.1	13.3
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1928-1970	68	71	78	84	87	89	89	85	75	67	64	67	77
MEAN OVER 24 HOURS	1960-1969**	72	74	78	80	83	83	84	80	78	72	70	73	77
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1928-1970	13.3	13.6	13.1	11.5	9.1	7.5	7.2	8.0	9.0	9.9	10.9	12.6	10.5
SUNSHINE. HOURS														
HIGHEST	1935-1953	252	234	266	192	183	162	176	182	195	237	259	242	2200
AVERAGE	1935-1953	211	183	180	139	126	114	127	145	164	185	205	195	1974
% OF POSSIBLE	1935-1953	46	47	47	43	43	43	45	46	47	46	47	41	46
LOWEST	1935-1953	142	133	121	80	80	72	87	90	104	143	152	115	1873
WIND														
AVERAGE NO. OF DAYS WITH GUSTS 34 KNOTS OR MORE	1942-1970**	5.7	4.9	4.4	4.1	4.1	3.2	3.2	2.6	4.4	6.0	6.6	5.0	54.2
GUSTS 52 KNOTS OR MORE	1942-1970**	0.2	0.2	0.3	0.4	0.2	0.2	0.2	.	0.3	0.4	0.3	0.1	2.8
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1867-1970*	.	.	.	.	0.2	0.5	0.9	0.4	0.3	0.2	.	.	2.5
AVERAGE NO. OF DAYS WITH HAIL	1867-1970*	0.4	0.8	0.2	0.4	0.4	0.5	0.8	0.8	0.9	0.4	0.4	0.3	6.3
AVERAGE NO. OF DAYS WITH THUNDER	1867-1970*	0.8	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.5	0.6	3.4

* refers to observations at various sites in Christchurch
** refers to observations at Christchurch Airport

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

H32641 LINCOLN LAT. 43 39S LONG. 172 28E HT. 11 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1881-1970	139	233	179	204	197	199	209	236	142	133	150	192	986
NORMAL	1941-1970	56	56	66	58	76	58	58	56	46	48	53	58	689
LOWEST MONTHLY/ANNUAL TOTAL	1881-1970	7	0	5	10	11	9	4	8	7	3	12	3	338
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1881-1970	7	6	7	7	8	8	9	8	7	7	8	7	88
MAXIMUM 1-DAY RAINFALL MM.	1881-1970	98	102	92	79	79	106	81	60	47	65	51	69	106
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1881-1970	.	3	3	5	18	28	46	30	18	8	5	3	167
AVERAGE DEFICIT (MM)	1881-1970	41	36	23	10	3	.	.	.	.	.	5	28	146
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1881-1970	37.9	36.3	33.9	29.4	27.2	22.7	20.6	22.2	31.1	30.7	32.8	36.9	37.9
MEAN MONTHLY/ANNUAL MAXIMUM	1881-1970	31.1	30.7	29.0	25.3	20.9	17.4	16.6	18.6	21.8	25.0	26.7	29.4	32.5
MEAN DAILY MAXIMUM	1881-1970	22.1	21.9	20.0	17.3	13.7	11.1	10.3	11.8	14.4	17.1	19.0	20.9	16.6
NORMAL	1931-1960	16.0	15.8	14.1	11.4	8.1	5.6	4.8	6.4	8.5	10.9	12.8	14.8	10.8
MEAN DAILY MINIMUM	1881-1970	10.7	10.8	9.3	6.8	4.0	1.7	1.2	2.2	4.2	6.2	7.6	9.6	6.2
MEAN MONTHLY/ANNUAL MINIMUM	1881-1970	4.2	4.0	2.2	-0.3	-2.2	-3.9	-4.0	-3.3	-1.7	-0.3	1.3	3.2	-4.9
LOWEST MINIMUM	1881-1970	0.1	0.3	-1.9	-4.4	-6.1	-7.3	-11.6	-6.9	-7.2	-5.9	-2.7	-1.2	-11.6
MEAN DAILY RANGE	1881-1970	11.4	11.1	10.7	10.5	9.7	9.4	9.1	9.6	10.2	10.9	11.4	11.3	10.4
MEAN DAILY GRASS MINIMUM	1881-1970	7.9	7.9	6.4	3.6	0.9	-1.2	-1.6	-0.7	1.1	3.2	4.7	6.6	3.2
DAYS WITH FROST														
GROUND FROST AVERAGE	1881-1970	0.3	0.4	2.0	5.7	11.4	16.7	18.3	15.7	9.9	5.5	2.5	1.0	89.4
FROST IN SCREEN AVERAGE	1881-1970	.	.	0.1	1.0	4.6	9.7	11.4	7.8	3.2	1.1	0.3	.	39.2
EARTH TEMPERATURES (DEGREES C)														
AVERAGE AT 0.10 METRES	1943-1970	17.3	16.6	14.2	11.1	7.5	4.6	3.9	5.1	7.5	10.7	13.8	16.4	10.7
AVERAGE AT 0.30 METRES	1943-1970	17.8	17.7	15.8	12.8	9.7	6.9	5.8	6.7	8.7	11.3	13.9	16.4	12.0
AVERAGE AT 0.91 METRES	1943-1970	16.3	16.7	15.7	13.9	11.4	9.0	7.4	7.5	8.7	10.6	11.6	14.8	12.0
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1944-1970	65	66	75	80	84	84	85	82	74	68	64	65	74
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1944-1970	13.0	13.1	12.9	11.1	9.2	7.3	7.1	8.0	9.0	10.1	11.0	12.2	10.3
SUNSHINE. HOURS														
HIGHEST	1935-1970	294	238	270	185	190	158	174	191	225	250	270	278	2255
AVERAGE	1935-1970	222	187	176	143	122	114	119	145	166	198	209	215	2016
% OF POSSIBLE	1935-1970	48	48	46	44	42	43	42	46	48	49	48	46	47
LOWEST	1935-1970	178	126	117	76	80	71	83	67	89	142	135	110	1683
WIND														
DAILY WIND RUN (KILOMETRES)	1964-1970	327	325	288	293	251	222	230	254	296	323	311	323	287
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1881-1970	.	.	0.1	.	0.1	0.6	0.8	0.5	0.3	0.1	0.1	.	2.6
AVERAGE NO. OF DAYS WITH HAIL	1881-1970	0.3	0.1	0.2	0.1	0.3	0.5	0.6	0.5	0.6	0.5	0.4	0.3	4.4
AVERAGE NO. OF DAYS WITH THUNDER	1881-1970	0.7	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.6	0.6	3.3

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973"

H32791 ONAWE,AKAROA   LAT. 43 46S LONG. 172 56E HT. 46 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1934-1970	171	248	256	431	328	197	415	310	276	141	165	377	1595
NORMAL	1941-1970	64	58	74	102	124	99	112	89	66	58	66	81	993
LOWEST MONTHLY/ANNUAL TOTAL	1934-1970	15	11	15	10	21	20	19	26	12	13	10	1	547
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1934-1970	7	7	8	10	11	11	12	10	9	9	9	8	112
MAXIMUM 1-DAY RAINFALL MM.	1934-1970	99	83	75	206	112	59	109	107	186	52	53	217	217
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1934-1970	8	8	13	33	69	74	91	66	38	13	10	15	438
AVERAGE DEFICIT (MM)	1934-1970	30	25	23	5	.	.	.	.	.	.	5	18	106
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1937-1970	35.0	35.6	32.8	31.1	26.2	22.3	19.6	21.0	24.2	29.1	29.4	32.2	35.6
MEAN MONTHLY/ANNUAL MAXIMUM	1937-1970	30.5	30.8	28.8	25.2	21.2	17.1	16.6	18.7	21.8	24.3	26.3	28.8	31.9
MEAN DAILY MAXIMUM	1937-1970	22.0	22.1	20.1	17.1	13.9	11.3	10.4	11.9	14.6	17.0	19.1	20.5	16.7
NORMAL	1931-1960	16.9	16.9	15.3	13.0	10.1	7.7	6.7	8.1	10.1	12.2	14.1	15.7	12.2
MEAN DAILY MINIMUM	1937-1970	12.1	12.2	11.0	8.9	6.7	4.4	3.6	4.3	6.0	7.6	9.1	10.9	8.1
MEAN MONTHLY/ANNUAL MINIMUM	1937-1970	7.0	6.9	5.9	3.7	2.0	0.1	-0.6	-0.1	1.1	2.6	3.8	5.8	-0.9
LOWEST MINIMUM	1937-1970	3.3	5.0	2.8	-0.6	-1.1	-2.6	-1.8	-2.1	-0.9	0.0	0.0	4.4	-2.6
MEAN DAILY RANGE	1937-1970	9.9	9.9	9.1	8.2	7.2	6.9	6.8	7.6	8.6	9.4	10.0	9.6	8.6
MEAN DAILY GRASS MINIMUM	1937-1970	8.1	7.9	7.0	4.5	2.3	-0.2	-0.7	-0.1	1.5	3.8	5.6	7.5	3.9
DAYS WITH FROST														
GROUND FROST AVERAGE	1937-1970	0.5	0.6	0.3	1.7	6.7	14.3	15.1	14.8	7.7	2.6	0.6	.	64.9
FROST IN SCREEN AVERAGE	1937-1970	.	.	.	0.1	0.1	0.7	1.7	0.8	0.1	.	.	.	3.5
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1937-1970	67	68	73	75	78	79	81	78	70	67	67	68	73
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1937-1970	13.9	14.0	13.3	11.5	9.5	8.2	7.8	8.4	9.0	10.4	11.8	13.0	10.9
SUNSHINE. HOURS														
HIGHEST	1939-1970	286	232	252	213	139	145	142	178	222	256	252	278	2081
AVERAGE	1939-1970	219	184	171	135	99	93	98	130	163	193	205	205	1895
% OF POSSIBLE	1939-1970	47	48	45	42	34	35	35	41	47	48	47	43	44
LOWEST	1939-1970	139	132	102	86	65	58	56	64	108	118	140	122	1668
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1937-1970	.	.	.	.	.	0.3	1.0	0.2	0.1	0.1	.	.	1.7
AVERAGE NO. OF DAYS WITH HAIL	1937-1970	0.2	0.4	0.4	0.6	1.3	1.9	1.6	1.0	1.2	1.3	0.8	0.3	11.0
AVERAGE NO. OF DAYS WITH THUNDER	1937-1970	0.7	0.5	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.4	0.7	1.0	4.5

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973."

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973."

H40041 LAKE TEKAPO LAT. 44 0S LONG. 170 28E HT. 683 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1925-1970*	160	200	142	147	145	157	216	133	226	129	276	149	859
NORMAL	1941-1970	51	43	48	53	53	48	53	48	56	51	51	51	606
LOWEST MONTHLY/ANNUAL TOTAL	1925-1970*	2	1	0	1	8	2	6	2	0	0	3	3	324
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1925-1970*	6	5	6	6	6	5	6	6	6	6	6	6	70
MAXIMUM 1-DAY RAINFALL MM.	1925-1970*	52	91	61	73	83	59	75	51	57	121	97	70	121
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1925-1970*	.	3	.	5	13	23	38	33	20	13	8	3	159
AVERAGE DEFICIT (MM)	1925-1970*	38	38	33	13	3	.	.	.	.	.	8	28	161
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1925-1970*	33.3	32.2	30.0	26.6	21.2	17.8	17.1	18.3	23.4	26.1	28.3	30.6	33.3
MEAN MONTHLY/ANNUAL MAXIMUM	1925-1970*	28.3	27.7	25.9	21.8	17.2	13.2	12.2	14.0	18.0	21.6	23.5	26.6	29.7
MEAN DAILY MAXIMUM	1927-1970*	21.2	21.3	19.1	15.2	10.5	7.3	5.9	8.4	12.1	15.1	17.1	19.8	14.4
NORMAL	1931-1960	15.3	15.3	13.2	9.8	5.6	2.9	1.3	3.4	6.8	9.6	12.1	14.0	9.1
MEAN DAILY MINIMUM	1927-1970*	8.2	8.0	6.4	3.8	0.6	-1.7	-3.0	-1.4	1.1	3.6	5.2	7.3	3.2
MEAN MONTHLY/ANNUAL MINIMUM	1925-1970*	1.4	1.3	0.1	-1.8	-5.2	-7.3	-8.7	-7.2	-4.7	-2.7	-1.3	0.8	-9.7
LOWEST MINIMUM	1925-1970*	-3.2	-2.2	-5.1	-6.5	-11.1	-15.6	-13.4	-13.8	-10.1	-6.1	-6.6	-5.1	-15.6
MEAN DAILY RANGE	1927-1970*	13.0	13.3	12.7	11.4	9.9	9.0	8.9	9.8	11.0	11.5	11.9	12.5	11.2
MEAN DAILY GRASS MINIMUM	1930-1970*	3.9	3.7	2.0	-0.8	-3.5	-5.7	-6.7	-5.2	-2.6	-0.4	1.3	3.3	-0.9
DAYS WITH FROST														
GROUND FROST AVERAGE	1951-1970	1.6	1.4	4.7	11.9	18.7	23.8	26.4	23.8	17.8	10.7	11.0	2.5	154.3
FROST IN SCREEN AVERAGE	1951-1970	0.2	0.1	0.4	2.4	11.2	19.6	24.0	19.6	9.1	3.9	1.1	0.2	91.8
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1950-1970	57	61	71	75	79	80	83	78	69	60	55	58	69
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1950-1970	9.8	10.0	9.9	8.0	6.4	5.3	5.0	5.5	6.5	7.1	7.8	9.2	7.5
SUNSHINE. HOURS														
HIGHEST	1935-1970*	299	268	256	229	190	151	167	197	248	279	290	320	2445
AVERAGE	1935-1970*	257	218	206	169	133	106	115	155	179	217	224	244	2223
% OF POSSIBLE	1935-1970*	56	56	54	53	46	40	41	50	52	53	52	52	52
LOWEST	1935-1970*	187	150	147	111	90	69	79	120	112	161	163	172	1991
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1950-1970	.	0.1	.	0.7	1.0	1.5	3.4	1.8	1.1	1.0	0.4	0.1	11.1
AVERAGE NO. OF DAYS WITH HAIL	1950-1970	.	.	.	.	0.1	.	0.1	.	.	.	.	.	0.2
AVERAGE NO. OF DAYS WITH THUNDER	1950-1970	0.1	0.1	0.1	0.2	0.2	0.1	.	0.1	0.1	0.4	0.3	.	1.7

* includes observations at various sites

H41421 TIMARU 62 LAT. 44 25S LONG. 171 15E HT. 17 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1897-1970*	183	247	250	157	118	160	183	133	153	165	224	172	1019
NORMAL	1941-1970	58	58	58	48	48	36	41	38	41	48	58	69	601
LOWEST MONTHLY/ANNUAL TOTAL	1897-1970*	13	3	10	7	5	1	2	5	3	4	13	7	312
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1881-1970*	8	7	7	7	6	6	6	6	6	7	7	8	81
MAXIMUM 1-DAY RAINFALL MM.	1881-1970*	55	147	70	75	64	67	111	66	79	57	78	72	147
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1950-1970***	3	.	5	10	3	8	18	13	3	5	13	3	84
AVERAGE DEFICIT (MM)	1950-1970***	41	30	20	10	3	.	.	.	3	5	13	15	140
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1910-1970	37.2	35.4	33.1	29.1	25.6	20.9	22.4	23.2	26.1	32.8	32.8	33.9	37.2
MEAN MONTHLY/ANNUAL MAXIMUM	1910-1970	30.3	29.4	27.0	23.8	19.5	16.2	15.9	18.1	21.8	25.5	26.9	28.9	32.2
MEAN DAILY MAXIMUM	1910-1970	21.4	21.1	19.3	16.8	13.1	10.4	9.7	11.5	14.1	17.0	18.9	20.3	16.1
NORMAL	1931-1960	16.1	15.9	14.2	11.8	8.2	5.7	4.9	6.6	8.8	11.5	13.5	15.1	11.1
MEAN DAILY MINIMUM	1910-1970	10.9	10.7	9.4	6.8	3.5	1.3	0.6	1.9	3.9	6.2	7.8	9.8	6.1
MEAN MONTHLY/ANNUAL MINIMUM	1910-1970	5.2	4.9	3.4	1.2	-1.5	-3.0	-3.7	-2.8	-0.9	0.8	2.3	4.1	-4.1
LOWEST MINIMUM	1910-1970	1.4	1.4	-0.9	-1.1	-4.2	-6.8	-6.4	-5.9	-4.6	-1.3	-1.1	0.4	-6.8
MEAN DAILY RANGE	1910-1970	10.5	10.4	9.9	10.0	9.6	9.1	9.1	9.6	10.2	10.8	11.1	10.5	10.0
MEAN DAILY GRASS MINIMUM	1911-1970	8.7	8.5	7.0	4.1	0.7	-1.6	-2.2	-1.0	0.8	3.4	5.3	7.7	3.4
DAYS WITH FROST														
GROUND FROST AVERAGE	1911-1970	.	0.1	0.4	3.0	11.5	19.5	21.2	17.4	10.3	3.4	1.1	0.1	88.0
FROST IN SCREEN AVERAGE	1906-1970	.	.	.	0.3	3.5	10.3	13.5	8.3	2.2	0.3	0.1	.	38.5
EARTH TEMPERATURES (DEGREES C)														
AVERAGE AT 0.10 METRES	1961-1970	17.4	16.3	14.1	10.1	6.5	2.8	2.1	3.7	7.2	10.7	13.9	16.8	10.1
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1928-1970	72	74	78	83	83	82	82	79	74	69	67	71	76
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1928-1970	13.9	13.9	12.9	11.2	8.6	7.0	6.6	7.5	8.8	10.3	11.4	13.2	10.4
SUNSHINE. HOURS														
HIGHEST	1935-1970	251	219	244	188	187	165	160	186	205	236	258	255	2144
AVERAGE	1935-1970	195	168	153	136	127	122	126	144	156	185	188	187	1887
% OF POSSIBLE	1935-1970	42	43	40	42	44	47	45	46	45	46	43	39	44
LOWEST	1935-1970	129	111	94	68	94	76	85	95	96	127	1 1	90	1672
WIND														
DAILY WIND RUN (KILOMETRES)	1950-1970***	270	257	246	241	227	225	212	220	240	274	282	277	248
AVERAGE NO. OF DAYS WITH														
GUSTS 34 KNOTS OR MORE	1956-1970**	2.5	1.8	2.6	2.4	1.9	1.0	0.8	1.5	2.7	3.7	3.2	2.7	26.8
GUSTS 52 KNOTS OR MORE	1956-1970**	0.1	0.1	0.1	0.3	0.3	.	.	0.1	.	0.2	0.1	.	1.3
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1926-1970	.	.	.	.	.	0.2	0.4	0.2	0.2	0.1	.	.	1.1
AVERAGE NO. OF DAYS WITH HAIL	1921-1970	0.3	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.3	0.5	0.4	0.4	3.0
AVERAGE NO. OF DAYS WITH THUNDER	1921-1970	0.6	0.4	0.3	0.1	0.1	.	.	.	0.2	0.4	0.6	0.6	3.3

* includes observations from rainfall stations
** refers to observations at Timaru Aerodrome
*** refers to observations at Adair

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973."

H41701 WAIMATE LAT. 44 44S LONG. 171 3E HT. 61 M.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RAINFALL. MILLIMETRES														
HIGHEST MONTHLY/ANNUAL TOTAL	1898-1970*	151	297	282	184	153	214	195	139	211	133	182	170	1054
NORMAL	1941-1970	61	64	66	53	53	41	43	41	46	51	64	71	654
LOWEST MONTHLY/ANNUAL TOTAL	1898-1970*	10	10	9	7	3	2	5	6	4	5	15	6	372
AVERAGE NUMBER OF DAYS WITH RAIN 1.0 MILLIMETRES OR MORE	1908-1970	9	7	8	7	7	6	7	6	7	8	9	10	90
MAXIMUM 1-DAY RAINFALL MM.	1908-1970	60	115	107	48	51	64	124	47	76	65	74	55	124
ESTIMATED WATER BALANCE														
AVERAGE RUNOFF (MM)	1908-1970	3	5	5	5	8	13	23	15	15	8	5	5	110
AVERAGE DEFICIT (MM)	1908-1970	30	30	23	10	3	.	.	.	3	3	10	20	132
TEMPERATURE. DEGREES CELSIUS														
HIGHEST MAXIMUM	1930-1970	36.1	35.3	32.7	30.4	27.5	21.5	21.3	23.0	26.7	30.6	30.7	32.7	36.1
MEAN MONTHLY/ANNUAL MAXIMUM	1930-1970	30.1	30.0	28.1	24.3	21.1	17.5	17.3	18.9	21.9	24.9	26.4	28.3	31.8
MEAN DAILY MAXIMUM	1930-1970	21.2	21.0	19.4	16.9	13.8	11.5	10.7	12.1	14.4	16.8	18.6	19.8	16.3
NORMAL	1931-1960	15.8	15.7	14.2	11.8	8.8	6.5	5.7	6.9	9.2	11.4	13.2	14.8	11.2
MEAN DAILY MINIMUM	1930-1970	10.4	10.3	9.1	6.6	3.7	1.3	0.5	1.8	3.7	5.9	7.6	9.6	5.9
MEAN MONTHLY/ANNUAL MINIMUM	1930-1970	5.1	5.0	3.6	1.3	-1.3	-3.1	-4.0	-2.9	-1.1	0.8	2.1	4.5	-4.3
LOWEST MINIMUM	1930-1970	1.4	2.8	-0.4	-1.3	-4.4	-5.6	-8.4	-5.3	-3.8	-3.3	-1.4	0.9	-8.4
MEAN DAILY RANGE	1930-1970	10.8	10.7	10.3	10.3	10.1	10.2	10.2	10.3	10.7	10.9	11.0	10.2	10.4
MEAN DAILY GRASS MINIMUM	1930-1970	7.7	7.7	6.3	3.3	0.1	-2.4	-3.1	-1.8	0.4	2.7	4.7	7.0	2.7
DAYS WITH FROST														
GROUND FROST AVERAGE	1936-1970	0.1	0.4	1.5	5.4	13.2	21.3	23.4	19.1	11.7	5.0	1.8	0.3	103.2
FROST IN SCREEN AVERAGE	1936-1970	.	.	.	0.1	2.4	9.1	13.1	7.2	1.7	0.3	0.1	.	34.0
RELATIVE HUMIDITY (%)														
AVERAGE AT 9 A.M.	1936-1970	71	75	78	79	80	79	80	78	75	70	70	72	76
VAPOUR PRESSURE (MBS)														
AVERAGE AT 9 A.M.	1936-1970	13.5	13.9	12.6	10.7	8.5	6.9	6.5	7.3	8.8	10.1	11.3	12.7	10.2
SUNSHINE. HOURS														
HIGHEST	1935-1970	236	218	223	174	180	161	161	188	210	231	237	215	1933
AVERAGE	1935-1970	166	150	141	130	122	116	122	139	147	163	162	148	1706
% OF POSSIBLE	1935-1970	36	39	37	40	42	45	44	44	42	40	37	31	40
LOWEST	1935-1970	103	92	90	63	95	74	92	92	87	116	81	60	1489
WIND														
DAILY WIND RUN (KILOMETRES)	1936-1970	134	124	111	100	93	90	85	92	108	129	138	137	112
SPECIAL PHENOMENA														
AVERAGE NO. OF DAYS WITH SNOW	1936-1970	.	.	.	0.1	0.1	0.1	0.4	0.2	0.2	0.1	.	.	1.2
AVERAGE NO. OF DAYS WITH HAIL	1936-1970	0.2	0.1	0.1	0.1	0.1	0.1	.	.	0.2	0.4	0.3	0.3	1.9
AVERAGE NO. OF DAYS WITH THUNDER	1951-1970	0.5	0.2	0.3	0.1	0.1	0.1	.	.	0.1	0.3	0.5	0.4	2.6

* includes observations from rainfall station

"extract from N.Z. Meteorological Service, Miscellaneous Publication No. 143, 1973."

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