Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

A STUDY OF DAIRY-FARM MANAGEMENT IN THE WAIPA COUNTY.

1. A Dairy-Farm Management Survey.
2. A Study of Dairy-Farming Trends Between 1941 and 1950.

Massey University Library
New Zealand & Pacific Collection

BY

J.B. HUTTON

Being a thesis submitted in partial fulfilment of the requirements for the degree of M. Agr. Sc. of the University of New Zealand.

Massey Agricultural College.

August, 1953.

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

TABLE OF CONTENTS.

Page No.

Index of Tables .....

Index of Figures .....

Index of Appendices .....

Table of Symbols used in the Presentation of the Statistical Results. .....

PART ONE

SECTION I

INTRODUCTION 1

SECTION II

DEFINITION OF TERMS 8

Soil Rating 9
Cultivated Area 11
Percentage of Cultivated Area Cropped ... 11
" " Grassland Topdressed..... 11
" " " Limed 11
" " " Cut for Hay..... 11
" " " Cut for Silage... 11
Stock Units 13
Cows in Milk 23
Replacement Numbers per 100 Cows in Milk. 23
Carrying Capacity 23
Effective Butterfat Production 23
Butterfat Production at the Pail 24
Production per Cow 26
Production per Acre 26
Labour Units 26
Butterfat per Labour Unit 26

SECTION III

REVIEW OF THE LITERATURE 27

Page No.

SECTION IV

DESCRIPTION OF THE AREA..... 38

Climate 38
Geology 40
Topography 41
Soil Types 41
Development of Agriculture in the Waipa County 42

SECTION V.

SCOPE OF THE INVESTIGATION 47

SECTION VI.

THE METHOD OF STUDY 50

The Preparatory Stage 50
The Nature and Sources of Data..... 52
Analysis of the Data
(1) The Analysis of the Survey Data 55
(2) The Analysis of the Trends Data 61

PART TWO

SECTION VII.

RESULTS AND DISCUSSION OF THE RESULTS OF THE DAIRY-FARM MANAGEMENT SURVEY 63

A. Description of the Average Sample Farm.. 63

B. The Problem and the Method 65

C. Presentation of Results 67

I. Results of the Analysis of Farms Grouped According to "Production per Acre." 68
II. Results of the Analysis of Farms Grouped According to "Carrying Capacity." 79
III. Results of the Analysis of Farms Grouped According to "Production per Cow" 85
IV. Results of the Analysis of Farms Grouped According to"Soil Rating". 90
V. Results of the Analysis of Farms Grouped According to "Cultivated Area" 95
VI. Results of the Analysis of Farms Grouped According to the "Percentage of the Cultivated Area Cropped"..... 103
VII. Results of the Analysis of Farms Grouped According to the "Percentage of Grassland Cut for Hay" 106

Page Number

SECTION VII (Contd.)

VIII. Results of the Analysis of Farms Grouped According to the "Percentage of Grassland Cut for Silage" 112
IX. Results of the Analysis of Farms Grouped According to the "Percentage of Grassland Top-dressed" with Artificial Fertilizers 116
X. Results of the Analysis of Farms Grouped According to the "Percentage of Grassland Limed".. 121
XI. Results of the Analysis of Farms Grouped According to "the Number of Cows in Milk" 122
XII. Results of the Analysis of Farms Grouped According to "Replacement Stock Numbers per 100 cows in milk" 128
XIII. Results of the Analysis of Farms Grouped According to "Production per Labour Unit" 133

SECTION VIII

SUMMARY OF THE SURVEY RESULTS 143

SECTION IX

RESULTS OF THE STATISTICAL ANALYSIS OF THE FARM SURVEY DATA 150

1. "Carrying Capacity" 156
2. "Production per cow" 159
3. "Cows milked per labour unit" 163

SECTION X

DISCUSSION OF THE STATISTICAL RESULTS... 166

SECTION XI.

SUMMARY OF THE STATISTICAL RESULTS 175

PART THREE

SECTION XII.

PRESENTATION AND DISUUSSION OF THE RESULTS FROM A STUDY IN DAIRY-FARMING TRENDS IN THE WAIPA COUNTY 1941-1950.... 178

I. Analysis of Trends for Farms Grouped According to Changes in "Production per Acre" for individual farms..... 182
II. Analysis of Trends for Farms Grouped According to Between-Farm Differences in "Carrying Capacity".. 196

Page No.

SECTION XII (Contd.)

III. Analysis of Trends for Farms Grouped According to Changes in "carrying capacity" for individual farms 202
IV. Analysis of Trends for Farms Grouped According to Between-Farm Differences in "Production per Cow".. 209
V. Analysis of Trends for Farms Grouped According to Changes in "Production per Cow" for individual farms 213
VI. Analysis of Trends for Farms Grouped According to Between-Farm Differences in "Cultivated Area" 219
VII. Trends in Topdressing 225
VIII. Analysis of Trends for Farms Grouped According to Between-Farm Differences for the "Percentage of Grassland Topdressed" 227
IX. Analysis of Trends for Farms Grouped According to Changes in the "Percentage of Grassland Topdressed". 229
X. Trends in the Quantity of Supplementary Feed Saved..... 235
XI. Analysis of Trends for Farms Grouped According to Changes in the "Percentage of Grassland Cut for Hay".240
XII. Trends in Farm Machinery 242
XIII. Trends in Farm Labour 243

SECTION XIII.

SUMMARY OF THE STUDY IN FARMING TRENDS ... 245

PART FOUR

SECTION XIV.

INTEGRATING SUMMARY AND CONCLUSIONS 255

BIBLIOGRAPHY 278

ACKNOWLEDGEMENTS 281

INDEX OF TABLES

Table Number		Page No.
PART I - PRELIMINARY DATA.		
I.	Stock Conversion Factors.	18
II.	Comparison of Sheep Stock Conversion Factors Calculated by three methods.	20
III.	Dairy Cow Conversion Factors Corrected for Variations in "Production per Cow" . . .	21
IV.	Table of Corrections for Estimating Butterfat "at the pail"	24
V.	Data for Six Independent Dairy-Farm Surveys Undertaken Between 1928 and 1948	29
VI.	System of Man Units Used by Doig (1940) . .	32
VII.	Summary of Results from Hamilton's & Mitchell's unpublished surveys	35
VIII.	Annual Rainfall and Temperature Data. Waipa County 1941 - 1950	39
IX.	Conditions of Temperature and Rainfall for the months December, January & February from 1940-41 to 1949-50	40
X.	Land Utilization - Waipa County	45
XI.	Number and Area of Allocated Farms and Holdings (total area 10 acres and over). .	46
PART II - THE FARM MANAGEMENT SURVEY.		
XII.	Causes of Wastage in a Sample of 400 Waipa Dairy-Farms	52
XIII.	Comparison of Herd Averages	64
XIV.	Analysis of Farms According to "Production per Acre"	69
XV.	Analysis of Farms According to "Carrying Capacity"	80
XVI.	Analysis of Farms According to "Production per Cow"	85
XVII.	Analysis of Farms According to"Soil Ratings".	90
XVIII.	Analysis of Farms According to "Cultivated Area"	96

Table Number		Page No.
XIX.	Analysis of Farms According to "Percentage of Cultivated Area Cropped"	103
XX.	Analysis of Farms According to "Percentage of Grassland Cut for Hay"	107
XXI.	Analysis of Farms According to "Percentage of Grassland Cut for Silage"	112
XXII.	Analysis of Farms According to "Percentage of Grassland Topdressed"	118
XXIII.	Analysis of Farms According to "the Number of Cows in Milk"	123
XXIV.	Analysis of Farms According to"replacement of Stock Numbers"	129
XXV.	Analysis of Farms According to the "Number of Cows Milked per Labour Unit"	134
XXVI.	Analysis of Farms According to the "Output of Butterfat per Labour Unit"	135
XXVII.	Gross Correlations for all Inputs and Outputs.	152
XXVIII.	Analysis of Variance for "Carrying Capacity".	156
XXIX.	Summarized Results of the "F" Tests applied to each Factor when Included after Various Other Factors ("Carrying Capacity"). . .	157
XXX.	Analysis of Variance for "Production per Cow".	160
XXXI.	Summarized results of the "F" tests applied to each factor when included after various other factors ("Production per Cow") . .	161
XXXII.	Analysis of Variance for "the Number of Cows Milked per Labour Unit"	163
XXXIII.	Summarized results of "F" tests applied to each factor when included after other factors ("cows milked per labour unit") .	164
PART III - THE STUDY IN FARMING TRENDS.		
XXXIV.	Trends in Certain Indices of Farm Efficiency and Capacity	181
XXXV.	Distribution of Farms According to Changes in "Production per Acre" for Individual Farms	182
XXXVI.	Trends in "Production per Cow"	183
XXXVII.	Trends in "Production per Acre"	184
XXXVIII.	Trends in "Carrying Capacity"	185

Table Numbers		Page No.
XXXIX.	The Effect of Climate on Production . . .	191
XL.	The Number of Heifers (1-2 yrs) per 100 Cows in Milk	194
XLI.	Trends in "Carrying Capacity"	197
XLII.	Trends in "Cultivated Area"	198
XLIII.	Weight of Silage per Cow (Tons)	201
XLIV.	Weight of Hay per Cow (Tons)	201
XLV.	Trends in "Carrying Capacity"	203
XLVI.	Trends in the size of herds	205
XLVII.	Trends in "Production per Acre"	207
XLVIII.	Trends in "Production per Cow"	207
XLIX.	The Effect of Climate on "Production per Acre"	210
L.	The Effect of Season on "Production per Cow".	211
LI.	Weight of Hay per Cow	212
LII.	Weight of Silage per Cow	213
LIII.	Trends in"Production per Cow"	215
LIV.	Trends in "Production per Acre" (1945-47) .	217
LV.	Trends in "Production per Acre" (1941-50) .	219
LVI.	Trends in Total Farm Output	220
LVII.	Trends in "Production per Cow"	221
LVIII.	Trends in "Production per Acre"	221
LIX.	Trends in the rates of application of lime and artificial fertilizers	227
LX.	Changes in the Areas Topdressed with Artificial Fertilizers	231
LXI.	Changes in the Areas Topdressed with Artificial Fertilizers	232
LXII.	Changes in the Area Cut for Hay	240
LXIII.	Trends in Dairy-Farm Labour.	243

INDEX OF FIGURES.

Figure Number		Page No.
	PART I - PRELIMINARY DATA.	
1.	Holding's Card (A)	12
2.	Holding's Card (B)	12
3.	Holding's Card (C)	15
4.	The relationship between "effective" and "at the pail" production for herds of different size	25
	PART II - THE FARM MANAGEMENT SURVEY	
5.	The distribution of 253 sample dairy -farms between eight "production per acre"groupings.	70
6.	The distribution of 253 sample dairy-farms between five "carrying capacity" groupings. The relationship between "carrying capacity" and "production per acre"	81
7.	The distribution of 253 sample dairy-farms between six "production per cow" groupings. The relationship between "production per cow" and "production per acre".	86
8.	The distribution of 253 sample dairy-farms between four "soil rating" groupings. The relationship between "soil rating" and "production per acre".	91
9.	The distribution of 253 sample dairy-farms between five "cultivated area" groupings. The relationship between "cultivated area" and "production per acre".	97
10.	The distribution of 253 sample dairy-farms between seven groupings based on "the percentage of the 'cultivated area' cropped." The relationship between "the percentage of cultivated area cropped" and"Production per acre".	104
11.	The distribution of 253 sample dairy-farms between five groupings based on "the percentage of grassland cut for hay". The relationship between "the percentage of grassland cut for hay" and "production per acre".	108
12.	The distribution of 253 sample dairy-farms between five groupings based on "the percentage of grassland cut for silage". The relationship between "the percentage of grassland cut for silage" and "production per acre"	113

Figure Number		Page No.
13.	The distribution of 253 sample dairy-farms between eight groupings based on "the percentage of grassland topdressed." The relationship between "the percentage of grassland topdressed" and "production per acre"	119
14.	Distribution of 253 sample dairy-farms between nine size of herd groupings. Relationship between herd size and "production per acre"	124
15.	The distribution of 253 sample dairy-farms between seven groupings based on "the number of replacements per 100 cows in milk". The relationship between "the number of replacements per 100 cows in milk" and "production per acre"	130
16.	The distribution of 253 sample dairy-farmers between eleven "production per labour unit" groupings. The relationship between "production per labour unit" and "production per acre".	136

PART III - THE STUDY IN FARMING TRENDS

17.	Land transactions for 400 Waipa dairy-farms between 1941 and 1950	186
18.	Trends in "production per acre", "production per cow" and "carrying capacity" for the mean sample farm	186
19.	Distribution of farms according to the nature and extent of changes in "production per acre"	188
20.	Trends in total farm production for properties grouped according to the nature and extent of changes in "production per acre" . . .	188
21.	Distribution of farms according to the nature and extent of changes in "carrying capacity".	204
22.	Distribution of farms according to the nature and extent of changes in "production per cow".	214
23.	Trends in the areas topdressed and limed on the mean sample farm	223
24.	Distribution of farms according to the nature and extent of changes in "the percentage of grassland topdressed"	230
25.	Trends in the areas cut for hay and silage, and in the area cropped on the mean sample farm	237

Figure Number		Page No.
26.	Distribution of farms according to the nature and extent of changes in "the percentage of grassland cut for hay". . .	239
27.	Trends in the farm livestock on the mean sample farm	252

INDEX OF APPENDICES

Appendix Number		Page Number
i.	Summary of data for single soil type farms	(1)
ii.	Waipa Soil Types: 80 ch. Map	(2)
	Supplementary information required for the calculation of stock units.	(3)-(12)
iii.	Wallace's (1948) data (Border Leicester X Cheviot). . .	(8)
iv.	Massey College "Tuapaka" Romney Flock. .	(8)
v.	Weights of Romney ewes at Ruakura (1950-51)	(8)
vi.	Dairy cow requirements according to Morrison, and Gullickson & Eckles.(Diag.)	(13)
vii.	Stock Conversion Factors - From Morrison's Feeding Standards	(14)-(15)
viii.	Average Liveweights and Feed Requirements of Female Dairy Cattle from Birth to 2 years of age	(16)
ix.	Growth curve of Jersey Bulls (Ruakura data) (diagram)	(17)
x.	Growth curve of Beef Heifers (Ruakura data) (diagram)	(18)
xi.	Average liveweights and feed requirements for Jersey Bulls from birth to 2 yrs.of age.	(19)
xii.	Average liveweights and feed requirements of beef heifers from birth to 2 yrs. of age.	(20)
xiii.	Growth curve of beef steers (Ruakura data) (diagram)	(21)
xiv.	Daily requirements of beef cattle (Morrison's data) (diagram)	(22)
xv.	Average liveweights and feed requirements of beef steers from birth to 2 yrs.of age.	(23)
xvi.	Dairy cow conversion factors corrected for variations in "production per cow" . .	(24) & (25)
xvii.	Daily requirements of lambs (Morrison's data) (diagram)	(26)

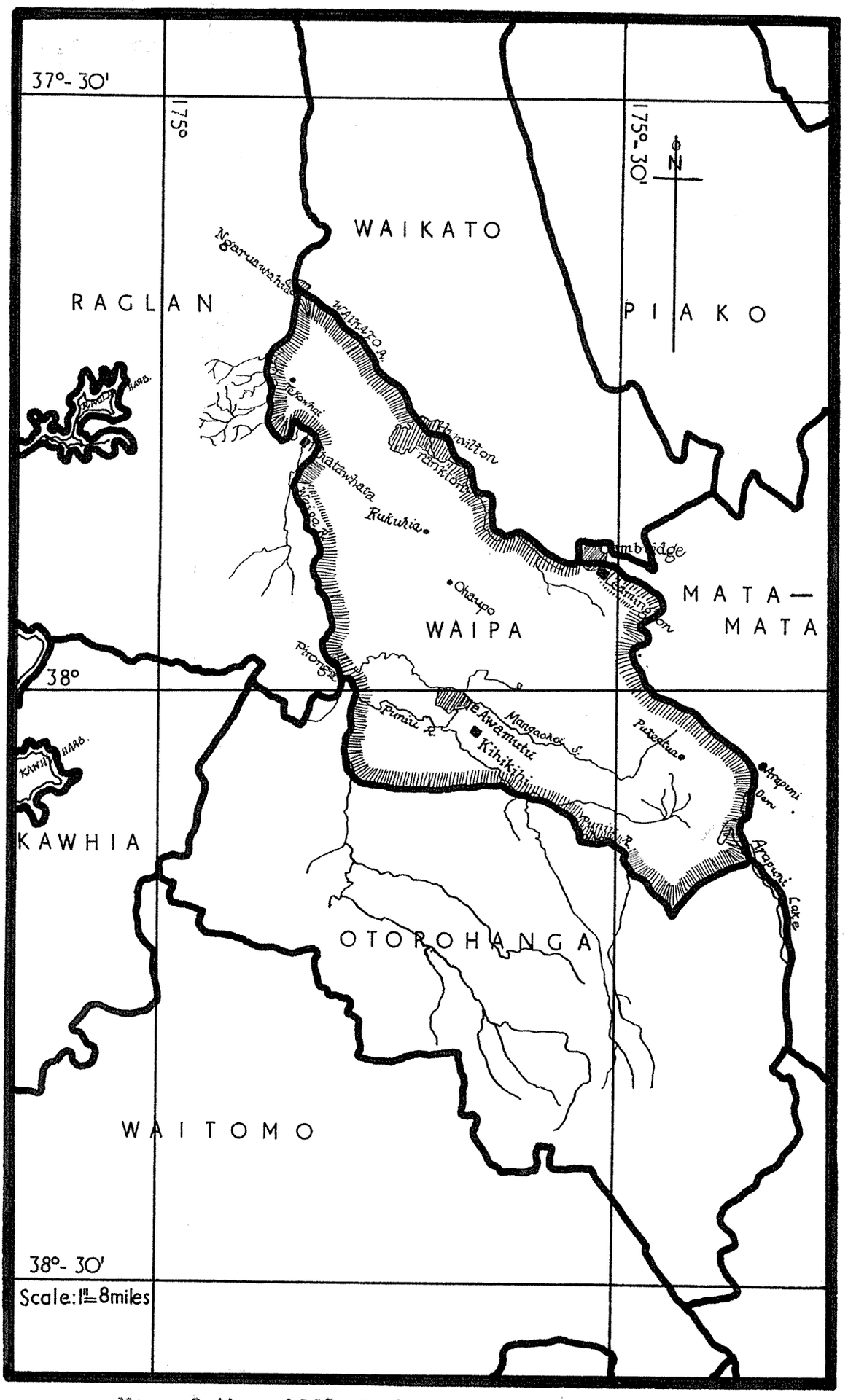
Appendix Number		Page Number
xviii.	Growth curves of Border-Leicester X Cheviot lambs and of Romney lambs (diagram)	(27)
xix.	Average liveweights and feed requirements of sheep from birth to one year of age.	(28)
xx.	Correction table for estimating "at the pail" production	(29)
xxi.	Gross Correlations as determined by Hamilton (1944) and Mitchell (1948). .	(30)
xxii.	The abbreviated Doolittle Solution for determining both R^2 and the standard partial regression coefficients . . .	(31)-(32)
xxiii.	Dwyer's method of inverting a symmetric matrix	(33)
xxiv.to xlvi.	Groupings based on within-farm changes in "production per acre"	(34)-(49)
xlvii. to lxix.	Groupings based on between-farm differences in "carrying capacity" ("stock units" per acre).	(50)-(65)
lxx. to lxxvii.	Groupings based on within-farm changes in "carrying capacity" ("stock units" per acre)	(66)-(70)
lxxviii. to xcvii.	Groupings based on between-farm differences in "production per cow".	(71)-(85)
xcviii. to cv.	Groupings based on within-farm changes in "production per cow".	(86)-(90)
cvi. to cxxvii.	Groupings based on between-farm differences in "cultivated area" . .	(91)-(105)
cxxviii. to cxlv.	Groupings based on between-farm differences in "the percentage of grassland topdressed with artificial fertilizers".	(106)-(121)
cxlvi. to cliv.	Groupings based on within-farm changes in"the percentage of grassland topdressed with artificial fertilizers" .	(122)-(127)
clv. to clxiii.	Groupings according to within-farm changes in "the percentage of grassland cut for hay"	(128)-(133)

Appendix Number		Page Number
clxiv	Temperature and rainfall data for the months December to February (1941-50) .	(134)
clxv. to clxiii.	Trends for the mean sample farm (1941 - 1950)	(135)
clxvii.	Trends in the number of farms concerned in certain farm practices (1941-1950) .	(136)
clxviii.	Changes in areas for the mean sample farm expressed as percentage changes .	(136)
clxix.	Analysis according to lbs. of butterfat per cow	(137)
clxx.	Analysis according to lbs. of butterfat per acre.	(137)
clxxi.	Analysis according to carrying capacity (cows per 100 acres)	(138)
clxxii.	Analysis according to carrying capacity ("stock units" per acre)	(138)
clxxiii.	Analysis according to "the percentage of grassland cut for hay"	(138)
clxxiv.	Analysis according to "the percentage of grassland cut for silage"	(139)
clxxv.	Analysis according to "cultivated area" .	(139)
clxxvi.	Analysis according to "percentage of 'cultivated area' cropped"	(139)
clxxvii.	Analysis according to "percentage of grassland topdressed"	(140)
clxxviii.	Analysis according to "percentage of grassland limed"	(140)
clxxix.	Analysis according to size of herd. . .	(141)
clxxx.	Analysis according to "the number of replacements per 100 'cows in milk'" .	(141)
clxxxi.	Analysis according to "butterfat per labour unit".	(142)
clxxxii.	Analysis according to "soil rating" . .	(142)
clxxxiii.	Analysis according to "cows milked per labour unit"	(143)
clxxxiv.	Analysis according to "stock units" per labour unit	(143)

TABLE OF SYMBOLS AND ABBREVIATIONS USED IN THE PRESENTATION OF THE STATISTICAL RESULTS.

Symbol.	Description.
x	every variable successively.
y	the dependent variable.
$\sigma^2 x$	the variance of x, an independent variable.
$\sigma^2 y$	the variance of y, a dependent variable.
S.S.	sum of the squares.
S.P.	sum of the products.
M.S.	mean square of variance.
n	number of items in each class or group.
d.f.	degrees of freedom.
e.d.f.	error degrees of freedom.
r	correlation coefficient.
R	multiple correlation coefficient from the Doolittle method.
R^2	the fraction of the total variance accounted for.
$1 - R^2$	the residual variance.
β'	the standard partial regression coefficient.
β	the natural partial regression coefficient.
C'	an element of the inverse of the correlation matrix.
"F" test	Snedecor's "F" test.
"t" test	"Student's" "t" test.
N.S.	not significant at the 5% level.
*	significant at or above the 5% level.
* *	significant at or above the 1% level.

oooo000oooo



Map of the middle Waikato basin, showing the position of the Waipa County.

PART I

INTRODUCTION

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

PART I

SECTION I

INTRODUCTION

Farm management differs from the natural sciences in that it can not be studied in the laboratory or on sample plots. It must be studied in the actual operation of real farms. These individual farms differ so widely that large numbers of them must be studied in order to find enough farms similar in any one character to make a sufficient sample. Farm management surveys provide the most practicable method of procuring detailed information, at reasonable cost, on the operation of large numbers of farms. It is now generally accepted that in farm management studies a large number of observations is more important than extreme accuracy in individual observations.

The primary object of farm management research is to determine facts and principles that will aid individual farmers to organize their farms most profitably. As Ashby (1934) has pointed out, "It is not the business of the research worker to tell a man how to run his farm. This is his job. If he can be given information which will assist him in checking up on his policy or actions, then at this point the functions of the research worker cease. A basis for intelligent examination and criticism should be supplied."

There are continual alterations in economic conditions affecting agriculture and it is necessary in meeting these changes, to make adjustments in farm organization. The increased costs of labour and the consequent stimulus to a more intelligent use of resources, is an example of this reaction. Inevitably there is a lag in adjustment, perhaps the result of uncertainty as to the permanency of changes. Research and education can do much to lessen this time lag and the associated financial losses to both the individual and the nation.

Many of the surveys carried out in the U.S.A. through the agricultural experimental stations, and land grant colleges, have dealt mainly with detailed costing and budgetting procedures. Frequently these have proved extremely successful in predicting trends and providing valuable information, especially where diversified farming has allowed flexibility among enterprises. However, under the conditions of specialized farming existing in New Zealand, the demand for costing and budgetting has not been so great.

In spite of guaranteed prices and the fact that returns for dairy products are not affected by local markets to an extent comparable with that observed in certain overseas countries, the relative inelasticity of dairyfarming in New Zealand demands application of efficient farming systems.

In contrast to dairyfarming studies conducted in America and Great Britain, in this country most interest has been focussed on physical rather than monetary inputs and outputs. It has become customary to express farming efficiency in terms of two limiting factors, area and

labour, rather than by some index of profit. The fundamental reason for using different standards in different areas was expressed clearly by Ashby (1937) when he said ..... "There never can be, either in farm management or in the general social economics of Agriculture, any absolute standards of production or efficiency (with respect to) the three simplest standards, per acre, per unit of capital, and per man; each is in fact applied, if not in theory in actual practice, according to those conditions in which any one of the chief factors has to be used to the greatest possible advantage. Where land was plentiful as in Western Canada where it cost a dollar an acre, where labour was scarce and capital cost an average of about 12% per annum, the farmer had to think about the standard of production per unit of capital and per man employed. In parts of India where land is scarce and labour is plentiful and little capital is in use, the standard of production per unit of land will be dominant, and so one might go on."

On each farm the problem confronting the investigator is not the choice and integration of a combination of farming systems, but rather the determination of an association of managemental factors which will permit the most efficient production of a single commodity. Since the farm management survey deals with large numbers of farms operating at varying levels of efficiency, the information provided can be extremely valuable for the evaluation of the absolute and relative importances of the various managemental and organizational measures considered in the survey. Past experience has shown, however, that some of the most valuable information derived from the

application of survey methods has consisted of evidence questioning the efficacy of currently accepted practices and indicating the need for research in certain specific problems. As an example, the present questioning of the widespread use of heavy dressings of artificial fertilizers on dairyfarms may be cited (Mitchell (1948)). The results of this type of research may well save the country as well as individual farmers money and resources which otherwise would be expended needlessly.

Where decisions affecting agricultural finance have to be made, the results of farm management studies can fulfil the important function of supplying reliable, basic information. The misdirected land policies of the depression years still remain vivid in the memories of many farmers and it should be the aim of all who are concerned with agriculture, to prevent a repetition of these conditions. It is suggested therefore, that such organizations as money lending institutions, both private and state controlled, which are advancing money on land, should make full use of the results of present and potential land use surveys.

On the national scale, investigations such as these can be valuable in providing data of use in the formulation of public policies, for it is important to consider how measures on taxation, land and credit affect the individual farmers comprising the agricultural community.

Ignorance and neglect of farm management principles have, in the past, resulted in considerable loss and suffering. Nowhere is this better illustrated than in the United States where, between 1920 and 1930, public lands were divided into 160 acre farms, regardless of rainfall, topography or soil type. In the drier regions,

years of slow starvation and great economic loss resulted, before farms were combined into holdings adapted to economical operation under the particular conditions obtaining in each locality. It was not until the obvious weaknesses of this system were so graphically illustrated, that attention was focussed upon the results of land utilization surveys and only then was the real value of these data appreciated. Governments began to realize how vital was the need for a prosperous farming community and thenceforward the object of agricultural research became, in the words of A.N. Duckman (1930), "to increase the purchasing power of the farming population." In his opinion this ideal could be attained "by measuring the problems which limit rural prosperity, solving them, and blending the solution into farming practice."

Although under the circumstances then existing, it was essential to improve the financial status of farming, with the passing of two decades, in New Zealand at least, some qualification of the original aim has become necessary. The purchasing power of the farming population has increased and in 1936 the institution of guaranteed prices inaugurated a period of comparative security. Those who formulated and presented to the farming population this system of stabilization also considered the necessity of maintaining the efficiency of the dairy industry. Hamilton (1944) provided information which, supplemented by more recent data, (N.Z. Dairy Board Annual Report, 1952, and N.Z. Official Year Book, 1951) queried whether this objective was being achieved, and indicated the necessity for discovering new methods and extending the application of others in promoting greater efficiency in the industry.

The second section of this investigation, viz., the study in farming trends, developed as a natural consequence of the possibilities suggested by Hamilton (loc.cit). Thus, although the objects of this particular research project could scarcely be expected to conform to the primary aim of farm management research as stated previously, its ultimate though indirect value to the farmers should not be overlooked.

There has been a real need to determine whether or not some loss in efficiency has resulted from the birth and growth of a stabilized price system. As a natural corollary, the problem of whether increased purchasing power functions as an obstacle or as an incentive to progress required a solution. The logical approach entailed the collection of detailed information from dairy farms, and from these data, contributions to the total production pool of all sections of a sample of the dairy-farming community were assessed. By supplementing the combined results of the survey and trends sections, with those from land utilization studies, sufficient information was made available to detect farm units producing below capacity.

Not only does the farm survey technique provide a method of determining varying degrees of efficiency among farms, but it also enables an evaluation of the inputs distinguishing farms located at these different levels. The results of this type of research find wide applications, not through demonstrating new techniques of greatest value to properties of established high productivity, but in what is currently a far more pressing problem, of indicating for the benefit of those farming at less efficient levels, what combinations of inputs have previously produced the best results.

Although in certain overseas countries much has been accomplished in the past, it appears that in New Zealand, the possibilities of the survey approach are scarcely appreciated, yet here may be an opportunity for agricultural research workers to achieve what should be their primary aim - to increase the prosperity of the whole population and to retain any such advances, rather than to increase the purchasing power of one section of the community.

S E C T I O N II

DEFINITION OF TERMS

Ratios, indices and percentage relationships have an indispensable function in all types of surveys. In a great number of instances it is only by the use of such standards that reasonable comparisons can be made among members of a highly variable population. Since any inaccuracies will be magnified in the resulting index, it is axiomatic that for the calculation of useful ratios, the integral parts comprise the best estimates available.

In the present survey it was found necessary to make free use of several compounded terms, some of which required rather involved derivations. The section which follows has been devoted therefore to an explanation of these compounded terms as applied successively to land, livestock and labour.

The data considered may be summarized under appropriate headings as follows:-

Land

Soil Rating.

Cultivated or effective area.

Percentage of the cultivated area cropped.

Percentage of the total grassland topdressed.

Percentage of the total grassland limed.

Percentage of the total grassland cut for hay.

Percentage of the total grassland cut for silage.

Self explanatory terms such as area in grass, area cropped etc., have not been included in this section.

A. Land. It was considered logical to define, first, the terms applied to those factors in the farming system over which the occupier had no control. There was an obvious need to ascertain for individual farms the potentialities of the land under good managemental control and the nature of the relationship between actual and potential productions. A system of soil ratings was required, but unfortunately appreciation of a term such as "soil rating" presupposes an understanding of the meaning of "stock units". It is obvious, however, that the prior treatment of the section dealing with livestock would entail similar complications in the explanation of such terms as "carrying capacity" and output per acre which are both related to farm area. Consequently," soil rating"has been considered first and a full explanation of the term "stock units" will be made in a later section.

1. Soil Rating.

As would be anticipated, the estimation of" soil ratings" requires a knowledge of the soil types of the County. Between 1933 and 1935 soils of the northern portion of the county were surveyed in detail (Grange et al (1939)), and a less detailed classification of types was available for the remaining area (Dept. Scientific & Industrial Research Annual Report (1931)).

The possibilities for the extensive use of soil survey data in assessing present and potential land use were first appreciated by Hamilton (1947). The system by which he calculated "soil ratings", was adopted in the present survey and involved an analysis of the productivity of all sample farms according to soil type. Because the initial survey carried out on Whangarei County (Hamilton 1944) included sheep farms as well as dairy farms located

on a wide range of topographical conditions, to enable comparisons to be made between these different systems of farming, some common measure of productivity was required. For this purpose "carrying capacity", as expressed in "stock units", was selected since, regardless of the type of farming considered, it enabled the comparison of actual farm capacities.

Frequently the soils of individual farms consisted of a complex of many different soil types. Especially was this a feature of areas where the more detailed survey had been undertaken and as a result, classification of farms into single soil-type groupings was virtually impossible. Though some sacrifice in detail resulted, this difficulty was overcome by combining similar soil types, and this enabled all sample farms to be classified into a reasonable number of groupings.

As a basis for the evaluation of these groupings, within each group the average carrying capacity of the top 10% of farms, as given by the mean plus twice the standard deviation, was used (Hamilton (1949)). This method was adopted since it was felt that using improved farming methods under existing economic conditions, the soils of the highest producing farms were being utilized at somewhere near an optimum level. Using Hamilton's (1949) method the soil types for both Whangarei and Waipa were grouped into eight grades according to their potential carrying capacities.

In Appendices i and ii, the results of this type of analysis are presented. The specific data in these tables refer to a survey conducted by Mitchell on 850 Waipa dairy farms for the season 1946-47. Future considerations will show the applicability of this information to the present survey.

2. Cultivated Area.

The "cultivated area" comprises the area actually utilized for dairying. At times throughout this survey the term "effective area" will be used as synonomous with "cultivated area". For the purposes of this study "cultivated" or "effective area" consists of the areas in sown grass, together with any additional land growing root or green forage crops. Definition of the "cultivated area" involved excluding certain portions of each property. Areas omitted included land occupied by farm buildings, orchards, hedges, plantations, scrub, forest and barren land. The latter consisted of various areas such as "sand, shingle, internal roads, dams, drains, water races and lakes which were useless for grazing and incapable of being made productive." Thus "effective" or "cultivated area" consists of that portion of each farm concerned with the production of feed.

3. Percentage of the Cultivated Area Cropped.

For each farm the "percentage of the cultivated area cropped" consists of the area growing root and/or green forage crops, expressed as a percentage of the "cultivated area".

4. The remaining four terms are self-explanatory but are included for completeness.

(a) "Percentage of grassland topdressed."

(b) "Percentage of grassland limed".

(c) "Percentage of grassland cut for hay".

(d) "Percentage of grassland cut for silage".

NO. S E L E C T E D H O L D I N G S. S.I.R. 402 (1946 PRINT)

NAME: HOLDING:

SOIL TYPES: SOIL RATING: TOPO.:

TENURE: DISTANCE TO RAIL MILES

GENERAL:

YEAR	REF. NO.	AREA	CROPS		HAY		SILAGE		SOWN GRASS	TUSSOCK	SCRUB	FOREST	TOPDRESSING			FARM MACHINERY				
			ROOTS	GREEN FOR.	AREA	YIELD	AREA	YIELD					ART. FERT.	LIME	BOTH	ELEC. MOT.	ENG.	TRACTORS	MILKING M. NO	MILKING M. BLS
40-41																				
41-42																				
42-43																				
43-44																				
44-45																				
45-46																				
46-47																				
47-48																				
48-49																				
49-50																				

FIG. 1: Holding's Card (A).

ITEM.	40-41	41-42	42-43	43-44	44-45	45-46	46-47	47-48	48-49	49-50	AVERAGE
DAIRY STOCK UNITS											
BEEF " "											
SHEEP " "											
TOTAL STOCK UNITS											

YEAR	DAIRY STOCK						BEEF CATTLE						SHEEP SHORN	LAMBS TAILED	SHEEP AT 30TH APRIL				
	BREEDING BULLS 2+	COWS & HEIFERS 2+ IN MILK	COWS & HEIFERS 2+ HEIFERS	DRY COWS	HEIFERS 1-2 YRS.	HEIFERS 1 YR.	BREEDING BULLS 2+	COWS & HEIF. 2+	HEIFERS 1-2 YRS.	HEIFERS 1 YR.	STEERS & BULLS 2+ YRS.	STEERS & BULLS 1-2 YRS.	STEERS & BULLS 1 YR.			RAMS & BREED	WETHERS	BR. EWES	DRY EWES	LAMBS
40-41																				
41-42																				
42-43																				
43-44																				
44-45																				
45-46																				
46-47																				
47-48																				
48-49																				
49-50																				
AV.																				

FIG.2: Holding's Card (B).

B. Livestock.

Stock Units.

Cows in Milk.

Replacement Numbers per 100 Cows in Milk.

Carrying Capacity.

Effective Butterfat Production.

Butterfat Production at the Pail.

Production per Cow.

Production per Acre.

1. Stock Units.

To obtain the most accurate measure of "carrying capacity," allowances must be made for all classes of livestock. The feed requirements for different classes of livestock differ and calculation of these offers the only method of comparing animals of various breeds, ages, weights etc. From such estimates of requirements a set of standards termed "stock units" can be readily calculated which will permit inclusion of all farm stock in estimates of "carrying capacity".

FIGS. 1,2 and 3 indicate the numerous classes of stock found on dairy farms in the sample studied. Although in most cases the dairy herd comprises the largest section of the farm livestock, allowances should be made for the other components. For each class of stock the problem was to decide the nature and extent of such allowances and to formulate bases for their estimation. Obviously it is difficult to compare mature milking cows with growing young stock and with different classes of sheep. The procedure which appealed as the only practicable one involved estimations of the average

feed intakes (measured in terms of S.E.*; D.O.M.**; or T.D.N. ***) for the various types of stock. Assessment of such data for any prescribed period would provide a series of statistics readily convertible to a set of standards applicable to the different classes of stock listed. The reliability of any such estimates depends on the accuracy with which the different feed requirements are determined.

Problems concerning the feed requirements of farm animals for maintenance, growth and other productive purposes such as wool growth and milk secretion, have occupied the attentions of many research workers. For the requirements of this particular survey, it is unfortunate that no single investigator has obtained experimentally a complete set of estimates for all the classes of stock. However, absolute accuracy in the estimates for any specific class is not essential, provided that errors affect all animal groups equally. The real requirement is a series of indices which are reasonably comparable.

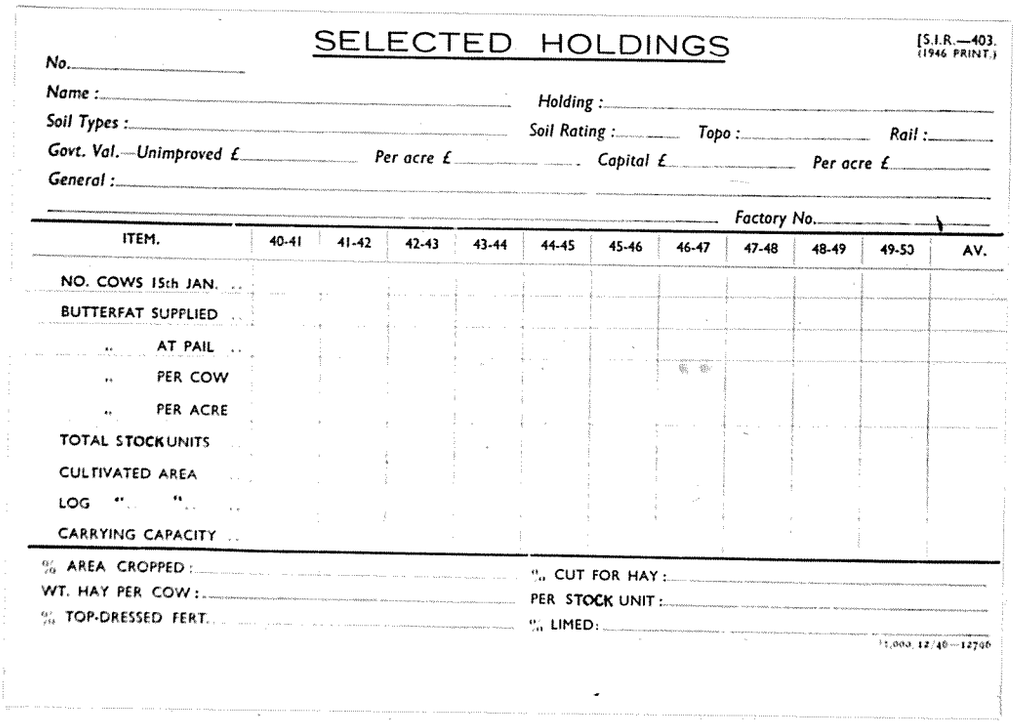
The relevant literature; Morrison (1950), Brody (1945), Wallace (1948), Eckles & Gullickson (1931) and Mitchell (1929) indicated that even when research is confined to a single breed within a species, remarkably divergent opinions are held by various workers as to what constitutes a sufficient ration for maintenance, growth, fattening or lactation and such lack of unanimity makes the choice of estimates most difficult. In the U.S.A., fairly general

---

* 1 lb. of "Starch Equivalent" (S.E.) = 1,071 calories of net energy.

** 1 lb. of Digestible Organic Matter (D.O.M.) = 1,707 calories of gross digestible energy.

*** 1 lb. of Total Digestible Nutrients (T.D.N.) = 1,814 calories of gross digestible energy.



SELECTED HOLDINGS

[S.I.R.—403. (1946 PRINT.)

No.

Name : Holding :

Soil Types : Soil Rating : Topo : Rail :

Govt. Val.—Unimproved £ Per acre £ Capital £ Per acre £

General :

Factory No.

ITEM.	40-41	41-42	42-43	43-44	44-45	45-46	46-47	47-48	48-49	49-50	AV.
NO. COWS 15th JAN.											
BUTTERFAT SUPPLIED											
" AT PAIL											
" PER COW											
" PER ACRE											
TOTAL STOCK UNITS											
CULTIVATED AREA											
LOG " "											
CARRYING CAPACITY											

% AREA CROPPED : % CUT FOR HAY :

WT. HAY PER COW : PER STOCK UNIT :

% TOP-DRESSED FERT. % LIMED :

1,000. 12/40—12706

FIG.3: Holding's Card (C)

use has been made of the results of Eckles and Gullickson (1931) to estimate the growth requirements of dairy cattle. Morrison's (1950) estimates for the total annual requirements of the same class of stock over a similar weight range show scarcely any difference from these, although for various ages they differ somewhat (see Appendix vi).

In contrast, for sheep stock no examples were found in which estimated requirements provided by one investigator were corroborated by independently obtained results. The work of Wallace (1948) at Cambridge showed that a mature ewe which weighed approximately 120 lbs. and produced a lamb, fat at 16 weeks under conditions comparable with those found in New Zealand, required 606 lbs. of gross digestible energy per annum. The substitution of data in Brody's (1945) general regression equation which was originally derived from dairy cow returns, yielded 711 lbs. of T.D.N. as the yearly requirement. A third estimate from Morrison's (1950) tables in "Feeds and Feeding" gave a maximum of 898 lbs. of T.D.N. when allowance was made for the extra demands of pregnancy and lactation. Although there are considerable diversities of opinion among workers as to the caloric value of a lb. of T.D.N., this source of variation accounts for but a fraction of the large differences occurring in these estimates.

Because of the complexity of this problem and the inconsistencies apparent in the literature, an alternative source of data was sought. On the basis of their experimental and practical experiences, Drs. Wallace and McMeekan were asked to give opinions on the relative carrying capacities of land for the different classes of stock listed. These opinions provided the basis for

drawing up a series of conversion factors which are presented in Table I as "stock units".

Some measure of the reliability of these estimates was considered necessary and as Morrison (1950) had been actively concerned in much of the experimentation on which his feeding standards were based, and since his tabled data covered the requisite range of farm animals, it seemed that a reasonable check could be obtained from his figures. As the daily feeding standards which he computed were influenced by body weights, one of the initial problems was to determine for different animals, average body weights applicable to Waipa County conditions. Detailed information is to be found in Appendices iii to xix. Information on the weights of all dairy and beef stock was supplied by the Animal Research Station, Ruakura, while data for sheep were obtained both from Ruakura and from Massey Agricultural College. This enabled average growth curves to be drawn for sheep, beef and dairy stock. Morrison's (1950) tables were converted where necessary to diagrammatical form (see Appendices vi, xiv and xvii) and as a result, it was possible to estimate daily feed requirements for animals of any known weight. In most instances these estimates were made from the weights of animals taken at monthly intervals from birth. The ranges in weights for the different species, breed, age and sex classifications are shown in parentheses in Table I. Thenceforward the calculation of annual feed requirements as pounds of T.D.N. was a comparatively simple process. Appendix vii summarizes these results and provides for comparison a second set of "stock units." The "stock unit" is calculated as the annual requirement of a ewe for maintenance and for the production of a lamb, fat when

TABLE I

STOCK CONVERSION FACTORS.

	Stock Units
A. DAIRY STOCK.	
1. Dairy cow (850 lbs. L.W. producing 506 galls. 5% milk per annum).	6.0
2. Dry cow (2 yrs. +)	4.0
3. Dry 2 yr. old (2-3 yrs.)	4.0
4. Yearling (1-2 yrs.) L.W. = (391 - 655 lbs.)	3.5
5. Calf (birth - 1 yr.) L.W.= (60 - 391 lbs.)	1.5
6. Bull (2 yrs. +) L.W. 1,300 lbs.	5.0
7. Bull calves (birth - 1 yr.) L.W. (60 - 524 lbs.)	2.0
8. Bulls (1 - 2 yrs.) L.W. = (524 - 900 lbs.)	4.0
9. Bulls (birth - 2 yrs.) L.W. =(60 - 900 lbs.)	3.5
B. BEEF STOCK	
1. Breeding bulls (2 yrs. +)	5.0
2. Cows and heifers (2 yrs. +) (1,150 lbs. L.W. producing 315 galls. of 3.9% milk per annum.)	5.5
3. Heifers (1-2 yrs.) L.W.= (565 - 803 lbs.)	4.0
4. Calf (birth - 1 yr.) L.W.= (80 - 565 lbs.)	2.0
5. Steers (2 + yrs.) L.W. = (1250 -1300 lbs.)	5.5
6. Bulls (1-2 yrs.) L.W.= (605 - 966 lbs.)	4.5
7. Bull calves (birth - 1 yr.) L.W.=(80 - 605 lbs.)	2.5
C. SHEEP	
1. Breeding ewe L.W.=(120 lbs.)	1.0
2. Ram L.W.=(152 lbs.)	0.75
3. Wether L.W.=(130 ")	0.70
4. Dry ewe L.W.=(100 ")	0.60
5. Lambs as at 30th April L.W. = (12-80 lbs)	0.50
6. Sheep shorn	0.75

weaned at 16 weeks of age. A full explanation of the assumptions made in determining certain average stock weights, feed requirements and milk yields can be found between pages (3) and (9) of the Appendices.

It is of considerable interest to compare the results from Morrison's (1950) feeding standards (Appendix vii) with the assessments of Wallace and McMeekan (1951), (Table I). With the exception of the data applicable to sheep stock, the notable feature is the marked similarity between the two series of indices. There were, however, some discrepencies; e.g. Morrison's estimates resulted in a conversion factor for the dairy cow which in terms of practical farming alone appeared to be rather low and the "stock unit" index for male beef calves appeared to be low when compared with the corresponding term for dairy stock. Apart from these differences which can be reconciled because of differences in conditions, there is quite a good correspondence between the two sets of data for both beef and dairy animals. However, the unsatisfactory situation obtained for the sheep fraction required investigation and classification. Reference was made to the work carried out by Wallace (1948) at Cambridge, part of which was concerned with the feed intake, milk production and lamb growth of Border Leicester-Cheviot sheep. Experimental feed conditions closely approximating those found on the average North Island fat lamb farm were obtained. Sheep and milk weights previously applied as average for the Waipa County, were substituted in the two regression equations from which daily requirements for maintenance and production were calculated (refer Appendices, pages (9) - (12) for the detailed procedure). Annual feed requirements as estimated by this method,

enabled the provision of a third group of conversion factors applicable to sheep stock. This is presented in Table II, (column C.) together with the comparable indices of Morrison (column B.) and Wallace and McMeekan (column A.)

TABLE II

COMPARISON OF SHEEP STOCK CONVERSION FACTORS CALCULATED BY THREE METHODS.

(See Text)

Class of Stock	(A)	(B)	(C)
1. Breeding ewe (L.W. = 120 lbs.)	1.00	1.00	0.88
2. Ram (L.W. = 152 lbs.)	0.75	0.98	0.79
3. Wethers (L.W. = 130 lbs.)	0.70	0.94	0.75
4. Dry Ewe (L.W. = 100 lbs.)	0.60	0.76	0.69
5. Fat Lamb (L.W. 67 lbs. at 16 wks.)	-	-	0.12
6. Lamb as at 30th April (L.W. 12 - 80 lbs.)	-	0.51	0.60

Since in both columns (A) and (B) the requirements of a lamb fat up to weaning have been included with those of the breeding ewe, the results obtained by methods (A) and (C) show close agreement. It will be recalled that mention was made previously of the diverse results obtained by various workers using sheep as the experimental animals. Under these circumstances the agreement between the results under (A) and (C) was considered sufficiently good for the retention in total of the former set of "stock units". The complete set of conversion factors shown in Table I were therefore used to reduce all stock on all the sample dairy farms to a common denominator.

There was, however, one further important adjustment necessary in the application of a system of "stock units" to dairy cattle. Obviously some allowance had to be made for differing herd averages on different farms. This required a definite answer to the question, "By how much does the amount of feed ingested by a high producer exceed that eaten by a low producer?". Even were an estimate available, the complications introduced by differences in genetic merit as well as plane of nutrition could nullify its usefulness in between-farm comparisons. At present there is some doubt as to whether the relationship between feed intake and milk production is linear or curvilinear. Jensen et al (1942) maintain that a diminishing returns curve is applicable, whereas Brody (1945) considers that over the feeding and production ranges obtained in farm practice, the relationship is linear. For the purposes of this survey the linear relationship was accepted and a detailed series of conversion factors was calculated to permit adjustments to be made for herd averages on all sample farms. Some indication of the magnitude of changes induced in the average indices is provided in Table III which is a condensation of the complete tabulation.

TABLE III.

DAIRY COW CONVERSION FACTORS

CORRECTED FOR VARIATIONS IN PRODUCTION PER COW

Production per Cow (lbs. of B.F.)	Stock Units
150	5.09
200	5.53
250	5.97
300	6.41
350	6.85

(The complete set of data appears as Appendix xvi and an explanation of the method used for the individual calculations is given on page (7) of the Appendices.)

Very little is known concerning the fraction of the total between-herd differences for average "production per cow" which is attributable to genetic factors. Plum (1935) suggests a heritability value of 25-40%, which is similar to the calculation for between-cow, within-herd differences.

Another complicating feature frequently appeared where limited numbers of sheep were carried in conjunction with the dairy animals. The nature of the annual stock returns was such, that two independent estimates of sheep numbers were obtainable for each season. The first concerned the numbers of sheep shorn and lambs tailed, while the second involved a return for the numbers in each class, appearing in Table II, which were being grazed on the 30th April of the same year. Thus in any year, a crude means of checking sheep numbers was provided, between the numbers which, in all probability would be wintered and the tally at the following shearing. The very crudity was due to the scope available for sales and purchases between the months of April and December.

The greatest difficulties in the application of common conversion factors to these data occurred, however, when returns for sheep shorn and lambs tailed were obtained, although there was no indication of the presence of such stock on 30th April of the same year. When, in successive years, returns of this nature were made consistently, it was apparent that there was a need for revision of the "stock unit'system" to include if possible, a factor for "sheep shorn". It was considered that the numbers of lambs docked but not carried through until the end of April were insufficient to warrant a special "stock unit". In any case the limited numbers returned in this particular livestock category were scarcely sufficient to permit derivation of any accurate term.

From information supplied on pages (11) and (12) of the Appendices, the term "sheep shorn" was calculated as equivalent to 0.75 "stock units". This statistic, together with the graduated scale of conversion factors based on differences in herd averages, completed the supplementary information required for a full appreciation of the data presented in Table I. As a result, a system of stock indices was made available which enabled the conversion of all stock to common units and thus permitted the inclusion of all elements contributing to total "carrying capacity".

2. Cows in Milk.

The term "cows in milk" includes "dairy cows and heifers, 2 years old and over, in milk at any time since 1st July or expected to be milked before 30th June of the following year".

3. Replacement Numbers per 100 Cows im Milk.

The term replacements refers to young dairy animals which are retained for later inclusion in the milking herd. Under the circumstances of the present survey, this group consisted of calves (birth - 12 months of age) and heifers (1 - 2 yrs.of age).

4. Carrying Capacity.

Two alternative measures were used for measuring "carrying capacity," viz., the number of cows in milk per 100 "effective acres" and the number of "stock units" per "effective acre".

5. Effective Butterfat Production.

The "effective butterfat production" refers to the fraction of total production for which payment is received from the factory.

6. Butterfat Production "at the pail".

"Butterfat production 'at the pail' " is concerned with the total quantity of butterfat produced by the herd before any deductions for household and calf-feeding purposes are made. It was shown from New Zealand Dairy Board Reports (1941 to 1945) that the average effective per cow production for small herds was lower than it was for large herds. Assuming that between herds of various sizes, the differences in the per cow averages determined from production "at the pail" are negligible, then proportionately more butterfat per cow is sent to the factory from large than from small herds.

Hence the determination of "at the pail" averages required the addition to "effective butterfat production" of a correction factor, the magnitude of which was dependent on the size of the herd concerned.

FIG. 4 provides the information from which the data appearing in Appendix xx was derived. Table IV which consists of an abbreviation of the detailed tabulation indicates the size of correction factors.

TABLE IV.

TABLE OF CORRECTIONS FOR ESTIMATING BUTTERFAT "AT THE PAIL"

Size of Herd	Correction per Cow (lbs. of B.F.)	Size of Herd	Correction per Cow (lbs. of B.F.)
10	60	40	31
20	54	50	27
30	39	60	24

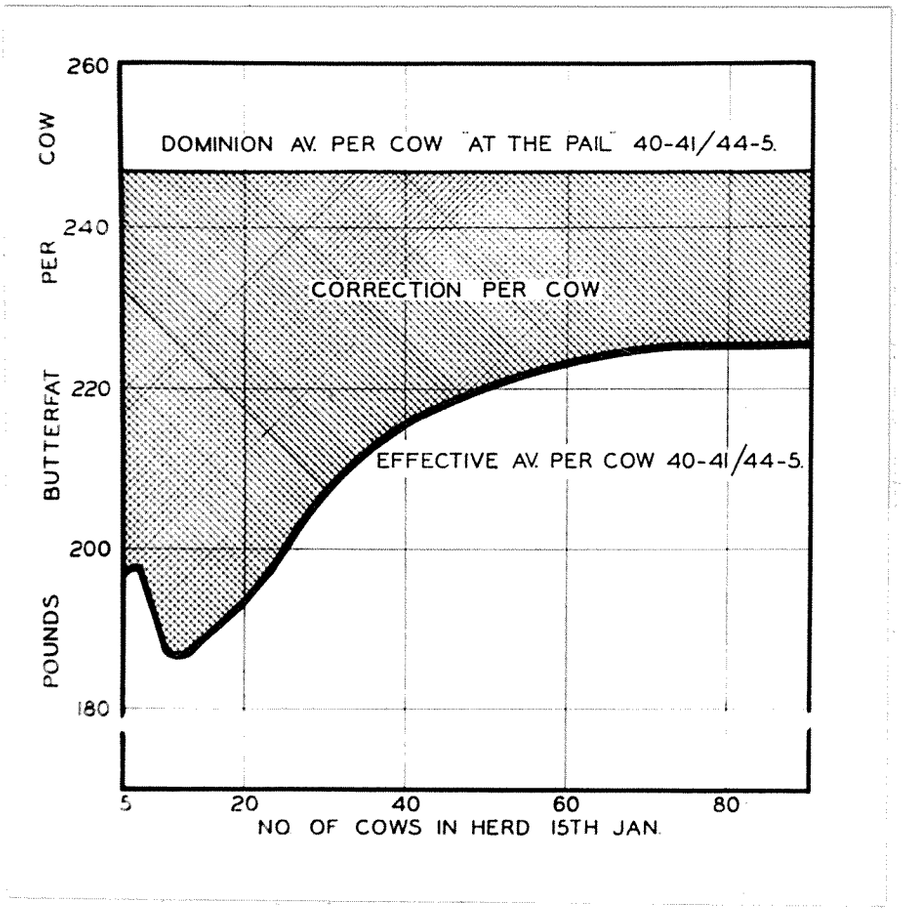


FIG. 4: The relationship between "effective" and "at the pail" production for herds of different size.

7. Production per Cow.

For individual farms in any season, "production per cow" was calculated from production "at the pail" and the number of "cows in milk" during the season.

8. Production per Acre.

For each season, "production per acre" was determined from the production of butterfat "at the pail" and the "cultivated area".

C. Labour.

Labour Units.

Butterfat per Labour Unit.

1. Labour Units.

On every dairy farm the size of the labour force determines in considerable measure the amount of butterfat produced (Mitchell (1948)). Measuring the quantity of labour available is therefore a very important feature of any survey dealing with factors affecting farm output. In such an estimation, the complication arises that the farm labour force is often not composed of a single class of workers, for men, women, boys and girls may all be full-time workers. There was a need to express all classes in terms of a common unit, so that genuine between-farm comparisons in labour concentration could be made. For this purpose a labour unit was computed as one full-time male worker. Both men (21 yrs. and over) and boys (15-21 yrs.) were accorded equal ranking, whilst all women over the age of 15 years were rated as equivalent to one half a labour unit. No consideration was given to part-time workers in this survey.

2. Butterfat per Labour Unit.

"Butterfat per labour unit" was determined for each farm from the total butterfat produced "at the pail" and the number of full-time "labour units" employed.

S E C T I O N I I I

REVIEW OF THE LITERATURE

There are many individual problems, facets of the complex system comprising dairy-farming which have provided and will continue to provide a great deal of material for research workers in many fields. The vast amount of potentially valuable information which becomes available every year because of the successful functioning of each farm enterprise, however, remains relatively untouched. As Myers (1930) pointed out ..... "it has sometimes been assumed, erroneously, that conclusions of one farm management study would be applicable to any farming region at any time. Even if the region and the sample included in the study have been selected intelligently, the resulting conclusions can be expected to apply only to the particular farming area studied under conditions existing at the time of the study." Because he appreciated that wide fluctuations in market prices could occur from year to year, Myers (loc. cit.) continued ....."knowledge of price trends and cycles and of the principles governing the movement of prices has been of great value to farm management workers in their attempts to show the application of farm management principles under changing economic conditions. Even with these aids it is desirable to repeat surveys at intervals of 5 to 10 years."

In New Zealand, the potential value of various survey investigations has scarcely been measured. Hamilton's (1944) "Dairy Industry in New Zealand" is the only

publication from which a concise but adequate account of the most important aspects of dairying in New Zealand is obtainable and it serves as an admirable example of the value of survey data in the forecasting of changes and in anticipating the effects of these changes.

As indicated by the scarcity of published data, only a limited number of dairy-farm surveys have been undertaken in New Zealand. Reports and investigations which have been of considerable value are those by Fawcett, (1929 & 1932); the Dairy Industry Commission, (1934); the Government Statistician (1938); and Doig, (1940). Apart from information collected by the Herd Recording Department of the New Zealand Dairy Board and presented in annual reports, no detailed dairy-farm survey data has been published during the past ten years. From time to time, papers such as those presented by Hamilton, (1947 & 1949); Hamilton & Ward, (1951); Mitchell, (1948); Mitchell & Hamilton, (1950); Hutton & Wright (1952) have provided summarized data, butapart from Milliken's (1948) unpublished thesis on sharemilking in Waikato, no recent investigation in dairy-farming has been presented in its entirety. As a result, in relating the scope of the present study to aspects already considered in the field of dairy-farm management research, initial comparisons must be made with the investigations undertaken more than twenty years ago. (See Table V.)

TABLE V.

DATA FOR SIX INDEPENDENT DAIRY FARM SURVEYS UNDERTAKEN BETWEEN 1928 AND 1948.

Source of Data & Seasons Referred to.	Dairy-Farm Survey Fawcett (1926-27)	Dept. of Agr. Dairy-Farm Survey. (1929-30)	Report of Dairy Industry Commission (1935-36)	Dairy Farming Survey Govt.Stat. (1935-36)	Standards of Life Survey, Doig. (1936-37)	Survey on Sharemilking Milliken (1945-46)
Farming area Concerned.	Waikato & Taranaki	Waikato-Bay of Plenty-Taranaki.	North Island	New Zealand	New Zealand	Waikato
Size of Sample (farms)	206	967	550	19307	413	126
Effective area (acres)	109*	142*	124*	91	106	138
"Effective area" as a % of total area.				54	81	96
No. of cows in milk.	40	54	58	42	59	90
"Effective Prodn." (lbs. of B/F.)	10531	14631	14610	9328	15323	18713
Prodn. per cow (lbs. of B/F.)	264	268	254	227	261	207
Prodn. per acre (lbs. of B/F.)	104	113	118	103	145	131
Cows per 100 ac.	39	42	46	46	56	66

* refers to the total area as no estimate was made of the "effective area".

With the exception of the two earliest investigations conducted by the Department of Agriculture (1929 & 1932), the only feature common to all surveys was that each referred to a single season's data. Differences of sample size and between-district variations, when considered in conjunction with the time lag between each survey, precluded any searching comparisons. In addition, the purposes for which each investigation was undertaken and therefore the standards set in defining dairy-farms often differed. As an example, the definitions of a dairy-farm for the surveys of the Government Statistician (1938) and the Dairy Industry Commission (1934) may be quoted. Under the conditions of the Government Statistician's survey a property was included as a dairy-farm if, during the season considered, either 5 cows were milked or 1,500 lbs. of butterfat were produced. In contrast, the sole requirement of the Dairy Industry Commission was that dairying provide a major part of each farmer's income. Obviously, the two samples were scarcely comparable and neither could be compared with Milliken's (1946) sample as the latter constituted a selected group of farms producing above the average for a particular district.

Partly as a result of these anomolies, considerable differences in both outputs per cow and per acre were obtained between surveys. The extremely low figure for "production per acre" reported in the Government Statistician's survey was due mainly to the inclusion of a large section of mixed-farming enterprises. The latter contributed a large total area but comparatively little butterfat and a low sample average resulted.

Effective output per acre is determined from the total butterfat sent to the factory divided by the area used for dairying, and since the latter may be defined in several ways, any between-survey differences in the meaning of "effective area" can invalidate comparisons of per acre yields. Evidence that different measures of expressing "cultivated area" have been employed, is provided in Table V, where the "effective areas", expressed as percentages of the total areas, ranged from 54% in the Report of the Government Statistician (1938), to 81% in Doig's (1940) survey and to 96% in the study conducted by Milliken (1948). The lowest figure (54%) is a consequence of the inclusion of many farms where dairying provided but one of several sources of income. In this particular instance, 49 of the 169 acres forming the total area for the mean sample farm were used for purposes other than dairying and only 29 acres comprised the unused portion. It was not stated whether the remaining 91 acres included the land occupied by buildings, plantations, hedges, ditches etc., or whether this was included as part of the 29 acres of unused land. There is a need to clarify such points since for Doig's survey, the area occupied by houses and buildings was included as part of the "effective area". Whether the 124 acres recorded as average for the 550 farms referred to in the Report of the Dairy Industry Commission is a measure of total or "effective area", is a matter for speculation. Consequently in the treatment of indices dependent upon "effective area", an exact definition of the latter must be obtained if valid conclusions are to be made from between-survey comparisons.

Several other important items, common to all farm investigational work require adequate description and the number of cows comprising the milking herd may be included in this category. It is not always stated clearly whether the term "size of herd" includes dairy young-stock and/or dry stock, or merely the milking cows. Although "size of herd" is often limited to the number of cows in milk at any time during the season of survey, in some cases the questionnaire may request only the number of cows milked on a specified date.

When the farm labour force is considered, a further problem becomes apparent, for the true assessment of output per worker, requires a reliable estimate of the relative contributions of full and part-time workers, both male and female. Doig (1940) in his standards of life survey has used a scale of man units determined by the Health Organization of the League of Nations. The ratings, which vary according to age and sex appear in Table VI.

TABLE VI.

SYSTEM OF MAN UNITS USED BY DOIG (1940)

Age of Worker (years)	Sex	
	Male	Female
2 - 13	0.2-0.8	0.2-0.8
14 - 59	1.0	0.8
59 & over	0.8	0.8

The system of ratings used by the Government Statistician also allowed for sex differences among workers. Full-time male workers were considered equivalent to 10 units and those employed on a part-time basis to 3 units.

Corresponding estimates for female workers were 6 and 2 respectively. In the investigations of both Fawcett (1929) and the Dairy Industry Commission (1934),a completely different procedure was adopted. It appeared that male and female workers were accorded equal rating and, judging from the number of workers per farm in relation to herd size, part-time employees were also included. As a result, there was a tendency to overestimate the individual farm labour force and this was reflected in a comparatively low output per worker.

The problem of determining a suitable conversion factor whereby all labour may be reduced to comparable units is a very difficult one. Some distinction between full and part-time workers is necessary and the number of hours worked is suggested as a reasonable basis for differentiation. Even after assessing the number of man-hours worked per day, or per week by the average dairy-farmer, there still reamins the problem of deciding the arbitrary level at which the distinction will be drawn between full and part-time workers. The contributions of individualworkers to total farm output are not dependent solely on the number of hours worked, however, since the enterprise and intensity of effort applied can serve as powerful modifiers. Thus, when all other factors are considered equal, some allowance should be made for such variability, if the most accurate measure of output per labour unit is to be obtained. This problem was first appreciated when a separation of male and female workers was made. In both Doig's (1940) and the Government Statistician's (1938) surveys, the farm

labour force was subdivided into full- and part-time, male and female groupings. Milliken (1948) reduced his farm population to "full-time male labour equivalents" and these accounted for "the sharemilker's own labour, if any, and employees' labour, both full- and part-time". Unfortunately Milliken (loc. cit.) failed to include the units of conversion which he had used.

These results emphasize the general weakness of most surveys in which data on farm labour is presented. So often the conditions distinguishing full- and part-time workers are not clearly stated and definitions of the conversion factors employed are not always provided. When the standards for conversion used in the present survey are considered in relation to those applied in previous studies, a lack of unanimity is apparent. This indicates the need to subject data concerning the productivity of labour to a thorough appraisal before between-survey comparisons are made.

Since, the majority of farm management studies refer to a single season's data, it is most important when comparing the results of individual investigations to appreciate the extent to which the climatic conditions prevailing when the surveys were carried out, differed from average. It is interesting to note that during 1945-46, the period for which Milliken (1948) carried out his investigation, production in the Waikato was severely affected by the late summer and early autumn drought. If such results are to be compared with others referring to different periods, then adequate allowances should be made for seasonal differences.

These considerations, serve to show the difficulties involved in interpreting trends indicated by independent surveys conducted in different years. Where certain indices peculiar to a single survey are employed and no definition of terms is provided, satisfactory comparisons become impossible. For the present study, however, it was rather fortunate that Mitchell (1948) had conducted a single season's survey (1946-47) on 850 dairy-farms in the Waipa County. Although most of the terms and indices used in this survey and the one previously carried out by Hamilton (1944), were similar to those employed in the present study, in any comparison of results from the three surveys due allowance must be made for differences in climate, topography and soil type existing between Whangarei and Waipa Counties. In addition it should be remembered that both of the earlier surveys were based on a single season's data, and for each investigation different sized samples were involved. Table VII shows certain important features which distinguish farms in established dairying areas from others in districts undergoing development.

TABLE VII SUMMARY OF RESULTS FROM HAMILTON'S AND MITCHELL'S UNPUBLISHED SURVEYS.

Source of data and season referred to.	Hamilton's Survey 1940-41	Mitchell's Survey 1946-47
Farming area concerned.	Whangarei	Waipa
Size of sample (farms)	510	850
Cultivated area (acres)	109	102
Cultivated area as % of total area.	63	91
No. of cows in milk per farm.	41	59
Production of B/F per cow (lbs. at the pail)	241	253
Production of B/F per acre (lbs.)	109	161
Cows per 100 acres.	38	60

These investigations, together with analyses undertaken on a Dominion -wide basis and published in the New Zealand Dairy Board Annual Report (1950) comprise the only contemporary dairy-farm surveys available for purposes of comparison.

Publications such as the annual statistical reports of the agricultural and pastoral production in New Zealand and the New Zealand Dairy Board Annual Reports, together with certain cyclostyled data issued by various Governmental and other organizations, enable farming inputs and outputs to be traced from year to year.

Philpott's (1937) "History of the New Zealand Dairy Industry" and later, Hamilton's (1944) "Dairy Industry in New Zealand" are the only two publications in which an attempt has been made to assemble, in a single comprehensive volume, all data relevant to the Dairy Industry.

Of necessity, these findings had Dominion-wide application and to obtain data of a more detailed nature such as that referring to specific land districts, it was necessary to refer to the Annual Agricultural and Pastoral Statistics and to the New Zealand Dairy Board Annual Reports. When within land districts specific farms are considered, however, little information is available.

The only studies involving the histories of samples of farms are those of Mitchell (1948) and Hutton (1952). Since there is a limit to the amount of currently unproductive land which can be converted to dairy-farming, the importance of investigating the changes occurring on a constant area should be appreciated. Data provided by such studies can help considerably in the making of predictions concerning possible changes in total production,

irrespective of alterations in "effective areas". It is unfortunate therefore that such scant information is available, for it would be desirable to have data for each of the main dairying districts with which to compare the trends provided by the present investigation. Because of this definite inadequacy, difficulties in the interpretation of experimental results are increased and consequently much of the reasoning applied to survey and trends data must depend largely upon inference.

S E C T I O N I V

DESCRIPTION OF THE AREA.

The Waipa County which is situated in the Middle Waikato basin covers an area of 435 square miles or 278,400 acres. The eastern and western boundaries consist of the Waikato and Waipa rivers respectively, which have their confluence at Ngaruawahia, the northernmost point in the county. The southern border is rather irregular extending from slightly south of Pirongia in the west, to south of Arapuni in the east and includes the western slopes of Maungatautari.

The three large towns of the County - Hamilton, Te Awamutu and Cambridge - are connected by road and rail with Auckland. The port of Auckland, 86 miles north of Hamilton is the chief export and supply centre for the whole of the Waikato. Four Auckland fertilizer works supply the major portion of the phosphate requirements, the remainder being imported directly through the port of Auckland. Most of the lime used in the Waipa County is obtained from Hangatiki, thirty-four miles south of Hamilton in the Waitomo County.

Climate.

Table VIII contains summarized information on temperature and rainfall conditions collected at the Hamilton East meteorogical station. Kidson (1939) has stated that temperature, rainfall and sunshine are fairly uniform over the area and for this reason returns from the Hamilton East

Station can be accepted as representative of climatic conditions prevailing throughout the county.

TABLE VIII.

ANNUAL RAINFALL AND TEMPERATURE DATA.

WAIPA COUNTY 1941 - 50.

Year	Mean Temperature (°F.)	Total Rainfall (ins.)	Number of Wet days
1941	54.7	52.03	170
1942	55.7	40.79	161
1943	55.0	42.94	161
1944	55.5	50.79	193
1945	54.5	47.75	164
1946	56.1	50.75	206
1947	54.9	41.22	162
1948	55.3	48.89	184
1949	54.7	40.19	187
1950	55.5	37.30	123

The ten year average returns for the period 1941-50, calculated from Table VIII were as follows:-

1. Temperature = 55.2° F.
2. Rainfall = 45.24"
3. Number of days on which rain fell = 171.

It is appreciated that for the maintenance of high production, provision of adequate feed is of especial importance during the months December to March and conditions of rainfall will determine in large measure the quantity available. Information on temperature and quantity and distribution of rainfall during these three months has therefore been collected for each year between 1941 and 1950, and is presented in Table IX.

TABLE IX.

CONDITIONS OF TEMPERATURE AND RAINFALL
FOR THE MONTHS DECEMBER, JANUARY AND FEBRUARY
FROM 1940-41 TO 1949-50.

Season	Mean temp. (°F.)	Total (3 mths.) Rainfall (ins.)	No. of Wet days
1940 - 41	63.3	11.43	25
1941 - 42	61.5	6.03	42
1942 - 43	62.8	7.29	27
1943 - 44		Not available	
1944 - 45	62.1	15.38	40
1945 - 46	61.1	3.60	25
1946 - 47	60.6	6.84	33
1947 - 48	62.8	7.29	27
1948 - 49	61.8	7.21	42
1949 - 50	60.7	9.32	27

Geology.

The Hamilton basin, of which the county occupies the western part is surrounded by higher country of older geological formations. The basin itself is relatively young having undergone three phases of development since the formation of the cones of Pirongia and Maungatautari. The first of these involved alluvial deposits of sands and gravels which were later uplifted, eroded and finally covered by 10 to 15 feet of volcanic ash. This volcanic layer constituted the second phase which inturn was covered by a layer of pumiceous gravel, sand and silt, forming an alluvial fan on the rolling lowland. As a result only

the tops of ash-covered hills remained projecting. The meanderings of the rivers produced natural barriers which impeded the flow of smaller streams and as a consequence of the dammingback, the Moana-tua-tua and Rukuhia swamps were formed. The terraces created somewhat later by the Waipa river as it became entrenched in its alluvial fan, are still subject to floods. In contrast those derived from the Waikato river are usually not susceptible to flooding.

Topography.

"The district is of low relief and lies mainly in the western part of the Hamilton basin, a depressed area which is bounded in on the north, east and west by higher country rising steeply from the lower surface to heights ranging from 600' to 3,000'. South of Hamilton basin the depressed area narrows and its floor rises and passes gradually into the higher country surrounding Te Kuiti." Four topographical groupings (Grange et al (1939)) have been used to describe the surface features of the county.

1. Flats of the Waipa flood plain.
2. Flats of the Waikato fans with their gravelly ridges, peaty swamps, and lakelets.
3. River terraces.
4. Low rolling hills formed from Pliocene beds.

Soil Types.

Between 1933 and 1935 Grange et al (1939) carried out a detailed soil survey of the northern half of Waipa County. In order to reconcile the soil types of the southern portion with those described from the more thoroughly mapped area, in the present study it was found necessary to reduce the complexity of the latter by grouping certain essentially similar soil types.

By this procedure the major soil types were included in one of the following seven groups:-

(a) Sandy loams and sands of the Waikato fan.

(b) Meadow soils derived from alluvium, from volcanic ash and in some cases sedimentary rock as well.

(c) Poorly drained meadow soils showing slightly peaty top soil.

(d) Peaty loams and loamy peats.

(e) Brown granular clay loams derived from the Hamilton ash-shower. These are the hilly texture soils of the rolling land in the northern portion of the county.

(f) The immature brown-yellow loams of the rolling and broken land in the southern portion of the county. These soils developed from the Mairoa and Tirau ash-showers.

(g) Hilly and skeletal soils derived from volcanic material.

Development of Agriculture in Waipa County.

Smallfield (1939) divided the history of farming in the Waipa County into four distinct historic periods, each of which was notable for certain striking individual features These he described as follows:-

(1) The period of Maori cultivation prior to 1863.

(2) The period of European settlement and mixed farming between 1865 and 1882.

(3) The period covering the gradual development of the dairying industry (1882-1900).

(4) The period of intensive stock fattening and dairying (1900 onwards).

It is with this most recent development in agriculture that the present investigation is concerned. Smallfield (loc.cit.) has dealt in some detail with changes in farm and stock numbers during the period 1926-27 to 1936-37. In view of the current importance attached to land development, it is of interest to note that the majority of the farm lands in Waipa County were in pastures by 1923. Thus additions to stock numbers were accommodated on a relatively constant area and carrying capacity has increased accordingly.

The liberal use of phosphatic fertilizers has produced remarkable improvements in production and modified soil types in such a way as to reduce their specific effects quite markedly.

Thus for the purposes of a farm management study, the Waipa County offers adequate scope for:

(a) Assessing how initial differences between soil types have been modified by intensive farming.

(b) Determining the characteristics of soils which appear to be most important in obtaining the highest production.

(c) Determining those managemental practices and their form of application which enable production increases to be made long after the developmental stage has passed.

Mitchell (1948) as part of his initial survey, conducted a detailed analysis of the land utilization in the Waipa County during 1946-47. Summaries of these data, indicating the pre-eminent position of dairy-farming are presented as Tables X and XI. Although, in terms of area alone, dairying is only twice as important as sheepfarming, a comparison based on farm numbers permits a more accurate

evaluation of the relative importances of the two systems. Table XI shows that there are more than six times as many dairy as there are sheep farms in the County. The remaining mixed-farming enterprises when considered together, involve only 23% of the total area surveyed. This provides a fair indication of the specialized nature of farming within the Waipa County.

TABLE X.

LAND UTILISATION - WAIPA COUNTY.

Total Area of County (435 sq. miles).	=	278,400 ac.
Area excluded from survey (Kihikihi and Leamington town districts, part Ohaupo town district, Pirongia, part Whatawhata settlement, and environs of Hamilton and Frankton).	=	6,944 ac.
Total area included in survey		271,456 ac.
Area of Holdings of 10 acres and over.		258,873 ac.
Area of Holdings under 10 acres, roads, lakes etc. (by difference).		12,583 ac.

Classification of Holdings of 10 acres and over. *

		%
Dairying.	118,655 ac.	49.4
Dairying and beef cattle.	4,854 "	2.0
Dairying and sheep.	44,603 "	18.6
Sheep.	65,457 "	27.2
Beef dry cattle (excluding dairy runoffs).	4,419	1.8
Special purpose (racehorses, sport, pigs, etc.)	2,487	1.0
Total area of holdings wholly or partly utilised.	240,619 acres.	
Unused (land wholly in scrub, bush, etc.).	18,254 acres.	
Total.		258,873 acres.

Note: These data state total area of holdings. A proportion of the area of many holdings will be in scrub or bush or otherwise not utilised for farming.

TABLE XI.

WAIPA COUNTY.

NUMBER AND AREA OF ALLOCATED FARMS AND HOLDINGS (TOTAL AREA 10 ACRES OR OVER).

		Number	Total Area
1.	Farms of 20 acres and over cultivated area.		
	(a) Dairy Farms:		
	Data complete.	850	95,257 acres
	Data incomplete	52	6,748 "
	Total.	902	102,005 "
	(b) Sheep farms:		
	Data complete	132	44,430 "
	Data incomplete	10	2,530 "
	Total.	142	46,960 "
	(c) Dairy and sheep farms:		
	Data complete	133	33,127 "
	Data incomplete	3	798 "
	Total.	136	33,925 "
	(d) Beef and dry cattle grazing farms:		
	Data complete	21	2,057 "
	Data incomplete	6	1,541 "
	Total	27	3,598 "
	(e) Dairy and beef farms:		
	Data complete	16	4,854 "
	Total	16	4,854 "
2.	Farms with under 20 acres cultivated area.	39	821 "
3.	Farms with over 20 acres cultivated area but less than 10 cows in milk.	1	27 "
4.	Holdings run with land outside area covered by survey.	32	8,388 "
5.	Changing hands at time of survey (stocking abnormal).	7	1,930 "
6.	Farms run by dealers.	6	674 "
7.	Special purpose (market gardens, sport, pigs, etc.)	21	1,534
	Total Allocated.	1,329	204,716 acres

S E C T I O N V

SCOPE OF THE INVESTIGATION.

From the collection of data relating to a single sample of dairy-farms during a ten year period, two distinct studies have been made possible. First, the application of a dairy-farm survey technique which involved the analysis of between-farm differences in management and productivity for a ten year period. The second, a study of year to year changes both within and between farms in respect of farm management practices and farm production during the same period.

Fundamental to both studies was the collection of a large body of detailed information on each farm in the sample. By reducing the different factors of production such as labour, soil type and stock capacity, to indices which may be expressed quantitatively, it has been possible to compare different farms and different systems of management in terms of common factors. Although for both methods the basic data was essentially similar, differences inherent in the systems of analysis necessitated separate presentation of the results for each study.

1. Farm Management Survey.

In this study the data for individual farms were derived by averaging returns collected annually during ten successive years and from these bulked data the consequences of between-farm differences were studied. Thus, application of a ten-year averages ensured that the results referred to a single period in time.

By the implementation of a system wherein the analyses were dependent on between-farm differences in certain inputs and outputs, a consideration of the following topics was made possible:-

(a) A description of the sample by the estimation of the means and the ranges of all factors studied. Of especial importance was the calculation of those statistics which can be regarded as satisfactory estimates of farm efficiency, viz., "butterfat per acre", "butterfat per labour unit", etc.

(b) A demonstration of the effects on farm capacity and efficiency of various inputs when applied at different intensities.

(c) An estimation of that fraction of the total between-farm variance for the indices "production per cow", "carrying capacity", and "cows per labour unit" - which is attributable to the managemental factors considered.

(d) An assessment of the relative and actual importances of the various farm practices which contributed to efficient production.

2. The Study of Farming Trends.

In contrast to the method described in the previous section, this analysis was based upon the changes which had occurred within and between farms over a period of time. The primary aims of the study were:-

(a) To establish the direction of long-term production changes, trends in farming methods and whether there were any apparent associations between these.

(b) To measure for individual farms the nature and extent of changes in production, and in certain farm practices. By classifying farms on these bases, relation-

ships between inputs and outputs can be observed and the degree of concordance between results obtained from within- and between-farm comparisons ascertained.

S E C T I O N V I.

THE METHOD OF STUDY.

The method of study is best considered under three major headings. These are as follows:-

1. The preparatory stage.
2. A description of the sources, collection and adaptation of the data.
3. The analysis of the data.

1. The Preparatory Stage.

This section is concerned with a description of the farm sample which was selected for the investigation. For a complete understanding of the manner in which this sample was obtained, a brief outline of certain features of Mitchell's (1948) initial survey of the Waipa County is required. The area with which Mitchell was concerned in his land utilisation survey, comprised all the Waipa County with the exception of Kihikihi and Leamington town districts, Pirongia, part of the Whatawhata settlement and the environs of Hamilton and Frankton. Thus, approximately 98% of the total county area was included in the survey.

By partitioning this area between the different types of farming, he estimated the total number and area of farms which were devoted solely to dairying (Tables X and XI), and what fractions these formed of the corresponding county totals. Thus of the 1,329 farms larger than

10 acres, 902 were "pure"* dairy-farms (see Table XI).

From this total, 850 were obtained which supplied full information for the 1946-47 season and these Mitchell (1948) took as his sample.

For the present study it was considered that the original sample of 850 farms, even allowing for wastage, would prove rather cumbersome. This opinion was based on a knowledge of the considerable work involved in collecting and filing input - output data for each farm in every year.

A method of random sampling was employed to reduce the sample size to manageable proportions. Since the farms showed great variation in size and "carrying capacity", some restrictions on complete randomisation were applied, however, in order to obtain a sample truly representative for both of these features This was accomplished by sorting the 850 dairy-farms into seven "carrying capacity" groupings within each of which, depending on the number and variability of the farms included, as many as six size-of-farm groupings were made. Thus the maximum number of groups possible was forty-two. Each of these was halved by placing alternate farms in different classes. By the toss of a coin the decision was made as to which of the two classes became a part of the sample and in this way the original number of sample farms was halved. For statistical reasons (Hamilton (1952)) some farms were subsequently rejected with the result that the sample was reduced to 400 dairy-farms.

Each of these 400 dairy-farms provided a complete set of data for the 1946-47 season. As the aim of the investigation was to accomplish both a study in farming

---

* To qualify as a dairy-farm the following conditions were required:

1. The area included within the farm boundaries was at least 20 acres.
2. There were at least 10 cows in milk.
3. The proportion of farm stock other than dairy animals did not in any year exceed 10% of total stock when all animals were expressed in "stock units".

trends and a farm survey using data collected for every season between 1940-41 and 1949-50, it was expected that by the time all the data was available for analysis, some reduction in the sample size would have occurred. This was indeed the case. The principal causes of sample wastage during the period 1941 to 1950, together with the number of farms and areas associated with each are presented in Table XII.

TABLE XII.

CAUSES OF WASTAGE IN A SAMPLE OF 400 WAIPA DAIRY-FARMS.

Cause of Wastage	Incomplete data in any year.	Change in farm area.	Change to other types of farming.	Total wastage
No. of Farms	107	25	15	147
Area of Farms (acres)	11,395	2,568	1,891	15,854

Thus there remained only 253 which provided data complete in every respect and suitable for the management studies.

2. The Nature and Sources of Data.

All the data recorded for each of the sample farms in this study were collected by various Government departments and certain other organizations using normal survey procedures. This was the same procedure as adopted previously by Hamilton (1944) and Mitchell (1948). Thus in systematising and analysing this work, the necessity of canvassing individual farmers was avoided and Hamilton (1949) estimated that this reduced the time required to accomplish a survey to one fourth.

Information acquired in this way was arranged on 8" x 11" cards, two of which were required per farm for the ten year period. Samples of the cards used are shown as FIGS. 1, 2 and 3, and a study of these will reveal the nature of the data collected. Certain terms referred to on the cards are peculiar to this survey and are explained fully in the section, "Definition of Terms" (see pages 8 to 26). Since they reduce to common standards those factors which in their original form can be compared only with difficulty, these indices enable complete between-farm comparisons to be made.

Although all the information used in the survey was obtained either directly or indirectly from data collected by various organizations, some, by its very nature, was not of a type secured by routine survey methods. Of especial importance in this respect was information supplied in map form which was essential for a full and accurate description of the farm lands included in the survey.

When the survey was commenced the following maps were available:-

1. Soil Survey Maps. The soils of the northern portion of the county had been surveyed in considerable detail and maps published on the scale 1" = 40 chains (Grange et al (1939)). For the southern half of the county the survey had been carried out with much less detail and the data entered on field sheets on the scale 1" = 80 chains (refer Annual Report D.S. & I.R., 1931).
2. Holdings' Maps. These were drawn to the same scale as the soil maps and showed farm boundaries. They had been prepared originally from the Lands and Survey County sheets.

3. The provisional series of topographical maps. These were prepared by the Lands & Survey Department primarily for defence purposes, but showed the areas of scrub and forest. (Scale 1" = 80 chains.)

4. Aerial Mosaics. The aerial mosaics which covered the whole of the County were reproduced on a scale considerably larger than any of the other maps. (Scale 1" = 20 chains.)

The main problem in utilising this information was so to adapt it as to alter its applicability from the general to the particular. This was accomplished by using the holdings' map in association with all the other maps. The boundaries for each of the sample farms were defined by the holdings' map and for reference purposes, the valuation roll number of each farm was entered in its correct position on the map and on the corresponding holding's card.

A print of the holdings' map was then taken and placed as a transparency over the topographical map and bush and scrub boundaries traced. These boundaries were not completely satisfactory for agricultural purposes, as scrub was defined as growth from four feet to ten feet in height and bush as growth over ten feet in height.

Holdings' boundaries and valuation roll numbers were sketched on the aerial mosaics and forest and scrub edges checked against the holdings' map. In this way, scrub below four feet in height was noted on the latter as scattered scrub.

By placing the holdings' map with bush and scrub edges over the soil map, it was then possible to note for each holding the soil types within the farm boundaries and those types actually being utilised i.e. in grass. This soil data was recorded on the individual holdings' cards.

Appendix ii lists the "soil ratings" ascribed to the various soil types. From information on the nature and proportions of the different soil types, a mean "soil rating" was calculated for each farm.

Apart from the function indicated above, the topographical maps and aerial mosaics proved very useful in assessing the accuracy of certain farmer-returns, such as estimates of the areas in scrub and forest and portions of the farm area occupied by buildings, gardens, orchards, plantations, lakes, streams and barren land. In all cases the farmer-estimates recorded on the cards (in the case of buildings etc. this was under the heading "General") were checked by an accurate interpretation of the aerial surveys.

3. Analysis of the Data.

For a full appreciation of the methods used in analysing the data collected it is necessary to refer to the experimental aims outlined in Section V.

The nature of individual farm input - output data enabled the application of two independent methods of study, one of which was based on analyses of differences between farms at a certain period in time (the survey approach), the other on comparisons both between and within farms during a period in time (the trends study). The methods differ basically one from the other and for this reason a separate explanation has been made of the analyses used in each case.

(1) TheAnalysis of the Survey Data.

All the data for each farm was averaged so that returns for all inputs and outputs represented mean figures derived from ten years' information. Sample means for all factors were determined by summing the particular estimates for every farm and dividing by the number of sample farms.

The most important of these are recorded in the preliminary section of the survey results. Additional information in the form of sample ranges for each input and output was provided by tabulation analyses.

Regardless of the terms in which production was expressed, the total between-farm variance was considerable and consequently the main object of the tabulation analyses was to observe features of farming practice associated with highly productive properties. This system of analysis does not give any precise estimate of the magnitude of any relationship established, nor does it provide any direct method of estimating the extent of these relationships, but it is particularly useful in indicating where associations exist. Due to widespread interactions between factors, relationships indicated between any two variables could not be accepted as valid without including for verification a second tabulation based on the substitution of the independent for the dependent variable. As a result, sixteen tabulation analyses were undertaken and the dependent variables for these included both measures of input and output relating to land, labour and livestock. The complete range of analyses are presented under these three headings, as follows:-

Land	Livestock	Labour
1. Soil Rating	1. Size of herd.	1. Production per labour unit. (lbs. of B/F.)
2. Cultivated area.	2. Replacement numbers per 100 cows in milk.	2. Cows in milk per labour unit.
3. Percentage of cultivated area cropped.	3. Carrying capacity (cows per 100 ac.)	3. Stock units per labour unit.
4. Percentage of grassland cut for hay.	4. Carrying capacity (stock units per acre.)	

Land	Livestock	Labour
5. Percentage of grassland cut for silage.	5. Production per cow. (lbs. of B/F.)	
6. Percentage of grassland T.D. with artificial ferts.		
7. Percentage of grassland limed.		
8. Production per acre. (lbs. of B/F.)		

By reference to Appendices clxix to clxxxiv and to the corresponding sections in the survey results, the sample ranges can be obtained for each of the sixteen factors listed. Since measures of efficiency and capacity are of the utmost importance in farm management studies, the relationships revealed by tabulations based on "production per acre", "production per cow" etc., are of particular interest.

Because of the desirability of checking such apparent associations, most of the input factors were also used as dependent variables in a series of additional tabulation analyses.* Such is the nature of farm survey data, however, that the presence of a third variable correlated with both the factors providing the apparent relationship, will under some circumstances, invalidate the conclusions drawn. This is a feature which limits the applicability of tabulation analyses to farm survey data. Because of the complex interrelationships it is impossible to evaluate the contribution of each input factor, independent of all others. Hamilton (1944 & 1947), and Mitchell (1948) used systems of correlation and partial correlation analyses in attempting to express clearly the degree of association between factors.

---

* This section of the work was made possible by the Powers-Samas equipment at the Biometrics Section of the Dept. of Scientific & Industrial Research.

The total correlations which made no allowances for interrelationships between factors were accepted as indicative of causal relationships. These were considered sustained if the partial correlations proved significant. However, the determination of partial correlations is dependent on a set of abiological circumstances which require all factors to be held constant, except those between which the correlation is being measured. The interpretation of the results of such analyses is therefore rather complicated.

The reason for applying statistical methods to this type of data can be expressed as the need to isolate the independent effects of inputs which make a significant contribution to high production. Irrespective of the way in which efficiency is expressed, interactions tend to complicate an assessment of the contributions of individual inputs. However, before any attempt is made to determine the individual effects of factors on efficiency, some analysis is required of the composition of indices used to express this term. It is appreciated that:-

(1) Butterfat per acre is the product of butterfat per cow and the number of cows in milk per acre;

and(2) Butterfat per labour unit is the product of butterfat per cow and "the number of cows milked per labour unit'

In both instances there is a three factor association forming a closed triangular relationship. Thus, both "production per acre" and "production per labour unit" represent only concise expressions of the products of their respective factor pairs. All inputs affect either cow numbers, "production per cow" or both of these and consequently direct relationships are measured between individual inputs and either or both of the latter.

Because of the difficulties in describing information relating to farming, the type of data supplied by the various organizations was such that it would ensure the minimum personal error on the part of the farmer. Many important features of every-day farming practice cannot be expressed in simple terms, however, and consequently these were not available for inclusion in the survey. It was considered important, therefore, to determine what fraction of the total between-farm variance for "production per cow", "carrying capacity" and "the number of cows milked per labour unit", each considered separately, was accounted for by the managemental factors included in the present survey.

A 14 x 14 factor correlation matrix was contructed from all possible correlations between the fifteen inputs and outputs. The correlation coefficients were determined from the equation:

$$r_{i.j} = \frac{\text{covariance (i.j)}}{\sqrt{(\text{variance i})(\text{variance j})}}$$

where r = the correlation coefficient and
i and j represent the two factors between which the correlation is to be estimated.

For the determination of the fractions of the total between-farm variances for "carrying capacity", "production per cow" and "cows milked per labour unit" attributable to all the inputs considered, the appropriate correlation coefficients were selected from the 14 x 14 correlation matrix. In the estimation of the accountable fraction of the total variance for "carrying capacity", neither "production per cow" nor "cows milked per labour unit" were

included among the variables, and comparable adjustments were made when "production per cow" and "cows milked per labour unit", were each treated as the dependent variable.

As explained previously (page 58), the composition of the variables "production per acre" and "production per labour unit" excluded them from these statistical calculations. An additional complication arose as a result of the high correlation between herd size and "cultivated area", and since the former was really a function of farm area, herd size was excluded from the group of independent variables.

Thus of the 15 original variables, 9 remained which were suitable for inclusion in the subsequent analyses. For the purpose of estimating the fractions of the total variances for "carrying capacity", "production per cow" and "the number of cows milked per labour unit" attributable to these inputs, 9 x 9 factor correlation matrices were constructed. From these matrices, R^2 (the square of the multiple correlation coefficients = the fraction of the total variance accounted for) was determined for each of the three dependent variables by application of the abbreviated "Doolittle solution"(Dwyer (1942)). (Refer to Appendix xxii for an example of the method.)

From the completed solutions it was possible to select for "carrying capacity", "production per cow" and "the numbers of cows milked per labour unit", those inputs which had contributed most to the fraction of the total variance accounted for. For the purpose of determining whether or not the inclusion of each selected input caused a significant reduction in the residual variance regardless of the combination of variables to which it was added, the

selected inputs were subjected to a repeated testing, involving the use of the "Doolittle Solution" in association with Snedecor's "F" test (Snedecor (1940)). It was essential to apply these tests to all combinations since the sequence in which an input was included often affected the result of the "F" test.

An additional extension of the Doolittle method enabled the standard partial regression coefficients (β') for each of the selected inputs for "carrying capacity", "production per cow" and "cows milked per labour unit" to be determined (see Appendix xxii.).

The Doolittle method does not allow a direct test of significance but by the use of an appropriate adaptation which is explained fully in Section IX and Appendix xxiii, Student's "t" test (Snedecor (1940)) was applied to the standard partial regression coefficients. From the standard partial regression coefficients, the corresponding natural partial regression coefficients were calculated and these data were used to formulate the regression equations for "carrying capacity", "production per cow" and "the number of cows milked per labour unit".

These analyses complete the farm survey investigation and thus the remainder of this section comprises an explanation of the methods employed in the study of farming trends.

2. <u>The Study in Farming Trends</u>.

Initially an investigation was undertaken so that the farming changes which occurred between 1941 and 1950 could be studied for the mean sample farm. The data used for this study consisted of weighted averages which were used in preference to summations of the averages for individual farms.

For the purpose of elaborating upon information obtained in this initial investigation, the farms were grouped and individual farm data analysed in a variety of ways. It was hoped that by the application of such methods it would be possible to establish what types of farms were undergoing greatest changes and whether in fact the absence of certain trends for the mean sample farm was a result of the levelling effect of averages masking within-sample variability. As no a priori evidence was available indicating the potentialities of different systems of analysis, two basically different methods were used.

1. Farms were classified according to between-farm differences in certain important factors, and for every farm these were determined as ten-year averages. The factors on which these classifications were based were as follows:-
   (a) "Production per cow" (lbs. of butterfat).
   (b) "Carrying capacity" ("stock units" per acre).
   (c) "Cultivated area" (acres).
   (d) "Percentage of grassland topdressed with artificial fertilizers."
2. The second method by which farms were classified depended on the nature and extent of changes recorded for individual farms between 1941 and 1950. For each factor considered, the change was estimated as the difference between the averages calculated for the first three and last three years respectively. The factors studied in this manner were:-
   1. "Production per acre" (lbs. of butterfat).
   2. "Production per cow" (lbs. of butterfat).
   3. "Carrying capacity" ("stock units" per acre).
   4. "Percentage of grassland topdressed with artificial fertilizers."

5. "Percentage of grassland cut for hay."

Implementation of these various systems of analysis enabled a full description to be made of the nature and extent of farming trends in the Waipa County. All the methods employed were essentially descriptive in nature and no statistical methods were used to test the validity of apparent relationships revealed. Although this method may lack the precision of the survey system of analysis, nevertheless, the study in trends has a very useful function in farm management research, and it may be argued that in the interpretation of relationships revealed by data collected from the same farms over a considerable period of years, a degree of accuracy, far superior to that obtainable by the descriptive treatment of survey data, can be accorded such results.

PART II

RESULTS AND DISCUSSION OF THE RESULTS OF THE DAIRY-FARM MANAGEMENT SURVEY.

PART II

SECTION VII.

RESULTS AND DISCUSSION OF THE RESULTS OF THE DAIRYFARM MANAGEMENT SURVEY.

A. DESCRIPTION OF THE AVERAGE SAMPLE FARM.

The average farm considered typical of the 253 farms comprising the present sample was located on land of soil rating 7.0 and consisted of 108 acres, of which 91% was utilized by the dairy herd. The area cropped, either as green forage or roots, was small and amounted to only 21% of the cultivated area. The proportions of the total grassland utilized annually for hay and silage and topdressed with artificial fertilizers were 17.0%, 4.3% and 79% respectively. Although liming by itself was not very popular, 49% of the total grassland received some lime, most of which was applied in conjunction with artificial fertilizer.

Sixty-two cows constituted the milking herd and to maintain numbers, twenty-two calves and heifers were retained as replacements. The farm livestock population totalled 445 "stock units" of which only 7 were contributed by beef and sheep stock. (One of the requirements of this survey limited other than dairy stock to 10% of the total stock units.) From these data, "carrying capacity" was estimated as 63 cows in milk per 100 acres or 455 "stock units" per 100 acres.

The "mean herd average" was 265 lbs. of butterfat and "production per acre", probably the most useful measure of farming efficiency, amounted to 167 lbs. of butterfat. Thus total output from the mean sample farm consisted of 16,334 lbs. of butterfat "at the pail", equivalent to an effective output of 14,785 lbs. of butterfat. A farm labour force of 1.8 labour units was available for this enterprise and as a result, the "number of cows milked per labour unit" and "production per labour unit" amounted to 34 cows and 9,015 lbs. of butterfat respectively.

In an attempt to assess the representativeness of the sample, the average "effective productions" of herds supplying factories in the Auckland district were computed from returns for the seasons 1940-41 to 1949-50. In addition, a similar statistic, differing in that it referred to production "at the pail", was obtained for all herds under Group Test in the Auckland land district.

These data appear in Table XIII.

TABLE XIII.

COMPARISON OF HERD AVERAGES.

Description	Production per Cow (lbs. of Butterfat)
Effective average (sample)	240
"At the pail" average (sample)	265
Effective average (Auckland district)	218
"At the pail" average for testing herds (Auckland district)	259

It appears that the average per cow production for the group of farms surveyed was higher than the comparable

figure for all herds under test. It would have been more satisfactory to have used returns for testing herds in the Waipa County, but these were not readily obtainable. It is suggested therefore, that the sample consisted of better than average farms and this may have been due in part to certain requirements of the survey. Factors which may have been influential in the latter respect are considered as follows:-

(1) Since constancy of farm area was a prerequisite, it was necessary to exclude farmers who had bought or sold land.

(2) Because of the complications associated with run-offs attached to the main holdings, farms on which land was utilized in this way, were also excluded from the sample.

(3) The restriction on the proportion of beef and sheep stock permissable, caused the rejection of another portion of the original sample.

It is possible that by removing dairy farmers who bought and sold land and others interested in beef and sheep stock, the representativeness of the sample has been affected. If this is so, then such characteristics as constancy of farm size and undivided attention to dairy-farming are features associated with slightly better than average farmers.

B. THE PROBLEM AND THE METHOD.

The principle requirements of this section are to provide a detailed description of the sample of 253 dairy-farms and to indicate where relationships exist between various inputs and measures of farm productivity.

In any study such as the present investigation, where a limitation is placed on the number of factors which can be investigated and measured, it is impossible to evaluate the relative importances of all farm practices as contributors to high production. However, a series of tabulation analyses gave a full account of the range and nature of the distributions of all important factors considered. In addition, certain relationships became apparent which indicated, within the limits of this investigation, the factors associated with high productivity. The various inputs, forming the bases for the extensive use of this system of tabulation analyses, were conveniently divided between the uncontrollable factors, consisting of the farm size, situation, topography, soil type and general standard of communications, all of which are accepted when ownership of the farm is taken and those subject to managemental control, such as the amount and rate of top-dressing and the provision of winter and summer supplementary feed.

In total, sixteen different analyses were completed and these appear unabridged as Appendices clxix to clxxxiv. The presentation of results has taken the form of descriptions of individual tabulations, for only in this way was it found possible to obtain complete coverage of all data available from each tabulation. It was realized at the outset, that conclusions concerning any factor could be considered valid only after consideration of the latter as the dependent variable. Thus a large number of analyses were undertaken, to include as far as was practicable, all the factors for which data was available. By such means it was found possible to avoid errors such as were made by

Fawcett (1929) in the calculation of topdressing costs from tabulations which were based only on such indices as "production per acre", "production per cow",etc.

C. PRESENTATION OF RESULTS.

Attention was directed firstly to a description of the tabulation analyses founded upon between-farm differences in "production per acre", "production per cow", and "carrying capacity", since each represented a measure of either farm capacity or farm efficiency. Following the completion of this portion of the results, emphasis was shifted to an interpretation of analyses based on a variety of inputs. The first of these were concerned with the unalterable factors, "soil rating" and "cultivated area", and were succeeded by the analyses for cropping, hay and silage making, topdressing, farm stock (milking cows and replacements) and finally, the farm labour force.

"Production per acre".

Since dairy-farms vary in size, total farm output gives no measure of farming success. As a measure of efficiency, "production per acre" provides the most satisfactory index and may be based on either total or "effective areas" and yields. For the purposes of this investigation, "effective" or "cultivated area" and "butterfat production 'at the pail' " were employed. "Butterfat per acre" is particularly valuable as a common measure of efficiency which enables direct between-farm comparisons. Under the conditions of the present survey where this statistic represented an average compiled from ten years' returns, the absolute value of the term "production per acre" had increased, for seasonal influences had been minimized and the effects of transitory features such as

occasional supplementary feed surpluses or cropping programmes, had been removed.

It is perhaps unfortunate that this index, "production per acre", is itself a composite of two ratios, "production per cow" and "carrying capacity". Since managemental factors affect both "production per cow" and "carrying capacity" directly, this closed triangular system of relationships ensures that their influence on "production per acre" is always indirect. The relative importance of "production per cow" and "carrying capacity" has been the subject of much debate, but no definite conclusions have resulted since it is doubtful whether two factors showing such a degree of interrelation can be evaluated separately.

I. Results of the Analysis of Farms Grouped According to "Production per Acre".

Using between-farm differences in "production per acre", it was found convenient to classify the 253 sample farms into eight groups, the averages for which ranged from 83 to 263 lbs. of butterfat per acre. See FIG. 5 and Table XIV for the distribution of farms between classes and the inter-class output of butterfat per acre.

TABLE XIV

ANALYSIS OF FARMS ACCORDING TO "PRODUCTION PER ACRE"

Group	Range in Production Per acre (lbs.of B/F)	No.of Farms	Cult. Area (ac.)	Av. Production of B/F.(lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	under 100	9	110	83	206	5422	40
II	100 - 124	15	106	114	214	7260	51
III	125 - 149	37	118	139	238	8781	57
IV	150 - 179	69	107	162	253	8867	63
V	180 - 199	69	95	186	266	10546	68
VI	200 - 224	34	75	211	280	9503	73
VII	225 - 249	11	77	233	281	10318	79
VIII	250 and over	9	49	263	301	10089	83

As stated previously, the average for the sample of 253 farms was 167 lbs. of butterfat per acre and this defined the modal class as the group of 69 farms described by the limits, 150-174 lbs. of butterfat. In both cases, the two extreme classes consisting of farms which yielded on the one hand, less than 100 lbs. and on the other, more than 250 lbs. of butterfat per acre, contained nine dairy-farms.

In describing this analysis, it is proposed to deal firstly with the two components of "production per acre", viz., "production per cow" and "carrying capacity". Subsequently, consideration will be given to the predetermined factors, "cultivated area" and "soil rating", and this will be succeeded by treatment of the data on the

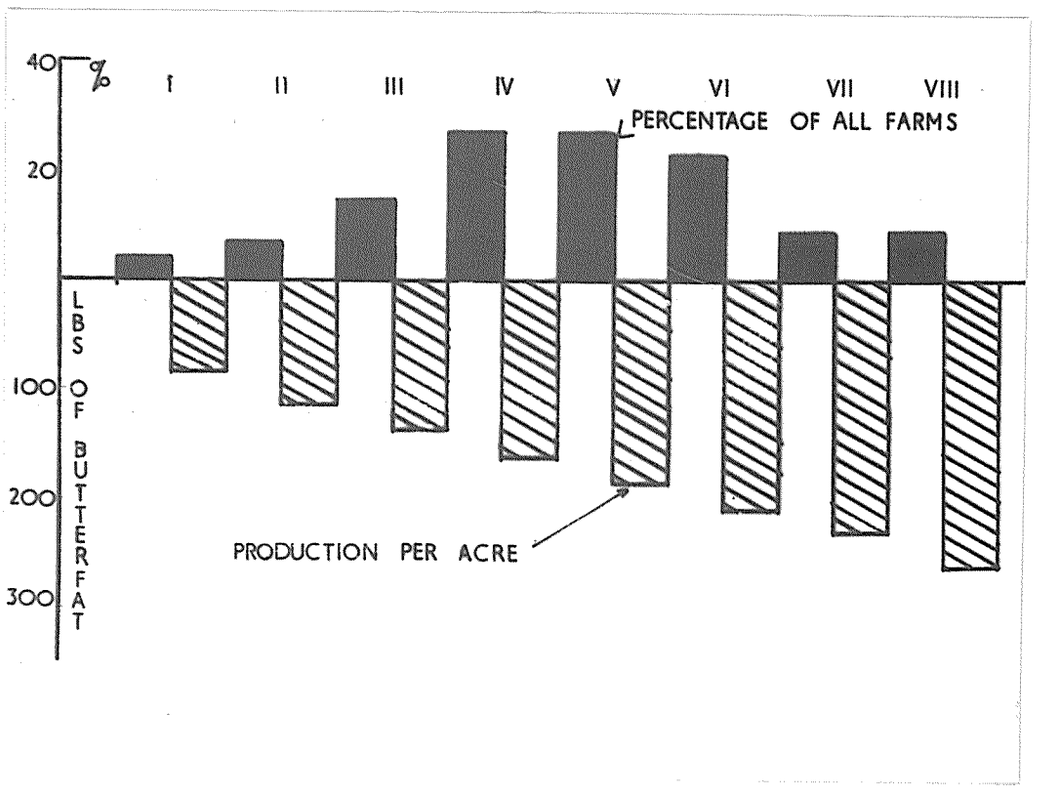


FIG.5: The distribution of 253 sample dairy-farms between eight "production per acre" groupings.

provision of supplementary feed, topdressing, herd size and maintenance, and finally farm labour and other related data. This will be the standard procedure adopted in the description of results obtained within each of the succeeding tabulations and will, it is hoped, help to systematise the presentation of the data.

(a) "Production per cow" and "carrying capacity".

Although increases in "production per acre" were accompanied by similar changes in "production per cow" and "carrying capacity", in neither case did these changes approach the threefold rise recorded for butterfat per acre. These data which are presented in Table XIV for the range represented by Groups I to VIII, show that whereas "production per cow" increased by less than 50%, "carrying capacity" (expressed as cows in milk per 100 acres) was more than doubled.

(b) "Cultivated area".

It is plainly shown from the analysis that highly efficient farming is associated with relatively small farm size. Ultimately size limitation and economic pressure must determine whether or not an area is farmed intensively. Thus, where intensive farming is practised, high per acre returns result and in times of economic prosperity, land values increase to an extent where limits are placed on the area which can be purchased. Hence, efficient farming can be size limiting, even as limitations in farm size are conducive to high efficiency. Where land was used to best advantage, the acreages were comparatively small, unutilized areas were small and the concentration of manpower, as measured by the number of labour units per 100 acres, was high.

(c) Farm Production.

The marked effect that variations in "production per acre" can have on total output was illustrated by properties producing more than 250 lbs. of butterfat per acre, for the factory supply of 12,000 lbs. of butterfat obtained from these farms exceeded the production of some properties three times as large.

Itemization of all the factors which have caused these different levels in farming intensity, presents a problem for which there is no complete solution. It is known that a fraction of the total between-farm variance for "production per acre" is due to differences in natural soil fertility, but in Waipa County it would be expected that the fraction accounted for in this way would be smaller than that attributable to factors subject to managemental control. Because of difficulties in the application of standards of measurement to such features as shed techniques and pasture quality, a large amount of data was not available for survey purposes. However, some interesting relationships between "production per acre" and data which related, both to the provision of supplementary feed and pasture maintenance, were provided.

(d) Cropping.

As measured by the proportion of the "effective area" utilized and the numbers of farmers who regularly adopted cropping practices, the growing of either green forage or root crops was of small importance. In this survey, no measure was taken of the importance of pig farming on individual farms and consequently it was impossible to relate the cropping programme to the needs of this section of the dairy-farm unit. It was observed that as "production per acre" increased the areas cropped

decreased. When, however, the acreages in crops were expressed as percentages of their respective "effective areas", the trend differed to the extent that only small between-group differences were observable for all except those farms producing less than 125 lbs. of butterfat per acre. Owing to the absence of data on pig farming, the value of terms such as the area cropped per 100 cows in milk and per 10,000 lbs. of butterfat produced, may be questioned. Nevertheless, it was noted that a considerable widening of these ratios occurred as "production per acre" increased.

(e) Hay and Silage.

By far the most generally accepted methods for providing supplementary feed involve the conversion of surplus grass to hay and silage. Since no accurate measures of either the yield or quality of hay and silage were available, quantitative estimates of supplementary feed were necessarily based on areas. As shown in Appendix clxx, there was coincident with the rise in "production per acre", a decline in the area cut for hay. When areas were expressed as percentages of the total grassland, however, a positive relationship was shown between "production per acre" and"the percentage of grassland cut for hay", indicating that on better than average farms, haymaking received especial emphasis.

From the relevant data, it was impossible to assume that the differences in the percentage areas cut for silage were positively correlated with differences in "production per acre", since between groups I and VII (ref. Table XIV), the "percentage of grassland cut for silage" increased from 0.4 to 5.4%, while the final group average fell unaccountably to 3.6% of the total grassland. The lack of any definite

between-group differences when silage making was expressed, either as the area cut for silage per 100 cows in milk, or as the area cut for silage per 10,000 lbs. of butterfat, indicated a real difference from the comparable results obtained for haymaking, which when expressed similarly, had shown economy of hay utilization where output per unit area was high.

(f) Topdressing.

Where "production per acre" was high it was apparent that far more topdressing and liming was practised than where "production per acre" was low.

The application of artificial fertilizers has become accepted as a standard method for both maintaining and building up pasture productivity and the importance attached to topdressing can be gauged from the fact that where farms produced more than 250 lbs. of butterfat per acre, 88% of the grassland was topdressed annually. The magnitude of this figure can be more thoroughly appreciated, when it is recalled that five of the ten years' returns from which this estimate was obtained included the war period, when fertilizer rationing was enforced. The data referring to area topdressed per 100 cows in milk and per 10,000 lbs. of butterfat indicate that the costs of topdressing are reduced where the per acre yields of butterfat are highest.

(g) Herd Size and Replacement Numbers.

Where the output per acre was low and the standard "carrying capacity" was approximately half a cow per acre, the average herd consisted of forty to fifty cows in milk. As such farms were larger than the mean sample holding ("cultivated area"), it was assumed that during the peak months of pasture growth, considerable wastage of feed surpluses occurred. This wastage may have been reduced in

some degree, however, by the proportionately large numbers of young stock retained on these low yielding farms.

By referring to the "number of cows in milk" and the "replacement numbers per 100 cows in milk" an interesting comparison was made between the herd management policies of farmers in each of the eight "production per acre" groups. From this tabulation the following facts were noted:-

(1) The largest herds were located on farms producing between 125 and 200 lbs. of butterfat per acre.

(2) A negative relationship existed between "production per acre" and the "number of replacements per 100 cows in milk".

(3) There was no relationship between herd size and "replacement numbers per 100 cows in milk".

Between farms, the proportion of youngstock retained, varied between the equivalent of 75 replacements per 100 cows in milk where output per acre averaged 83 lbs. of butterfat, to 17 replacements per 100 cows in milk where the output per acre exceeded 250 lbs. of butterfat.

Variations from the average were so marked as to suggest, between groups, the application of widely different systems of farm management. The relative efficiencies of the different systems and the possible effects on the dairy industry of inducing alterations in these, were considered worthy of investigation.

Physiologically, milk production provides the most efficient means of converting feed into animal products, regardless of the constituent in terms of which efficiency is measured. Raising young-stock entails a loss in the efficiency of food conversion, comparable with that realised when baby beef production is preferred to dairying

under comparable conditions. The fact that most farmers rear their own replacements ensures, on individual farms, that considerable amounts of pasture and pasture supplements are less efficiently utilized than would be the case if the dry stock were replaced by cows in milk.

Assuming the stock conversion factors are reasonable estimates, then the cost of feeding a growing animal until it comes into production is equivalent to the annual feed intake of the hypothetical average cow. When such an estimate is applied to farms of the type which have produced less than 100 lbs. of butterfat per acre, the reality of the loss in production is apparent. Seventy-five"replacements per 100 cows in milk" was the equivalent of thirty-two young-stock per farm, which on the assumption that the ratio of calves to heifers was 3:2, could be represented as 89.6 stock units or equivalent to sixteen milking cows of the same production standards as the mean herd for this particular group. Sixteen additional cows each producing 206 lbs. of butterfat could supply an extra 3,296 lbs. of butterfat to total farm production and as a result, boost output by 36%.

Naturally, too much importance should not be attached to the absolute value of these figures, but they do indicate possibilities which might be of importance to the industry. There is a real need during times such as the present, when prices for dairy produce are at high levels, to exploit to the full the potentialities of land which is both currently devoted to and potentially suitable for dairying. In all probability, the need for the application of more intensive farming methods would become even greater if the demand for our dairy products fell. The amount of land available for dairying is limited and

ultimately, a reorganisation of dairy-farming systems may be necessary to obtain that measure of efficiency, which will ensure the greatest economy within the industry.

In this connection, certain possibilities might be suggested from a comparison of the sheep and dairy industries. Admittedly the two are not strictly comparable, as sheep farming has proved economic over a wide range of topographical and climatic conditions, whereas dairying has been confined to temperate and geographically easy conditions. The most interesting feature of this comparison concerns fat lamb farming, the greatest competitor for land of actual and potential dairying worth. This section of the sheep farming industry functions comparatively efficiently because there is available each year, a ready source of breeding stock drawn from less productive areas. At any one time, nearly all of the stock carried on fat lamb farms are either actively producing, or due to come into production in the immediate future. This ensures a quick turnover of farm products, a full utilization of farm feed supplies and high returns per acre. Thus, in spite of the fact that the conversion of food to wool and flesh is only about one half as efficient as the process whereby milk is produced, in certain districts, fat lamb farming has competed successfully with dairy-farming for much of the better class land. Obviously it is impossible to have a similar stratification of the dairy industry, but the successful integration of two types of sheep farming suggest for dairy-farmers on highly productive land, the potential importance of a certain area of run-off, consisting of country which is uneconomic for milk production. It was pointed out in

the Government Statisticians' Survey (1938) that in the winter of 1936, 24½% of all dairy herds were wintered off. For the latter, the area devoted to dairying amount to 2.0 acres per cow, compared with 2.1 acres per cow where the herds were not wintered off. No information was provided concerning the management of the young-stock, but the results of this survey were sufficient to indicate the possibility of grazing a large proportion of all replacements away from the main productive area. Of course there will always be the problem of obtaining sufficient of this poorer type land close enough to the main farm area to enable reasonable supervision.

At the moment, the possibility that calves bred on the dairy-farms might be reared on special stock raising farms, does not suggest itself as a practicable alternative. Should the need to organise farming on a co-operative basis arise, such a move might become possible. At the moment, however, a plan of this nature might be interpreted as providing a threat to individual farmer liberty and as a move towards ultimate collectivism.

(h) Farm Labour.

With the exception of those farms where output per acre was highest and the farm area and labour force were smallest, the number of workers per farm was fairly constant for each group. When, however, the farm labour force was expressed as labour units per 100 acres, "production per acre" and the concentration of labour were shown to be associated. In comparing labour efficiency between groups, marked increases were noted for both cows milked and butterfat produced per labour unit on farms producing up to 200 lbs. of butterfat per acre.

Thereafter, no further advances occurred and this may be attributed to the limitations on farm size where high "production per acre" was obtained.

Although certain of the sample farms producing less than 125 lbs. of butterfat per acre may be located on peat lands the management of which is not yet fully understood, indications such as "soil rating" and the percentages of total areas under cultivation, suggest that most of these farms are not realising their fullest potentialities. Advances in butterfat payouts have indirectly affected the prices for young-stock and consequently, certain farmers have found it relatively easy and quite profitable to retain and raise all heifer calves. In addition, some farmers have followed the practice of purchasing surplus stock which are sold at appropriate times. Thus, the milking cow numbers have been kept within the limits which the owner can handle comfortably and no regard has been given to land potential.

This attitude might be condemned on the grounds of inefficiency, which if widespread, could have a considerable influence on the country's prosperity. When the rights of the individual landowners are considered, however, one would be tardy in condemning those who personally, might stand to gain little, yet who might sacrifice considerable leisure time in acceding to the demand for greater production.

II. Results of the Analysis of Farms Grouped According to "Carrying Capacity".

Two analyses, the one based on "the number of cows in milk per 100 acres" and the other on "stock units per acre" provided results which were essentially similar. The range in carrying capacities extended from an average of

0.43 cows per acre at one extreme, to 0.85 cows per acre at the other, while the average for the modal group, which included 42% of sample farms, was 0.65 cows per acre.

(a) "Production per acre" and "production per cow."

"Carrying capacity" is positively correlated with "production per cow" and "production per acre". Between groups I and V (Table XV) "carrying capacity" was doubled and over the same range, output per cow and per acre increased by 46 lbs. of butterfat and 137 lbs. of butterfat, respectively. Expressed in relation to the comparable figures in group I, the latter increases amounted to 21% and 140% respectively.

TABLE XV.

ANALYSIS OF FARMS ACCORDING TO AVERAGE CARRYING CAPACITY.

Group	Range in Carrying Capacities (Cows per 100 acres)	No.of Farms	Cult. Area (ac.)	Av.Production of Butterfat (lbs.)			Carrying Capacity (cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	under 50	16	120	98	220	6538	43
II	50 - 59	56	117	143	247	8764	56
III	60 - 69	107	98	175	263	9536	65
IV	70 - 79	58	80	201	264	9864	73
V	80 & over	16	70	235	266	10106	85

(b) "Cultivated area"

Intensively stocked farms tend to be smaller and more naturally fertile than average. This is a natural consequence of inelasticity of farm size, since the small farmer must ensure for himself a standard of living which, if not as high as that obtained by large

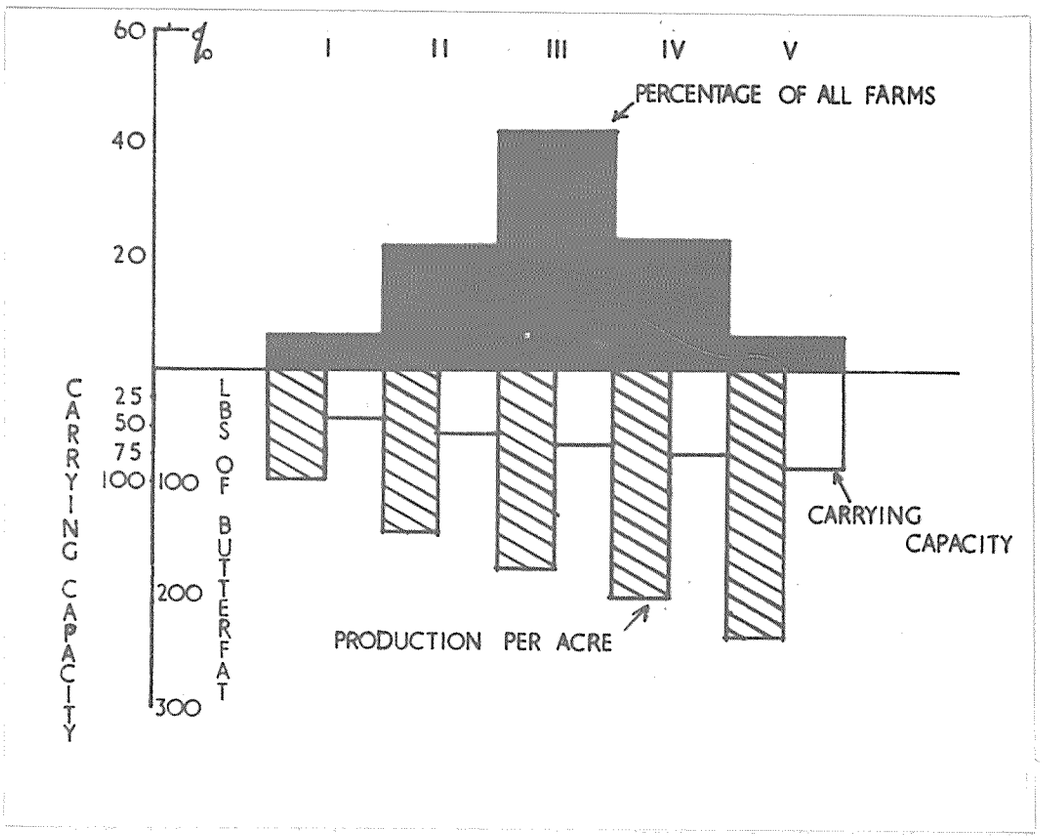


FIG. 6: The distribution of 253 sample dairy-farms between five "carrying capacity" groupings. The relationship between "carrying capacity" and "production per acre."

landowners, must be comparable with that obtainable in any other occupation. To solve this problem, the farmer must make full use of the land available with the best stock procurable.

(c) Cropping.

Where intensive farming is practised, adequate feed is required for each of the twelve months and it is evident that on those farms where the concentration of stock was highest, the greatest emphasis was placed on the value of supplementary feed. The apparent contradiction offered by the decline in the "percentage of the cultivated area cropped"associated with rising "carrying capacity" was discounted, when it was appreciated that in this county, cropping played a minor part in supplying supplementary feed.

(d) Hay and silage making.

The between-group differences in the "percentage of grassland cut for hay", though definite, were not particularly large. Hay has always provided the bulk of supplementary feed supplies and even where farms were poorly managed, an attempt wasusually made to convert some surplus spring and summer grass for winter use. It was possible to distinguish farmers who used only hay from those who made both hay and silage, since the latter made provision for both summer and winter shortages. Feed supplies were often depleted during dry summer months to the extent that production was markedly affected. Although silage feeding does not prevent this decline, it serves to reduce the rate of fall and enables a better recovery when pasture growth is resumed.

The "percentage of the grassland cut for silage" is an important feature for distinguishing high from low "carrying capacity" farms. Certainly the true value of silage cannot be measured in terms of acreage alone and it can only be assumed that its contribution to high stock concentration per acre is considerable. No information was collected about the autumn saving of pasture and the ommission of this data prevented computation of the total acreage which annually provided stored grass. For hay and silage, however, approximately 15% of the total grassland was saved annually where "carrying capacity" was lowest, compared with 23% where the concentration of stock was highest. Although estimates of feed supply based on areas are not entirely satisfactory, they are probably more reliable than individual farmer's estimates of yields.

(e) Topdressing.

The information on supplementary feed was supplemented by data on topdressing practices which indicated that as "carrying capacity" rose, the "percentage of grassland topdressed" also increased. It might be anticipated therefore, that a combination of high "carrying capacity" and the wide use of artificial fertilizers would raise fertility, and stimulate the production of greater quantities of more nutritious grasses. This would be reflected in improved quality and yields of hay and silage, which could cause even greater differences between low and high "carrying capacity" farms in the provision of stored digestible nutrients.

For farms of differing "carrying capacities", some idea of the relative economies of topdressing was obtained from returns for/the area topdressed per 100 cows in milk and

the area topdressed per 10,000 lbs. of butterfat. When farms carrying 43 cows per 100 acres were compared with others carrying 85 cows per 100 acres, it was estimated that the cost per cow was about 30% higher for the lower carrying capacity areas, while in terms of butterfat, this difference increased to 40%. Thus, although farmers who favoured high rates of stocking generally favoured more extensive topdressing programmes than others, the cost of this input when measured in terms of product, was substantially lower. Similar results were obtained when the areas cropped, cut for hay and cut for silage were expressed in the same form and emphasized the relatively high efficiency of intensively stocked holdings.

(f) Labour

Farm-worker efficiency increased by 3,568 lbs. of butterfat as the "carrying capacity" rose from 43 to 85 cows per 100 acres. Three reasons for this increase were suggested:-

(1) There were fewer workers per farm where "carrying capacities" were high than where they were low.

(2) Where the "carrying capacity" was high, more cows were handled per worker than where "carrying capacity" was low.

(3) There was a positive correlation between butterfat per cow and "carrying capacity".

In addition to the rise in the number of cows per worker, there was a complementary increase of 30% in the bails handled per worker and if it is assumed that one labour unit can handle 2.6 bails as efficiently as 2.0 bails, this should have allowed 37 cows to be milked as quickly as 29 cows.

There were more tractors in the low "carrying capacity" groups than in the high "carrying capacity" groups. Doubtless the size of the farm has been the main factor in determining whether or not a tractor is purchased and it is significant that the group of farms with the largest number of tractors also has the largest area per labour unit. The results of this analysis would suggest, however, that where the ratio of tractors to farms is high, very little use has been made of the additional horse power provided by these machines.

III. Results of the Analysis of Farms Grouped According to "Production per Cow".

TABLE XVI

ANALYSIS OF FARMS ACCORDING TO PRODUCTION PER COW (LBS. OF BUTTERFAT).

Group	Range in Production Per Cow	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	under 220	21	105	113	202	6943	54
II	220 - 239	39	108	142	229	8210	60
III	240 - 259	73	101	170	250	9534	66
IV	260 - 279	67	101	184	269	9918	66
V	280 - 299	38	79	205	287	9716	68
VI	300 & over	15	83	225	308	10253	69

Of the two hundred and fifty-three farmers, 8% possessed herds averaging 202 lbs. of butterfat per cow, while only 6% could boast of herd averages which exceeded 300 lbs. of butterfat per cow. Between these two extremes the remaining farms were normally distributed among four additional groupings. Two of these (Groups III and IV) included 55% of all sample farms.

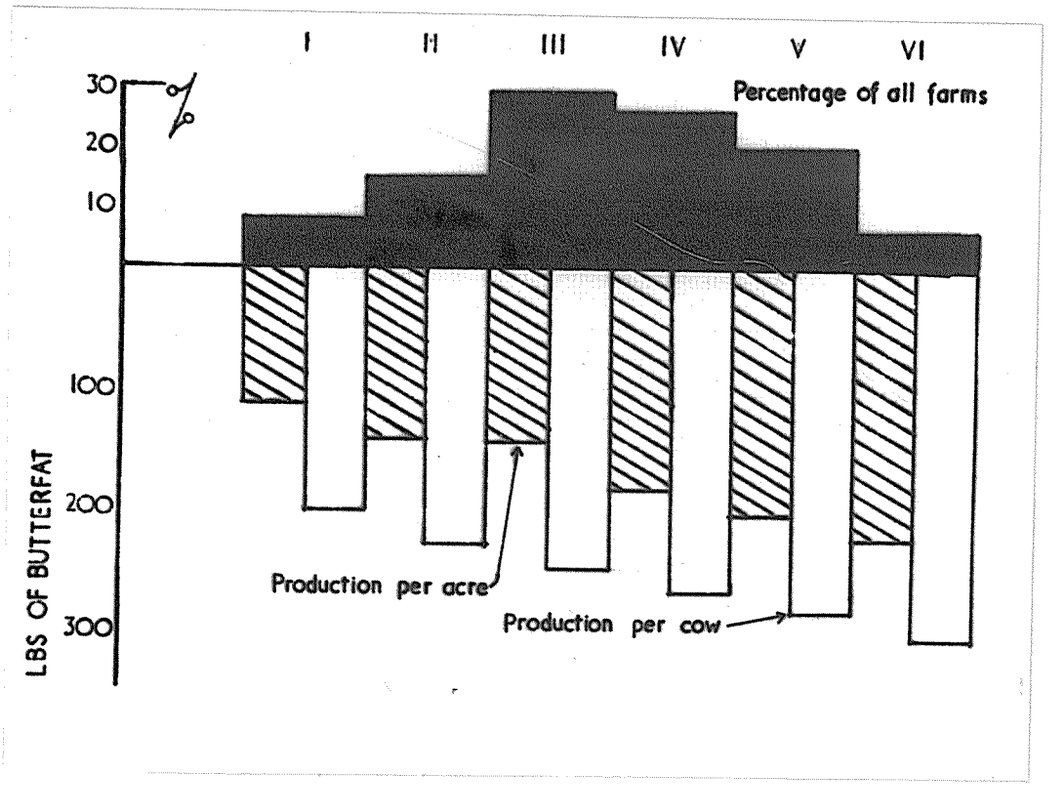


FIG. 7: The distribution of 253 sample dairy-farms between six "production per cow" groupings. The relationship between "production per cow" and "production per acre."

(a) "Production per cow", "production per acre" and "carrying capacity".

Herd averages for the six groupings ranged from 202 to 308 lbs. of butterfat per cow, but as shown in Table XVI, since there were fairly constant differences between these groupings there was a steady decline in the percentage rate of increase. Taking Group I as base, the overall increase in per cow output amounted to 52%, which was considerably less than that recorded for the corresponding change in "production per acre" (99%). A further demonstration of interrelationships existing between "production per acre", "production per cow" and "carrying capacity" was provided by a 28% increase in the latter which was associated with improved herd averages.

In many details therefore, this analysis yielded results similar to those already obtained from the "production per acre" and "carrying capacity" tabulations.

(b) "Cultivated area".

Cows of better than average production were generally found on smaller than average farms and, although the trend was not so marked as previously, high producing herds were usually found on better than average soil types. As a result, the 52% improvement in herd averages was associated with a 21% decline in the "cultivated area" and although there were, between groups, scarcely any differences in the number of workers per farm, this fall in "cultivated area" caused the density of the farm population to increase from 1.7 labour units per 100 acres in Group I, to 2.1 labour units per 100 acres in Group VI.

(c) Cropping.

The relationship between the "percentage of the cultivated area cropped" and butterfat per cow was similar

to that already considered in connection with "production per acre".

(d) Hay and silage making.

Between groups, there was very little difference in the mean "percentage of grassland cut for hay". This comparative constancy was also a feature of the tabulation, in which haymaking was expressed as the area of grassland cut for hay per 100 cows in milk (Appendix clxix) and differed quite markedly from the results obtained in the two previous tabulations.

By contrast, the data on silage making suggested changes in accord with those for "carrying capacity", for it was shown that the increases in "production per cow" were associated with similar changes in the "percentage of grassland cut for silage". Despite the fact that there was a positive relationship between "carrying capacity" and "production per cow", the area of grassland cut for silage per 100 cows in milk was larger on farms where herd averages were high than where herd averages were low.

(e) Topdressing.

The results for topdressing were practically identical with those obtained for haymaking, since, between groups, both the "percentages of grassland topdressed" and the areas topdressed per 100 cows in milk were relatively constant.

Evidence which showed the economy of high producing stock was provided in the section of the analysis where the areas cropped, cut for hay and silage and topdressed were individually expressed in relation to each 10,000 lbs. of butterfat produced. Although, as indicated earlier, between-group variations in the amount of topdressing and haymaking practised were negligible, when the returns were expressed in relation to each 10,000 lbs. of butterfat

produced, striking reductions in both areas topdressed and cut for hay were noted between Groups I and VI. Still more remarkable was the decline in the area cut for silage per 10,000 lbs. of butterfat, for in this case, the increased silage making practised on farms where herd averages were high must have produced a steadying effect on the rate of decline.

(f) Size of herd and total production.

Although there was some between-group variation for both herd size and production, neither the number of cows in milk, nor the total yields of butterfat per farm showed any pattern of change comparable with that for butterfat per cow.

(g) Replacement stock.

The results of this section, in common with certain others which have been mentioned already during the description of this tabulation, differed from those provided in the two previous tabulations. With the exception of farms in Groups I and II where young-stock numbers were rather high, no significant differences in the numbers of replacements per 100 cows in milk were apparent between groups.

(h) Farm labour.

Regardless of differences in "production per cow", the farm labour force remained close to the average of 1.8 labour units per farm, but worker efficiency increased as herd averages improved. Between groups, there was scarcely any alteration in the number of cows milked per worker and therefore, the 48% change in butterfat produced per "labour unit" was almost entirely the result of increased "production

per cow". This emphasises the importance of high dairy merit if maximum returns are to be achieved by a limited farm population.

IV. Results of the Analysis of Farms Grouped According to "Soil Ratings".

TABLE XVII

ANALYSIS OF FARMS ACCORDING TO SOIL RATINGS.

Group	Range in Soil Ratings	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	5 & < 5	21	117	122	226	7443	52
II	6	42	94	174	256	10064	65
III	7	109	97	176	259	9125	65
IV	8	81	95	182	262	9579	67

The 253 sample farms were grouped into four classes, which ranged from "soil rating" five and below at one extreme, to "soil rating" eight at the other. 75% of all dairy-farms were included in the high "soil rating" groups, 7 and 8. Thus the range in "soil ratings" was far less extensive than was the case in Whangarei County (Hamilton (1944)).

(a) "Production per acre", "production per cow" and "carrying capacity".

As illustrated in FIG.8 and Table XVII, improvements in output per acre were associated with increases in "soil ratings". By far the largest of these (52 lbs. of

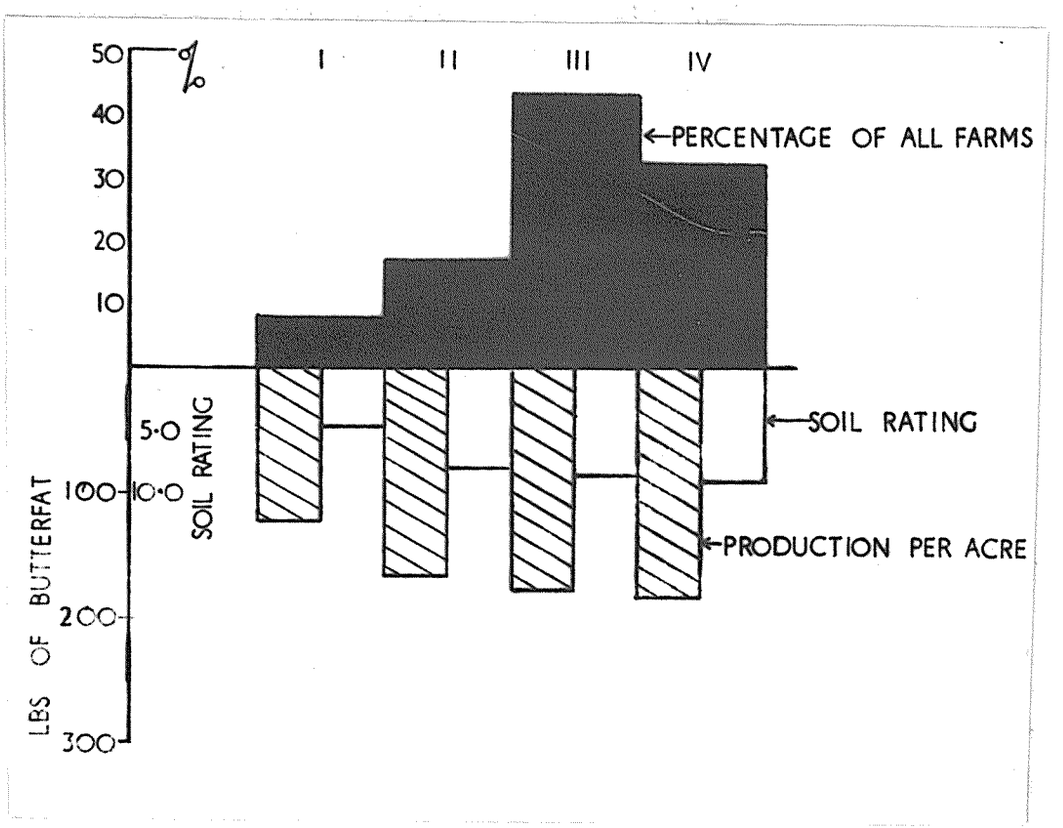


FIG.8: The distribution of 253 sample dairy-farms between four "soil rating" groupings. The relationship between "soil rating" and "production per acre."

butterfat per acre) occurred between "soil ratings" 5 and 6, but thereafter the changes were quite small. Somewhat similar relationships were shown for "production per cow" and "carrying capacity", with the result that the overall increases of 49%, 16% and 29% for "production per acre", "production per cow" and "carrying capacity", respectively, provided no indication of the actual nature of the changes incurred.

(b) "Cultivated Area".

With the exception of the farms in Group I which were considerably larger than the average, there was no association between "soil rating" and "cultivated area". Judging from the trend in "cultivated area" when expressed as a percentage of the total area, farms on poor soil types contained relatively more unproductive land than those where "soil ratings" were higher.

(c) Cropping.

A measure of the extent to which farmers differed in their feed conservation programmes was provided by the "soil rating" analysis. The actual and percentage areas growing crops were sufficiently high, where "soil ratings" were low and sufficiently low where "soil ratings" were high to suggest the existence of a negative relationship between "soil rating" and "the percentage of cultivated area cropped".

(d) Hay and silage.

The comparable figures for the areas cut for hay were relatively constant, but silage making gained in importance on highly rated soils. When the returns were expressed as percentages of the total grassland, it was

seen that on farms of "soil rating" 8, the percentage area saved for silage was three times as great as where soils were rated as 5 and below.

(e) Topdressing.

Topdressing trends followed a pattern similar to that described for haymaking, since the only farms which deviated markedly from average were located in Group I.

Certain apparently feasible explanations can be suggested for the relationships revealed between "soil rating" and cropping and "soil rating" and the area cut for silage, but none can be considered entirely satisfactory when restricted solely to the present tabulation. It was assumed that within the County, the influence of climate on farms located in different areas would be small and therefore the soil type, other factors being equal, would be the main determinant of the length of the growing season. As the summers and early autumns were often dry it may have been customary on farms of low "soil rating", prone to dry out, to supplement low pasture growth at this time with summer crops. This possibility was difficult to reconcile with the data showing quite small areas cut for silage on farms of low "soil rating". If the farmers concerned were sufficiently interested in maintaining production by growing summer crops, they must have considered the possibility of increasing the area of grass for silage and reducing the area cut for hay. In this way the early flush of grass would have been handled more satisfactorily and better aftermath growth obtained before the start of the dry period.

It will be recalled that the "cultivated area" when expressed as a percentage of the total area was lowest in

Group I (Table XVII) (75%), and highest in Group IV (95%). Herein was a possible reason for the differences between groups observed for cropping. Many farms with low "soil ratings" were located close to the Rukuhia and Moana Tua Tua swamps and the figures available indicated that on these farms there was considerable scope for development. On such farms cropping could constitute an important part in any programme providing for the recovery of land from secondary growth. Further evidence supporting this suggestion was provided by the tractor numbers, which were much higher in the lowest "soil rating" group than in any other.

(f) Farm livestock and production.

Virtually the same numbers of "cows in milk" and "replacements per 100 cows in milk", were present in each of the four groups, but improvements in "production per cow" insured that the total production of butterfat per farm increased in association with "soil rating".

(g) Labour.

There was a between-group constancy in the number of workers per farm which was reflected in the butterfat returns per labour unit. However, the number of labour units per 100 acres increased from "soil rating" 5 and below to "soil rating" 8.

(h) Summary.

By classifying farms according to their "soil ratings", certain differences, the most noteworthy of which concerned areas saved for supplementary feed, were made apparent. These may have been instrumental in causing some of the between-group differences in "production per cow" and "carrying capacity", although when the areas

cropped and cut for hay and silage were expressed per 100 "cows in milk" and per 10,000 lbs. of butterfat, the differences between groups were negligible. This apparent constancy might have been transformed to marked variability if actual yields had been substituted for the indirect measures involving estimations of areas. Under such circumstances, differences in "soil ratings" would have assumed considerable importance.

Obviously it is very difficult to evaluate the individual contribution of soil type to high output per acre. From this analysis it can be suggested that in most cases, better than average farmers have taken up land which, by present survey standards is rated highly and because of this inherent fertility, a smaller area is required for an economic unit than where conditions are less naturally favourable.

V. Results of the Analysis of Farms Grouped According to "Cultivated Area".

The 253 dairy-farms were included in five "cultivated area" groupings, the range for which extended from 44 acres to 182 acres of "effective area" per farm. The distribution of farms about the modal group was normal.

TABLE XVIII

ANALYSIS OF FARMS ACCORDING TO CULTIVATED AREA

Group	Range in Cult.area (acres)	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	under 50	38	44	203	276	8247	71
II	50 - 74	47	61	184	260	8606	68
III	75 - 99	72	89	168	250	9168	65
IV	100 - 149	63	123	161	253	10166	61
V	150 & over	33	182	156	254	10030	59

(a)"Production per cow", "production per acre" and "carrying capacity".

The different "productions per cow" associated with changes in "cultivated area" were a reflection of the application of different managemental intensities to small and large farms. Where properties were less than 50 acres in size, the returns per cow were 22 lbs., or 9% better than returns from holdings more than three times as large. These data referred to butterfat "at the pail" but when "effective production" was considered, between-group differences were no longer apparent. This was attributed to the fact that a higher proportion of the total output was required for home consumption on small farms, than on large farms. Since it is more difficult to apply a breeding programme in small herds than in big ones, different farm environments probably contributed in greatest measure to the difference of 22 lbs. of butterfat per cow between Groups I and V (Table XVIII).

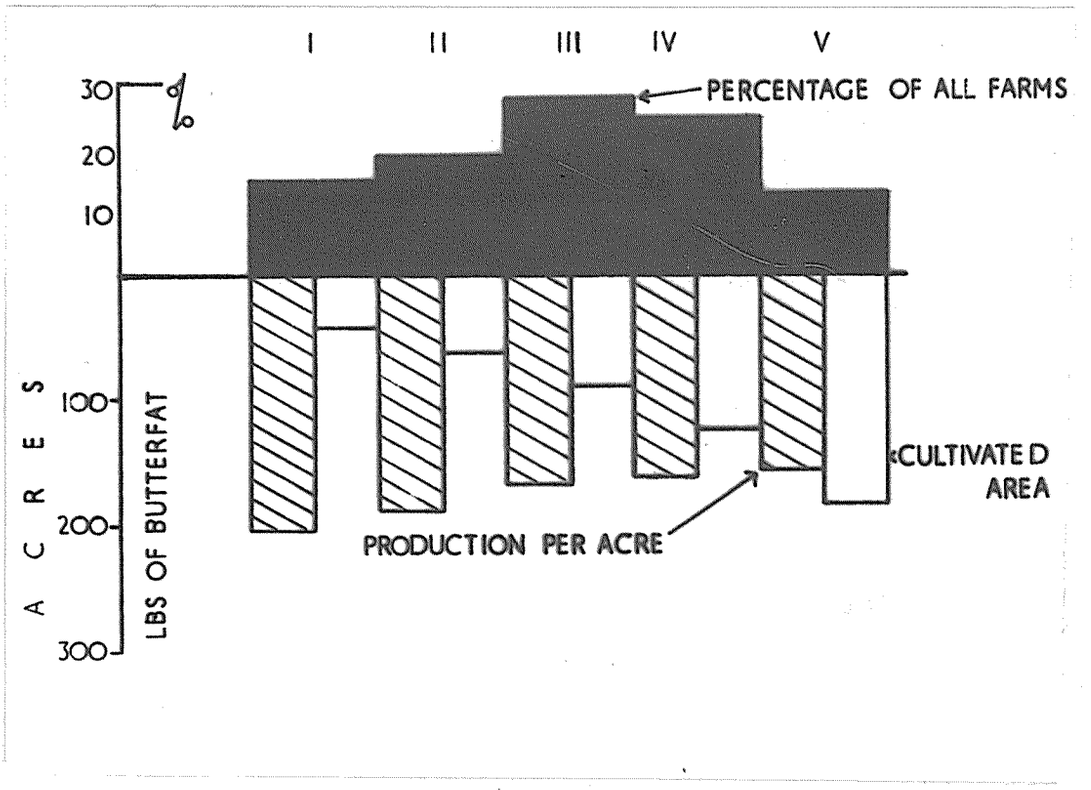


FIG.9: The distribution of 253 sample dairy-farms between five "cultivated area" groupings. The relationship between "cultivated area" and "production per acre."

First impressions were that per acre returns had yielded results analagous to those which have just been considered. "Cultivated area" and "production per acre" appeared to be negatively correlated to the extent that between Groups I and V there was a difference of 47 lbs. of butterfat per acre. This meant that on the average, 30% more butterfat per acre was produced from a 44 acre farm than from a 182 acre farm. Although this margin fell to 32 lbs. of butterfat (an increase of 22%) when "production per acre" was expressed in terms of effective output, the decline was small in comparison with that already noted for "production per cow". The reason for this was that the average "carrying capacity" of farms in Group I was 20% higher than for farms in Group V. (Actually this difference amounted to 20% when the stock numbers were expressed as "cows in milk per 100 acres" and 18% when "stock units" were used.) This particular result suggested therefore, that changes in "carrying capacity" were mainly responsible for "production per acre" differences on different sized farms.

Subsequent consideration has been given to the nature of the relationships between other measurable factors and "cultivated area", and especial interest has been taken in those likely to have affected "carrying capacity".

(b) Cropping.

As farm size increased, so did the area growing crops. However, when the latter was expressed as a percentage of the "cultivated area", the trend for between-group differences disappeared.

(c) Hay and silage.

Similar conditions to those outline for cropping applied to the areas cut for hay, but apparently silage making was more popular on large than on small farms.

(d) Topdressing and Soil rating.

On the basis of "cultivated area" alone, there were no significant differences between groups in either the "soil ratings", or the "percentages of grassland topdressed with artificial fertilizers". On larger than average farms, however, there seemed to be additional emphasis place on liming.

In an attempt to measure the relative economies of these various managemental practices the results for the different groups were expressed in relation both to the "number of cows in milk" and the total butterfat produced per farm. When the data for Groups I to V (Table XVIII) were expressed in relation to the number of cows in milk, total increases in the areas cropped, cut for hay, cut for silage and topdressed, amounting to 75%, 13%, 23% and 17% respectively, were observed (Appendix clxxv). As "production per acre" was negatively correlated with "cultivated area", these results were interpreted as indicating low efficiency of supplementary feed utilization on larger than average farms. As might have been expected, the changes indicated above were accentuated when the same terms were expressed in relation to output of butterfat. Under the conditions of the present survey, this is probably the most satisfactory way of measuring input/output relationships, as each input is expressed in relation to the end product, viz., butterfat. Thus between Groups I and V (Table XVIII), the extent of the percentage increases for the

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

areas cropped, cut for hay and cut for silage per 10,000 lbs. of butterfat were 97%, 23% and 30%, respectively.

(e) Herd size and replacement numbers.

The strong correlation between "cultivated area" and "the number of cows in milk" was made apparent by the data in Table XVIII which showed that, on average, the smallest dairy unit consisted of 31 "cows in milk", compared with 108 cows where holdings exceeded 150 acres of "cultivated area". Naturally there was an associated increase in the number of replacement stock, but it was noticeable that the numbers were proportionately larger on big farms than they were on small ones. For properties differing in both size and efficiency, this feature was quite distinctive.

(f) Total production.

There is a high correlation between "cultivated area" and farm output. Thus between farms in Groups I and V the difference in total butterfat sent to the factory amounted to 18,551 lbs., or 2½ times the quantity produced from the farms in Group I.

(g) Labour.

The farming of large areas requires a substantial labour force and an addition of 0.3 labour units per farm was noted between Groups I & II, II and III and III & IV, and in total, from the smallest to the largest properties, a change from 1.1 to 2.9 "labour units" per farm occurred.

There was a decided difference between the "number of cows milked per labour unit" on small as compared with large farms, and this was naturally reflected in a similar trend for "production per labour unit". Additional time had to be spent at shed work to obtain the extra milk, but some time saving could have been effected if the number of bails

per shed worker had been increased. There was no evidence to suggest that this particular expedient was being applied and it was concluded that although on large farms, economies of scale may afford greater scope for improving shed efficiency, at present , the shed work associated with big herds appears to occupy more time than where herds are small.

The only estimate of the amount of labour available for farm maintenance was the number of "labour units" per 100 acres and this was negatively correlated with "cultivated area". Obviously labour units per 100 acres was not a completely satisfactory index for estimating how well different farms were maintained. In most cases small farms are more thoroughly subdivided than large ones and consequently, the maintenance of fences could be higher on an average basis. However, certain features of farming practice such as weed control, the maintenance of pastures, hedges, plantations, drains etc., are directly influenced by the area of land involved and this may help to explain why in general, large holdings are less intensively farmed than small ones. The farm labour supply is limited and in most cases, large units have not been receiving sufficient workers for fullest exploitation of the acreage available. This is partly a consequence of the present system of employing men wherein little reward is offered for the expression of latent ability. In many cases, the able worker transfers to a form of employment where he can use his natural talent to better advantage and this may include purchase of his own property. It is usual in such cases for the new owner-farmer to provide only a small part of the total finance and initially, he must be content with

the return from his labour alone. These beginners, farming under conditions dominated by shortages of capital, do not immediately invite additional risks by borrowing further to intensify their management, but prefer extensive farming involving low labour and capital inputs, until their financial positions are safer.

For the established land-owner, a partial solution to the problem of encouraging and retaining good farm labourers could result from the establishment of bonus systems or other production incentives. Each worker could then feel that he was receiving adequate compensation for any extra effort applied.

(h) Machinery.

Farm machinery must be considered in any investigation where a full understanding of farm labour problems is desired. As indicated previously, tractor numbers were the only satisfactory measure of mechanisation available for this survey.

Between Groups I & V, the proportion of tractors to farms increased from 7 in every 100 to 42 in every 100 farms - a six-fold increase. It is reasonable to suppose that on large properties the high tractor/farm ratio has affected managemental policies, although there are no indications that any resulting changes have caused increased output per acre. Probably it is safe to say that up to the present the main benefit tractors have conferred has been to ease the burden of existing work, rather than to stimulate an increase in farm production.

VI. Analysis of Farms Grouped According to the Percentage of the "Cultivated Area" Cropped.

From the actual areas, the percentages of the "cultivated areas" involved and the number of farms actually concerned, it was evident that root and green forage crops, were of small importance to dairying in Waipa County.

TABLE XIX

ANALYSIS OF FARMS ACCORDING TO PERCENTAGE OF CULTIVATED AREA CROPPED.

Group	Range in % area Cropped	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	Under 1.0	107	91	182	261	9398	67
II	1.0 - 1.9	31	102	164	251	9213	62
III	2.0 - 2.9	42	107	173	260	9295	63
IV	3.0 - 3.9	27	115	158	247	8796	61
V	4.0 - 4.9	22	84	171	258	8918	64
VI	5.0 - 5.9	10	118	167	254	10530	64
VII	6.0 & over	14	86	164	247	9207	63

Each of the 253 dairy-farms was classified into one of seven groups according to "the percentage of cultivated area cropped". The nature of the data was such that the distribution of sample farms was markedly skewed. For 42% of the farms, less than 0.9% of the "cultivated area" was under crops and on a considerable number of these properties no cropping was practised at all. The range in "the percentages of cultivated areas cropped" (0.1% - 7.9%) was estimated from the group averages for those farms cropping

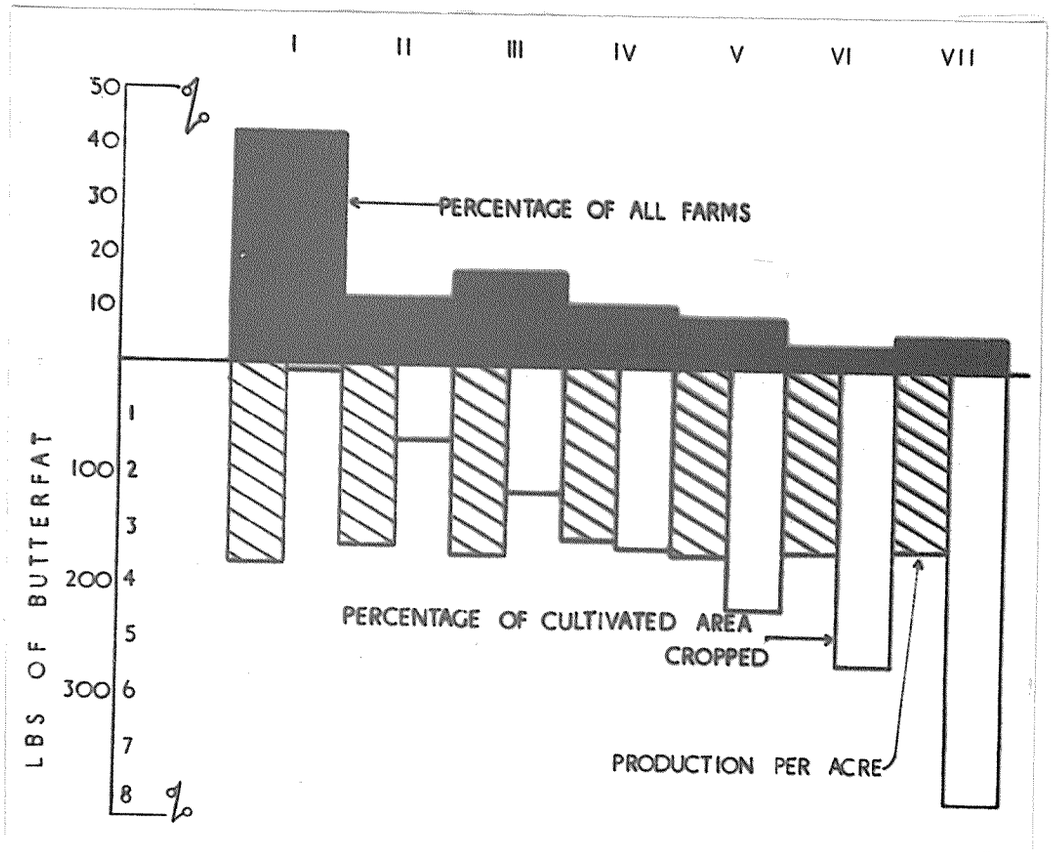


FIG.10: The distribution of 253 sample dairy-farms between seven groupings based on "the percentage of the 'cultivated area' cropped. The relationship between "the percentage of 'cultivated area'cropped" and "production per acre."

most and least. Because of this restricted range which limited such a large proportion of all dairy farms to one group, it was not expected that much information would be provided by this tabulation.

(a) "Production per acre", Production per cow", and "Carrying Capacity".

Reference to the three most important indices - "production per acre", "production per cow" and "carrying capacity" - showed this to be true, for there was a between-group constancy not apparent in any of the previous analyses.

(b) "Soil Rating" & "Cultivated Area".

It will be remembered that the tabulation based on "soil ratings" showed the existence of a negative correlation between "soil rating" and "percentage of cultivated area cropped", which it was suggested was probably the result of the association of cropping with land reclamation on the poorer types of country. When the farms were classed according to the amount of cropping carried out, however, this association was no longer evident. Irregular variations in "soil ratings", "effective areas", and percentage effective areas were apparent, but these were not related to changes in the "percentage of the cultivated area cropped".

(c) Hay, silage and topdressing.

There appeared to be no connection between the amount of cropping practised and the area saved for hay and silage, or the proportion of each farm topdressed (Appendix clxxvi).

(d) Farm production and livestock.

Total farm production (lbs. of butterfat "at the pail") declined from 16,179 lbs. in Group I to 13,814 lbs.

in Group VII, and this was due to a corresponding reduction in "the number of cows in milk". There were no alterations of a similar nature in the proportions of replacement stock, but the trend in total "stock units" was as for herd size.

(e) Farm labour.

Slight reductions in the labour force were observed as the percentage area cropped increased. When it is recalled that between Groups I and VII total production fell markedly while "production per labour unit", in accord with the other measures of farm efficiency, remained extremely constant, the significance of the decline in workers per farm can be appreciated.

VII Results of the Analysis of Farms Grouped According to the "Percentage of Grassland Cut for Hay".

According to "the percentages of grassland cut for hay", the 253 farms were classified into five groups, the range for which was defined by the limits 10% and less and 25% and over. The mean percentage areas for each of the five classes were 6, 12, 17, 22 and 27, indicating sufficient variability to provide a possible cause of between-farm variations in "production per acre".

TABLE XX

ANALYSIS OF FARMS ACCORDING TO PERCENTAGE OF GRASSLAND CUT FOR HAY

Group	Range in % Grassland Cut for Hay	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	Under 10.0	14	82	152	238	7279	61
II	10.0 - 14.9	60	105	171	258	10132	63
III	15.0 - 19.9	111	101	169	258	9234	63
IV	20.0 - 24.9	50	90	188	264	9406	69
V	25.0 & over	18	85	175	243	8022	69

It was noteworthy, however, that almost half the farms were included in the modal group.

(a) "Production per acre", Production per cow" and "Carrying capacity".

Although there was a general tendency for "production per acre" to rise as "the percentage of grassland cut for hay" increased, this trend could scarcely be accepted as evidence justifying the importance currently attached to haymaking. The trends in output per cow were comparable, but it appeared that herd averages were less sensitive than per acre returns to differences in the amount of hay available. By contrast, "carrying capacity" increased with each addition to the acreage cut for hay.

(b) "Cultivated area" and Soil rating".

If those dairy-farms which made least provision for hay were excluded, there was a tendency among the remainder for "cultivated area" to vary inversely with increases in "the percentage of grassland cut for hay."

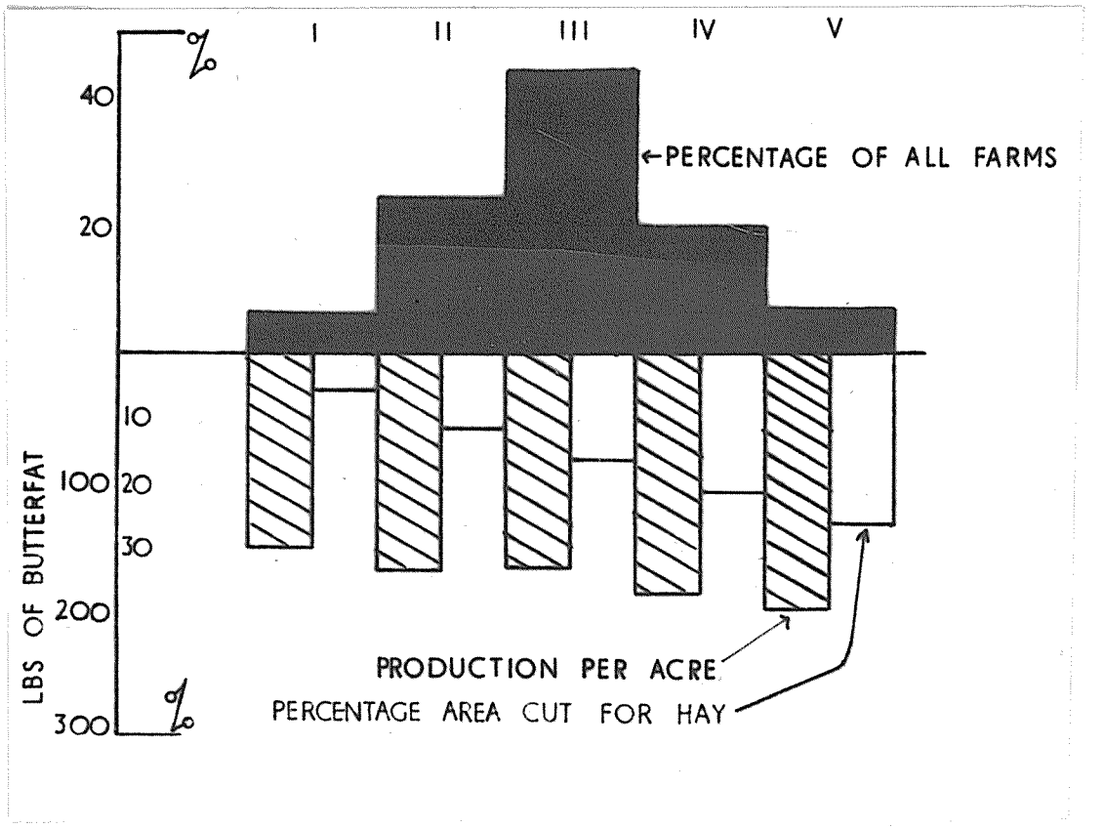


FIG.11: The distribution of 253 sample dairy-farms between five groupings based on "the percentage of grassland cut for hay." The relationship between "the percentage of grassland cut for hay" and "production per acre."

When, however, soil types were considered, a relationship which covered all groups was apparent between "soil rating" and "the percentage of grassland cut for hay".

(c) Hay and silage.

As might have been anticipated, where the area retained for hay involved a large proportion of each farm, silage making was of small importance and between Groups I and V (Table XX) a reduction of 11% in "the percentage of grassland saved for silage" was accompanied by a 3½ fold increase in the "percentage area cut for hay". The area of grassland cut for hay per 100 cows in milk gave the best availableestimate of the provision made for winter feed. (As the between-group figures for replacements were fairly stable, it was assumed that on farms where the area cut for hay was proportionately high, the amount of hay available per cow was increased accordingly.) Between Groups I and V, comparisons were made of "the percentages of grassland cut for hay" and silage per 100 cows in milk, and it was found that the amounts of hay and silage per cow were respectively 3½ and 1½ times as great in the latter group as in the former. Since most farmers save some hay, it is unfortunate that there is no better quantitative measure available than the area cut. Although yields from similar areas can vary so markedly that conclusions based solely on area differences may be invalid, the inaccuracies of farmer estimates of yield precludes the acceptance of these measures. Digestibility and feed values of hay cut and cured on different properties can also vary appreciably, and will influence any relationships between estimates based on areas cut for hay and "production per acre".

However, the analysis based on between-farm differences in "production per acre" showed there was a definite relationship between "the percentage of the total grassland cut for hay" and output per acre.

One of the functions of the present analysis was to check the validity of this apparent relationship and Table XX showed that increases in "production per acre" did not continue beyond Group IV where "the percentage of grassland cut for hay was between 20% and 25%. Under these circumstances, it was suggested that the most successful managemental programmes included allocations for hay of approximately 22% of the total grassland. Where this limit was exceeded, "productions per acre" and "per cow" declined, although "carrying capacity" remained consistently high. Probably combinations of low producing pastures and high "carrying capacities" necessitated the conversion of excessively large areas of grass to supplementary feed. Since, the aftermath growth of pastures cut for hay can be seriously retarded in dry summers, where approximately 30% of each property is closed for hay the effect on milk production could be quite marked. Even if seasonal effects are discounted, the exclusion of the dairyherd from 30% of the farm for a substantial period during peak lactation could impose considerable restrictions on feed intakes of individual cows.

(d) Topdressing.

Although, as will be shown in the subsequent analysis on topdressing, it appeared that those who topdressed extensively saved large areas for hay and silage probably as a result of an increased surplus of grass being made available, this tabulation suggested the further

possibility, that farmers who repeatedly saved large areas for hay were aware of the drain on fertility likely to be incurred by this practice. Certainly, this tabulation indicated that where hay-making achieved greatest popularity, added importance was attached to topdressing practices. Each year many farmers, from habit, or of necessity, close the same areas and later cut and cure the surplus growth for hay. This practice can have detrimental effects on soil fertility and both directly and indirectly on pasture quality. Where possible, this system should be avoided, but if no alternative is available, regular applications of fertilizers can help to maintain the useful life of the pastures.

(e) Farm production and livestock.

Regardless of changes in the emphasis accorded haymaking, herd-size, "replacement stock numbers per 100 cows in milk", and total farm output, have all remained constant between groups.

(f) Farm labour.

For farms which differed in"the percentages of grassland cut for hay", the differences in the average number of workers per farm,"labour units"per 100 acres, and "production per labour unit" were negligible.

VIII. Results of the Analysis of Farms Grouped According to "the Percentage of Grassland Cut for Silage"

TABLE XXI.

ANALYSIS ACCORDING TO PERCENTAGE OF GRASSLAND CUT FOR SILAGE.

Group	Range in % Grassland Cut for Silage	No.of Farms	Cult. Area (ac)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 ac)
				Per Acre	Per Cow	Per Labour Unit	
I	Nil	66	78	166	252	8327	63
II	0 - 4.9	88	107	168	255	9233	63
III	5.0 - 9.9	64	100	180	261	9888	66
IV	10.0 - 14.9	25	111	186	265	10028	67
V	15.0 & over	10	104	180	257	10390	69

Although for any group of farms, the maximum area cut for silage did not exceed 18% of the acreage in grass, there were sufficient between-farm differences to allow classification of all farms according to "the percentage of grassland cut for silage". It was found that 26% of all farmers did not make any silage and therefore lost the benefit of feed which could be cut at the correct stage of growth, regardless of climate and with the assurance that adequate re-growth would follow. In addition, 81% of the remainder were satisfied with saving less than 10% of the available area in grass for silage. It can be appreciated, that the grouping of farms on this basis produced a distribution curve which was decidedly skewed.

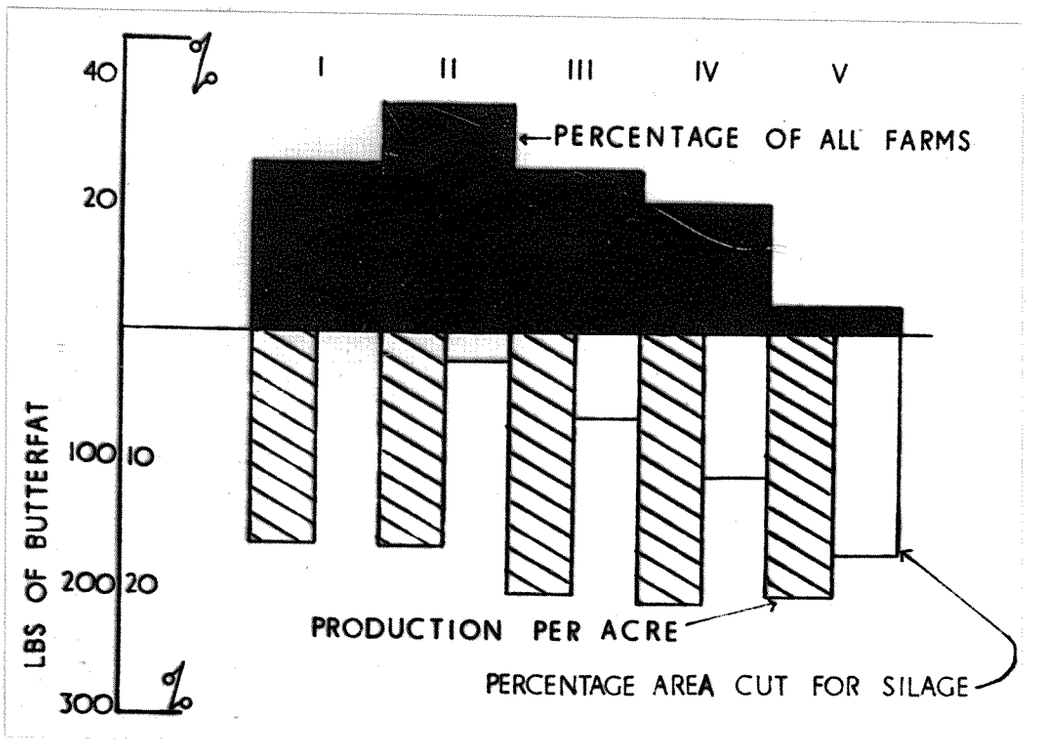


FIG.12: The distribution of 253 sample dairy-farms between five groupings based on "the percentage of grassland cut for silage." The relationship between "the percentage of grassland cut for silage"and "production per acre".

(a) "Production per acre", "Production per cow" and "Carrying Capacity"

The trends in output per cow and per acre were similar to those obtained in the analysis on hay and maximum returns for each of these indices were recorded in the penultimate group, consisting of those farms where on average, 11.3% of the grassland was saved for silage. Between Groups I and V, improvements in the "carrying capacities" amounted to 0.68 "stock units" or 0.06 cows in milk per acre.

(b) "Cultivated area"

Most of the properties on which silage making achieved greatest popularity were considerably larger than average.

(c) Hay and silage.

As indicated by the previous tabulation, there was a reciprocal relationship between the "percentages of total grassland cut for silage" and "hay". Where hay and silage making were associated practices, the area cut for hay exceeded that for silage, except in cases where more than 15% of the total grassland was ensiled. The results obtained after expressing areas cut for hay and silage in relation to both "the number of cows in milk" and the butterfat produced, were in marked contrast to those supplied by the tabulation analysis for hay (refer Appendices clxxiii & clxxiv). In Group V the area cut for silage per 100 cows in milk was 6½ times as large as for Group I, whereas for the latter, the area cut for hay per 100 cows in milk was 1⅕ times greater than in Group V. A similarity between the analyses based on hay and silage differences concerned the relationships between the percentage areas cut for hay and silage and output per acre, for in both cases maximum "production per acre" was

obtained in the penultimate groupings. With respect to silage-making a similar trend was evident from the "production per acre" tabulation, although the percentage areas were much smaller and per acre yields much larger than in the present instance. This data provided another example of the many ways in which the results for hay and silage differed

(d) Topdressing.

The trends in topdressing and "soil rating" were similar to those described in the previous analysis for hay, with the result that between Groups I and V, the overall increase for "soil rating" was quite large. (0.8 units in a range extending from 5.0 to 8.0 "soil rating" units.)

(e) Herd size and production.

Although "cultivated area" and "soil ratings" changed with alterations in the percentage areas saved for silage, herd size and farm output remained fairly constant between groups. Essentially the same result was obtained in the previous analysis for hay, a result which became more difficult to explain when it was recalled that farms on which silage was most popular were larger than average.

(f) Farm labour.

Between Groups I and V, the returns measuring efficiency of worker output, namely, "the number of cows milked per labour unit" and "butterfat per labour unit", increased by 8 cows and 2,063 lbs. of butterfat respectively.

Of particular interest in this section was the fact that the ratio tractors/farms became narrower as the percentage of grassland cut for silage increased.

IX. Results of the Analysis of Farms Grouped According to "the Percentage of Grassland Topdressed with Artificial Fertilizers".

Even as the area of grassland cut for hay can be criticised as a quantitative measure for hay, so the area of grassland topdressed can be considered a rather inadequate standard with which to assess the role of topdressing. It is rather unfortunate therefore, that this is the only quantitative measure available for the present survey.

Fawcett (1929) stated in his survey of dairy farms in Waikato and Taranaki, "manure for topdressing is the most important item of maintenance, accounting for approximately 38% of the total". By this he was referring to farm maintenance costs and his estimates were confirmed by the costing undertaken by the Dairy Industry Commission in 1934-37. The accurate determination of the effect of variations in rates of fertilizer application on pasture production is indeed an important problem. As the unit costs of fertilizers are high, any experiments indicating that continued high output is obtainable with reduced topdressing and that the long-terms effects of such a policy are not detrimental to farm productivity, would be of great importance. If the collection of data was sufficiently detailed, the results of a large survey might indicate whether the general tendency was to topdress too heavily or too lightly. When analysing the results it would be necessary in the first place, to group the farms as thoroughly as possible according to similarities of soil type, but as can be seen from soil survey maps drawn on a scale of 40 chains to the inch (refer D.S. & I.R. Bull. 76 (1939)), each farm consists of a variety of types, which complicate the interpretation of farm

topdressing figures. Even though a system of soil evaluation based on productivity may permit farms to be given equivalent ratings, it is very difficult to compare farms in their responses to fertilizer topdressing when their constituent soil types differ markedly.

Should the classification of farms by soil types be accomplished accurately, there still remains the problem of estimating results due to the effects of different topdressing rates independently of those attributable to other associated input factors. Ultimately the conclusions arrived at can only take the form of general recommendations and whether or not they are applicable would have to be determined by individual experiments and experience. In the selection of experimental plot sites, the farmer or advisory officer is again faced with the important problem of soil type variability, and the representativeness of the areas selected determines the accuracy of the results.

Owing to the limited nature of the data available, this present consideration of topdressing can offer little help in unravelling the problems outlined above, for it can serve to show only what has happened on farms differing in the proportions which were topdressed, and as has been evident in several other analyses, apparent associations between percentage areas topdressed and various indices of productivity are not always indicative of simple causal relationships. The range in "the percentages of grassland topdressed with artificial fertilizers" was sufficient to allow the classification of farms into eight groupings, the extreme members of which comprised on the one hand, all those farms where less than 40% of the grassland was top-dressed, and on the other, farms where all the grassland

was topdressed. The uneven distribution between the groups is made apparent in FIG. 13. From Table XXII it was calculated that 89% of sample farms topdressed more than 60% of their total areas in grass, and since the

TABLE XXII

ANALYSIS OF FARMS ACCORDING TO THE PERCENTAGE OF GRASSLAND TOPDRESSED.

Group	Range in % Grassland Topdressed	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	Under 40	4	75	96	194	5700	49
II	40 - 49	7	104	144	233	7029	59
III	50 - 59	18	90	151	250	8861	58
IV	60 - 69	34	99	163	256	8291	61
V	70 - 79	58	100	169	252	9162	65
VI	80 - 89	58	101	182	258	9840	65
VII	90 - 99	66	100	192	267	10050	69
VIII	100	8	67	199	271	8838	71

practice of topdressing had such wide approval and was accepted as an essential feature of pasture maintenance, it was expected that where this phase of management was neglected, production per acre would suffer. It should not be inferred, however, that such a trend would be the result solely of differential emphasis on topdressing programmes, but rather that where variations in the latter existed, these would act as indicators of the general standard of farming.

(a) "Production per cow","Production per acre" and "Carrying Capacity".

By reference to productivites per cow and per acre which, from the lowest to the highest topdressing

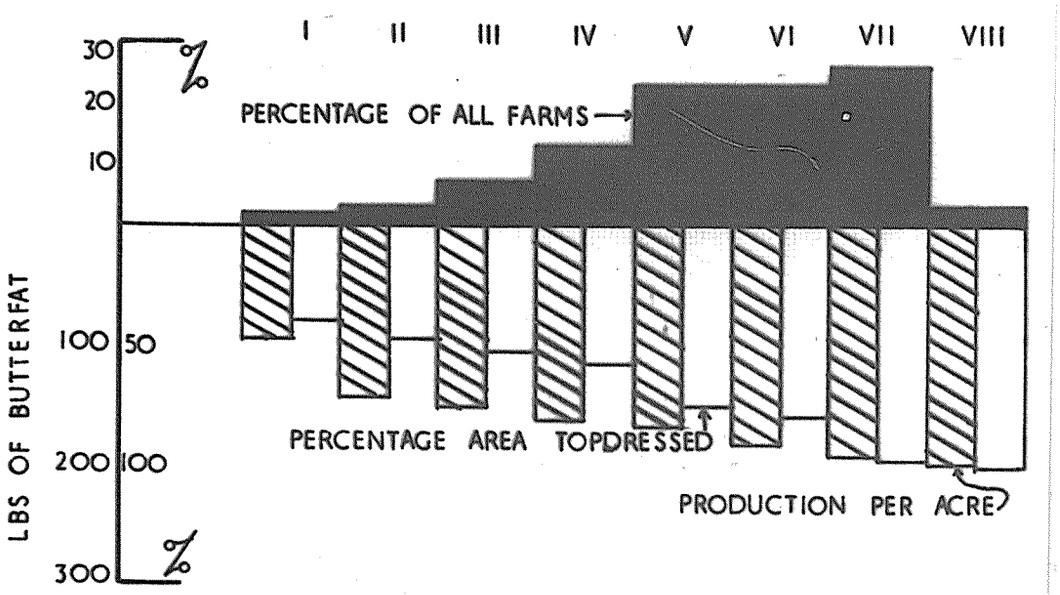


FIG.13: The distribution of 253 sample dairy-farms between eight groupings based on "the percentage of grassland topdressed."
The relationship between "the percentage of grassland topdressed" and "production per acre."

groups showed increases of 40% and 107% respectively, substantial evidence was provided in support of the predictions made previously.

"Carrying capacity" showed a similar trend, which resulted in improvements of 35% and 45% for "stock units" and "cows in milk" per 100 acres, respectively. These results confirmed the expectations provided by the analysis for "production per acre".

(b) Hay and silage.

When the nature of supplementary feed programmes was considered, it was made clear that those who considered it important to topdress all, nr nearly all of their farms, also saved relatively large quantities of hay and silage. The implications of this result were discussed previously in the corresponding section of the tabulation for "percentage of grassland cut for hay".

(c) Topdressing.

There were no between-group differences in the ratio, area topdressed per 10,000 lbs. of butterfat, a rather remarkable result considering the extent of between-farm variance for "the percentage of grassland topdressed".

(d) Total farm production.

Due to irregular between-group differences in both "cultivated area" and herd size, there was no correlation between "the percentage of grassland topdressed" and total farm production.

(e) Farm labour.

As the efficiency of farm labour, measured by "the number of cows milked per worker" was comparatively constant, between Groups I and VIII the 55% increase in the butterfat produced per "labour unit" was due mainly to variations in "production per cow".

X. Results of the Analysis of Farms Grouped According to "the Percentage of Grassland Limed"

Owing to the nature of the farm returns, there was a close association between "the percentage of grassland topdressed with artificial fertilizers" and "the percentage of grassland limed". The areas topdressed and limed were denoted by individual farmers as:-

(a) Area topdressed with artificial fertilizers.

(b) Area limed.

(c) Area topdressed with both lime and artificial fertilizers.

In computing the percentage area topdressed and the percentage area limed (c) was included in both cases and contributed $^{9}/_{10}$ths and $\frac{1}{2}$ of the total areas limed and topdressed with artificial fertilizers, respectively. This explains why the results obtained from the two tabulations were so similar. Classification of farms according to differences in percentage areas limed indicated that the majority of farmers limed no more than about $^{2}/_{3}$rds of their properties. In addition, the following features distinguished this analysis from the previous one:-

(1) the apparent association between "the percentage of grassland limed" and "the percentage of cultivated area cropped",

(2) the negative correlation between the "percentage of grassland limed" and "soil rating",

and (3) the between-group constancy for butterfat "production per labour unit".

Generally, however, the relationships indicated by the tabulation, though differing somewhat in degree, were similar to those already indicated for topdressing.

It seems appropriate at this stage which marks the completion of an individual section of the analysis, to establish how far the pattern initially outlined has been followed. In the first place, various indices of farm efficiency and capacity, were considered and thereafter further investigations made into different managemental factors indicated as important. From observations concerning soil type and "cultivated area", attention was shifted to the different methods, both direct and indrect, used by farmers to meet the requirements of their animals.

Two analyses which follow deal with the stock - the milking cows and the replacement animals - which by their inherent merit determine how economically feed is converted to milk. A third deals with certain features of dairy-farm labour.

XI. Results of the Analysis of Farms Grouped According to "the Number of Cows in Milk"

Under the original conditions of the survey, whether or not a dairy-farm was defined as such depended upon the herd size and the farm area. In spite of the exclusion of herds with less than 10 cows in milk, however, there was a very wide range in cow populations, necessitating nine size-of-herd groupings.

TABLE XXIII

ANALYSIS OF FARMS ACCORDING TO THE SIZE OF THE DAIRY HERD.

Group	Range in herd sizes	No. of Farms	Cult. Area (ac.)	Av. Production of B/F. (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	Under 30	21	43	166	256	6071	62
II	30 - 39	39	53	195	271	8718	68
III	40 - 49	32	72	167	251	8628	64
IV	50 - 59	37	85	175	256	9659	65
V	60 - 69	44	103	168	253	9300	64
VI	70 - 79	25	119	166	251	10720	64
VII	80 - 89	23	139	162	256	10352	62
VIII	90 - 99	11	155	160	250	10218	62
IX	100 & over	21	187	181	262	10514	67

The first of these comprised herds of less than 30 cows and successive increments of 10 denoted the limits of each group so that Group IX consisted of herds with more than 100 "cows in milk".

(a) "Cultivated area" and total production.

Between Groups I and IX, the mean number of cows per group ranged from 26 to 123 and "cultivated area" changed to a comparable extent. In total, both of these changes consisted of four to five fold increases and total production per farm was augmented to an even greater extent.

(b) "Production per cow" and "production per acre".

When the total returns per farm, -"effective" and "at the pail" - were converted to measures of "production per acre" and "production per cow", no appreciable differences could be found for herds of different sizes.

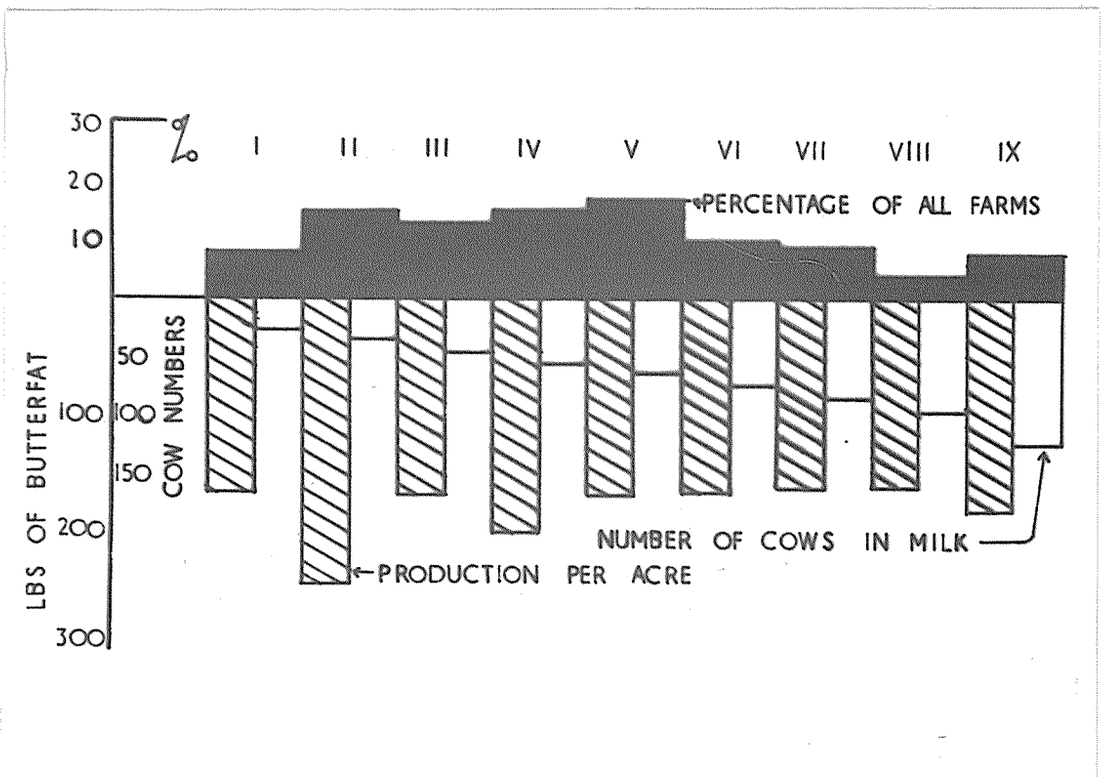


FIG.14: Distribution of 253 sample dairy-farms between nine size of herd groupings.
Relationship between herd size and "production per acre."

There was therefore no expression of any advantage resulting from breeding policies where cow numbers were large and the chances of proving bulls greatest. It is possible that the daily milk yields receive closer scrutiny on small farms and in such cases, adjustments are more quickly made to prevent, or reduce any declines in milk production. There are, however, no data available to show that large herds have implemented more successful breeding plans than small ones, or that small herds are better fed or managed than large ones.

(c) Cropping, hay and silage.

It was evident that the practices of cropping and saving grass for hay and silage were extended as herd size increased, but of the three, the area cut for silage was the only one which advanced proportionately. Further confirmation of this was provided by the data when expressed per 100 cows im milk and per 10,000 lbs. of butterfat for in both cases only the area cut for silage tended to increase from Groups I to IX.

(d) Topdressing and "Soil rating".

There was no relationship either between the number of cows per farm and the percentage area topdressed, or between the former and "soil rating". This analysis, however, provided evidence concerning "soil rating" which differed from results obtained by Hamilton (1944) for Whangarei. Hamilton (loc. cit.) had found that both large herds and farms of large area were generally located on areas of low natural fertility, but this situation does not obtain in the Waipa County.

(e) Replacements.

Regardless of herd size, the proportion of replacement stock remained fairly constant at approximately 35%. This can be interpreted as meaning that few of the small

dairy units favoured buying in replacements in preference to raising their own young-stock. When the average size of these holdings is considered, this is rather surprising, for under these circumstances, the carrying of extra milking cows would appeal as a more economic policy than the running of replacements. Dairy young-stock are costly at present, but farm units consisting of 26 - 35 cows, producing between five and nine thousand pounds of butterfat are paying propositions only because of the currently high butterfat payouts. Certainly there is a need for these small farmers to review their herd management policies.

(f) Farm Labour.

Although between groups, there was a correlation between the average number of workers and "the number of cows in milk," increases in the latter were proportionately much greater than for the former and consequently, both in terms of cows milked and butterfat produced, workers on the 123-cow farms outyielded those on 26-cow properties. It was interesting to note, however, that on farms where between 73 and 123 cows were milked, (Appendix clxxix), the returns per labour unit appeared to be uninfluenced by herd size. It appeared as though 41 cows and 10,720 lbs. butterfat was the maximum output which could be expected from workers, irrespective of the number of cows in the herd. From the smallest to the largest herds, the overall increase in "production per labour unit" was 4,443 lbs. of butterfat, representing a 73% increase in individual output. Contributing in greatest measure to this difference was a 70% rise in "the number of cows milked per worker". The extent of these changes suggested the desirability of finding how this increase affected the

the farm-worker and the proportion of each working day which had to be spent in the shed. It was quite obvious that farms with large herds had large milking shed, but the present analysis showed that the additions to shed and herd sizes were not proportional. The limiting factor appeared to be the number of bails which each worker could handle efficiently, and irrespective of herd size, this appeared to be about 2.2 bails, the figure calculated as average for the sample. It was assumed, regardless of herd size, that on the average the number of cows milked per worker per hour was constant. Evidence supporting this assumption appeared in the N.Z. Dairy Board Annual Report (1948-49) where it was shown that the distribution of herds according to size was much the same for hand-stripped and non-stripped herds. From an analysis of 378 sheds where due allowance was made for both single and doubled-up units, the same report cited the average number of cows milked per labour unit per hour as 23. If this is used as a standard, then milking time varied from slightly less than an hour in the smallest herds, to about one and three-quarter hours where more than seventy cows were milked. In the assessment of the number of hours involved in shed work, the time spent in cleaning the shed and machines must be included and regardless of the size of the unit, this may be conservatively estimated as one hour per day. As a result, it was calculated that the time involved in milking-shed routine varied from about 3 hours for small sheds to approximately 4½ hours for medium to large units.

If 8 hours are accepted as constituting a reasonable working day, the time spent in milking would account on the one hand, for 38% and on the other, for 56% of the

total hours available, depending on whether few or many cows were involved.

It is significant that as herd size became larger, increases appeared in the proportion of tractors to farms, although when expressed per 100 acres, tractor numbers and herd size were found to be negatively correlated.

XII. Results of the Analysis of Farms Grouped According to "Replacement Stock Numbers per 100 Cows in milk".

In the opening section which consisted of an analysis based on between-farm differences in "production per acre", some attention was paid to the economy of raising young-stock and especial interest was taken in farms, both small in area and in cow numbers where the owner reared his own replacements. It was shown that "production per acre" was prejudiced on farms where high replacement numbers were carried and some criticism was offered of the management which permitted this state of affairs. Due importance, however, must be paid to the replacement stock as a source of farm income.

Undoubtedly the aim of many farmers in running a high proportion of young-stock is not to produce a surplus for sale, but to maintain milking cow numbers and improve quality by appropriate breeding programmes. Many farmers receive a great deal of personal satisfaction from following the growth and development of young-stock they have bred themselves, and the home-raising of replacements is a policy to be commended when it results in improved herd averages and farm output. Although future developments in Artificial Breeding will ensure a greater degree of certainty of achieving this end, there will always be a certain proportion of small farms where intensive

management will be necessary for financial success and where the chances of economic survival will depend on the most efficient use of grass with productive stock.

According to the Annual Report of the N.Z. Dairy Board (1943), 17 heifers per 100 cows in milk are required annually as replacements for the milking herd. Under such circumstances, if farms are to be self-contained with respect to replacement animals, it is necessary to save approximately 24 heifer calves per 100 "cows in milk" and consequently, in any year, the average dairy-farm would possess between 40 and 45 replacements for each 100 "cows in milk."

Table XXIV and Appendix clxxx show the wide variations in numbers reared on the different farms in the survey (from 3 to 78 calves and heifers per 100 "cows in milk").

TABLE XXIV.

ANALYSIS OF FARMS ACCORDING TO REPLACEMENT STOCK NUMBERS.

Group	Range in replacement numbers per 100 cows in milk.	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	0 - 4	7	90	208	274	10043	72
II	5 - 14	15	74	209	270	9860	69
III	15 - 24	38	88	188	262	9912	69
IV	25 - 34	69	95	173	259	9416	64
V	35 - 44	71	105	167	252	9115	64
VI	45 - 54	38	108	158	248	8955	62
VII	55 & over	15	102	150	258	7807	56

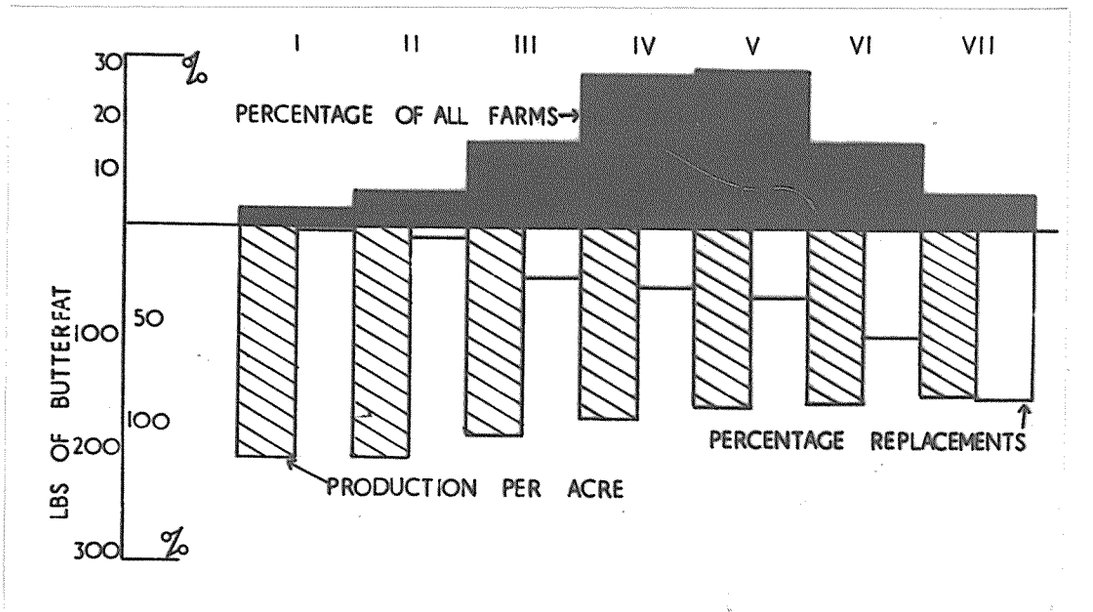


FIG. 15: The distribution of 253 sample dairy-farms between seven groupings based on "the number of replacements per 100 cows in milk". The relationship between "the number of replacements per 100 cows in milk" and "production per acre."

If the properties in Group V (Table XXIV) are included with those in Groups VI & VII, then according to the Dairy Board figure, 49% of the sample farms saved sufficient young-stock to be classed as self-supporting. The 129 farms excluded from this category were incorporated in Groups I to IV, the average number of replacements for each of which was 3, 10, 21 and 30 per 100 cows in milk, respectively.

(a) "Production per cow", "production per acre", and "carrying capacity".

It is interesting to note that with every successive addition to the proportion of replacement animals, there was a corresponding fall in "production per acre", the cumulative effect of which was a total reduction of 58 lbs. of butterfat per acre. Thus it was shown that properties which were self-sufficient with respect to herd replacements, produced less butterfat per acre than the average sample farm and considerably less than properties that relied on a policy of buying in some young-stock.

Associated with the increase in the proportion of replacement stock per farm was a decrease in "carrying capacity" '("cows in milk" per 100 acres)' comparable with that for output per acre. When, however, "carrying capacity" was expressed in "stock units", no such trend was apparent. The system of "stock units" is based on differences in the total feed requirements of different classes of animals and consequently a reasonable estimate of the total digestible nutrients available per farm is provided by the total "stock units". Estimation of the total "stock units" per farm revealed a slight increase from Group I to Group VII (Table XXIV), but competition provided by the additional young-stock for the total digestible nutrients available, considerably reduced the quantity available for milk productio

"Production per cow" was no higher on farms which bred their replacements than on properties where this class of stock was purchased and in fact, somewhat the reverse situation was apparent. This does not necessarily mean that breeding has been of no importance in obtaining high output per cow but does indicate that other factors have a large influence on herd averages at these levels of production. This information serves as corroborative evidence in support of comparable results presented in the tabulation for "production per cow".

(b) Cropping, hay and silage.

The percentage areas cropped and cut for hay remained remarkably constant between groups and lent support to the contention that differences in butterfat yields were not so much the results of feed variations, but rather caused by stock imbalance. These returns contrasted with the data for silage, since "the percentage of grassland cut for silage" increased slightly with the rise in replacement stock numbers. Attempts to measure the efficiency of supplementary feed utilisation, by expressing the areas cropped and cut for hay and silage per 100 cows in milk and per 10,000 lbs. of butterfat produced were of necessity complicated by changes in the proportions of replacements. Nevertheless, it appeared that in all cases there was a marked drop in efficiency concurrent with the increases in the proportions of replacements per farm.

(c) "Soil Rating" and Topdressing.

Between groups, changes in "soil ratings" and "the percentages of grassland topdressed were unrelated to the alterations in the proportions of young-stock.

(d) "Cultivated area", herd size and total production.

There were certain between-group differences in "cultivated area" which indicated that self-sufficient farms were slightly larger than average, a fact which would not have been appreciated from considerations limited either to herd size or farm output which were relatively constant for the same range of groupings.

(e) Farm Labour.

A fall which commenced in Group II and persisted to Group VII was recorded for output per "labour unit". This overall decline of 2,236 lbs. of butterfat per "labour unit", was due mainly to between-group differences for "production per cow". (See Appendix clxxx.)

XIII. Results of the Analysis of Farms Grouped According to "Production per Labour Unit".

"Production per labour unit"is an index of dairy farm efficiency second only in importance to "production per acre" and at the present time, with the restricted number of farm labourers available, the value of this productivity estimate is greatly enhanced. While, by considering different worker outputs, it may be possible to estimate the production potential of the existing farm labour force, returns which refer solely to labour yield cannot show present or potential land productivity. At present one of the factors limiting the country's total dairy production is the relatively small proportion of the total population actually employed on dairy-farms. So long as dairying land is supporting less than the optimum number of people and "production per acre" differs on properties which are distinguished by size alone, consideratio of the total variance attributable to between-worker differences in output will be an important part of dairy-farm

surveys.

In the present instance, two measures of labour output, viz.' "cows milked per labour unit" and lbs. of butterfat per "labour unit", were employed. The results obtained were, essentially similar for both analyses and attention has been concentrated mainly on that based on "production per labour unit".

TABLE XXV.

ANALYSIS OF FARMS ACCORDING TO THE NUMBER OF COWS MILKED PER LABOUR UNIT.

Group	Range in numbers of cows per labour unit.	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	Under 20	12	52	176	265	4492	64
II	20 - 24	25	80	159	252	5820	61
III	25 - 29	42	89	166	258	7262	62
IV	30 - 34	48	104	176	261	8777	64
V	35 - 39	51	90	181	254	9659	68
VI	40 - 44	30	117	173	256	11110	65
VII	45 - 49	23	119	173	261	12461	65
VIII	50 & over	22	118	174	252	14150	67

Where farms were classified by the number of cows milked per labour unit, it was found convenient to include all properties in 8 groupings, the range for which extended from less than 20 to 50 and more. Thus, within each of the remaining 6 groupings the maximum between-farm difference possible was 5 cows per labour unit. A wide range in "the number of cows milked per labour unit" (extending from 18 to 59) was provided by the group averages.

TABLE XXVI

ANALYSIS OF FARMS ACCORDING TO THE OUTPUT OF BUTTERFAT PER LABOUR UNIT.

Group	Range in Production of B/F. per Labour Unit. (lbs. of B/F)	No.of Farms	Cult. Area (ac.)	Av. Production of Butterfat (lbs.)			Carrying Capacity (Cows per 100 acres)
				Per Acre	Per Cow	Per Labour Unit	
I	under 5000	11	60	126	223	4164	54
II	5000 - 5990	23	78	156	247	5465	61
III	6000 - 6990	21	97	151	240	6400	61
IV	7000 - 7990	30	101	160	250	7540	61
V	8000 - 8990	33	101	179	264	8479	66
VI	9000 - 9990	35	94	184	261	9454	68
VII	10000 -10990	33	97	183	260	10409	67
VIII	11000 -11990	18	109	193	269	11367	69
IX	12000 -12990	24	105	185	268	12488	66
X	13000 -13990	11	114	179	264	13391	66
XI	14000 & over	14	122	184	265	15114	67

The alternative analysis dealing with butterfat per "labour unit" included 11 groupings which ranged from 5,000 lbs. and below to 14,000 lbs. and above. 1,000 lbs. of butterfat constituted the group interval for each of the remaining 9 groups. In absolute figures, the group averages increased by successive increments from the minimum of 4,164 lbs. up to 15,114 lbs. of butterfat per labour unit. Some of the reasons underlying this 3½ fold increase were revealed by the tabulations, interpretation of which was facilitated by studying the 11 groupings as 3 major sections - "lower", "middle" and "upper" - both within and between which, changes were considered. Of the three major classes indicated above, the "lower" comprised all farms where output per "labour unit" was less than 8,000 lbs.

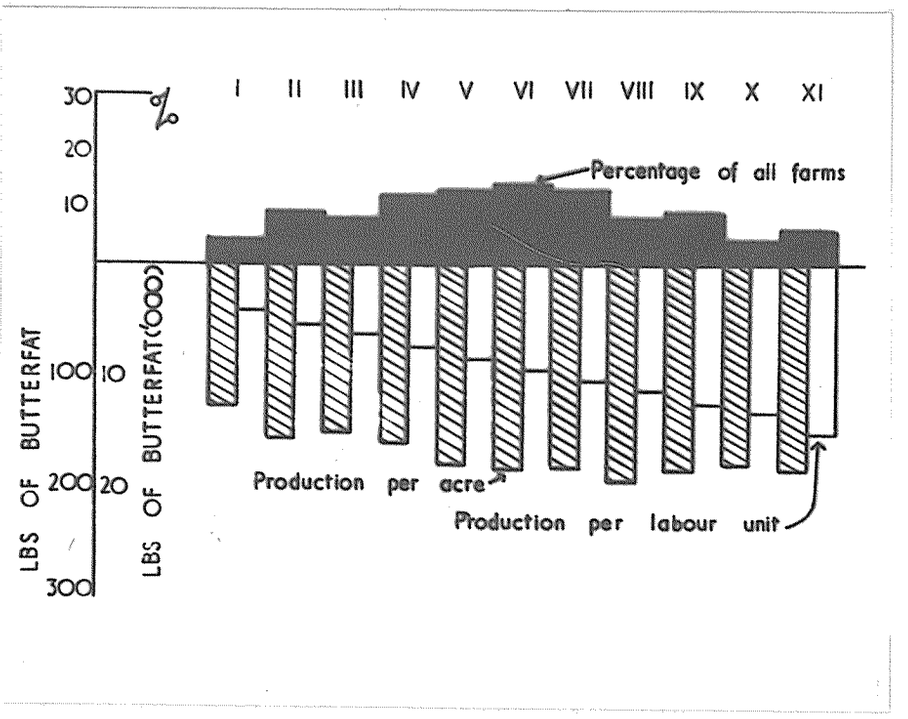


FIG.16: The distribution of 253 sample dairy-farmers between eleven "production per labour unit" groupings.
The relationship between "production per labour unit" and "production per acre."

of butterfat. The "middle" section was composed of farms where the output per "labour unit" was between 8,000 and 12,000 lbs., while the "upper" section included all properties where "production per labour unit" exceeded 12,000 lbs. of butterfat.

By the comparing of data for each of these sections, certain features distinguishing farms which differed in output per worker were made apparent.

The following characteristics were quite distinctive for farms where "production per labour unit" was high.

(a) Both in area and in total output, these farms were consistently larger than average.

(b) The labour force employed was considerably smaller than on the mean sample farm. Expressed as "labour units" per 100 acres, this difference was even more noticeable.

(c) Herd size was larger than average.

(d) Fewer "replacements per 100 cows in milk" were retained than in the "middle" and "lower" sections.

(e) On these farms, more cows were milked per "labour unit" than in the "middle" section and considerably more than in the "lower" section.

(f) "Production per acre" and "carrying capacity" were slightly lower than the comparable figures for the "middle" group, but were superior to those for the "lower" section.

Reasons for all these between-farm differences cannot be ascertained from the data presented, but it may be helpful to consider some information additional to that already given.

(1) Total Production.

Between Groups I and IV which constituted the "lower" section, increases of 81% and 117% were recorded for "production per labour unit" and per farm respectively. Between Groups IV and VIII, and IX and XI, the comparable increases were 24% and 14%, and 21% and 14% respectively.

In Groups I and II, low total output determined low "production per labour unit" and in turn, low total output was associated with smaller than average farm area.

Between Groups VI and XI, trends in total output were much less marked, and the factor causing between-group differences i n output per worker was the size of the farm labour force. Thus at one extreme, a shortage of land to combine with the labour was the limiting factor, while at the other, a shortage of labour was the determining factor.

(2) After the nature of the association between output per labour unit and total farm production had been determined, consideration was given to the relationships between certain inputs and "production per labour unit".

(a) Cultivated Area.

As indicated previously, improvements in production per worker were associated with increases in"cultivated area". There was, however, a greater percentage rise for "cultivated' than for total area and this would indicate that the properties from which high individual worker outputs were obtained were more fully developed than those with a low return per labour unit.

(b) Hay, silage and topdressing.

Changes in output per worker between Groups I and IV were accompanied by a more intensive application of farm practices such as hay and silage making and greater use of artificial fertilizers. When comparisons were made between this and the remaining two sections, certain differences appeared, for within the latter two, there were no marked increases in either the proportions of grassland set aside for hay and silage, or in the percentage areas topdressed.

In this section the feature requiring emphasis is the wide variation in the productivity of labour. The maximum individual worker output appears to be about 15,114 lbs. of butterfat or the product of 55 cows and the minimum production 4,164 lbs. of butterfat from 19 cows. Since the guaranteed price is based on an individual worker output of 6,000 lbs. of butterfat per year, the economic stability of properties, where production amounts to scarcely more than 5,000 lbs. of butterfat per labour unit, must be questioned. Undoubtedly this was an exceptional group of farms for the average number of replacements, (66 per 100 cows in milk), was almost double the sample mean. Nevertheless farms producing at a slightly higher level, where production per worker amounted to 5,465 lbs. of butterfat, could not have been in a particularly sound financial position. Under circumstances in which an effective farm output of 9,543 lbs. of butterfat has to provide cash returns to meet interest payments, farm working and maintenance and the labour reward for the equivalent of two full-time male workers, capital improvement work and debt repayment must have been at a minimum and the economic stability would be seriously endangered in times of falling prices.

This situation may be contrasted with circumstances in which individual workers milked 55 cows or produced 15,000 lbs. of butterfat. These high outputs per labour unit are the result of farm combinations which involve:-

(1) Large areas of land where little attention is paid to intensive feeding methods.

(2) No developmental work.

(3) Neglect of maintenance both in terms of labour and materials - a form of living on capital.

In many cases where men have acquired farms on borrowed capital, it is imperative that they meet interest payments and increase their own equity by various economies and by taxing to the maximum their own physical resources. Under these circumstances, there is some justification for farming policies which require a high labour output. Such systems cannot be justified, however, if they involve no developmental work, unsatisfactory land utilization and neglect of maintenance. Conditions like these can result from share-milking arrangements which emphasise the importance of herd production, but place no stress on farm maintenance.

Where the farm-owner manages the property, he has complete control over farm maintenance, and worker bonuses or other production incentives, when provided, are not made at the expense of capital invested. Of course it is scarcely likely that these bonuses would permit workers' wages to equal those received under satisfactory share-milking arrangements, but they encourage increased production without incorporating some of the undesirable features of share-farming.

In any consideration of farm labour, it must be remembered also that labour is a very inelastic factor of production and while many farms produce below optimum with

a certain labour complement, the inclusion of an additional full-time worker may render them uneconomic. Often this problem is solved by employing labour as required, while the wide elasticity of family labour can, at certain times, provide considerable assistance. Consequently, where "production per labour unit" is measured for full-time workers only, the calculated returns probably exceed their actual values.

The results of this analysis suggest that, in general, exceedingly high "production per labour unit", when obtained consistently over considerable periods, is an undesirable feature of present-day dairy-farming. As the data considered consists of 10-year averages, the effect of newly-established farmers must be small and consequently it is suggested that rather than apply the intensive methods of which they are capable, many farm operators prefer to farm their land below its optimum capacity, rather than to apply the intensive methods which are really required. For those who would apply the more efficient systems, labour shortage presents a real difficulty, and this problem of labour recruitment and retention must be considered as both economic and social. There is a need for some farmers to reduce the disparity existing between the wages which they are willing to offer and those obtainable in other industries, but irrespective of the monetary returns offered, many people will not consider farm work as a way of life.

The farmer who employs men desires permanency in his staff and his chances of securing this are greater with married than with single men. By employing the former, however, he must undertake the responsibility of providing adequate housing and rather than incur the necessary capital expenditure, many farm-owners prefer to employ youths

and single men. From all classes of industry comes the demand for this type of labour at a time when in cities, regular work-hours are short, leisure time is comparatively plentiful and overtime rates are high. Consequently dairy-farm work which offers none of these advantages holds little appeal. For many people, dairy-farming and shed-work are synonomous terms and as has been shown (page 127) a considerable portion of each day is spent in the routine of milking. Prospective employees realise that at certain times of the year, the requirements of farm maintenance and seasonal work when super-imposed on this will demand considerable overtime work for which there may be little reward. Thus under present circumstances, the desire to undertake farm employment must be particularly strong and in many cases where this is evident, it can be interpreted as the first expression of an ambition to possess and successfully farm land. Those who have this as their aim, will sooner or later leave the ranks of the farm labourers and consequently there will be a continual drain on and demand for farm workers.

Improved shed techniques and the introduction of machinery which is adaptable to a variety of purposes have served to remove certain of the undesirable features of dairy-farming, but it appears that in the future, additional emphasis will have to be placed on mechanisation as an aid for the recruitment of an adequate farm labour force.

S E C T I O N VIII

S U M M A R Y

Using data which consisted of ten year averages for annual returns recorded between 1941 and 1950, a farm management survey was conducted on 253 Waipa dairy-farms.

The estimation of averages for all inputs and outputs enabled a description to be made of the mean sample farm which was complete with respect to the main factors considered in this survey. A more precise description of this sample of dairy-farms was provided by a series of tabulation analyses. For most inputs and outputs, the distribution of farms about the mean values were normal. Exceptions included the percentage areas cropped and cut for silage, in both of which the majority of farms were concentrated in the lower groupings, and "soil rating" and percentage area topdressed where the distributions of farms were skewed towards the high ratings.

For each holding, farming efficiency was measured by "production per acre" although it was appreciated that output per "labour unit" also constituted a very important index of productivity. The functions of the tabulation analyses, especially those based upon "production per acre" and its components, "production per cow" and "carrying capacity", were extended to a denotation of the inputs associated with highly efficient farming. The remaining tabulations provided a very useful check on the validity of associations derived previously and, in addition, yielded valuable supplementary data concerning the causal factors in these relationships.

The close relationships between "production per acre" and "carrying capacity" and "production per acre" and "production per cow" were shown in the corresponding tabulations.

The negative relationship between "production per acre" and "cultivated area" was a result of the association between"carrying capacity"and "cultivated area". '"Effective" production per cow' appeared to be uninfluenced by changes in "cultivated area", although the tabulation based on "production per cow" supplied some evidence, that as the latter increased, "cultivated area" decreased.

By contrast, there were no apparent relationships between either "production per acre", "production per cow" or "carrying capacity" and total production. These results provided striking examples of how intensive farming methods modified the physical limitation of farm area.

In general, increases in "production per acre", "production per cow" and "carrying capacity" were associated with increases in "soil ratings", although these trends were not so marked as might have been anticipated from the "soil rating" tabulation.

Since there was no relationship between either increases in farming efficiency and cropping or increases in cropping and farming efficiency, it was accepted that root and green forage crops were relatively unimportant to dairy-farming in the Waipa County.

As "carrying capacity", "production per acre" and "production per cow" improved, associated increases were noted for the "percentage of grassland cut for hay". For silage, however, trends which were initially similar to those for hay, were later terminated in the penultimate groupings of both the "production per cow" and "production per acre" analyses.

In only the "carrying capacity" tabulation was the upward trend for "the percentage of grassland cut for silage maintained throughout. These results for silage were verified by reference to the appropriate tabulation, but the analysis of farms according to the "percentage of grassland cut for hay" showed that here also the associations between the latter and "production per acre", "production per cow" and "carrying capacity" successively, were terminated in the penultimate grouping. As a result it was suggested that somewhat less than 25% of the total area in grass was sufficient to provide optimum hay requirements. The implications of this proposal were discussed.

The importance of topdressing to farm production and capacity was established from the relevant tabulations which suggested the existence of high positive correlations between the "percentage of grassland topdressed" and "production per acre", "production per cow" and "carrying capacity".

Apparently there was no relationship between farm efficiency or capacity and herd size, but there was a negative correlation between"the number of replacements per 100 cows in milk"and both "carrying capacity", "production per cow" and output per acre. The analysis which depended on the number of replacements per 100"cows in milk"verified these findings, the important implications of which were discussed in detail, both in relation to present and to future farming policies.

With the exception of farms where "production per acre" exceeded 250 lbs. of butterfat and where the labour complement was particularly small, classification of farms

by yield per acre revealed no between-group differences in the number of "labour units" per farm. From the tabulation for "production per cow" a result which was essentially similar was obtained but for "carrying capacity" an increase in the number of cows per unit area was associated with a reduction in the number of "labour units" per farm.

Since in each of these analyses, the total farm production remained relatively constant between groupings, it was not anticipated that the relationship between any of the measures of farming efficiency and "production per labour unit" would be particularly strong. This supposition was proved correct by the results from the relevant tabulations, although the exact nature of the trends were best shown from the analyses for "production per acre" and "production per labour unit".

By extending inquiry beyond the confines created by the search for direct relationships between inputs and outputs, much supplementary information was acquired. As an example, the negative relationship between "soil rating" and the "percentage of cultivated area cropped" may be cited. The possible reasons for this association were discussed in detail, although speculation was tempered to some extent by the results of the analysis for cropping which provided no indication of a relationship between cropping and "soil rating".

Evidence which suggested that hay and silage were not as important as might have been anticipated was provided by the results from the corresponding tabulations. Further data in support of this contention was provided by the "soil rating" analysis where, in spite of the association between

the latter and output per acre, only the "percentage of grassland cut for silage" showed any tendency to increase with increased "soil ratings".

Considerable stress was laid on the difficulty of trying to measure the quantities of supplementary feed available from data relating to areas, but it was suggested that the results of the analysis on "soil ratings" were indicative of the importance of "soil rating" as a factor affecting grass yields. This possibility received some support from the analysis for haymaking wherein was recorded a negative relationship between "soil rating" and the "percentage of grassland cut for hay". Evidence which was more indirect in nature was supplied by the tabulation based on topdressing differences. Within this analysis, associations, the validity of which were established from the relevant tabulations, were noted between the "percentage of grassland topdressed" and successively, "production per acre", "percentage of grassland cut for hay" and"percentage of grassland cut for silage". There was, however, no relationship between the dependent variable and "soil rating". The implication is that where between farms there were no differences in "soil ratings", variations in the quantity of hay saved would depend upon differences in the areas closed for hay, but where "soil ratings" differed, these area differences might not be so important.

It was noted that most farmers attached considerable importance to topdressing, but there was a lack of data available by which the actual contribution of topdressing to increased production could be measured. The inadequacies of the information used in the present study were described, together with what the writer considered would be more fruitful methods for solving problems specifically concerned with topdressing.

On some farms liming was practised either alone or in conjunction with topdressing but lime could not be considered an important farm input in the Waipa County. During the war years when fertiliser was rationed, lime was often used as a spreader and in consequence probably assumed greater importance than was warranted. Whatever was the cause, somewhat less than two-thirds of the total area in grass appeared to be the average area limed by most farmers.

The tabulation analyses which referred specifically to farm stock numbers were especially notable in two respects.

1. The high positive correlation between herd size and farm area.
2. The negative correlation between "the number of replacements per 100 cows in milk" and "production per acre".

By grouping holdings according to the number of cows in milk, however, some additional information was contributed which was quite valuable, especially when considered in conjunction with results from the tabulation for "production per labour unit". It was significant that in both instances the maximum output per "labour unit" was obtained on farms where approximately 70 cows were milked. Although in the analysis based on size of herd, the productivity of labour did not increase beyond this limit, the tabulation on "production per labour unit" showed that as a result of reductions in the size of the farm labour force, increases in output per labour unit continued beyond this point.

It was noted that farms on which high outputs per "labour unit"were obtained were considerably larger than average.

The various possible reasons underlying high output per labour unit were enumerated and the effects of extensive systems of farming when continued over a period of years were discussed. The problem of labour shortage was naturally considered herein and possible measures for simplying problems in the recruitment of suitable workers were suggested. The importance of increasing the farming population was stressed, for it was contended that the greatest prosperity for the Dairy Industry and therefore the farmers in general would be obtained, only when the optimum number of workers were engaged in dairying.

S E C T I O N IX

RESULTS OF THE STATISTICAL ANALYSIS OF THE FARM SURVEY DATA.

The information supplied by the tabulation analyses and presented in the previous section permitted a full description both of the outputs and the inputs of individual sample farms. Although various associations between factors were revealed, neither measures of the closeness of relationships, nor estimates of the value of individual farm practices in contributing to farm output had been provided.

As was indicated in a consideration of the scope of this study, two of the main purposes in conducting this investigation were:-

(1) To estimate the fraction of the total between-farm variance for "production per cow", "carrying capacity" and "cows per labour unit" accounted for by the managemental factors considered.

(2) To assess the relative importance of the various farm practices contributing to efficient production

The nature of these requirements and the complicate series of interrelationships inherent in the data, necessitated the use of a statistical approach. The method employed, as outlined in the appropriate section, is subject to the criticisms raised by Frisch (1934) and expressed by Dick (1950). For the non-mathematician, however, this method does provide a more convenient and not necessarily a less accurate approach than the system of confluence analysis advocated by Dick (loc.cit).

As a basis from which to estimate the fraction of the total between-farm variance for "production per cow", "carrying capacity" and "cows per labour unit" attributable to all inputs, correlation coefficients were determined between all inputs and outputs (see Table XXVII). The notable features are the very high correlations between "cultivated area" and herd size ($r = +0.93$), "cows milked per labour unit" and "production per labour unit" ($r = +0.92$) "carrying capacity" and "production per acre" ($r = +0.85$) and "production per cow" and "production per acre" ($r = +0.75$). Reference to Appendix xxi will enable these correlation coefficients to be compared with those calculated by Hamilton (1944) and Mitchell (1948) for Whangarei and Waipa dairy-farms respectively.

As was explained under "Methods" the interrelationships affecting "production per acre" and "production per labour unit" necessitated successive treatment of their components "carrying capacity", "production per cow" and "cows milked per labour unit" as the dependent variables in subsequent statistical analyses. For each of these three, R^2 (the square of the multiple correlation coefficients = the fraction of the total variance accouhted for) was determined from the "Doolittle Solution" (Appendix xxii consists of an example of this method) and the fraction of the total between-farm variance contributed by nine inputs collectively, was assessed.

The nine factors of production considered were:-

1. "Soil Rating."
2. "Cultivated Area."
3. "Percentage of grassland topdressed with artificial fertilizers."
4. "Percentage of grassland cut for hay."

TABLE XXVII

GROSS CORRELATIONS FOR ALL INPUTS AND OUTPUTS.

	Soil Rating	Tractor Numbers	No. of Replacements per 100 cows in milk.	No.of Cows in Milk	B/Fat Per Cow	B/Fat Per Acre	Cult. Area	Stock Units Per Acre	% of Cult. Area Cropped.	% of Grassland Cut for Hay.	% of Grassland Cut for Silage.	% of Grassland Top-dressed.	% of Grassland Limed.	No.of Cows per Labour Unit.	B/Fat per Labour Unit.
Soil Rating	1	-.1335	.0612	.0372	.2874	.3439	-.0787	.4020	-.1722	.1754	.2482	.2366	-.0231	.0487	.1280
Tractor Nos.			.0892	.1697	-.0971	-.1162	.2000	-.0777	.1113	-.0236	.0863	-.0579	.0288	.0262	-.0051
No. of Replacements per 100 cows in Milk.				-.0184	-.1408	-.3262	.1239	.0068	.0381	-.0001	.0364	-.0247	-.0264	-.1479	-.1749
No. of Cows in Milk.					-.0275	-.0525	.9265	-.0134	.0088	-.0091	.1975	.1340	-.0205	.3764	.3446
Butterfat Per Cow						.7525	-.1234	.5101	-.1156	.1109	.1380	.3515	.1481	-.0343	.3262
Butterfat Per Acre							-.3245	.8488	-.1324	.2000	.1874	.4322	.1550	.0661	.3389
Cult. Area								-.2964	.0658	-.0702	.1158	.0221	-.0403	.3079	.2494
Stock Units per Acre									-.1381	.2474	.2598	.4143	.1008	.0695	.2398
Percentage of Cult. area Cropped.										.0762	-.0049	.0187	.1267	.0694	.0233
Percentage of Grassland Cut for Hay.											-.0727	.2173	.0385	-.0299	-.0044
Percentage of Grassland Cut for Silage.												.1860	.1321	.1472	.1925
Percentage of Grassland Topdressed.													.4071	.1377	.2696
Percentage of Grassland Limed.														-.0260	.0390
No. of cows per Labour Unit.															.9230
Butterfat per Labour Unit.															

5. "Percentage of grassland cut for silage."
6. "Percentage of grassland limed."
7. "Percentage of cultivated area cropped."
8. "Replacements per 100 cows in milk."
9. Number of tractors.

The estimated fractions available from the three analyses were tested for significance by Snedecor's (1940) "F" test. In each case it was also possible to assess with reasonable accuracy, the factors contributing in greatest measure to this total reduction in the residual variance.

A. For "carrying capacity" these were:-

1. "Percentage of grassland topdressed with artificial fertilizers."
2. "Percentage of grassland cut for silage."
3. "Percentage of grassland cut for hay."
4. "Soil Rating".
5. "Cultivated area."

B. For "production per cow" the five major inputs noted were as follows:-

1. "Percentage of grassland topdressed with artificial fertilizers."
2. "Percentage of cultivated area cropped."
3. "Replacements per 100 cows in milk."
4. "Soil rating."
5. "Cultivated area."

C. The analysis based on the "number of cows milked per labour unit" was less instructive and only four factors of production, viz.,

1. "Replacements per 100 cows in milk."
2. "Cultivated area."
3. "Percentage of grassland topdressed with artificial fertilizers."
4. "Percentage of grassland cut for silage,"

were considered worthy of more detailed study. Thus, in at least one of the three major analyses, seven of the nine original inputs were given detailed consideration. The number of tractors and the "percentage of grassland limed" comprised the two factors which were rejected completely.

The accuracy of these interpretations was measured by the repeated use of the "Doolittle Solution" in conjunction with the "F" test on various combinations of the five factors selected for A. and B. and the four selected for C. In this way it was possible to test the extent of the reduction in residual variance attributable to any factor, regardless of the combination of factors to which it was added. The latter is a very important condition in this type of analysis where there is a high degree of interrelationship between factors. The sequence in which each input is introduced to different combinations of the same inputs can influence the results of the "F" test.

A further extension of the "Doolittle Solution" permitted the computation of standard partial regression coefficients (β'). These were determined for each of the five main inputs for "carrying capacity" and "production per cow" and for the four inputs selected from the analysis on "cows milked per labour unit". The Doolittle method does not allow a direct test of the β' and to accomplish this, either the correlation or cross-products matrix must be inverted (Dwyer's (1945) Method - Appendix xxiii). The significance of these standard partial regression coefficients was tested by Student's "t" test (Snedecor (1940)) according to the formula

$$"t"_{e.d.f} = \frac{\beta'_i}{\sqrt{\text{var}\,\beta'_i}}$$

β'_i = the standard partial regression coefficient,

$\text{var}\,\beta'_i$ = the variance of $\beta'_i = \frac{1 - R^2}{e.df} C'_{ii}$

where R = multiple correlation coefficient from the Doolittle method.

$1 - R^2$ = the residual fraction of the variance.

e.df = error degrees of freedom,

C'_{ii} = iith element of the inverse of the correlation matrix.

From the standard partial regression coefficients the natural partial regression coefficients (β) were calculated by using the following formula:-

$$\beta_i = \beta'_i \sqrt{\frac{\sigma^2_y}{\sigma^2_{x_i}}}$$

where β_i = the natural partial regression coefficient,

β'_i = the standard partial regression coefficient,

σ^2_y = the variance of y the dependent variable,

$\sigma^2_{x_i}$ = the variance of x_i an independent variable.

The determination of partial regression coefficients for each factor included in the analyses for "carrying capacity", "production per cow" and "cows milked per labour unit enabled the formulation of the three corresponding regression equations.

To conform with the method of analysis, the results are presented under the three headings, "carrying capacity", "production per cow" and "cows milked per labour unit".

1. "Carrying Capacity"

It was estimated that forty percent of the between-farm variance for "carrying capacity" was attributable to corresponding differences in the nine factors of production listed on pages 151&153.

By the use of the "F" test (Snedecor 1940) it was shown that this was a highly significant fraction of the total between-farm variance for "carrying capacity". (Table XXVIII).

TABLE XXVIII

ANALYSIS OF VARIANCE FOR "CARRYING CAPACITY"

Source	Portion of S S	df	M S	F	Result
Due to 9 factors	.4038	9	0.04487	18.29	* *
Residual	.5962	243	0.00245		

* * Significant at 1% level.

* " " 5% "

The various combinations of the five factors estimated as contributing the most substantial portions of the variance accounted for, together with the results of the "F" tests applied to each input are included in Table XXIX,

TABLE XXIX

SUMMARIZED RESULTS OF THE "F" TESTS APPLIED TO EACH FACTOR WHEN INCLUDED AFTER VARIOUS OTHER FACTORS.

(y = the dependent variable, "carrying capacity")

Order of Independent Variables.	Independent variables and F's obtained on their inclusion in marginal order.				
	x_1	x_2	x_3	x_4	x_5
	Soil Rating	Cult. Area	Percent. of grass-land top-dressed.	Percent of grass-land cut for hay.	Percent of grass-land cut for silage.
$x_3\ x_1\ x_5\ x_2\ x_4$	* * (33.50)+	* * (35.36)	* * (51.99)	* (6.60)	* (5.18)
$x_3\ x_5\ x_4\ x_1\ x_2$	* * (22.85)	* * (34.70)	* * (51.99)	* * (10.9)	* * (11.14)
$x_1\ x_2\ x_3\ x_4\ x_5$	* * (48.38)	* * (22.99)	* * (44.13)	* (4.10)	* * (12.84)
$x_1\ x_5\ x_4\ x_2\ x_3$	* * (48.38)	* * (28.89)	* * (32.47)	* * (13.09)	* * (8.41)
$x_2\ x_4\ x_5\ x_3\ x_1$	* * (19.76)	* * (24.19)	* * (39.41)	* * (14.96)	* * (31.67)
$x_4\ x_2\ x_1\ x_3\ x_5$	* * (40.31)	* * (22.72)	* * (38.31)	* * (16.36)	* * (12.84)
$x_2\ x_3\ x_4\ x_5\ x_1$	* * (19.80)	* * (24.19)	* * (59.95)	* (6.64)	* * (21.46)

* * significant at 1% level.
* " 5% "
\+ figures in brackets are the estimated "F" values.

(All of the tests involve 247 - 252 d.f. and consequently the "F" values which are required for significance at the 5% and 1% levels are 3.89 and 6.76 respectively (refer Snedecor (1940) page 174)).

In the majority of cases each input produced a highly significant reduction in the residual variance. Inclusion of "the percentage of grassland cut for hay" in three of the six combinations caused reductions in the residual variance which were significant at the 5% but not at the 1% level. An explanation for this is provided by the highly significant correlation (r = +.2173) between"the percentage of grassland topdressed with artificial fertilizers" and "the percentage of grassland cut for hay". The "F" values show that in all cases where the addition of the latter produced a highly significant reduction in the residual variance, "the percentage of grassland topdressed" had been added after the inclusion of "the percentage of grassland cut for hay". Where topdressing had been included in the combination of inputs, the subsequent addition of "the percentage of grassland cut for hay" caused only a significant reduction in the residual variance.

The information obtained from these analyses was supplemented by data resulting from the determination of standard partial regression coefficients (β') for each of the terms x_1 .....x_5 inclusive, when y, the dependent variable was "carrying capacity".

These coefficients together with the results of the "t" tests applied to each are presented as follows:-

$\beta'y.1 = .2372 \quad t = 4.46$ **

$\beta'y.2 = -.2969 \quad t = 5.89$ **

$\beta'y.3 = .3006 \quad t = 5.69$ **

$\beta'y.4 = .1334 \quad t = 2.57$ *

$\beta'y.5 = .1891 \quad t = 3.59$ **

From the standard partial regression coefficients natural partial regression coefficients were calculated from these the following regression equation was derived:-

$$y = 244.87 + 16.27x_1 - 0.46x_2 + 1.36x_3 + 1.85x_4 + 2.90x_5$$

(y = "carrying capacity")

Since all of the partial regression coefficients are statistically significant, it is possible to interpret the equation as follows:-

If while measuring the association between the dependent variable and any independent variable the remaining factors are held constant, the following relationships hold in the data:-

(1) An increase of one "soil rating" unit is accompanied by an increase of 16.27 units in "carrying capacity".

(2) An increase in "cultivated area" of one acre is associated with a decrease in "carrying capacity" of 0.46 units.

(3) An increase of one percent in "the percentage of grassland topdressed" is associated with an increase in "carrying capacity" of 1.36 units.

(4) and (5). Unit increases in "the percentages of grassland cut for hay"and "the percentage of grassland cut for silage" are associated with increases in "carrying capacity" of 1.85 and 2.90 units respectively.

2. "Production per Cow".

The inclusion of the nine inputs previously mentioned enabled 23% of the between-farm variance for "production per cow" to be accounted for. Although this represents a considerable reduction on the fraction estimated for "carrying capacity" from the same inputs, it still represents a highly significant portion of the total between-farm variance.

TABLE XXX

ANALYSIS OF VARIANCE FOR "PRODUCTION PER COW"

Source	Portion of S.S.	d.f.	M.S.	F	Result
Due to nine factors	.2256	9	0.02567	7.8657	* *
Residual	.7744	243	0.00319		

As previously, the five man contributors to the estimated fraction of the total variance were tested in various combinations to determine for each, the extent of the reductions effected in the residual variance.

Table XXXI consists of these results in tabulated form.

TABLE XXXI

SUMMARIZED RESULTS OF THE "F" TESTS APPLIED TO EACH FACTOR WHEN INCLUDED AFTER VARIOUS OTHER FACTORS.

(y = "production per cow" - the dependent variable)

Order of independent variables	Independent variables and "F's" obtained on their inclusion in marginal order.				
	x_1	x_2	x_3	x_4	x_5
	Cult. Area	Soil Rating	Percent. of cult. area cropped.	Percent. of grass-land top-dressed.	Replace-ments per 10(cows ir milk.
$x_1\ x_3\ x_2\ x_5\ x_4$	N.S. (3.87)+	* * (18.53)	N.S. (2.98)	* * (26.77)	* (5.71)
$x_4\ x_5\ x_3\ x_1\ x_2$	N.S. (3.51)	* * (11.54)	* (4.04)	* * (35.40)	* (5.06)
$x_2\ x_1\ x_5\ x_3\ x_4$	N.S. (2.81)	* * (22.60)	N.S. (0.87)	* * (26.77)	* (6.07)
$x_1\ x_4\ x_3\ x_5\ x_1$	N.S. (3.87)	* * (11.52)	N.S. (3.80)	* * (36.55)	N.S. (3.81)
$x_4\ x_3\ x_1\ x_2\ x_5$	* (4.47)	* * (10.13)	* (4.32)	* * (35.40)	* (5.21)
$x_2\ x_3\ x_4\ x_5\ x_1$	N.S. (2.61)	* * (22.60)	N.S. (1.23)	* * (26.53)	* (6.29)
$x_5\ x_1\ x_3\ x_2\ x_4$	N.S. (2.94)	* * (21.19)	N.S. (2.81)	* * (26.77)	* (5.07)
$x_5\ x_3\ x_1\ x_4\ x_2$	N.S. (2.60)	* * (11.54)	N.S. (3.15)	* * (37.04)	* (5.07)
$x_4\ x_2\ x_5\ x_1\ x_3$	N.S. (2.82)	* * (13.25)	N.S. (1.68)	* * (35.40)	* (6.63)
$x_2\ x_5\ x_1\ x_3\ x_4$	N.S. (1.86)	* * (22.60)	N.S. (0.96)	* * (35.40)	* (7.06)

* * significance at 1% level
* " " 5% "
N.S. (non significant)
\+ Figures in brackets are the estimated "F" values.

(All tests involve 247 - 252 d.f. and consequently the "F" values which are required for significance at the 5% and 1% levels are 3.89 and 6.76 respectively.)

It is apparent that only three inputs, "soil rating", "percentage of grassland topdressed" and "replacement numbers per 100 cows in milk" account for significant fractions of the between-farm variance for "production per cow".

The standard partial regression coefficients and the results of the "t" tests applied to each are as follows:-

$\beta' y.1 = -.0929$ "t" = 1.61 N.S.
$\beta' y.2 = .2033$ "t" = 3.40 * *
$\beta' y.3 = -.0751$ "t" = 1.30 N.S.
$\beta' y.4 = .3036$ "t" = 5.20 * *
$\beta' y.5 = -.1314$ "t" = 2.29 *

The natural partial regression coefficients were calculated from the corresponding standard partial regression coefficients and included in the equation

$$y = 187.36 - .06x_1 + 5.59x_2 - .09x_3 + .55x_4 - .15x_5$$

(y = "production per cow")

Hence, if the relationship between the dependent and any other variable is measured when all other variables are held constant, then the following relationships hold in the data:-

(1) A unit increase in "soil rating" is associated with an increase of 5.59 lbs. of butterfat per cow.

(2) A unit increase in the "percentage of grassland topdressed with artificial fertilizers" is associated with an increase of 0.55 lbs. of butterfat per cow.

(3) An increase ofone replacement per 100 cows in mil is associated with a decrease of 0.15 lbs. of butterfat per cow.

The two partial regression coefficients determined for "cultivated area" and "percentage of cultivated area cropped" were found to be non-significant.

3."The Number of Cows milked per Labour Unit".

This term suggests a simple derivation from the number of cows comprising each herd and the available labour force. Neither of these variables was included amongst the factors analysed, yet inputs such as topdressing and silage are influenced by herd size. Some importance was attached, therefore, to the computation of the fraction of the total between-farm variance for "cows milked per labour unit" accounted for by the nine inputs considered previously. This fraction amounted to 17% of the total variance, which when subjected to the "F" test was found to be highly significant (Table XXXII).

TABLE XXXII.

ANALYSIS OF VARIANCE FOR "THE NUMBER OF COWS MILKED PER LABOUR UNIT"

Source	Portion of S S	d.f.	M S	F	Result
Due to nine factors	.1693	9	0.01881	5.5027	* *
Residual	.8307	243	0.00342		

Four selected inputs were included in subsequent analyses and as shown in Table XXXIII, regardless of the combination of factors to which they were added, only two of these inputs consistently accounted for significant fractions of the total variance for "cows milked per labour unit".

TABLE XXXIII

SUMMARISED RESULTS OF "F" TESTS APPLIED TO EACH FACTOR WHEN INCLUDED AFTER OTHER FACTORS.

(y = the dependent variable","cows milked per labour unit")

Order of Independent Variables	Independent variables and "F's" obtained on their inclusion in marginal order			
	x_1	x_2	x_3	x_4
	Percent.of grassland topdressed	Percent.of grassland cut for silage	Replace-ments per 100 cows in milk	Cultivate area.
$x_2\ x_3\ x_1\ x_4$	N.S. (3.04)+	* (5.57)	* (6.15)	* * (28.78)
$x_3\ x_4\ x_1\ x_2$	* (4.63)	N.S. (2.61)	* (5.62)	* * (31.03)
$x_1\ x_2\ x_3\ x_4$	* (4.86)	* (3.96)	* (5.93)	* * (28.78)
$x_4\ x_2\ x_3\ x_1$	N.S. (3.30)	N.S. (3.53)	* * (10.54)	* * (26.29)
$x_1\ x_3\ x_2\ x_4$	* (4.86)	* (4.43)	* (5.44)	* * (28.75)
$x_1\ x_4\ x_2\ x_3$	* (4.86)	N.S. (2.26)	* * (10.21)	* * (26.18)

* * significance at 1% level
* " " 5% "
N.S. non significant
\+ The figures in brackets are the estimated "F" values.
(All of the tests invole 247 - 252 d.f. and consequently the "F" values which are required for significance at the 5% and 1% levels are 3.89 and 6.76 respectively.)

The standard partial regression coefficients for each of the four inputs were determined from the "Doolittle Solution" and together with the results of the "t" tests, are as follows:-

β' y.1 = .1080 "t" = 1.82 N.S.
β' y.2 = .0972 "t" = 1.64 N.S.
β' y.3 = -.1881 "t" = 3.19 * *
β' y.4 = .3176 "t" = 5.36 * *

The corresponding natural partial regression coefficients were calculated and included in the equation,

$$y = 24.45 + .07x_1 + .21x_2 - .08x_3 + .07x_4$$

(y = "cows milked per labour unit"

As neither the regression coefficient for x_1 nor that for x_2 was significant, the interpretation of this equation was restricted to the variables x_3 and x_4.

(1) When x_1, x_2 and x_3 are held constant, the regression of "replacement numbers per 100 cows in milk" on "cows milked per labour unit" shows that a unit increase in the number of replacements per 100 cows in milk" is associated with a decrease of 0.08 "cows in milk per labour unit".

(2) When similar assumptions are made, a unit increase in "cultivated area" is associated with an increase of 0.07 "cows milked per labour unit".

S E C T I O N X

DISCUSSION OF THE STATISTICAL RESULTS.

The following quotation from Mellor on the role of mathematics in research was given by Mr. A.D. Munro in the Annual Mellor Memorial Lecture in June 1947.

' "There are so many misconceptions about the part played by mathematics in research that I venture to make a brief digression. Thirty years ago I defined mathematics as an economical process of reasoning. I hold the same opinion today. A mathematical demonstration is a powerful auxiliary, for it can guide observations in advantageous and remunerative directions; it can bring to light results previously obscure - but they must afterwards be confirmed by observations before they can be accepted; it can give us some confidence in the results of empirical observations by showing that they fit in with general knowledge so that a series of isolated observations becomes a precise, quantitative part of a general system; it can extend, in certain directions, the range of empirical observations; and it can compress an indefinitely large number of measurements into one, more or less simple rule which enables future workers to progress with a greater economy of thought - e.g. the so-called gas laws.

"A mathematical demonstration is treacherous and deceptive when it gives an appearance of precision and verity to inferences which may be faulty or even false. To me, H.E. Armstrong's battle with the ionic theory of solutions was a timely protest against the tendency of mathematical reasoning to obscure, by a kind of hypnosis, some fundamentally unsound premises. Mathematical demonstrations always proceed from the assumption that the premises are correct. Consequently, the conclusions are at least as vulnerable as are the fundamental assumptions on which they are based. For clear, honest thinking, it is therefore important to have as explicit a statement of the assumptions as it is of the conclusions even though that statement might appear to weaken the force of the argument." '

This quotation is especially pertinent to the following discussion of the statistical results presented in Section IX.

No absolute proof is available in support of the premises postulated in this study, yet in the past, (see Section VI)

sweeping statements have been made by investigators who

have used similar techniques. Fawcett (1932) after having applied a system of correlation analysis, concludes, "It has been mathematically established from a detailed study of 144 Bay of Plenty farms included in this analysis, that the movement in per acre production is influenced by carrying capacity and per cow production in the ratio 2: 1." Similarly Mitchell (1950) makes a statement which, if judged according to the evidence presented, is completely unwarranted. Mitchell (loc. cit) has stated; "In both the farm surveys made about 15 - 20 years ago by Fawcett and the present series of surveys by Hamilton and Mitchell, it is found that high production of butterfat per acre is much more closely associated with high rates of stocking, i.e. carrying capacity, than with high production per cow. From the results of the most recent survey, viz., that of Waipa, it can be estimated that high carrying capacity is at least three times as important as high production per cow for obtaining high production per acre."

It should be pointed out that on the evidence presented by Fawcett (1929) it cannot be justifiably concluded that carrying capacity was"much more closely associated" with production per acre than was production per cow with production per acre. In addition, there exists a highly significant correlation between "carrying capacity" and "production per cow" which effectively complicates the interpretation of calculations which, it is suggested, are indicative of the relative importance of each.

In the present investigation it was appreciated that since the partial regression coefficients were calculated under conditions where, excepting the dependent and the independent variable concerned, all variables were held constant, some restraint was required in interpreting the corresponding prediction equations.

It must be conceded, however, that even though the conditions necessary for the application of a regression analysis may not occur in practice, this particular method enables each input to be tested under similar sets of circumstances and independent of all other factors. Obviously under practical farming conditions, factors of production do not function independently and it is certain that when several inputs are considered together, their cumulative effect is not equivalent to the sum of their estimated independent contributions. Nevertheless the system of regression analysis constitutes a useful comparative method and has served to verify certain results obtained in the estimation of R^2.

Because the most important variables can be selected from the completed solution, the Doolittle method for the determination of R^2 is particularly valuable. Once the value of R^2 has been obtained, a certain proportion of the inputs can be rejected as unimportant in contributing to between-farm differences. The remainder may then be subjected to further testing to ascertain whether some attain importance merely because they are closely associated with genuinely important factors. From these results, the inputs which distinguish farms of different efficiencies can be obtained. It is only by inference, however, that the relationships revealed can be considered as causal and considerable difficulty would be encountered in establishing which were the most important and which the least important of these inputs.

It has been shown in the present investigation, however, that following the estimation of the fraction of the total between-farm variance for "carrying capacity" attributable to nine inputs, only five were selected as major

contributors to this fraction. It is significant that this result could have been predicted if superficial reference had been made to the relevant tabulation analyses. Although there was not quite the same accuracy of prediction, a similar result was obtained for "production per cow", but possibly because R^2 for "cows milked per labour unit" was rather small, there appeared to be, in this case, a lack of agreement between the tabulations and the statistical results. There was ample evidence, however, to prove that both statistical and descriptive methods provided results which were essentially similar.

A comparison of the two methods shows that the statistical approach has the advantage, that the data is subjected to tests which either accept or reject the inputs as important factors of production. The descriptive method proves inadequate in this respect, for it is often impossible to decide just how important certain inputs are and for such cases there is no threshold level which can serve as the determinant. Nevertheless, the agreement between the results derived on the one hand, by the descriptive approach and on the other by statistical procedures, is noteworthy and provides evidence in support of the assumptions made in applying the statistical formulae, viz., that the relationships between all variables are linear.

What was perhaps the most informative feature of the statistical section comprised the results which showed, that the nine selected inputs accounted for only 40%, 23% and 16% of the total between-farm variances for "carrying capacity", "production per cow" and "cows per labour unit", respectively. These nine factors are listed on pages 151 and 153 and since, without exception, they did not account

for as much as one half of the total variance, it was felt that some consideration should be given to the factors which were not taken into account in the survey but which were probably important contributors to the residual variance

Certain inputs have been mentioned which contributed to differences in both "carrying capacity" and "production per cow". By way of illustration, differences in quantity (as measured by weight) and quality of supplementary feed may be cited. It is appreciated also that, depending on the needs of different soil types, responses to different rates of topdressing vary. Even as the "percentage of grassland topdressed" is highly correlated with "production per acre", so also is productivity influenced by the quantity of fertilizer applied.

Soil type and farm location can determine whether or not land requires drainage. Farm drainage programmes, where applied efficiently on land which can benefit from such procedures, will result in marked differences between farms, especially in "carrying capacity".

Other features which distinguish farms, such as differences in the thoroughness of subdivision, whether or not farmers employ the electric fence system of break grazing, practise the autumn saving of grass and employ special purpose pastures can affect both "carrying capacity" and "production per cow".

The ability of farmers to include these and other practices within their farming programmes is often dependent upon the degree of mechanization which has been attained and as a measure of this, the number of tractors per farm is scarcely a fair index.

To the inputs which influence both "production per cow" and "carrying capacity" must be added others which are more specific in their effects on one or other of these outputs. At the present time, it is impossible to obtain a measure of the real genetic merit of each herd, although knowledge of this, would result in a marked reduction in the residual variance for "production per cow".

The regularity and efficiency with which milking is practised can also have quite a considerable influence on the yields of individual cows. Hence, even at this stage, the competence of the farm operator constitutes an important factor in the efficient conversion of grass to milk.

No enumeration of the factors contributing to the residual variance would be complete, without inclusion of the farm operator. The ability of the farm operator constitutes an aspect of farm management which is rarely treated, yet considerable effort should be applied towards the discovery of a reliable index to express managerial capacity. It is appreciated that the farmer's ability is reflected in some measure in the farm returns, but some feature is required which is common to all farm operators yet which will serve as a means for distinguishing men of different ability. Undoubtedly it is of advantage to recognize the important inputs, but ultimately, the degree of success which results from their application depends, in large measure, upon the farm operator.

Westermarck, (1951),although speaking in economic rather than physical terms, expresses this principle clearly when he suggests that

> '"however important the interplay between the natural and economic factors may be, these are even so only the instruments of production. It is the farm operator

> who, with varying success, co-ordinates the means of production. When all is said and done, it is his personal influence that is decisive to the economic results, though of course the extent of the apparatus used must also be taken into consideration."'

From the results of a farmer-opinion survey, Westermarck (loc.cit.) selected "extent of education" and "previous practical farming experience" as two criteria with which to measure operator-ability. His conclusions are worthy of reiteration, not because it is suggested that the technique used is applicable to New Zealand conditions, but rather because of the sound basis they provide for further speculation. Westermarck's findings are summarized as follows:-

> 1.'"In all size groups, the earnings of the sub-group 'Farmers with at least rural secondary school education' exceeds that of the sub-group 'Farmers with only elementary school education'. The difference for all the farmers, taken as a whole, is also statistically significant.
>
> 2." Within all size-groups, the sub-group 'Farmers with outside practice' shows both higher farm family earnings and family earnings from agriculture only, than is shown by the sub-group 'Farmers without outside practice.' The difference for all farmers, taken as a whole, is, however, not statistically significant."'

Westermarck concludes that since "in all comparative groups, farmers with a more thorough practical and theoretical education have achieved better economic results, it cannot be considered presumptuous to assert that this must depend on mental æpacity which here finds expression."

In stressing the importance of the farmer's personal contribution to the enterprise in which he is engaged, Aerebol (1919) maintained that among other things, intensification of production placed increased demands upon the farmer's qualifications and that a rise in the

cultural level implied an increase in the importance of the farmer to final economic results. "The more agriculture develops", he said, "the greater will be the risks to the enterprise, the management of which is non-qualified." This cannot be denied, but it is this increase in the "cultural level" which makes the derivation of a single statistic incorporating the principal features which contribute to farming ability, so difficult.

Westermarck's (loc.cit.) attempt to express mental and physical capacities separately, by reference to academic and farming records, constitutes an interesting approach but one which is scarcely thorough enough for New Zealand conditions. Doig (1940) showed in his standards of life survey, "that there was no apparent relationship between the standard of schooling attained by the farmer and the amount of butterfat produced, nor between schooling and butterfat produced per acre." From data supplied by Wild (1953) it would appear that the chances of indicating effects of different educational levels were greater at the time Doig conducted his survey, than at the present time. The successful implementation of improved farming methods requires that farmers possess an adaptability of outlook and this can be fostered by a sound educational background. Evidence produced by Wild (loc.cit.) and Hamilton (1944) show that the general educational standard of farmers is increasing appreciably.

Doig (1940) indicated that there was no relationship between the age of farmers and the total farm production, but these results were at variance with evidence produced by Pond (1932) in the U.S.A. and Westermarck (1951) in Sweden. During recent years, large numbers of returned

servicemen have settled on the land and consequently, it seems reasonable to suspect that increases in farm output will have been highest amongst farmers in the 30-40 years of age group. A large proportion of these men will have attended intensive farming courses arranged for exservicemen, and if the rising standard of education has conferred an additional benefit, then this particular group of farmers should have a more thorough appreciation of the theoretical aspects of farming than have most of the members of the previous generation. If a situation such as this exists at the present time, then an increase will have occurred in the fraction of the total between-farm variance for operator ability which is attributable to theoretical education.

Obviously both the manual and managerial functions of the operator are closely interrelated and it would appear most satisfactory to combine them in a single index, which even when biassed towards one of the components, could provide reasonable expression for each. For this purpose, a carefully devised intelligence test seems to offer the greatest possibilities and if handled correctly, and used in conjunction with normal survey procedures, could provide information of considerable value.

S E C T I O N XI

SUMMARY OF THE STATISTICAL RESULTS.

By the application of statistical methods, an attempt was made to establish mathematically, the importance of various inputs in farm production as contributors to efficient dairy-farming. For this purpose, three methods of approach were employed.

1. The gross correlation coefficients were calculated between all inputs and outputs. The results were essentially similar to those obtained by Mitchell (1948). The inadequacies of this method were discussed together with certain difficulties encountered in the interpretation of the results.
2. The Doolittle solution was employed for determining R^2 (the square of the multiple correlation coefficients = the fraction of the total variance accounted for) for "carrying capacity", "production per cow" and "the number of cows milked per labour unit". Nine selected inputs for which data were available were used in each analysis, but by using the Doolittle method, a separation of the more important from the less important contributors to R^2 was accomplished.

Thus, although for "carrying capacity", R^2 attributable to the nine factors was 0.4038, it was estimated that only five of them - "soil rating", "cultivated area", "percentage of grassland topdressed", "percentage of grassland cut for hay", and "percentage of grassland cut for silage" made contributions which

produced significant reductions in the residual variance. For "production per cow", R^2 attributable to the nine factors was 0.2256 but only three of these nine inputs namely, "soil rating", "percentage of grassland topdressed" and "replacements per 100 cows in milk" produced significant reductions in the residual variance.

For the "number of cows milked per labour unit", R^2 attributable to nine factors was .1693, but this fraction was almost completely contributed by the two inputs "cultivated area" and "replacement numbers per 100 cows in milk".

Since without exception, the nine selected inputs failed to account for as much as one half of the total between-farm variance accounted for, possible major contributors to the residual variance for "production per acre" were considered. Certain inputs were dealt with in detail and among these, especial emphasis was accorded the human factor and success in farming.

3. The standard partial regression coefficients for all inputs selected as major contributors to the accountable fractions of the total variances for "carrying capacity", "production per cow" and "the number of cows per labour unit", were calculated from the corresponding, completed Doolittle solutions. Application of Student's "t" test showed:-

(a) that the successive regressions of "cultivated area", "soil rating", "percentage of grassland top-dressed", "percentage of grassland cut for hay" and "percentage of grassland cut for silage" upon

"carrying capacity" were all significant;
(b) that the successive regressions of "soil rating", "percentage of grassland topdressed" and "the number of replacements per 100 cows in milk" upon "production per cow" were all significant;
(c) that both the regressions of "cultivated area" and "replacement numbers per 100 cows in milk" upon the "number of cows milked per labour unit", were significant.

The corresponding regression equations were formulated. The difficulties of interpretation and the care necessary in applying regression analysis to farm study data were discussed.

P A R T I I I

PRESENTATION AND DISCUSSION OF THE RESULTS FROM A STUDY IN DAIRY-FARMING TRENDS IN THE WAIPA COUNTY 1941-50

PART III

SECTION XII

PRESENTATION AND DISCUSSION OF THE RESULTS FROM A STUDY IN DAIRY-FARMING TRENDS IN THE WAIPA COUNTY 1941-50

The results presented in this section are derived, for the most part, from a study of year to year and long-term changes in those inputs and outputs first considered in the present management survey (see Section VII).

It was noted in Section VI that when this investigation was commenced, a sample of 400 was selected from the 850 dairy-farms for which full information was available in the 1946-47 season. For the purposes of this study it was essential that the ten years' data collected for these 400 farms referred to a constant area and, consequently, in Table XII, one of the factors listed as responsible for the wastage in numbers of sample farms is "Change in farm area". These data, however, provide material for an interesting trend study and together with certain information on changes in type of farming (which also reduced the final sample size) will be considered briefly.

The year to year fluctuations in both the number of farms and the areas involved in land transactions are shown in FIG. 17. These are presented as percentages of the total number of farms and total area respectively. Complete ownership changes and those resulting in the loss or gain of portions of farm property have been classed as farm

transactions. The salient feature is the sudden rise in the number of transactions recorded in 1949-50, following the repeal of the Land Sales Act. The area changes show a similar, but less marked, trend.

Twenty-five per cent of all sample farms showed complete changes in ownership during the ten years. Of the 75% remaining in the same families, 10% record a transfer to, or subdivision among, other family members.

In the sample of 400 dairy-farms drawn in 1946-47, only two had changed to sheep-farming by 1949-50. Ten farms which were dairying in 1946-47 had been engaged in other types of farming in the period since 1941. These constituted the only alterations in types of farming, a fact which may be considered a tribute to the prosperous state of the Dairy Industry.

Other trends considered were concerned with a constant area, about which full information was available, and consequently the 253 dairy-farms forming the survey sample were used.

Initially all the farms were treated as a collective unit, the nature of the trends or the absence of these being concerned with the whole sample.

Subsequent to this, an attempt was made through various systems of classification, to localize the sources of these trends. In addition, it was hoped by this method to show whether certain annual returns which, though appearing constant for the mean sample farm, were, in fact, on some properties showing changes with time.

With these objects in view, two different schemes for the detailed analysis of all the data were adopted. The first involved the classification of farms according to

between-farm differences in respect of certain features, which for each farm were expressed by ten-year average figures. These are listed as follows:-

1. "Production per cow" (lbs. of butterfat "at the pail").
2. "Carrying capacity" ("stock units" per acre).
3. "Cultivated area" (acres).
4. "Percentage of grassland topdressed with artificial fertilizers".

The second analysis depended on the grouping of farms according to within-farm changes in certain indices. In each case, the changes were measured by the differences between the averages for the first three and last three years during the period 1940-41 to 1949-50. In this manner analyses were completed on the bases of changes in:-

1. "Production per acre" (lbs. of butterfat "at the pail").
2. "Production per cow" (lbs. of butterfat "at the pail").
3. "Carrying capacity" ("stock units" per acre).
4. "Percentage of grassland topdressed with artificial fertilizers."
5. "Percentage of grassland cut for hay."

In the derivation of data for both the mean sample farm and for the more detailed classifications, such indices as "production per acre", "production per cow", "carrying capacity" and all similarly derived ratios were calculated as weighted averages rather than by summing the appropriate terms for individual farms and dividing by the number of properties involved.

As in the dairy-farm management section (Section VII), the various measures of farm efficiency and capacity will be

first considered and, after noting the extent and nature of any trends an attempt made to relate these to associated changes in those managemental factors for which information is available.

Table XXXIV shows changes in "production per acre", "carrying capacity" and "production per cow" for the mean sample farm between the seasons 1940-41 and 1949-50.

TABLE XXXIV

TRENDS IN CERTAIN INDICES OF FARM EFFICIENCY AND CAPACITY.

Season	Carrying Capacity		Butterfat production ("at the pail")	
	Cows per 100 acres	Stock units per acre	Per cow lb.	Per acre lb.
1940-41	62	4.7	289	180
1941-42	63	4.6	265	166
1942-43	62	4.5	249	155
1943-44	62	4.5	253	157
1944-45	64	4.7	281	179
1945-46	63	4.3	229	144
1946-47	62	4.4	265	164
1947-48	63	4.5	260	165
1948-49	64	4.6	285	181
1949-50	66	4.7	275	179

It is apparent that very little change has occurred over the ten-year period, and only in the case of "carrying capacity", when measured in terms of the "number of cows in milk" per 100 acres is any perceptible increase noted. Per acre output shows no definite trend, but considerable year to year fluctuations are evident (FIG.18) and these emphasise the importance of climatic variations.

I. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO CHANGES IN "PRODUCTION PER ACRE" FOR INDIVIDUAL FARMS.

Beneath the apparent constancy of sample averages, it was reasonable to suspect that certain properties had recorded an improvement and others a decline in efficiency. To investigate this possibility, the 253 sample farms were classified into seven groups, according to the nature and extent of within-farm changes for "production per acre". The latter were obtained by estimating the differences between the averages calculated for the first three and last three years of the ten year period. As shown in Table XXXV and FIG. 19, all farms were grouped into seven classes which included at one extreme, farms where the yield per acre had fallen by 50 lbs. of butterfat and at the other, farms where "production per acre" had increased by at least 50 lbs. of butterfat. The distribution of farms, according to the nature of the changes in "production per acre", is decidedly skewed towards the fraction showing increased efficiency. When average per acre butterfat yields for the first three and last three years are compared, the reason for this bias is revealed as an 8 lbs. increase in the latter.

TABLE XXXV

DISTRIBUTION OF FARMS ACCORDING TO CHANGES IN PRODUCTION PER ACRE FOR INDIVIDUAL FARMS

Prod. per acre diff.(lbs.B/F.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
No. of Farms	7	16	48	59	62	39	22
No.of farms as a percentage of all farms	2.8	6.3	19.0	23.3	24.5	15.4	8.7

Thus, of all sample farms, approximately 28% showed a definite decrease in "production per acre", 23% maintained a

reasonably stable condition and 49% recorded improvements of varying degree.

(a) "Production per acre" and "Production per cow"

For the seven farms where the greatest losses occurred, an average decrease of 65 lbs. of butterfat per acre was noted, compared with an increase of 69 lbs. of butterfat per acre for the 22 farms where the greatest gains were made. It was shown that although changes in "production per cow" were not so marked, the trends were similar for all groups. Tables XXXVI and XXXVII show that where losses in "production per acre " and "production per cow" were recorded, the greatest rate of decline occurred in the initial years, whereas where increases occurred, most of these were accomplished towards the end of the period. To abbreviate the original tables and to reduce seasonal effects as far as was possible, these data were presented in condensed form, by combining three years' returns into a single statistic.

TABLE XXXVI

TRENDS IN PRODUCTION PER COW

(LBS. B/FAT "AT THE PAIL")

No. of Farms	7	16	48	59	62	39	22	253
Prod. per acre change (lbs.B/Fat)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Av.
1941 - 43	275	282	275	273	260	263	247	268
1944 - 46	241	262	254	254	251	258	255	255
1948 - 50	227	258	258	273	275	285	303	273

TABLE XXXVII

TRENDS IN PRODUCTION PER ACRE

(LBS. OF B/FAT "AT THE PAIL")

No.of Farms	7	16	48	59	62	39	22	253
Prod.per acre change (lbs.of B/F)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Av.
1941 - 1943	216	182	183	174	158	148	152	167
1944 - 1946	177	161	163	162	157	152	168	160
1948 - 1950	151	136	165	174	178	186	221	175

A noteworthy feature is the similarity in the trends for "production per cow" and "production per acre". During the period 1941-43, farms which ultimately showed the greatest decline in output per cow and per acre were producing at higher levels than others which later recorded the greatest improvements. For 1944-46, the between-group differences for both "production per cow" and "production per acre" were quite small but by 1950 a complete reversal of the conditions existing in 1941 had occurred. Many farms, which in the initial years had been producing below capacity, by 1950 had increased their yields to well above the average. There were, however, a considerable number of farms for which a trend was obtained which was almost the complete reversal of this.

(b) "Carrying capacity".

When "carrying capacity", the other component of "production per acre" was considered, the magnitude of the changes resulting in the lowered per acre returns was quite clearly expressed.

TABLE XXXVIII

TRENDS IN CARRYING CAPACITY

(COWS PER 100 ACRES)

No.of Farms	7	16	48	59	62	39	22	253
Prod.per acre change (lbs.of B/F)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Av.
1941 - 1943	79	64	66	64	61	56	62	62
1944 - 1946	73	61	64	64	63	59	66	63
1948 - 1950	67	53	64	64	65	65	73	64

Alterations in herd size determined that in one of the extreme groupings 11 cows per 100 acres were added, whilst in the other, 12 fewer cows per 100 acres were carried. When these were expressed as percentage changes (plus 8% and minus 15%), however, it was apparent that alterations in "carrying capacity" were in no way comparable with those for "production per acre" and "production per cow". By studying the nature and extent of differences between group and sample averages in Tables XXXVI, XXXVII and XXXVIII, these tentative conclusions were confirmed. In Table XXXVI, where"production per acre" had declined by more than 50 lbs. of butterfat per acre, output per acre had been initially well above the sample average, but subsequently had fallen considerably below this standard. The complete antithesis of this situation was evident for farms on which comparable per acre increases had been obtained. By reference to Table XXXVIII it was apparent, however, that such extreme changes had not occurred for the "carrying capacities" and that during the seasons 1941-50, the seven properties exhibiting greatest losses in "production per acre" were

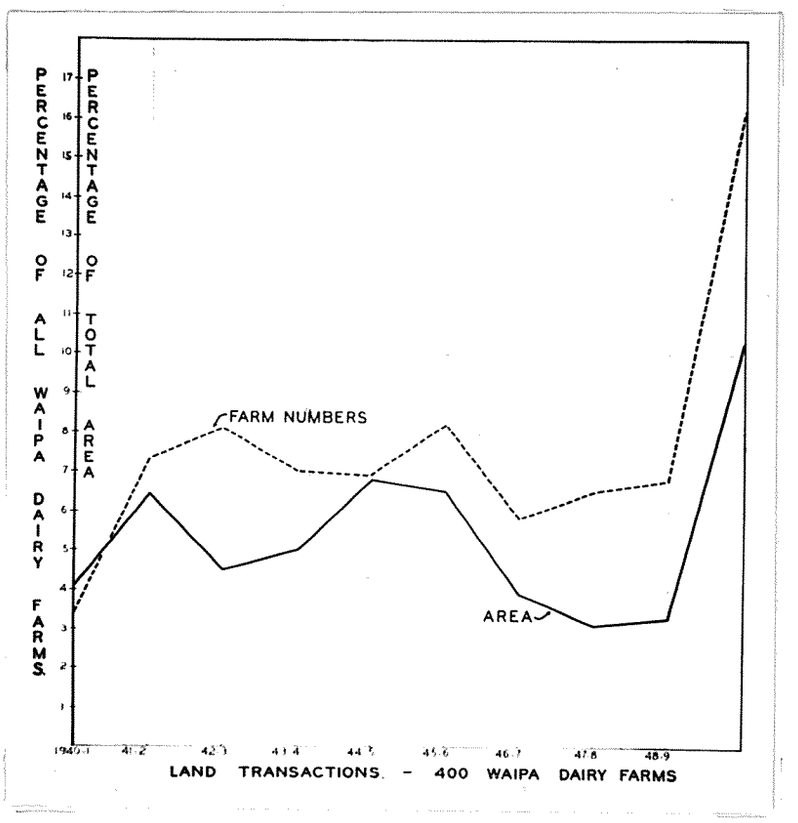


FIG.17: Land transactions for 400 Waipa dairy-farms between 1941 and 1950.

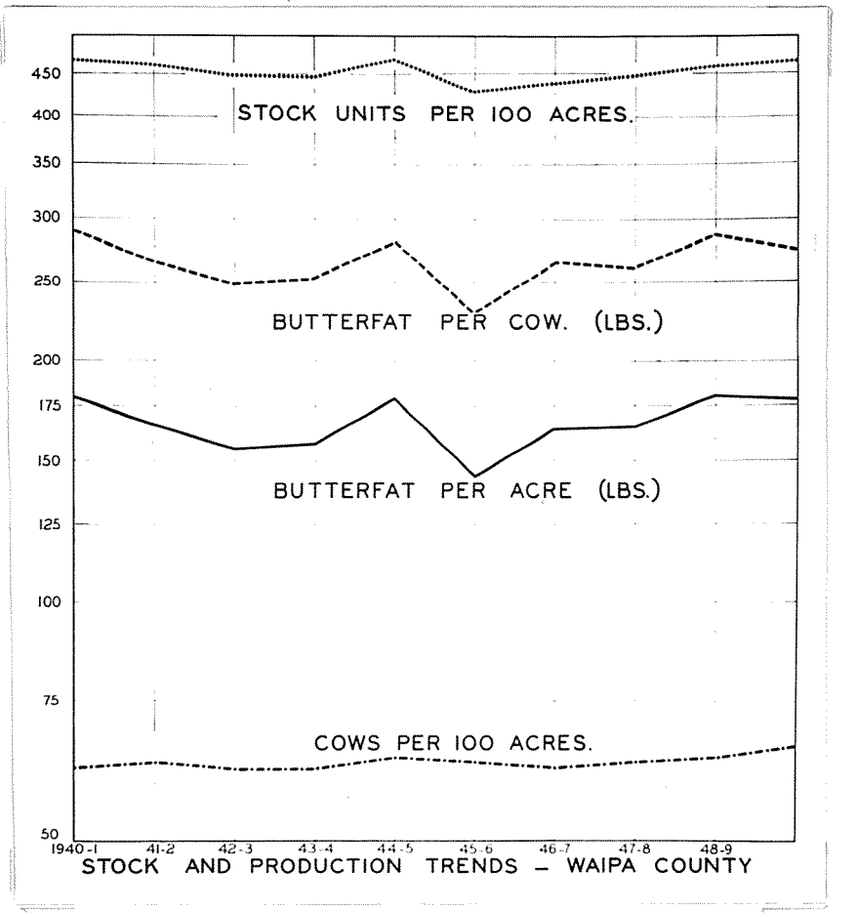


FIG.18: Trends in "production per acre", "production per cow" and "carrying capacity" for the mean sample farm.

running more cows per 100 acres than the mean sample farm.

The cumulative effect of either increasing or decreasing "carrying capacity" and "production per cow" is illustrated in FIG. 20, which shows the trends in the mean total production for each grouping.

As might have been anticipated, a rise in "production per acre" was associated with an increase in the total farm output. For each grouping, the magnitude of the changes in total output were comparable with those for "production per acre".

(c) Total Farm Production.

It was noted previously that actual changes, whether positive or negative, were of similar magnitude for both "production per cow" and "carrying capacity". This situation was in marked contrast to that apparent for total farm output, since both on an actual and a percentage basis, increases in total yield were much greater than the losses incurred where "production per acre" had fallen. The results obtained from farms included in the two extreme groups (± 50 lbs. of butterfat per acre) of the analysis are cited to illustrate this feature. One set of conditions has produced a 45% increase, amounting to 5,386 lbs. of butterfat per farm, whilst the other has resulted in a 19% decrease of 3,063 lbs. of butterfat. In terms of total production, those farmers who achieved the largest improvements were the smallest producers in the season 1940-41, but by 1949-50 the average production of their group had become the second largest and this position was attained without increasing the "cultivated areas" of their properties. (Refer to Appendices xxvii and xxviii.)

The climatic conditions during 1940-41, 1944-45 and 1948-49 were particularly suitable for dairying, but it was

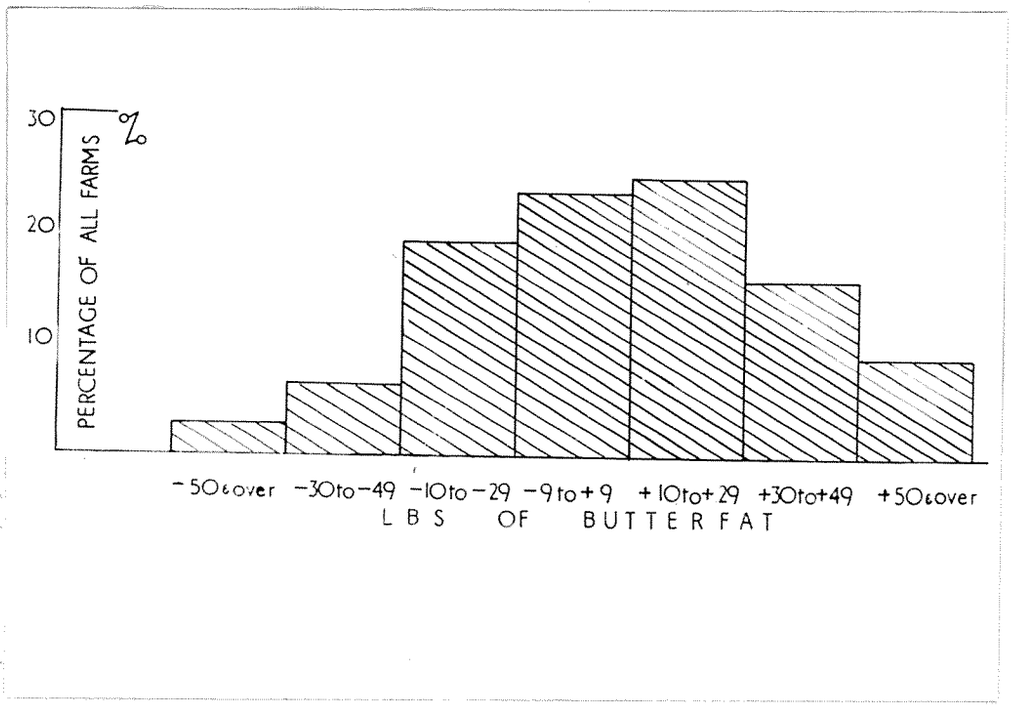


FIG.19: Distribution of farms according to the nature and extent of changes in "production per acre."

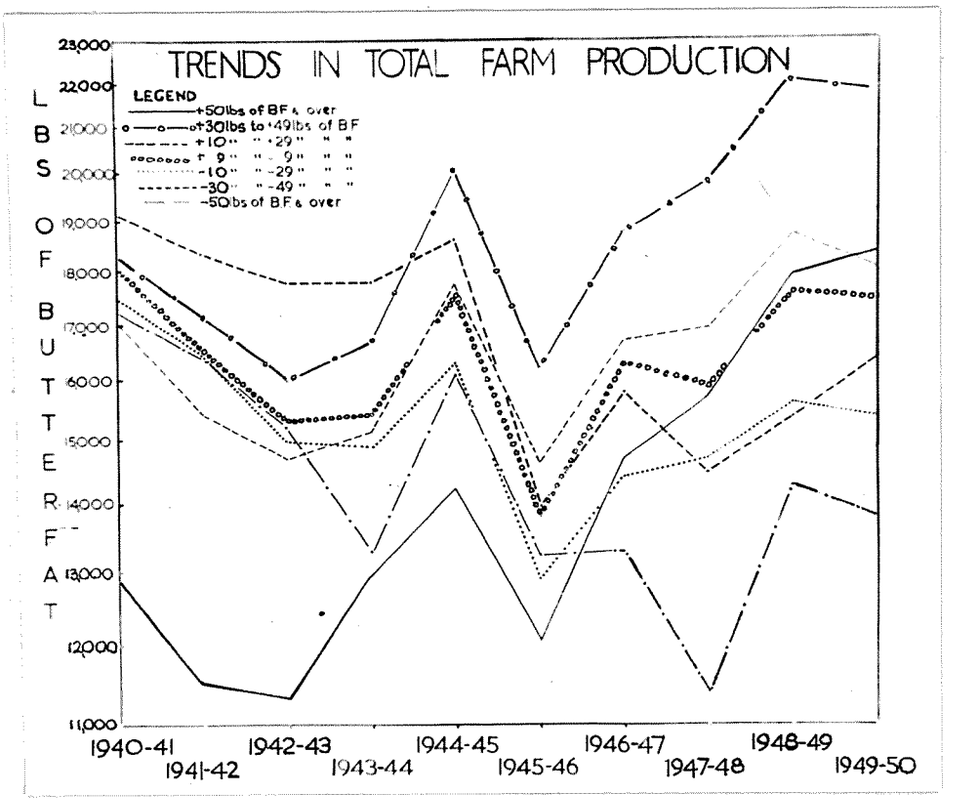


FIG. 20: Trends in total farm production for properties grouped according to the nature and extent of changes in "production per acre."

noticeable that total yields for 1940-41 were exceeded in later seasons only on those farms where improvements in farming efficiency had occurred. If the particularly bad summer of 1945-46 is excepted it can be stated with reasonable assurance, that the only farms which maintained a steady improvement regardless of seasonal fluctuations, were those constituting the group where output per acre increased by more than 50 lbs. of butterfat.

(d) The effect of season on farm output.

In Section IV, Tables VIII and IX provided some details concerning the climate of the Waipa County. If Table VIII is considered in conjunction with dairy production returns referring to the same seasons, the fallacy of attempting to relate annual rainfall data to total production becomes apparent. As indicated in Table VIII, between 1941 and 1950 the highest average temperature was recorded in 1946. During this year, nearly 51 inches of rain fell, a quantity which was exceeded only on one other occasion during the ten years, and, for the same period, the total number of wet days, viz., 206, constituted a record. Superficially it appeared that these returns were the reflection of a year, climatically suitable for high production. Consideration of dairy production for the Waikato showed however, that the reverse was true and a more thorough analysis of the data revealed the reason for this apparent contradiction.

It is appreciated that for the maintenance of high production, provision of adequate feed is essential during the months December to March and conditions of temperature and rainfall will determine in large measure, the quantity available.

Some degree of independence is obtained during this time, only where irrigation or a regular summer cropping

policy is applied. For this reason, climatological data referring to the months December, January and February should be analysed separately for each season, if it is hoped to correlate dairy production with some aspects of climate. The information relevant to this investigation appears in Table IX, and reveals the reason for dairy production in the Waikato slumping so dramatically during 1945-46. Apart from this evidence, however, Table IX provides less information than might have been anticipated from our knowledge of seasonal effects on production. The best example which can be cited in support of this contention, involves the climatic dissimilarities between the years 1940-41, 1944-45 and 1949-50, all of which were periods of high production. In some instances a comparatively low total rainfall was compensated for by a particularly good distribution during the vital summer period. Thus, the production obtained in certain seasons was equal to that secured in other seasons when the total rainfall was much greater. It may be concluded therefore, that although apparent anomolies in the general association between rainfall data and total production can often be explained on these grounds, climatological data possess the rather unsatisfactory feature, that no single statistic is available which can represent satisfactorily, the feature of climate which has the greatest influence on farm production.

For the dairy-farmer 1946 was a particularly poor year but, for the purposes of this survey, it provided data on the way in which different properties farmed at different levels of efficiency were affected by a period of intense drought. The effect of the dry period on production for the same season and the extent of recovery in the following year is shown in Table XXXIX.

TABLE XXXIX

THE EFFECT OF CLIMATE ON PRODUCTION.

No.of Farms	7	16	48	59	62	39	22	253
Prod./acre difference (lbs. of butterfat)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Av.
1944 - 45	16105	18619	16307	17549	17708	20078	14386	17495
1945 - 46	13069	13908	12876	13823	14633	16216	12329	14066
1946 - 47	13127	15775	14385	16285	16680	18767	14673	16144
Percent. decline in B/F prod. (1945-46)	-19%	-25%	-21%	-21%	-17%	-19%	-14%	-20%
Percent. increase in B/F prod. (1946-47)	+0.4%	+13%	+12%	+18%	+14%	+16%	+19%	+15%

By using the sample mean as a standard and comparing, between groups, the percentage changes in total production, it became apparent that the effects of poor seasons were most severe where "production per acre" had already been declining for several years. In addition, as indicated in Table XXXIX, the extent of recovery following any setback was usually greatest amongst those farms which had been showing upward trends in production. Hence the response to better conditions was least marked on the 71 farms on which, between 1941 and 1950, output per acre fell by more than 9 lbs. of butterfat.

For the seven properties on which the decline in "production per acre" was most severe, the dry summer of 1945-46 produced effects from which there was apparently no recovery. Continuous losses in total yields were recorded for these farms until 1947-48, when the returns

per acre and per cow reached their lowest levels. Subsequently some measure of recovery was obtained but it seemed that in 1950, these farms were still suffering from the long-continued effects of the drought. (Refer Appendix xxvii)

FIG.20 illustrates the trends in total butterfat production for all farms classified according to the nature and extent of changes in output per acre. It is apparent that where improvements in total production were large, most progress was made during the latter years, and this contrasts with results from farms on which the decline in "production per acre" was appreciable.

The graphical presentation of this data emphasizes the wide year to year fluctuations in total output. These cannot be attributed solely to year to year variations in the quantity and the distribution of local rainfall for the months December, January and February (refer Appendix clxiv). It is quite conceivable, however, that a wide within-sample range in farmer ability can serve as a powerful modifier of climatic effects.

(e) "Cultivated area"

Where the efficiency of production had declined, a remarkable situation was apparent, for, as indicated in Appendix xxviii, considerably more land was brought into production on these properties than on the remainder. There was a close relationship between changes in "production per acre" and changes in the "effective area". Where the greatest improvements had been made in production per acre, there were no real changes in "cultivated area" and it is therefore difficult to understand the policy of farmers who had increased their "effective dairying areas"

by as much as 16% but had not fully utilized the land previously available to them. It might be argued that where increases in "effective area" were secured during the latter half of the period, insufficient time had elapsed for the returns from this policy to be realized. It is apparent from Appendix xxviii, however, that although the greatest proportion of additional land was brought into production in the latter half of the decade, certain increases occurred throughout. When the levels of production attained on these properties are considered, it is difficult to believe that the introduction of land which was previously unproductive, is a more economical method of increasing output than is one which involves the improvement of the original "cultivated area".

(f) Size of herd.

When alterations in herd size and output were considered in conjunction with the results presented in the previous section, certain other peculiarities appeared. These were noted as follows:-

(1) A reduction in the "number of cows in milk" was associated with a decline in "production per acre" and an increase in "effective area".

(2) As "production per acre" increased there was an associated increase in "the number of cows in milk." These changes which had been completely obscured in the 5% increase for the mean sample farm, amounted to a decline in cow numbers of 8% at one extreme, and to an increase of 19% at the other.

(g) Replacement stock.

Although on most farms there was a tendency for the average number of young-stock to increase, this

generalization did not apply to properties where output per acre had risen by more than 30 lbs. of butterfat. Indeed, Table XL shows that where the increase in production per acre exceeded 50 lbs. of butterfat a decline in replacement numbers occurred even when the number of heifers was expressed as a percentage of all cows in milk.

TABLE XL

THE NUMBER OF HEIFERS (1 - 2 yrs) PER 100 COWS IN MILK.

No.of Farms	7	16	48	59	62	39	22	253
Prod. per acre diff. (lbs.of B/F)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Tot-al
1941 - 43	11	12	13	11	14	17	13	14
1944 - 46	15	12	15	15	16	15	15	15
1948 - 50	16	16	15	15	16	17	11	15

(h) Supplementary feed.

As a result of the wide range in production trends shown for individual farms, it was considered important to determine whether farmers who had increased output had made more thorough use of feed surpluses when they were available. Little evidence to support this contention was obtained from the data relating to the provision of supplementary feed supplies.

For each of the seven different farm groupings, the trends in areas cropped were all very similar to that for the sample averages. Similar results were obtained for the areas cut for hay and silage. Although farmer-estimates of the yields of hay and silage are notoriously inaccurate,

these data were considered quite valuable in the analysis of trends. No measure of the repeatability of farmer-estimates is available, but it can beassumed that in any year, competent farmers are capable of estimating their supplementary feed supplies relative to those available in the previous season.

Even with the inclusion of information on the yields of hay and silage, however, no factual evidence was available to support the suggestion that additional supplies of these forms of supplementary feed had contributed to the large increases in "production per acre" on certain farms. Rather, the most notable feature made apparent from the relevant data in Appendix xxxvi was that where "production per acre"had fallen by 50 lbs. of butterfat, although by the end of the ten year period the quantity of silage per cow had declined by about 20%, that which remained was still greater than the amount available per cow in any other group, at any time during the ten years. Trends in the quantity of hay per cow followed a more regular pattern which was expressed by little, if any change where increased output per acre was obtained, and by a definite increase where "production per acre" had fallen. No evaluation of the quality of either the hay or the silage was possible, and if reliance had been placed solely on farmer-estimates of quantity for comparing between groups, the yields of hay per acre and the amounts available per cow, the results would have been subject to considerable error. Nevertheless, if the provision of supplementary feed had been an important factor in improving per acre returns, corresponding changes in hay, silage and cropping would have been expected. Since these were not apparent, it was concluded that the feeding of different quantities of hay, silage

and crops contributed very little to the remarkable within-farm variance revealed for "production per acre".

II. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO BETWEEN-FARM DIFFERENCES IN "CARRYING CAPACITY".

It is clear from Table XXXIV that for the mean sample farm, year to year changes in "carrying capacity" were quite small and only in 1949-50 was there any appreciable increase in the dairy cow numbers per 100 acres. It did seem, however, that where there were wide differences between farms in "carrying capacities", there were real possibilities for discovering changes in certain inputs which, for the whole sample, appeared relatively constant. As a result, a system was adopted which involved grouping all farms according to the average number of "stock units" carried per acre during the seasons 1941 to 1950. This was the same method for grouping farms as was employed in the management survey and the number of farms included in each group together with the limits defining each are shown in Table XLI.

(a) "Carrying capacity"

Certain differences in the nature and extent of trends in "carrying capacity" depended upon whether the latter was expressed as "stock units" per acre or "cows in milk" per 100 acres. Since "stock units" were influenced to some extent by butterfat production per cow, in considering "carrying capacity" most attention was accorded data which referred to"the number of cows in milk".

TABLE XLI

TRENDS IN "CARRYING CAPACITY"

("COWS IN MILK" PER 100 ACRES)

No.of Farms	14	22	57	90	47	16	7	253
Carrying Capacity (Stock units per acre)	below 3.5	3.5 - 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus	Av.
1941 - 43	44	50	59	64	71	77	85	62
1944 - 46	44	51	59	65	72	78	88	63
1948 - 50	41	56	61	67	72	76	87	64

Where "carrying capacities" were between 3.5 and 5.5 "stock units" per acre, slight but regular increases in the number of cows per 100 acres occurred. These were similar to the changes in the sample mean, but outside these limits certain peculiarities appeared. Where "carrying capacities" were less than 3.5 "stock units" per acre, a reduction in the number of cows per 100 acres was noted in every season subsequent to the severe drought of 1946. For properties which were farmed intensively, increases in "carrying capacity" occurred during the mid-years of the ten year period and in all the cases where deviations from the average trend were noted, maximum "carrying capacities" were attained in the season 1944-45.

(b) "Production per cow" and "Production per acre"

The trends for both "production per acre" and "production per cow" followed the same pattern as outlined for "carrying capacity". Consequently, the absence of any observable trend in "production per acre" for the mean sample farm was the result of the slight improvements achieved on dairy-farms of average "carrying capacities", which served to minimise certain losses recorded on

farms in the extreme groupings.

(c)"Cultivated area".

Appendix lvi shows that farms contributing most to the 2% increase in the average "cultivated area" were those properties where stock numbers per acre were low and where farm area was considerably above average. The greatest increase (9%) in "cultivated area" occurred in the group composed of the 14 farms with lowest "carrying capacities", whereas the "effective areas" of farms with high average"carrying capacities" remained unchanged. Thus, as a result of the efforts of certain farmers over a period of ten years, 687.25 acres were converted from unproductive to productive purposes.

TABLE XLII

TRENDS IN CULTIVATED AREA (ACRES)

No. of Farms	14	22	57	90	47	16	7	253
Carrying Capacity (Stock units per acre)	below 3.5	3.5 - 3.99	4.0 - 4.49	4.5 - 4.99	5.0 - 5.49	5.5 - 5.99	6.0 plus	Av.
1941 - 43	108	115	109	97	83	78	47	97
1944 - 46	110	116	110	98	84	78	47	98
1948 - 50	118	119	112	98	85	78	47	99

(d) Herd size.

Between 1940-41 and 1949-50 the total dairy cow numbers increased from 15,153 to 16,340 "cows in milk". In contrast to the changes in "cultivated area", there was, with one exception, an increase in herd size in each of the "carrying capacity" groupings. For individual groupings these increases were quite small, but when measured in total they accounted for an 8% increase in the number of cows milked (refer to Appendix lvii).

(e) Dairy herd replacements.

Data relating to the number of heifers showed that during the ten year period, a slightly greater increase had occurred in replacement numbers than in "the number of cows in milk." Within each "carrying capacity grouping" there was a regular increase in the number of heifers per 100 acres between 1941 and 1950 (Appendix lv). As might have been anticipated, where the concentration of cows per 100 acres increased, there was an associated increase in the average number of replacement stock, with the result that at all times, there were between "carrying capacity" groups, quite small differences in the numbers of replacements retained per 100 "cows in milk". In addition, it was shown that in any year, only 14% of farms comprising the two lowest carrying capacity groupings, retained fewer heifers per 100 acres than were recorded for the mean sample farm.

(f) Supplementary feed.

Because of the restricted nature of the data, the problem of relating the various trends in butterfat production to availability of feed supplies, was a difficult one. Contributions from crops, hay and silage can provide only a small part of the total annual requirements for the dairy herd, but because they can be utilized during periods of pasture shortage, their importance must not be under-estimated. Thus, even though quantitative changes in these factors do not always appear to be directly related to alterations in farm output, they can contribute by other means to the total between-farm variance. For those farmers who practised cropping and whose properties were located in the three lowest "carrying capacity "groupings,

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

small but definite increases in the areas cropped were recorded between 1941 and 1950. Those farmers included in the remaining four groups, tended to increase their areas in crops during the war years, but in 1946-47 when the subsidy on crops grown for pigfood was removed, much of this land reverted to pasture.

The small average increase in the area cut for hay recorded for the mean sample farm during the ten year period was typical of a trend that applied to all farms, regardless of differences in "carrying capacity".

The area devoted to silage making increased steadily between 1941 and 1950 for farms on which less than 5.0 "stock units" per acre were carried. The greatest change, amounting to a 66% increase was noted on properties, the "carrying capacities" of which averaged less than 3.5 "stock units" per acre. Until 1949-50, when a general increase in the popularity of silage occurred, the data suggested that where intensive systems of farming had been applied, the practice of silage making had fallen from favour.

Only on farms of average "carrying capacities" was any evidence available which suggested that the weight of silage per cow had increased between 1941 and 1950. By contrast, between 1947 and 1950 the weight of hay saved per cow increased appreciably on those farms carrying more than 5.0 "stock units" per acre.

TABLE XLIII

WEIGHT OF SILAGE PER COW (TONS)

No. of Farms	14	22	57	90	47	16	7	253
Carrying Capacity (stock units per acre)	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.00 plus	Av.
1941 - 43	.16	.28	.33	.24	.31	.39	.46	.29
1944 - 46	.11	.18	.25	.21	.21	.17	.23	.21
1948 - 50	.13	.17	.30	.33	.41	.31	.29	.31

TABLE XLIV

WEIGHT OF HAY PER COW (TONS)

No. of Farms	14	22	57	90	47	16	7	253
Carrying Capacity (stock units per acre)	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.00 plus	Av
1941 - 43	.53	.60	.53	.54	.48	.44	.47	.52
1944 - 46	.54	.51	.49	.51	.50	.42	.39	.50
1948 - 50	.50	.60	.56	.54	.54	.51	.55	.54

(g) Topdressing.

For farms on which "carrying capacities" were high, the wartime rationing of fertilizers induced only small reductions in the areas topdressed. Obviously these farmers had reacted to the restrictions placed on the importation of phosphates and other artificial fertilizers by reducing rates of application, but it was impossible to conclude from the information available,

whether this compromise materially affected the amount of butterfat produced during the period of rationing.

(h) Machinery and farm labour

The remainder of the "carrying capacity" analysis was concerned with :

1. Changes in both the size of the milking plant and the number of tractors per farm for which data were available for only seven of the ten seasons.

2. Changes in the farm labour force, detailed returns for which covered only the four seasons, 1946-47 to 1949-50.

Since, without exception, trends within any grouping did not differ appreciably from those for the mean sample farm, the detailed presentation of these data was considered unnecessary and consideration was given instead to the results obtained when farms were classified according to within-farm changes in "carrying capacity".

III. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO CHANGES IN "CARRYING CAPACITY" FOR INDIVIDUAL FARMS.

By grouping properties according to the within-farm changes in "carrying capacity", the 253 dairy-farms were classed in five "carrying capacity" groupings, the extreme members of which involved changes both positive and negative of $\frac{3}{4}$ of a "stock unit" per acre.

FIG.21 which shows the normal distribution of all farms between the different groupings, serves to illustrate the reason for the "carrying capacity" of the mean sample farm remaining relatively constant between 1941 and 1950.

(a)"Carrying Capacity"

Depending on whether the analyses were concerned with "the numbers of cows in milk" per acre or "stock units" per acre, differing degrees of change were observed. Illustrating this were the results for farms included in the two extreme groupings (±0.75"stock units"per acre), where losses of 19% and gains of 26% were apparent in "the number of cows" per 100 acres, whereas the comparable figures for "stock units" per acre were 24% and 26% repectively.

TABLE XLV

TRENDS IN CARRYING CAPACITY

("COWS IN MILK" PER 100 ACRES)

No. of Farms	22	54	85	68	24	253
Carrying Capacity change (Stock units per acre)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus	Av.
1941 - 43	64	66	64	60	54	62
1944 - 46	61	63	64	62	59	63
1948 - 50	52	62	66	67	68	64

In both cases, the rates of change were accelerated after 1945, the main increases in "carrying capacity" occurring during the seasons 1944-45 and 1947-48, whilst for farms on which substantial losses were recorded in "carrying capacities" no appreciable recovery was evident following the summer drought of 1946. Where the rise in "carrying capacity" reached a maximum, this increase, which was continuous regardless of season, established a situation

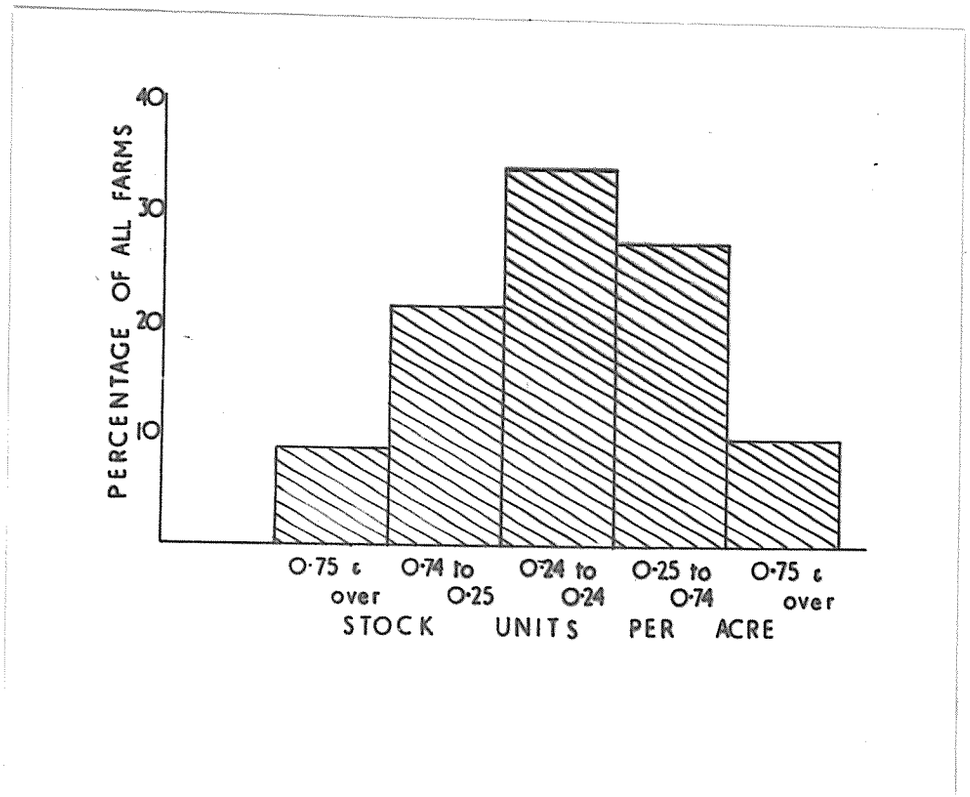


FIG.21: Distribution of farms according to the nature and extent of changes in "carrying capacity".

which was peculiar to this group of farms. In 1941, the mean "carrying capacity" of this group, which was then in the vicinity of ½ a cow per acre represented the lowest rate of stocking of any group at that time. Changes in farming policy, however, subsequently effected increases in the mean "carrying capacity" of this group of farms to such an extent that by 1950 the latter was higher than had been recorded in any group, at any time previously.

(b) Size of herd.

Rather similar to the trends in "carrying capacity" were those referring to herd size and it was clear that in certain groups, the percentage increases in cow numbers were somewhat of the same order as the comparable improvements in "carrying capacity". Where the concentration of stock had declined, some reductions in herd size had resulted, but, as shown in Table XLVI, these losses were in no way comparable with those for "carrying capacity".

TABLE XLVI

TRENDS IN THE SIZE OF HERDS.

No.of Farms	22	54	85	68	24	253
Carrying Capacity change (Stock units per acre)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus	Avrg.
1941 - 43	60	60	63	61	47	60
1944 - 46	59	59	64	63	52	61
1948 - 50	57	59	66	67	59	63

It was found instead, that the factor which contributed most to the overall reduction in carrying capacity was the large area of land brought into production by farmers included in this group. Three hundred and ninety-two acres, most of

which were added during the latter years of the ten-year period, produced a 17% increase in average "effective area" on each of the 22 farms, showing losses greater than 0.74 "stock units" per acre. Thus, increased "cultivated area" and reduced herd size ensured a decline in "carrying capacity".

(c) Farm production.

Associated with the within-farm changes in "carrying capacity" there were alterations in total farm production. For each farm these changes were proportionately the same as were previously recorded for herd size (Appendix lxxiv). Hence, in spite of the efforts of farmers to increase their "cultivated areas", by the end of the ten-year period total yields were still considerably below those obtained in 1941 when "carrying capacities" were much higher. Greatest increases in total outputs occurred on farms where the most striking improvements in "carrying capacities" had been made, and between 1941 and 1950 the percentage increases for total production and "carrying capacity" were 21% and 26% respectively.

(d) "Production per acre", "Production per cow" and "Carrying capacity".

As indicated by Table XLVII, when farm output was expressed as "production per acre", the within-group trends were practically indentical with those for "carrying capacity" (measured as "cows in milk" per 100 acres).

TABLE XLVII

TRENDS IN PRODUCTION PER ACRE (LBS. B/FAT)

No.of Farms	22	54	85	68	24	253
Carrying Capacity change (Stock units per acre)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus	Aver-age
1941 - 43	171	178	171	159	144	167
1944 - 46	157	160	164	158	150	160
1948 - 50	138	167	182	183	186	175

By comparison, the contributions of "production per cow" to both positive and negative changes in "production per acre" were particularly small.

TABLE XLVIII

TRENDS IN PRODUCTION PER COW (LBS.B/FAT)

No.of Farms	22	54	85	68	24	253
Carrying Capacity change (Stock units per acre)	- 0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus	Aver-age
1941 - 43	267	270	268	265	267	268
1944 - 46	255	254	255	254	253	254
1948 - 50	265	268	277	275	275	273

Although alterations in "production per cow" were generally associated with similar changes in "carrying capacity", the former were always comparatively small. This was shown from results for the ten-year period supplied by the farms on which "carrying capacities" had increased by at least 0.75 "stock units" per acre. For these farms,

the average "production per cow" had increased by approximately 4% between 1941 and 1950, compared with increases of 12% and 15% noted for "carrying capacity" and "production per acre" respectively.

These facts can be interpreted as showing that 92 dairy-farmers, representing 36% of all sample farmers, with no apparent attempt at improving dairy merit, but simply by improving "carrying capacity", have increased both total and per acre yields substantially. Prior to 1946-47, the average "production per acre" of this group of farms was regularly well below the sample mean, but subsequently, the gap between sample and group averages widened and reached a maximum in 1949-50.

Within this same group, however, trends in "production per cow" provided quite a different picture. (See Appendix lxx) On four occasions, between 1941 and 1947 the average of the group (+0.75 plus "stock units" per acre) exceeded the sample mean and, on occasions, when the latter exceeded the former the difference never amounted to more than 9 lbs. of butterfat per cow. Contrast this with the situation already referred to (Appendix lxxi), in which between 1941 and 1947 the group average was always less than the sample mean and the maximum difference amounted to 25 lbs. of butterfat per acre.

These results serve to emphasise, first, the lack of correspondence between the trends in per cow and per acre productions and, secondly, the very important role of "carrying capacity" in ensuring improved farming efficiency on many dairy-farms.

From experience gained in the survey section, it was appreciated that the results obtained from one analysis were often contradicted when additional investigations

were conducted to test the validity of tentative conclusions made. Thus, in view of the importance of both "carrying capacity" and "production per cow"as the components of "production per acre"and partly as a consequence of the results presented above, additional analyses were conducted in which "production per cow" was included as the dependent variable.

IV. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO BETWEEN-FARM DIFFERENCES IN "PRODUCTION PER COW".

All dairy-farms were grouped according to their ten-year herd averages into six classes as shown in Table XLIX.

(a) Farm livestock and production.

Regardless of the extensive differences in herd averages between sample farms, the trends for the average herd size, the numbers of replacements per farm and the total outputs per farm were similar in all groups to those recorded for the mean sample farm. Essentially similar results were obtained for output per cow, output per acre and "carrying capacity". For the first two of the three, however, certain interesting features became apparent as a consequence of the dry summer of 1946.

Table XLIX indicates for each group of farms, the decline in "production per acre" from 1944-45 to 1945-46 and also the extent of the recovery in the following year.

TABLE XLIX.

THE EFFECT OF CLIMATE ON "PRODUCTION PER ACRE" (LBS. OF BUTTERFAT)

No. of Farms	21	39	73	67	38	15	253
Butterfat per Cow (lbs.)	below 220	220-239	240-259	260-279	280-299	300 plus	Average
Decrease in production per acre between 1945 & 1946 (lbs.of B/F)	19	31	36	35	46	47	35
Increase in production per acre between 1946 & 1947 (lbs.of B/F)	7	12	24	24	26	26	20

It was apparent that the severity of the effects induced by the drought were directly related to the magnitude of the herd averages and consequently, farms with high herd averages suffered the greatest losses in "production per acre". In 1947 when feed conditions were more typical, dairy-farms showing the greatest recoveries were those with highest per cow productions. Although during the same period, the changes in "production per cow" were considerably larger than those for "production per acre," as shown in Table L, they were similar in nature.

TABLE L

THE EFFECT OF SEASON ON "PRODUCTION PER COW" (LBS. OF BUTTERFAT)

No. of Farms	21	39	73	67	38	15	253
Butterfat per Cow (lbs.)	below 220 lbs.	220-239	240-259	260-279	280-299	300 plus	Average
Decrease in production per cow between 1945 & 1946 (lbs. of B/F)	38	45	51	50	65	67	52
Increase in production per cow between 1946 & 1947. (lbs. of B/F)	22	29	36	35	44	56	36

For the same years losses in the number of cows per 100 acres were noted, but it was impossible to express these in a manner comparable with that previously adopted. However, between 1945 and 1946 a decline in "carrying capacity" occurred in most groups and without exception, there was a considerable time-lag before "carrying capacities" returned to normal. For the 60 farms on which herds averages were less than 240 lbs. of butterfat per cow, the "carrying capacities" of 1945 were not recovered by 1950.

(b) "Cultivated area"

Contrary to the results obtained in all the previous analyses, changes in the "effective areas" occurred in every grouping.

(c) Supplementary feed.

For five of the six groups, the trends in the areas sown in crops were similar to the trend for the mean sample farm on which increases continued until 1946-47 and were subsequently succeeded by a decline,

which, however, did not reduce the area cropped below the 1941 average. The single exception concerned farms on which group herd averages were less than 220 lbs. of butterfat and on these properties, rather irregular increases occurred between 1941 and 1950 which ultimately resulted in a 46% addition to the average area cropped.

Such rather unspectacular changes were typical of data which referred to farm areas used in the provision of supplementary feed.

Within every group there were indications of small increases in the areas cut for both hay and silage during the ten year period and although a similar trend was noted for the yield of hay per farm, greatest increases in the average yield of silage were restricted to farms where per cow productions exceeded 300 lbs. of butterfat. Tables LI and LII indicate that trends in the quotas of hay and silage available for cows producing at different levels are essentially similar to those for the average yields of hay and silage.

TABLE LI

WEIGHT OF HAY PER COW (TONS)

No. of Farms	21	39	73	67	38	15	253
Butterfat per Cow (lbs.)	below 220	220-239	240-259	260-279	280-299	300 plus	Average
1941 - 43	.55	.49	.57	.49	.50	.55	.53
1944 - 46	.54	.48	.53	.47	.51	.45	.50
1948 - 50	.59	.51	.59	.51	.51	.55	.54

TABLE LII

WEIGHT OF SILAGE PER COW (TONS)

No. of Farms	21	39	73	67	38	15	253
Butterfat per Cow (lbs.)	below 220	220-239	240-259	260-279	280-299	300 plus	Average
1941 - 43	.30	.28	.23	.29	.46	.19	.29
1944 - 46	.19	.16	.21	.19	.32	.17	.21
1948 - 50	.30	.30	.28	.30	.45	.38	.31

(d) Topdressing.

When the changes in the areas topdressed were considered in conjunction with the areas devoted to supplementary feed, a remarkable similarity of trends was apparent. There was nothing to suggest that changes in hay, silage or topdressing were limited to particular farms and for all groups, the small increases in supplementary feed appeared due to some common factor such as a general improvement in climatic conditions.

V. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO CHANGES IN "PRODUCTION PER COW" FOR INDIVIDUAL FARMS.

By concentrating on individual properties and noting the trends in the herd averages, a more detailed analysis was made of the sample variance for "production per cow". A classification of farms based on the nature and extent of changes in individual herd averages during the period 1941 to 1950, enabled seven different groupings to be used. (See FIG. 22)

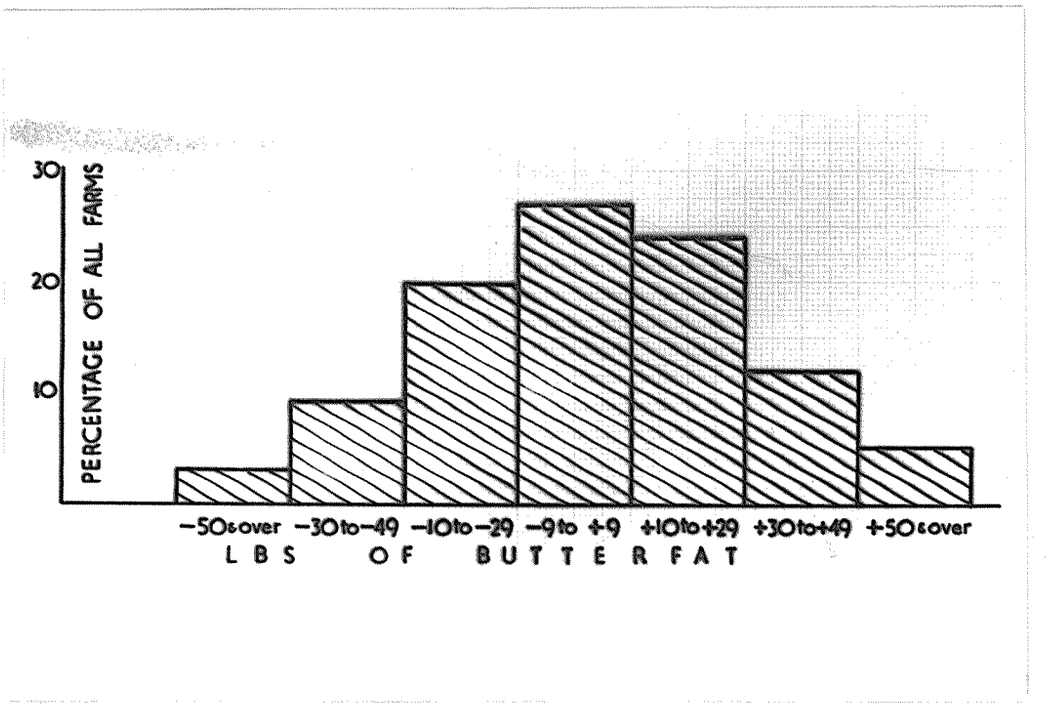


FIG.22: Distribution of farms according to the nature and extent of changes in "production per cow".

Forty-one percent of all dairy-farmers effected fairly substantial improvements in their herd averages, 27% accomplished scarcely any changes and the remainder possessed herds which showed marked reductions in "production per cow". Thus, improvements in "production per cow" were recorded on the majority of farms. (The increase in the sample average was estimated after "productions per cow" for the years 1941-43, 1944-46 and 1948-50 had been grouped and averaged separately. The nature and the extent of the changes in "production per cow" were then calculated from these data.) Changes in the individual group means were quite extensive, involving at one extreme, average losses of 53 lbs. of butterfat, and at the other, average increases of 74 lbs. of butterfat per cow (Table LIII). Between 1941 and 1950 the most severe setbacks in "production per cow" were experienced by herds which were originally the highest producers. On these properties, most of the losses occurred during the first 5 years, whereas farms which recorded increased per cow productivities, showed greatest changes during the second half of the ten year period.

TABLE LIII

TRENDS IN PRODUCTION PER COW (LBS. OF B/FAT)

No. of Farms	8	23	50	68	61	30	13	253
Production per Cow difference (lbs. of B/F	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Av.
1941 - 43	286	290	278	272	262	254	228	268
1944 - 46	243	251	256	255	256	257	243	254
1948 - 50	233	247	259	272	282	293	302	273

Where attention was restricted to the two extreme groups, the one consisting of 8 farms where losses in "production per cow" exceeded 50 lbs. of butterfat, the other, consisting of 13 farms where herd averages improved by more than 50 lbs. of butterfat, it was apparent that the various trends were rather similar to those described in the analyses for "carrying capacity".

In comparing the trends for "production per cow" in the two extreme groupings, it was shown that the results obtained within one group of farms during the ten years, was practically the antithesis of the results obtained in the other (Table LIV). For example, in 1940-41 the herd averages of farms where "production per cow" ultimately fell by 50 lbs. of butterfat, were 20 lbs. above the sample mean, but by 1949-50 they were 37 lbs. of butterfat below this standard. By contrast, the comparable returns from farms which ultimately showed improvements exceeding 50 lbs. of butterfat per cow, were in 1940-41, 49 lbs. of butterfat below and in 1949-50, 37 lbs. of butterfat above the averages for the mean sample farm.

(a) "Production per acre"

The improved managerial techniques which had produced increases in both per cow and per acre averages, were instrumental in reducing the intensity of the effects of the 1945-46 drought. It was concluded from the data presented in Table LIV that a decline in herd averages was indicative of a deterioration in farm efficiency and it was shown, for farms recording the greatest losses in "production per cow", that particularly adverse seasonal conditions effected losses in "production per acre" which were considerably in excess of those recorded for the mean sample

farm. From this result it was anticipated that in 1946-47, differences in the extent of recovery would be evident for different groups, but the results in Table LIV showed that this did not occur.

TABLE LIV.

TRENDS IN PRODUCTION PER ACRE 1945 - 47

(LBS. OF BUTTERFAT)

No. of Farms	8	23	30	68	61	30	13	253
Production per cow difference (lbs. of B/F)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Av.
1944 - 45	155	185	184	179	179	179	169	179
1945 - 46	118	148	147	142	145	146	143	144
1946 - 47	139	161	170	159	168	171	156	164
% decrease in B/F per cow (1944-45)-(1945-46)	24	20	20	21	19	18	15	20
% increase in B/F per cow (1946-47)-(1945-46)	18	9	16	12	16	17	9	14

(b) "Carrying capacity"

In 1945-46 there was a decline in "carrying capacity" (cows per 100 acres) which included all groups, but the most noteworthy losses were recorded for farms on which the losses in both per cow and per acre yields, were smallest.

This prompted a consideration of the relationships between "carrying capacity" and both output per cow and output per acre, within the different groupings of this analysis. With the exception of the group in which the greatest advances in "production per cow" occurred, increases in "the numbers of cows in milk" were noted for all groups.

In addition, for those farms where "production per cow" decreased by more than 50 lbs. of butterfat, a 7% reduction in "cultivated area" was recorded between 1941 and 1950 and as a result, "carrying capacity" increased although both herd and per acre yields fell. This proved to be a feature of all the groupings in which the latter two indices had declined during the ten year period and in cases where both had increased, the associated improvements in "carrying capacity" were small.

(c) Relation of total production to "production per cow", "production per acre" and "carrying capacity".

As shown in Table LV and Appendix cii, within the corresponding farm groupings, the trends in both total and per acre yields of butterfat were remarkably similar to those for "production per cow". A measure of this similarity was provided by the data which showed that during the ten year period, increases amounting to 32% had been obtained for output per cow, per acre and per farm by the 13 farms recording the greatest increases in "production per cow".

Within the other extreme grouping, however, the parellelism was not so striking and in this case, the corresponding figures which referred to 8 farms, amounted to losses of 19%, 9% and 15% respectively. Obviously the changes in "production per cow" and total output were comparable, but although herd averages had fallen steeply, an increase in "carrying capacity", shown for farms in this grouping, had effectively prevented the "production per acre" from declining to a comparable extent.

TABLE LV

TRENDS IN PRODUCTION PER ACRE

(LBS. OF BUTTERFAT)

No. of Farms	8	23	50	68	61	30	13	253
Production per cow difference (lbs. of B/F)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus	Av.
1941 - 43	156	188	178	166	162	159	148	167
1944 - 46	142	167	165	158	159	161	153	160
1948 - 50	142	172	171	168	180	189	196	175

From a study of the data on individual farm trends presented in the previous sections, it was concluded that some managerial practices might not be as important as was previously believed. For the purpose of establishing causal relationships, further analyses of the data appeared to be warranted. Detailed investigations were undertaken after the sample farms had been classified according to:-

(1) Between-farm differences in "effective areas".

(2) " " " " "the percentage of grassland topdressed".

(3) Within-farm changes in "the percentage of grassland topdressed".

(4) " " " " "the percentage of grassland cut for hay".

VI ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO BETWEEN-FARM DIFFERENCES IN "CULTIVATED AREA"

All farms were included in five "cultivated area" groupings, the range for which extended from less than 49 acres to more than 180 acres.

Although the average "effective area " for the mean sample farm altered very little from year to year, in the space of ten years a small increase (2% to 3%) occurred which was mainly caused by changes on the large farms. It should not be inferred from this that the 33 biggest farms were the only properties on which additional land was brought into production, although in this respect they offered the greatest opportunities. Additional land was brought under cultivation, regardless of farm area and during the ten year period, the stock population was increased to a comparable degree in each grouping.

(a) Farm Production.

As a result of the increases noted for farm area and herd size, changes in total farm output occurred in all size-of-farm groupings. (See Table LVI)

TABLE LVI

TRENDS IN TOTAL FARM OUTPUT

(LBS. OF BUTTERFAT)

No. of Farms	38	47	72	63	33	253
Cultivated Area (acres)	below 50	50-74	75-99	100-149	150 plus	Average
1941 - 43	8843	11142	14843	19630	27671	14581
1944 - 46	8567	10591	14399	19042	26895	14053
1948 - 50	9329	11920	15840	20765	31028	15763

Although improvements in the total outputs were made in all groups, only where the "cultivated areas" were larger than 150 acres were the increases proportionately greater than those for the mean sample farm.

(b) "Production per acre" and "production per cow"

Within each of the five groupings, the trends for "production per acre" were similar to the trend for the mean sample farm and this served to distinguish the results for "production per cow" from those for "production per acre".

TABLE LVII

TRENDS IN PRODUCTION PER COW
(LBS. OF BUTTERFAT)

No. of Farms	38	47	72	63	33	253
Cultivated Area (acres)	below 50	50-74	75-99	100-149	150 plus	Average
1941 - 43	291	276	263	265	264	268
1944 - 46	279	259	249	253	251	254
1948 - 50	293	279	268	271	274	273

TABLE LVIII

TRENDS IN PRODUCTION PER ACRE
(LBS. OF BUTTERFAT)

No. of Farms	38	47	72	63	33	253
Cultivated Area (acres)	below 50	50-74	75-99	100-149	150 plus	Average
1941 - 43	206	184	167	160	155	167
1944 - 46	197	174	161	154	149	160
1948 - 50	210	194	177	167	165	175

When three-year averages were compared (Table LVII), it was shown for the ten year period, that the principal contributions to the 5 lbs. increase in the herd average

of the mean sample farm were made by farms which were larger than average. No comparable changes were apparent for "production per acre" (Table LVIII).

Some interesting data concerning changes in "production per acre" between 1945 and 1947 were presented in Appendix cvii. Here it was shown that during the dry summer of 1946, small properties were most severely affected. Farms smaller than 50 acres, showed returns for the season 1945-46 which were 51 lbs. of butterfat per acre less than those for the previous year. This compares unfavourably with the reduction of 29 lbs. of butterfat per acre recorded during the same period for farms of more than 150 acres "effective area". Since between 1946 and 1947, the losses in "production per acre" were considerably less on large farms than on small farms, it was concluded that the large "cultivated areas", together with the associated low "carrying capacities" had been responsible for minimizing the effects of the drought. Thus, although small farms are usually most efficient, in achieving this superiority the balance between stock numbers and feed available becomes very sensitive to the vagaries of climate.

(c) "Carrying capacity"

When "carrying capacity", expressed either in "stock units" or "cows in milk" per 100 acres was considered, very little change was apparent within any of the size groups for the ten year period. (Appendices cviii and cix.)

(d) Supplementary feed.

Since, between 1941 and 1950 increases in total outputs had occurred in all groups, the estimation of the extra costs of these improvements became a matter of interest. It was found that the amount of cropping, hay and silage

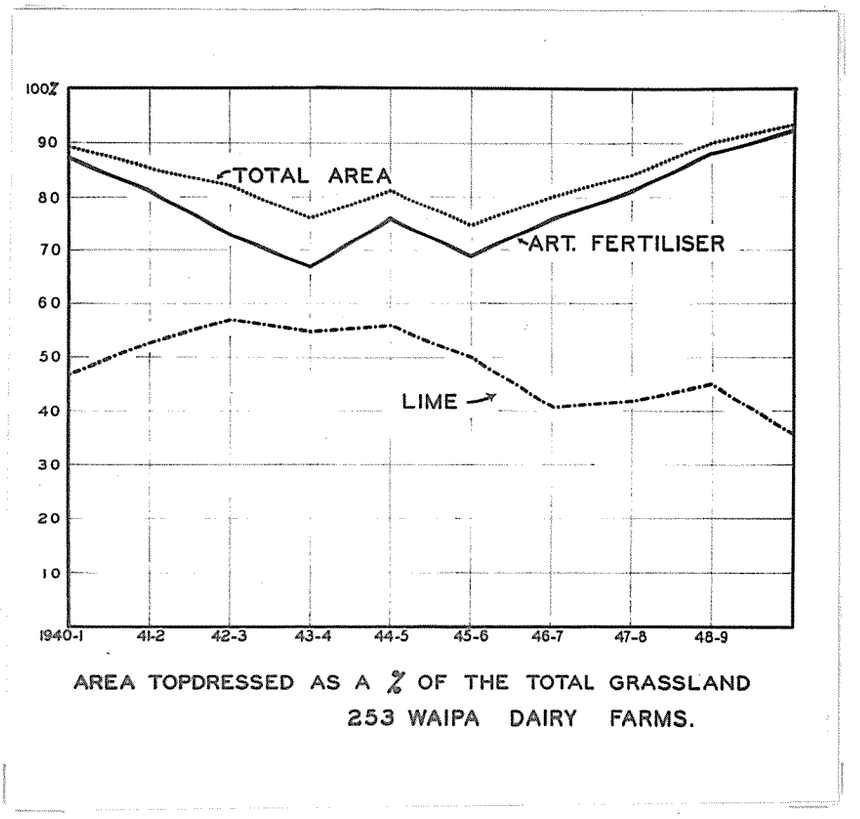


FIG.23: Trends in the areas topdressed and limed on the mean sample farm.

making practised all increased to the greatest extent on farms which were larger than average, whilst on many small properties, reductions occurred in the areas cut for silage.

(e) Topdressing.

It was shown that irrespective of farm size, increases occurred in the areas topdressed with artificial fertilizers. At no stage did all farmers in every group include topdressing in their farming programmes, but by the end of the decade, the numbers of farmers who employed this practice had increased. According to the size of properties, differences were noted in farmer-reactions to the imposition of rationing. For 1942, each farm's fertilizer quota was determined as a proportion of that used in the two years immediately before rationing began. In general, farmers whose properties were larger than average attempted to maintain rates of application by reducing the areas topdressed, while on small holdings, the practice of applying lighter dressing over approximately the same area proved more popular (Appendix cxxi). After the removal of the restrictions, proportionately greater increases in the areas topdressed occurred on farms with large "effective areas", where efforts were made to include the areas which had been regularly manured in previous years. Since the within-group trends for butterfat "production per acre" were all very similar, it was impossible to assess the merits and demerits of either, or both, of the compromises employed during the period of rationing.

VII. TRENDS IN TOPDRESSING.

Amongst the recurrent items of farm expenditure, the costs of purchasing and applying both lime and artificial fertilizers are particularly large (refer to page 116). The success which has so often attended the use of superphosphate on the pastures of the Waikato caused many farmers to make repeated use of this form of topdressing, often, it is believed (Ward (1953)), to an extent which has been wasteful of both capital and materials.

The period, 1941 to 1950 was particularly interesting because it included the years in which rationing was imposed and also those which followed the removal of the restrictions. It was therefore possible to obtain some appreciation of farmer-reaction to these two sets of circumstances, by studying the nature and extent of the changes both in the areas topdressed and in the numbers of farmers concerned.

Fertilizer rationing commenced in 1941-42, this season's ration being computed as 40% of the farmer's average annual usage in the base years 1939-40 and 1940-41. 28% of the base ration was available for the next three years, but this period of scarcity was followed by a gradual increase in supply until in 1947-48, 67% of the base ration was obtainable. For the mean sample farm, rationing caused an immediate decrease in the area topdressed with artificial fertilizers alone (FIG. 23). By comparison, the practice of liming, either alone or in conjunction with superphosphate, gained in favour and by 1944-45 the area topdressed with lime and superphosphate was more than double that sown with artificial fertilizers alone.

In 1944-45, the increase in the quota of 1 cwt. of superphospate per "cow in milk" was reflected in a marked rise in the area topdressed with lime and superphosphate. Subsequently, with increases in fertilizer supplies, the practice of sowing artificial fertilizers alone regained favour at the expense of the mixed topdressing system and in every year since 1947-48, the area topdressed with artificial fertilizers alone exceeded the comparable area for 1940-41.

Unfortunately no figures were available showing trends in the rates of application. The best estimate obtainable was merely an index derived from the total output of lime and fertilizer works supplying the county and the areas topdressed and limed in corresponding years.

It was necessary in the compilation of this index to appreciate that in each year a difference of five months existed between the times at which annual returns for farms and fertilizer works were made. As most topdressing on dairy-farms was carried out in the autumn, in any season, the returns submitted referred to the acreage topdressed in the previous autumn. It was necessary, therefore, to relate the area topdressed in one year to deliveries from fertilizer works during the previous season. The deliveries from fertilizer works and rates of application for 1940-41 were used as bases and rated at 100. (See Table LIX.)

TABLE LIX.

TRENDS FOR THE RATES OF APPLICATION OF LIME AND ARTIFICIAL FERTILIZERS.

Season	Topdressing with Artificial fertilizers.			Liming		
	Av.area topdressed (1 yr.lag) (acres)	Index of Fertilizer Works Deliveries	Index of rate of application	Av.area limed (acres)	Index of lime deliveries	Index of rate of application
1940-41	77	100	100	50	100	100
1941-42	70	54	59	55	111	101
1942-43	64	50	60	53	128	121
1943-44	72	54	58	54	110	102
1944-45	66	63	73	48	174	181
1945-46	72	77	85	39	155	199
1946-47	78	96	92	40	145	182
1947-48	85	102	92	44	130	148
1948-49	89	112	100	35	128	183

The decrease in the area topdressed was associated with a decline in the rate of application. Thus, in the second year of rationing, 83% of the area topdressed in 1940-41 received only half the fertilizer distributed in the base period, but by 1948-49, when the area topdressed and the fertilizer output were at their maxima, the mean sowing rate was again approximately equal to that for 1940-41. By contrast, liming trends showed an increased rate of application per acre and a reduction in the total area limed.

VIII. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO BETWEEN-FARM DIFFERENCES FOR PERCENTAGE OF GRASSLAND TOPDRESSED.

To investigate more fully the topdressing changes described in previous sections, detailed analyses were undertaken similar in method to those applied to the

different inputs and outputs considered earlier.

The first of these involved the classification of farms according to between-farm differences in"the percentage of grassland topdressed". A description of the farm groupings may be obtained from the corresponding section of the management survey (pages 117 and 118).

Very little additional information was provided by this analysis. In only one group, and this comprised properties on which the whole of the farm area was topdressed, did every farmer in every year practise top-dressing. On these farms, there was no evidence that wartime rationing restricted the area topdressed. Within this group the small decrease in the area topdressed between 1941 and 1950 was due mainly to an increase in the area cropped.

Where more than 90% of the total grassland was top-dressed, most farmers regarded regular topdressing as essential but, between 1941 and 1950, within the remaining groups, increases were noted in the numbers of farmers practising topdressing.

By the end of the decade, the number of farmers using lime had decreased in each group and, with the exception of farms where more than 90% of the total grassland was topdressed, a similar result was also evident for the areas limed. On farms not included in this generalisation, a definite increase in the area limed was noted.

The remaining tables, derived from the classification of farms according to "the percentage of grassland top-dressed", gave results which did not permit a precise evaluation of the importance of topdressing. The general nature of these data is exemplified by the tables for crops and hay, wherein trends for all groups are similar to those for the mean sample farm. (See Appendixes cxxxvii and cxl.)

IX. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO CHANGES IN "THE PERCENTAGE OF GRASSLAND TOPDRESSED".

The second section of the topdressing analysis consisted of an investigation of trends for farms grouped according to within-farm changes in "the percentage of grassland topdressed". According to the extent and the nature of the changes, farms were placed in one of seven groupings and within and between these groupings, consideration was given to the different indices of farming efficiency.

In every year, more than 96% of the 253 dairy-farmers in the sample studied, topdressed at least a part of their properties, although the size of this fraction varied from year to year. FIG. 24 shows the wide within-farm changes in the area topdressed on different farms. Between 1941 and 1950 49% of the farms studied showed increases in the area topdressed, 32% showed little alteration and 19% showed reductions in the area topdressed annually. The corresponding changes in the areas topdressed in the first and last of the these three groups of farms amounted to an increase of 49% on the one hand, and a loss of 8% on the other (see Table LX).

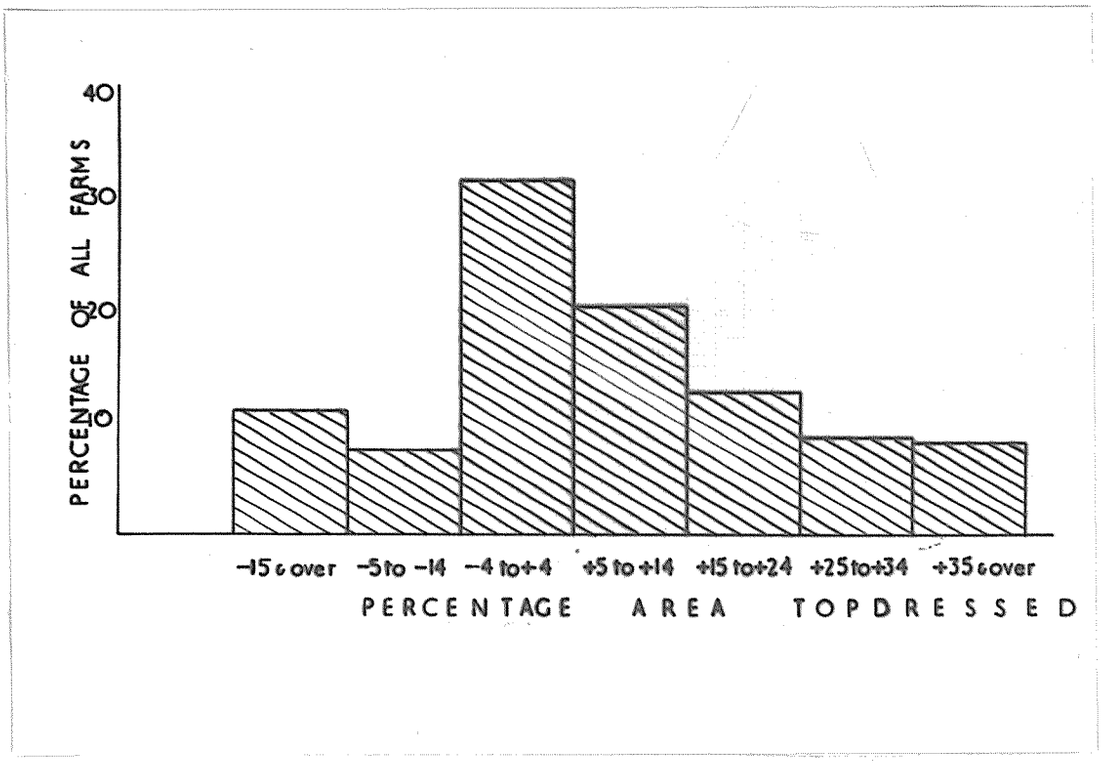


FIG. 24: Distribution of farms according to the nature and extent of changes in "the percentage of grassland topdressed."

TABLE LX

CHANGES IN THE AREAS TOPDRESSED WITH ARTIFICIAL FERTILIZERS.

(Group and sample means were calculated for the farms on which topdressing was applied.)

No.of Farms	28	19	80	51	32	22	21	253
Change in % area TD with art. ferts.	-15% plus	-5 to -14%	-4 to +4%	5 to 14%	15 to 24%	25 to 34%	35% plus	Av.
1941 - 43	77	89	92	85	72	75	49	82
1944 - 46	63	77	82	72	67	66	54	72
1948 - 50	71	86	92	92	88	90	73	88

The latter estimates relating to areas topdressed referred to those farmers who, during the ten year period studied, applied fertilizers. When all farms were included in the computation of the group and sample means (Table LXI), the percentage changes were much larger, and whereas the area receiving artificial fertilizers (in the group 35% plus (Table LX)) actually increased by 49%, when expressed in relation to the whole sample, this change appeared to be more than double this estimation (Table LXI). The reason for these differences was that in the calculation of the data in Table LX, the average areas topdressed in any year were estimated from the total area topdressed, divided by the number of farmers topdressing in the particular year concerned. Since the trends in the number of farmers topdressing were similar to those for the areas topdressed, the percentage change in the mean area topdressed was less when calculated for those farms on which topdressing was practised, than for the mean sample farm.

TABLE LXI

CHANGES IN THE AREAS TOPDRESSED WITH ARTIFICIAL FERTILIZERS.

(Group and sample means were calculated for all farms regardless of whether topdressing was or was not applied.)

No.of Farms	28	19	80	51	32	22	21	253
Change in % area T.D.with art. ferts.	-15% plus	-5 to -14%	-4 to +4%	5 to 14%	15 to 24%	25 to 34%	35% plus	Av.
1941 - 43	77	88	91	81	66	59	33	76
1944 - 46	60	78	76	68	65	60	50	67
1948 - 50	58	81	91	91	87	90	72	84

In common with the results of previous analyses of a similar type, between 1941 and 1950 the greatest reductions in the areas topdressed were recorded by farms which, in the initial years of the ten year period had provided the highest topdressing returns. As the full effects of wartime restrictions were felt, many farmers reduced the area which they normally topdressed, some maintained it but lowered their usual rate of application, while others neglected topdressing programmes altogether.

Within a single group, it was possible to follow the changes in both areas topdressed and numbers of farmers topdressing. The twenty-eight farms on which the "percentage of grassland topdressed" fell by more than 15% were most severely affected by the restrictions of the early 1940's and until the 1949-50 season, little attempt was made on these properties to use fertilizer to an extent comparable with that of the pre-rationing period. (Appendix cliv.)

With the exception of the properties on which "the percentage of grassland topdressed" increased by more than 35%, on all other farms, trends in the area topdressed consisted of a decline during the war years followed by an increase, the extent of which varied for the different groupings. For farms of the group constituting the exception noted, regular increases occurred between 1941 and 1950, both in the number of farms and in the "percentage of grassland topdressed". As a result, on each of the farms in this group "the percentage of grassland topdressed" increased from 60% to 90% during the ten year period.

(a) Farm size.

There was no relationship between the extent of the changes in topdressing and differences in the "cultivated areas", although it was noted that where greatest increases had been made in "the percentage of grassland topdressed", the "cultivated areas" had remained unchanged throughout the ten year period.

(b) Farm output.

The remaining tables, all of which were concerned with indices of productivity, provided results most of which were essentially similar, one to the other. Thus, tables relating to size of herd, "carrying capacity", butterfat per cow, butterfat per acre and total output of butterfat per farm, had this in common, that as the extent of the increases in "the percentage of grassland topdressed" became larger, the rising trend for each of these indices became progressively steeper and the maximum rate of increase was recorded for farms on which "the percentage of grassland topdressed" had increased by 15 to 24%. (Appendices cxlvi, cxlvii, cxlviii and cliii.) Although increases in herd

size, "production per acre", "production per cow" and output per farm were noted in the two groups recording the greatest topdressing increases, the changes were comparatively small.

It cannot be concluded that additions in excess of this 25% level of increase were uneconomic, but it would appear that improvements in other important, but perhaps less obvious managerial factors have been neglected and as a consequence, "production per acre"did not attain the high levels expected.

The real importance of topdressing with artificial fertilizers in different districts has recently received increasing attention. It may be concluded that in some cases the repeated use of heavy phosphate applications has resulted in the accumulation of sufficient reserves and under these circumstances it is uneconomic to continue topdressing at high levels. It is interesting to note, therefore, that Ward(1953) has recently presented the results of a fertilizer survey from which he concludes that on dairy-farms in general, farmers apply excessively heavy dressings of phosphates. However, the application of the findings of this survey to individual properties, is a most difficult problem. It must be appreciated that in the Waipa County there is a considerable diversity of soil types and consequently a wide range of soil types may be found on individual farms. Because of these differences, the response which any farmer obtaine from topdressing may differ from paddock to paddock, but it is unlikely that farmers would be concerned with determining the optimum dressing for each paddock. At the present time, the approved method probably consists of applying an average

dressing which appears to give good returns, but which is perhaps, financially wasteful.

To prevent losses which, when considered in total, must be considerable, farmers should obtain an accurate estimate of the rate of application which is optimum for the major portion of their properties. There is the possibility, however, that on an individual property, a comparatively small and highly productive section which is dependent on heavy fertilizer applications may, if restricted to an average topdressing rate undergo a decline in productivity, sufficient to place a limitation on the farm output. Such cases would be exceptional, however, and would not contradict the general applicability of accurately determined average topdressing rates.

X. TRENDS IN THE QUANTITY OF SUPPLEMENTARY FEED SAVED.

Since the purpose of topdressing is to stimulate pastures and crops to increased and prolonged production, the description of the results from the topdressing analyses was followed by a consideration of the utilization of feed surpluses. For a full description of methods of pasture utilization employed by a sample of dairy-farmers, data such as:-

(1) the number of farmers using autumn-saved grass;

(2) the number of farmers using systems of break feeding or close subdivision;

(3) the number of farmers renewing worn out pastures and practising oversowing; are required in addition to the information supplied in the present study. Much of these data would be unsuitable for use in survey methods of investigation, and still greater difficulties would be

encountered in any attempt to adapt individual farm data on grazing days to this type of analysis.

In the present investigation the information available referred only to the areas of grass cut for hay and silage, the yields derived therefrom and the numbers of farmers practising these methods of pasture conservation. (See FIG.25 for trends in areas cut for hay and silage on the mean sample farm.)

In every year over 90% of dairy-farmers saved portions of their farms for hay and for the mean sample farm, this fraction reached a maximum in 1945 when 18% of the total area in grass was cut for hay. For the mean sample farm, these data showed small seasonal fluctuations, but no perceptible trend, whereas much greater variability was apparent for the area of grassland cut for silage in different years. In 1940-41, this area represented 5% of the total grassland but by 1945-46 it had fallen to 3%, at which level it remained for three years before rising suddenly, in 1950, to a record of 6% of the total area in grass. A similar trend was noted for numbers of farms on which silage was made. In comparing the relative popularities of hay and silage, it should be noted that in only one season (1941-42), did more than half the sample farmers use silage as a means of conserving grass growth surpluses, whereas haymaking was carried out annually, on more than 90% of all properties.

The trends for hay and silage yields were very similar and reductions noted in the early years of the decade might have been quite extensive but for the favourable season experienced in 1944-45. In the following year, extremely dry conditions reduced yields to the lowest

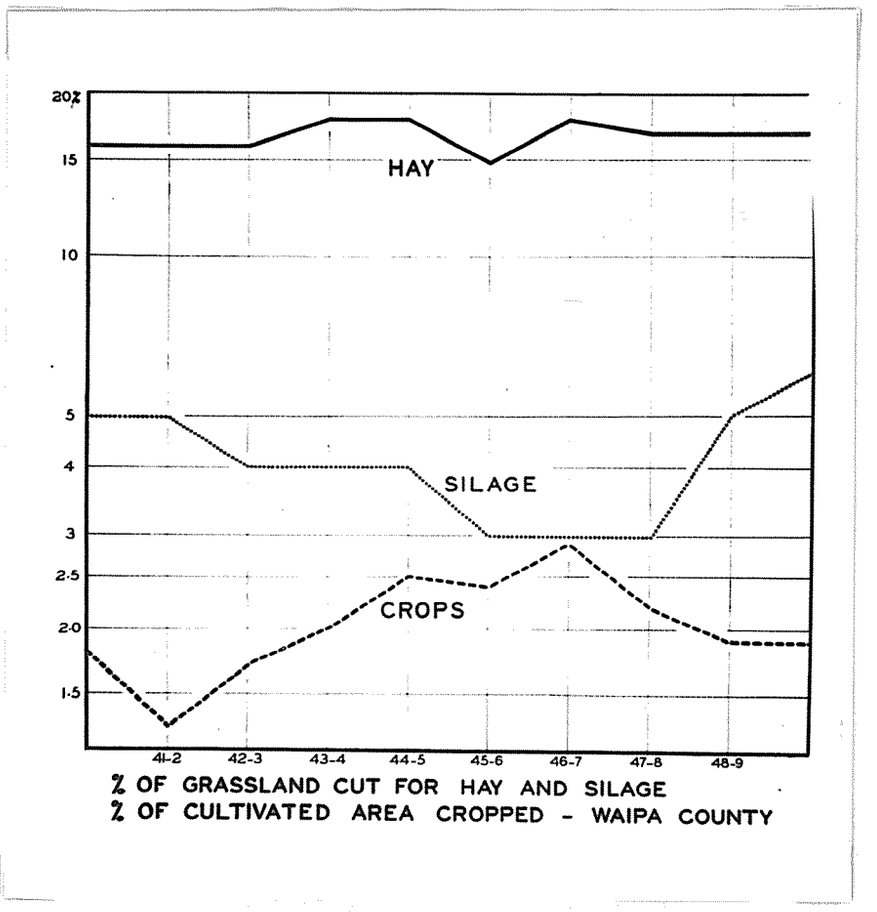


FIG.25: Trends in the areas cut for hay and silage, and in the area cropped on the mean sample farm.

experienced in the ten years studied, but thereafter, total and per acre yields of both hay and silage increased, the most noteworthy changes occurring in the quantity of silage produced per acre. Thus between 1941 and 1950, the weight of silage per cow increased from 6 cwt. to 8.5 cwt. on the mean sample farm and although there was scarcely any change in the area cut for hay, as the yields had improved slightly a ration of 11 cwt. of hay per cow per year was maintained.

Since silage appeals as a satisfactory form in which to conserve grass surpluses at the correct time, it is rather surprising that in most years, less than half of the dairy-farmers in the sample included silage making in their managerial programmes. In most seasons there are better opportunities for making good silage than good hay, and silage, when well made is certainly superior to most hay. The heavy nature of the work involved both in making and in feeding out silage, together with other undesirable features associated with the latter, probably tend to limit its popularity. By comparison, each year, almost every dairy-farmer endeavours to close some part of his property, and, from the extra growth,obtain hay for the period of winter shortage. In estimating their hay requirements, most farmers are invariably guided by the results they have obtained in the past. This was shown by the limited extent of the changes recorded on individual farms for "the percentages of grassland cut for hay", between 1941 and 1950. (See FIG.26 and the subsequent analysis.)

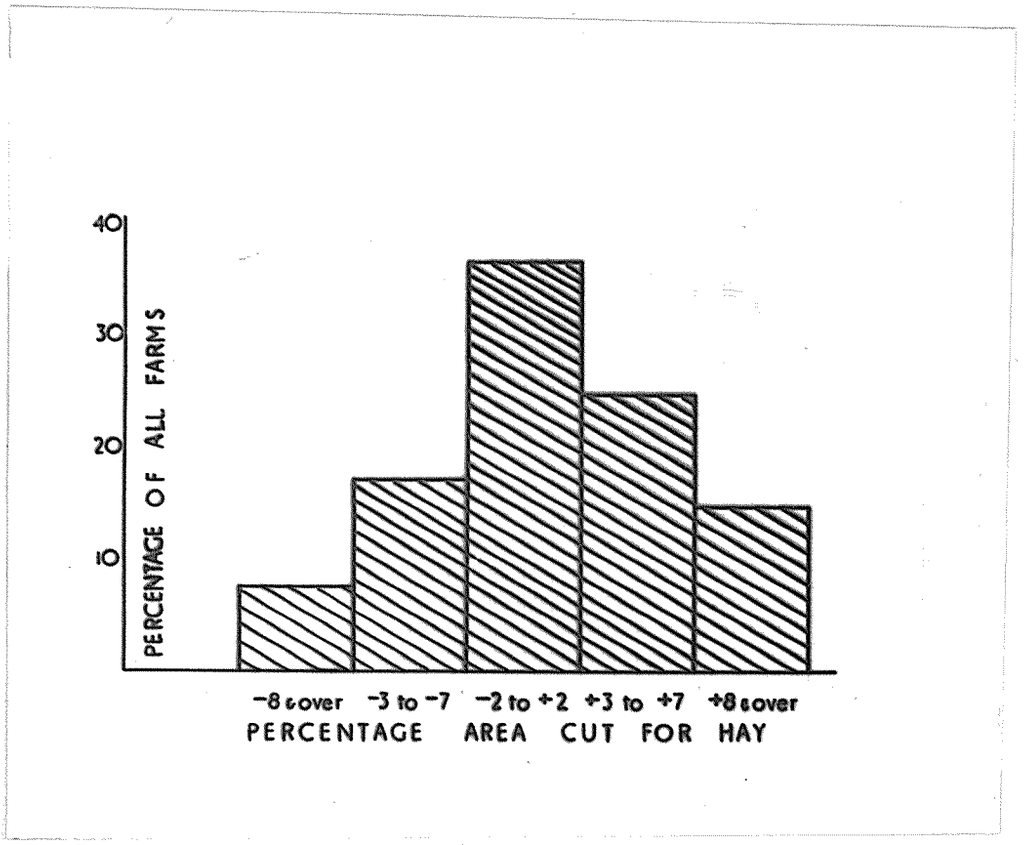


FIG. 26: Distribution of farms according to the nature and extent of changes in "the percentage of grassland cut for hay."

XI. ANALYSIS OF TRENDS FOR FARMS GROUPED ACCORDING TO CHANGES IN "THE PERCENTAGE OF GRASSLAND CUT FOR HAY" FOR INDIVIDUAL FARMS.

Individual farms which during the ten years considered, recorded the greatest changes in the areas cut for hay, were included in either of two groups depending on whether "the percentage area of grassland cut for hay" had increased or decreased by more than 7%. Although no indication was given from these data of the actual area changes involved, these were quite marked. On the nineteen farms where, during the ten year period, "the percentage of grassland cut for hay" declined by more than 7%, the actual area cut for hay decreased by 35%. During the same period, but within the other extreme grouping in which "the percentage of grassland cut for hay" increased by more than 7%, a 57% increase was recorded in the area cut for hay. When, for the mean sample farm the change in the area cut for hay was estimated from the averages for the first three and last three years of the ten year period, an 8% increase was noted. It was significant, however, that only 39% of all farms had recorded larger increases than this. For farms located in the two extreme groupings, the changes in the areas cut for hay were gradual and occupied the whole of the ten year period.

TABLE LXII

CHANGES IN THE AREA CUT FOR HAY

No.of Farms	19	43	92	62	37	253
Change in % area cut for hay.	-8% plus	-3 to 17%	-2 to +2%	+3 to +7%	+8% plus	Average
1941 - 43	19.7	19.1	15.8	13.7	15.4	16.1
1944 - 46	17.0	17.2	16.1	15.9	20.1	16.9
1948 - 50	12.8	14.9	16.3	17.5	24.2	17.4

Changes in the numbers of farmers making hay were confined mainly to the two extreme groupings and were similar in nature to those recorded for the areas involved. For the group in which the percentage of grassland cut for hay fell by at least 8%, a 32% reduction in the number of farmers making hay was recorded between 1941 and 1950. Where the percentage of total grassland increased by at least 8%, a 12% increase was recorded in the number of farmers making hay.

(a) "Cultivated area"

Some information which might account in part for the reduction in the percentage area cut for hay, was supplied by the table on "cultivated area" relating to farms on which the reduction in haymaking was greatest (Appendix clx). It appeared that within this group a considerable area of land was brought into production in the latter years of the period and, although there was some increase in herd numbers, "carrying capacity" was reduced. Consequently, the amount of pasture available to be eaten in situ increased and this probably caused a reduction in the requirements for supplementary feed.

(b) Farm output.

Although such a compromise may have proved successful, it was shown that a definite association existed between the increases in the percentage areas cut for hay and the additions to the total output of butterfat. During the ten year period, an 8% rise in total production was recorded for the mean sample farm and although increases were general in each grouping, in only one case, where the increase in "the percentage of grassland cut for hay" exceeded 8%, was this figure surpassed. Similarly,

it was found that the 3.2% rise in "carrying capacity" on the mean sample farm was mainly attributable to farms on which the areas utilized for haymaking had increased between 1941 and 1950 (Appendix clvii). The changes in "production per acre" were essentially similar to those for "carrying capacity" but differed from the comparable trends for "production per cow". Between 1941 and 1950, a considerable improvement in "production per cow" was indicated for farms on which "the percentage of grassland cut for hay" had increased by more than 8%. For all other groupings, however, in contrast to the analyses carried out for output per acre and "carrying capacity", it was shown that no changes in "production per cow" were associated with the regular alterations in the percentage areas cut for hay.

XII. TRENDS IN FARM MACHINERY.

The information on farm machinery was limited to the following:- (1) electric motors; (2) engines; (3) tractors; (4) milking machines and the number of bails per shed. As changes in most of these items could scarcely be considered indicative of alterations in the state of farm mechanization, it was necessary to rely on tractor numbers as the sole guide in this respect. Unfortunately during the war, data for three seasons were not collected. In 1940-41 one in every six farmers possessed a tractor, but by 1949-50, this ratio had narrowed remarkably to two out of every three. The most spectacular changes occurred in the latter three years when the tractor force increased by 59%.

At present, in view of the continuing shortage of both skilled and casual labour, the merits of a high

degree of mechanization on farms whose general character, situation and layout lend themselves to it, are so patent as to require no elaboration. Speedier and more timely work, greater output per man employed, lower costs per unit of output and a general easing of the farm labour situation - these advantages are so universally conceded nowadays and are of such moment that they completely outweigh the disadvantages arising from the initial, heavy capital outlay involved and the financial risks arising from obsolescence or costly breakages. It should be reccgnized, however, that on a mechanized farm the whole organization moves at a greater momentum which calls for a higher plane of managerial efficiency and organizing ability on the part of the farmer, besides an abundance of energy, skill and business acumen.

XIII. TRENDS IN FARM LABOUR.

Coincident with the sudden rise in mechanization was a decline in the farm labour force. Especially was this true for labour connected with shed work. Detailed collection of labour statistics began in 1946-47 and the figures available covered four seasons only. Because of this limitation and the wide between-season fluctuations, it was difficult to ascertain the trends in the dairy-farming labour force.

TABLE LXIII

TRENDS IN DAIRY-FARM LABOUR.

Season	21 yrs. and over		15 - 21 years		Total Persons	Total Labour Units.
	Men	Women	Boys	Girls		
1946-47	327	41	76	15	459	431
1947-48	371	57	76	13	517	482
1948-49	372	55	69	15	511	476
1949-50	362	15	58	5	440	430

In 1947-48, the average number of cows handled per worker was 33. By 1949-50, it had risen to 38 and over the same period, bails per milker increased from 2.0 to 2.6, an advance of 30%. As a result, the number of cows per bail decreased by two and some reduction in milking time should have been effected. If in 1949-50 workers were in the shed no longer than they were in 1947-48, their efficiency in terms of "cows milked per labour unit" per hour was increased by 15%. Doubling up and improved shed methods increased efficiency, but in the 1950-51 season only 48% of the dairy-farmers had installed doubled-up plants. It appeared that although a certain increase in efficiency was obtained, a depleted shed force had to work longer hours than was required three years previously. This placed limitations on the field work possible which showed little expansion despite the large increase in tractor numbers. It appeared that tractors were used mainly in lightening the existing work rather than in the extension of farm work. "Production per acre" was maintained, however, and due to the large increase in cows milked per worker, output of butterfat per labour unit advanced by 10%. This emphasises the value of tractors as time-savers where there is a limited labour force, but unfortunately dairy-farms require considerable manual labour. In the future more time may have to be spent in the shed and reliance placed on contractors for seasonal work. Other alternatives might be found in increased shed efficiency, a reduction in the less essential field work, or a depletion of cow numbers. Any changes in milking cow numbers would, however, be affected by the ruling price for butterfat.

S E C T I O N XIII

SUMMARY OF THE STUDY IN FARMING TRENDS.

Data collected from a sample of Waipa dairy-farms, were studied in an attempt to distinguish year to year and long-term changes in farming practices and production during the period 1941 to 1950.

The original sample was selected in 1947 and at that time consisted of 400 dairy-farms. Of these, however, only 253 farms provided full information for each of the ten years and consequently the greater part of this investigation was concerned with these properties. The only information obtained from the complete sample of 400 farms related to changes in farm area and changes in the type of farming. In respect of these data it was shown that:-

(1) The number of land transactions increased markedly following the repeal of the Land Sales Act.

(2) Of the 400 dairy-farmers selected in 1947 only two had changed from dairy to sheep-farming by 1950, whereas ten were not dairying prior to 1947.

The remainder of this investigation in farming trends referred to the 253 dairy-farms providing full information on the various factors of production (inputs and outputs) considered in this study.

(a) Trends in Farm Production.

The different measures of farming capacity and efficiency were considered first. Between 1941 and 1950, trends in "production per acre", "production per cow" and "carrying

capacity" were studied for the mean sample farm and it was shown that with the exception of "carrying capacity" ("cows in milk" per 100 acres) which had increased slightly, no lasting changes had occurred in any of the above indices.

Subsequently the "production per acre", "production per cow" and "carrying capacity" of individual farms were used as bases for classifying farms into groups within which, trends for various inputs and outputs were studied, and between which, trends were compared.

By grouping farms successively, according to the nature and extent of individual changes in "production per acre", "production per cow" and "carrying capacity" during the ten years, three separate analyses were made possible. The results derived from each of these three analyses were essentially similar and are presented as follows:-

1. Between 1941 and 1950, the majority of farms showed a gain rather than a loss in productive efficiency.
2. Greatest increases in farm efficiency occurred in the latter half of the ten year period, whilst greatest losses were recorded during the first five years.
3. The effects of severe climatic conditions were least for farms on which production was increasing and greatest for farms on which production was decreasing.
4. In each of the three separate analyses, there was always a close similarity between the trends for "production per acre" and "production per cow", and "production per acre" and "carrying capacity".

When farms were grouped according to within-farm changes in "production per cow", however, the extent of the changes in "carrying capacity" was in no way comparable with that for either "production per cow" or "production per acre". A contrary result was obtained when farms were grouped according to within-farm changes in "carrying capacity", for in this case, the alterations in "production per cow" during the ten year period were quite small when compared with those for "production per acre" and "carrying capacity".

5. On farms which recorded changes in efficiency, comparable alterations were shown in the total farm output.

6. On farms which showed the greatest losses of efficiency, considerable increases in "cultivated area" occurred during the ten year period. This trend was noted in both the analyses based on changes in "production per acre" and "carrying capacity", but was not observed in the corresponding analysis for "production per cow". The peculiarity of a situation in which both farming efficiency and total production decreased whilst "effective area" increased, has been discussed.

In only one of these three analyses, viz., the analysis based on changes in "production per acre", were the trends in areas and yields of crops, hay, and silage studied. It was concluded from the evidence obtained from this analysis that there was no relationship between the nature and extent of alterations in "production per acre" and any quantitative changes in the different forms of supplementary feed considered in this study.

The analysis of trends in "production per cow" and "carrying capacity" was extended to a consideration of the changes revealed when farms were grouped according to between-farm differences for each of the two indices. Ten year average figures for "production per cow" and "carrying capacity" were each used successively as a basis on which to classify farms prior to analysis of the data.

Less information was provided by the analysis of data for farms classified according to ten year averages than when grouped according to the nature and extent of changes in the two indices. Nevertheless, by applying the former method some useful information was provided concerning the effects of abnormal climatic conditions upon farms producing at different efficiency levels.

The problem of obtaining a single component of "climate" which expressed satisfactorily the relationship existing between climate and production, was discussed. The results of the present investigation showed the limited applicability of rainfall data.

The influence of the severe summer and autumn drought of 1946 upon dairy-farm production, both in this and succeeding years received considerable attention. In respect of this, the analysis of farms grouped according to differences in "cultivated area" was particularly informative. It was shown that on large properties "production per acre" was least affected by the period of summer drought and it was noteworthy that these farms contributed in greatest measure to the small increases in "cultivated area", and farm output recorded for the mean sample farm between 1941 and 1950.

(b) Trends in Supplementary Feed.

During the ten year period very little change occurred in the acreages conserved for supplementary feed although considerable year to year variability was noted (FIG. 25). For the mean sample farm, the area in crops (root and green forage) increased during the mid-1940's but by 1950 had declined to approximately the 1941 level. The increase in the area cropped during the mid-1940's was quite marked and may be attributed to the introduction of a £5 per acre Government subsidy introduced in September 1944, to encourage farmers to increase their pig numbers. This subsidy was continued until 1947 and, following its removal, a sudden decline of 24% occurred in the area cropped on the mean sample farm. However, it was shown that when farms were grouped according to between-farm differences in "carrying capacity", between 1941 and 1950 one group of farms (< 4.0 "stock units" per acre) recorded a regular increase in the area cropped.

In every year, over 90% of dairy-farmers made some hay, and, although on the mean sample farm the area cut for hay showed seasonal fluctuations, there was no perceptible trend. In contrast with this finding, the amount of silage made each year showed much greater variability and, by 1950, a definite increase had been recorded in the average area cut for silage. During the same period, the average weight of silage made per cow also increased from 6 cwt. to 8.5 cwt., while the weight of hay saved remained at about 11 cwt. per cow, per year.

A detailed analysis was made of farms grouped according to individual changes in the "percentage of grassland cut for hay". In every year, most farmers saved approximately the same acreage for hay although certain notable exceptions were

constituted by, on the one hand, the group of farmers who reduced the average area cut for hay by 35% and on the other, the group of farmers who increased the average area cut for hay by 57%. On the farms on which the area cut for hay declined, there was no indication of any associated reduction in either "production per acre", "production per cow" or "carrying capacity". This might have been due in part, to the increases in "cultivated area" recorded by farms on which the area cut for hay declined, since the increased availability of pasture in situ would reduce the need for supplementary feed. However, although no evidence was available suggesting the existence of a relationship between the decline in the area cut for hay and farm production, it was noted that between 1941 and 1950 the greatest increases in both "carrying capacity" and "production per acre" occurred in the group of farms for which the "percentage of grassland cut for hay" had increased by more than 7%.

These conclusions should be regarded as tentative, however, since they were not supported by the independent results derived from the analysis of farms grouped according to "production per acre".

(c) Trends in Topdressing.

Influenced by war conditions, the areas topdressed and the rates of application showed year to year variations which probably would not have occurred under other circumstances. Reference was made to the system of rationing invoked in 1942 and a method was presented by which trends in rates of topdressing (for which there was no direct measure in this study) could be studied.

Various compromises, some of which involved an increased use of lime were the expedients by which farmers countered the fertilizer shortages. It was shown that

much larger year to year changes in the areas topdressed occurred on large farms than on small, although the nature of the trends were similar, irrespective of farm size. For properties on which "carrying capacities" were high, very little reduction occurred in the "percentage of grassland topdressed" during the period of rationing.

For the purpose of analyzing more fully the trends in the areas topdressed and the number of farmers topdressing noted previously for the mean sample farm, the 253 farms comprising the sample were classed according to the between-farm differences in "the percentage of grassland topdressed". Subsequent analysis of the data on this basis provided little additional information but by grouping farms according to the nature and extent of changes in "the percentage of grassland topdressed", it was discovered that between 1941 and 1950, more than twice as many farmers had extended their topdressing programmes than had reduced them. Moreover, those farmers who by 1950 had reduced their topdressing programmes to the greatest extent, had been in 1941, the greatest exponents of the extensive use of topdressing.

Another striking result obtained from the analysis of the 253 farms when grouped according to changes in "the percentage of grassland topdressed" was that "production per acre", "production per cow" and "carrying capacity" had increased on farms, the topdressing programmes for which had been reduced. Within this analysis, based upon changes in the area topdressed, the greatest increases in "production per acre", "production per cow" and "carrying capacity" recorded between 1941 and 1950 occurred in the penultimate group, consisting of farms on which the "percentage of grassland topdressed" had increased by 25-34%.

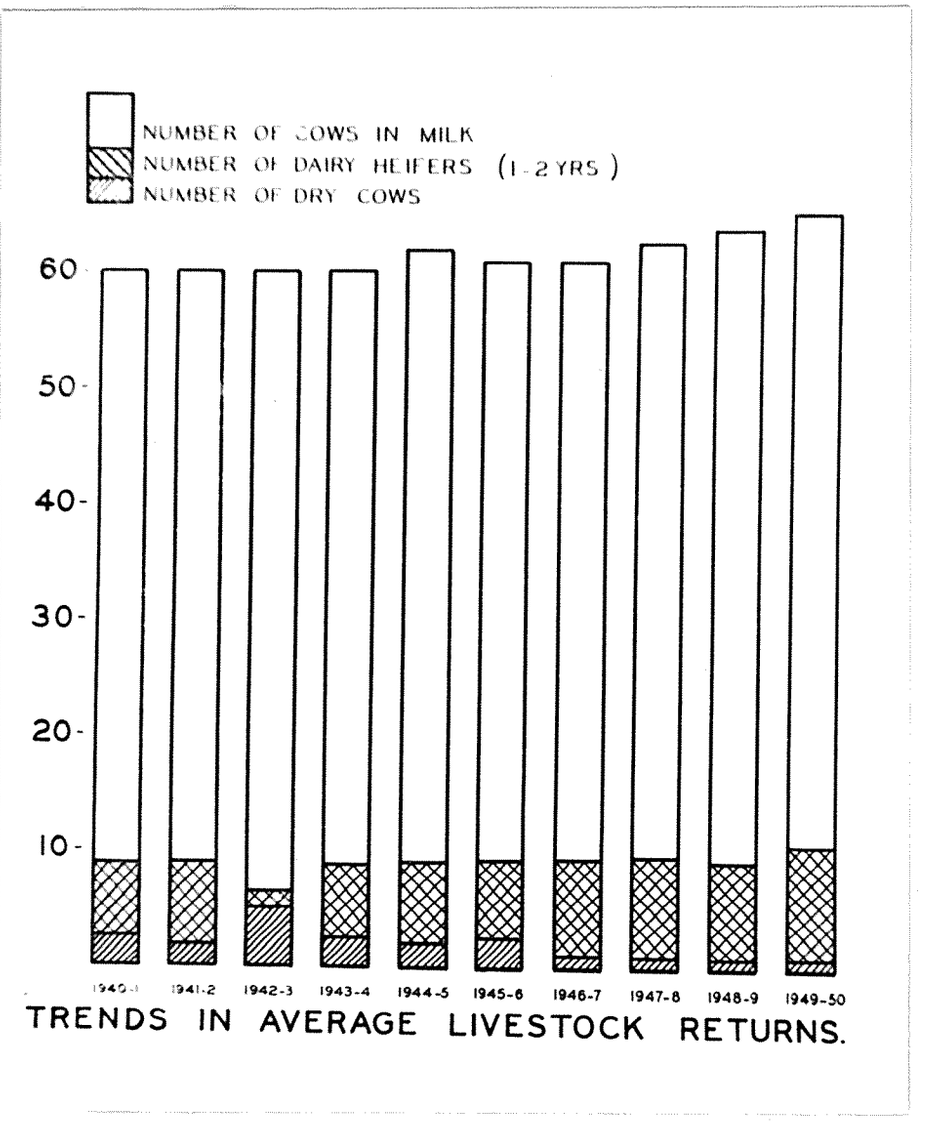


FIG.27: Trends in the farm livestock on the mean sample farm.

It was impossible to assess from this result, however, the importance of fertilizers, especially superphosphate, to dairy-farming in the Waipa County. For the mean sample farm it appeared that "production per acre" had not been affected by fertilizer restrictions. To prevent the needless waste of money and resources it was suggested therefore, that there was an urgent need for each farmer to ascertain accurately, the optimum topdressing needs of his property. Certain problems associated with the assessment of this requirement were discussed.

(d) Trends in Farm Livestock Numbers.

Between 1941 and 1950 additions were made to the total "number of cows in milk" and as a result, the herd size for the mean sample farm increased by 8%. Since scarcely any change was recorded in "production per cow", the change in total farm output was practically identical with that for herd size.

During this ten year period, the number of dry animals per farm decreased (see FIG. 27), due probably to the increased application of more enlightened methods for countering diseases such as mastitis and contagious abortion, but no change was recorded in the average annual number of replacements per 100 cows in milk.

(e) Trends in Farm Machinery & Labour.

Only a limited amount of data was available concerning farm machinery and it was apparent that alterations in farm tractor numbers were scarcely an adequate measure of trends in farm mechanization. Nevertheless, a remarkable increase in the tractor/farm ratio occurred between 1941 and 1950.

The importance of mechanical power for conserving labour and expediting work was considered briefly.

The final section of the study in dairy-farm trends was concerned with farm labour but only four seasons' data were available. Even in this short period, however, it appeared that workers were being drawn away from farming and, as a result of the labour shortage thus created, working conditions were being made more difficult for those remaining in dairying.

P A R T I V

INTEGRATING SUMMARY AND CONCLUSIONS

PART IV

SECTION XIV

INTEGRATING SUMMARY AND CONCLUSIONS.

An investigation was made of dairy-farm production in the Waipa County from data collected for the period 1941 to 1950. This investigation was composed of two distinct sections:-

1. A dairy-farm management survey.
2. A study in dairy-farming trends.

The same sample of farms was used in both studies and consisted of 253 holdings for which full information was available in each of the ten consecutive years.

All data analysed related to physical inputs and outputs. Most of the information was obtained by various Governmental and other organizations in the form of routine returns. Some of the terms employed in this investigation were obtained readily from the original returns. Others, however, such as "soil rating" and "stock units" which have been explained in detail were of more complicated origin.

By averaging the ten years' data for each farm, mean figures were obtained which were used subsequently in the management survey. These mean figures for each farm were again averaged and the resultant means used to describe the mean sample farm.

The series of ten annual returns representing the inputs and outputs for individual farms comprised the basic data for the trends study.

In the analysis of these data, the three following

methods of investigation were employed, two of which were concerned solely with the management survey.

1. The Dairy-farm Management Survey.

From a study of the mean sample farm, a description was provided of the standard of farming practised and the system of management applied in the Waipa County. Greatest importance was attached to the indices of farming efficiency and capacity.

It was shown that the average sample farm, consisting of 108 acres and carrying 63 cows per 100 acres, produced 167 lbs. of butterfat per acre. "Production per cow" amounted to 265 lbs. of butterfat and with a labour force of 1.8 labour units per farm, "production per labour unit" was estimated at 9,015 lbs. of butterfat.

A more detailed description of the sample was made possible from data derived from a series of tabulation analyses which included as dependent variables, many of the inputs and all of the major outputs. Sixteen tabulation analyses were included and it was noteworthy that for each of twelve of these, the distribution of sample farms about the modal group was normal. The four exceptions were the following inputs :- "percentage of cultivated area cropped", "percentage of grassland cut for silage", "percentage of grassland topdressed" and "soil rating". For the first two, distributions were skewed towards low levels of input, while for the latter, more farms were included in the higher groupings.

Despite the Waipa County being considered an established dairying district, there was considerable between-farm variability for the different indices of productivity.

The extent of these differences was sufficient to make possible classification of the 253 sample farms into -

(1) eight "production per acre" groupings, the averages for which ranged from 83 to 263 lbs. of butterfat per acre,

(2) five "carrying capacity" groupings, the averages for which ranged from 43 to 85 "cows in milk" per 100 acres,

(3) six "production per cow" groupings, between which herd averages ranged from 202 lbs. to 308 lbs. of butterfat,

and (4) eleven "production per labour unit" groupings, the averages for which ranged from 4,164 lbs. of butterfat to 15,114 lbs. of butterfat.

By a similar method of classificiation, the sample variability for a number of inputs was likewise clearly expressed.

By classing farms on the bases of different inputs and outputs and subsequently analysing the data within these groups, associations were revealed between certain variables. Particular attention was paid to the tabulations based upon "production per acre", "production per cow", "carrying capacity" and "production per labour unit", since it was especially desirable to identify inputs associated with these factors. The relationships revealed were subjected to verification, by referring to the tabulation where the independent variable functioned as the dependent variable.

This method of ascertaining where relationships existed constituted a purely descriptive form of approach to the problem. It enabled important inputs to be distinguished from those which were unimportant, but it

did not possess the specificity of the statistical method employed for the same purpose.

With the object of substantiating and supplementing information resulting from application of the descriptive method, a statistical form of analysis was introduced. The accuracy of the results provided by this method depended on the truth of the premise that relationships between all variables were linear.

Gross correlations were calculated between all inputs and outputs. Since direct expression of relationships was not obtainable between the various inputs and both "production per acre" and "production per labour unit", values of R^2 (the square of the multiple correlation coefficient = the fraction of the total variance accounted for) for "production per cow", "carrying capacity" and "the number of cows milked per labour unit" which were attributable to nine specified inputs were determined from the appropiate correlations, by application of Doolittle's Solution (described by Dwyer (1942)). From the completed Doolittle solutions it was possible to estimate with a fair degree of accuracy, the important inputs in each of the three measures of farm capacity. By an appropriate adaptation of Doolittle's method (loc. cit.), the accuracy of these estimates was determined and the results obtained were subsequently confirmed by a further refinement of the same technique which permitted calculation of the standard partial regression coefficient for each input. From the standard partial regression coefficients, the corresponding natural partial regression coefficients were calculated for each selected input. Regression equations were then determined for the dependent variables "production per cow",

"carrying capacity" and "the number of cows milked per labour unit", after which, the component coefficients were interpreted.

The relative merits of the statistical and descriptive analyses were discussed and certain fundamental differences between the two approaches were described. These consisted of the lack of restrictions placed upon the original data (e.g. no unproven assumptions) and the absence of a certain decisiveness about some of the results, both of which were features of the descriptive approach, contrasted with the restrictions imposed on the original data and the definite answers resulting from application of the statistical method. In view of this, the results supplied by the tabulation and statistical analyses were accorded additional importance.

It was significant therefore, that the five inputs:-

"Soil Rating"

"Cultivated Area"

"Percentage of Grassland Topdressed"

"Percentage of Grassland Cut for Hay"

and "Percentage of Grassland Cut for Silage"

which were shown to make major contributions to R^2 as determined for "carrying capacity" from all inputs, showed high degrees of relationship with "carrying capacity" in the relevant tabulations. Thus it was possible to distinguish the important from the unimportant factors by both methods.

For "production per cow", the tabulations revealed fewer close relationships than were found for "carrying capacity", but the results obtained were in agreement with those obtained by the statistical technique.

Of the five inputs, three, viz.,

"Soil Rating",

"Percentage of Grassland Topdressed"

and "Replacement Numbers per 100 cows in milk"

were shown to be the most important affecting "production per cow". This represented a reduction of the number of inputs estimated to be of importance for "carrying capacity". Such a result was not unexpected, however, since the calculated values of R^2 for "carrying capacity" and "production per cow" were 0.4038 and 0.2256 respectively. The continuous reduction in the values for R^2 was extended to the analysis in which "the number of cows milked per labour unit" constituted the dependent variable. In this case the value of R^2 attributable to the nine inputs was 0.1693. Only two of the nine variables, viz., "cultivated area" and "replacement numbers per 100 cows in milk" were found of importance. However, these results were not in full agreement with those from the corresponding tabulation analyses.

Apart from the lack of agreement obtained in the last analysis, which, in view of the low value of R^2, was understandable, it appeared that the results obtained by the descriptive and statistical methods were essentially similar. This does not permit the assumption, however, that one method would serve as a complete substitute for the other, since the results from each method had certain distinctive features. On the one hand, the system of tabulation analyses possessed the advantage that data in the finalized tabulations were always adaptable to further analyses. In the present survey this particular virtue was demonstrated where, after the principal analyses had been completed, calculations were made of the relative

economies of topdressing, cropping etc., between different groups of farms. On the other hand, no descriptive technique would have permitted estimation of the fraction of the total between-farm variance (R^2) for "carrying capacity", "production per cow" and "the number of cows milked per labour unit" attributable to all inputs. These data represented an important contribution to the survey results and stimulated speculation concerning possible major contributors to the residual variance. As befitted its position among these variables, the human factor was accorded considerable attention and it was suggested that appropriate intelligence tests applied in conjunction with normal survey procedures, could help considerably in obtaining a satisfactory measure of the individual farmer's contribution to the total between-farm variance for "production per acre".

Additional information was supplied following the application of regression analyses which, regardless of their merits and demerits when used in farm studies, enabled a comparison of inputs to be made under comparable sets of circumstances.

In many respects therefore, the contributions of both statistical and descriptive methods were complementary and thus permitted a more thorough utilization of the available data than would have been possible had a single system of analysis been applied.

It was established by both methods that only six inputs in one case and four in the other were important in accounting for differences between farms in "production per acre" and "production per labour unit". "Cultivated area" and "soil rating" achieved significance in both instances, but represented features over which the farmer,

once he accepted title, had no control. The negative correlation between output per acre and "cultivated area" was explained in terms of the necessity for maximizing the returns from farms of restricted area. It was appreciated that expressing farming efficiency in terms of "production per acre" was rather misleading when, in times of low prices, farms producing the largest per acre returns were not economic units. Under such circumstances, by reference to "production per labour unit" in conjunction with "production per acre", a more realistic attitude in comparing farm efficiencies was ensured.

It was considered debatable whether "soil rating" was important in its own right - high inherent soil fertility and desirable physical features effecting greater and more prolonged growth than was possible on less fertile land - or whether, better managers had acquired higher quality land than their less gifted neighbours. The solution of this problem was not one of the purposes of this survey but from the evidence of the modifying influence that man has had upon the soils of the Waikato, it appeared likely that better than average farmers were located on land of high "soil rating".

Information of value to individual farmers because it was concerned with adjustable inputs included data which showed that increases in the percentage areas cut for hay and silage were associated with improvements in "carrying capacity" but not with improvements in "production per cow". It was concluded therefore, that the outputs of many farms could have been improved by increasing the quantities of supplementary feed saved and subsequently used in th e periods of pasture shortage. However, the magnitude of the corresponding regression coefficients suggested that

increases obtained by this means would not be particularly large. Regression analyses do not make allowances, however, for the cumulative effects that the introduction of a single unit of input may produce. Thus, if an increase in the number of cows per acre resulted from an increase in supplementary feed supplies, several secondary effects may have been produced. For example, an increase in the area of surplus grass converted to hay and silage during the period of maximum growth may have improved the pasture utilization at that time and ensured a longer period of high pasture production. Better utilization of pasture and its products by more cattle involves a quicker cycle of fertility and a consequent addition to the original soil productivity. Since these improvements may permit further increases in "carrying capacity", for any input the magnitude of the regression coefficient provides a rather theoretical measure of its potential value in increasing production.

"The percentage of grassland topdressed"was included among the factors of production which, from the results of the present investigation appeared to be important, yet owed this importance to a rather complex set of circumstances The present study showed that the influence of topdressing on "carrying capacity" and "production per cow" was quite marked, but it was difficult to decide whether these results were due to the direct influence of topdressing upon pasture production, or whether they were the expression of circumstances in which good managers topdressed a greater proportion of their properties than did poor managers. Alternatively the correct solution may have been a combination of these two features.

Should the first suggestion prove correct, then there is scope for some farmers to increase pasture production by extending their topdressing programmes. Since data on rates of topdressing were not available for this study, it was assumed that the rates would remain unchanged. In view of the possibility that the "percentage of grassland topdressed" constituted an indirect expression of farmer-ability, however, it was concluded that further investigation was required to ensure that topdressing was actually producing the effects attributed to it.

The only other input to which attention was drawn, viz., "the number of replacements per 100 cows in milk", was considered in detail within the corresponding tabulation analysis and also in the study of between-farm differences in "production per acre".

By grouping properties according to "production per acre", "carrying capacity" ("cows in milk" per 100 acres) and "production per cow", a negative relationship was shown in each case between the dependent variable and "the number of replacements per 100 cows in milk". The negative relationships revealed in the first two analyses were much stronger than that shown in the third. The results of the regression analysis showed, however, that the input "replacement numbers per 100 cows in milk" was of importance in affecting "production per cow" and "the number of cows milked per labour unit" but not "carrying capacity".

For "carrying capacity", the lack of agreement between the results derived from the statistical and descriptive methods was due to the availability of alternative forms in which to express "carrying capacity". Thus for the statistical analyses, "carrying capacity" was expressed in

"stock units" and within the tabulation analysis in which "stock units" per acre was the dependent variable, a very weak negative relationship was apparent between "carrying capacity" and "replacements numbers per 100 cows in milk". If "carrying capacity" had been expressed as "the number of cows in milk" per 100 acres, a more accurate estimate of the influence of young-stock numbers on "carrying capacity" would have been obtained. Under the circumstances the coefficient calculated from the regression of "replacement numbers per 100 cows in milk" on "production per cow" was considered a gross underestimate of the importance of an input which, the writer contends, has a marked influence on between-farm differences in "production per acre".

Since facts and principles were derived from this investigation which could be of benefit to individual farmers, application of the survey technique was considered justified. The limitations of the basic data, however, prevented fullest exploitation of this comparative method of study and therefore precluded a more comprehensive coverage of farming practices. It was appreciated that the information obtained was mainly of value to farms in the low efficiency classes and did not represent a basis for distinguishing the best farms from those whichwere not quite as efficient, but which were well above average. Many of the physical inputs which add to levels of production already high, are very difficult to express in forms suitable for survey analysis.

In the utilization of survey results, it must be appreciated that such results invariably refer to average conditions which may differ substantially from those obtaining on individual farms. Thus, these results often find most useful application as general guides for extension

workers. They can be used, in many cases, to indicate factors causing differences between farms and the general recommendations can be modified to fit individual circumstances.

Whether, in the future, the survey method will continue to provide useful information concerning physical inputs alone, is a debatable question. It was pointed out that a considerable proportion of farm data does not lend itself readily to systems of survey analysis and in view of this, the application of survey methods in the future may depend upon the extent to which farm management policies differ between districts.

It would seem that there is scope for the extension of district surveys involving the assessment of present and potential land productivities on different soil types. It should be noted, however, that in the past, productivity has been measured in terms of "stock units" per acre. Since the series of "stock units" derived for the present survey represents only a best approximation of the actual conversion factors, continued application of this method may jeopardize the accuracy of future results. Under these circumstances, it may be more satisfactory to express output in terms of monetary returns per unit area and to accept prices for a particular season or group of seasons as the reference standard.

2. The Study in Farming Trends.

Any comparison between survey and trend studies is really a contrast between the static and the dynamic. Data are presented in the trends study as they are recorded from year to year, while surveys are invariably concerned

with information referring to a single period in time. As a result, the mean sample farm usually proves a far more profitable source of data for a trends study than it does for a survey study. With time as a variable, it is possible to trace changes in inputs and outputs and to study farmer-reaction to events which are conducive to such changes.

For the purpose of making a detailed study of farming trends, the sample holdings were classified according to within-farm changes and between-farm differences for various inputs and outputs. Within these groupings the data for individual farms were analysed and the results compared with those for other classifications.

In 1947 the original sample of 400 dairy-farms was selected for this investigation, but by 1950, the requirement that each farm supply complete data for the period 1941 to 1950 had depleted this number to 253 properties. Some useful information was provided by certain causal factors in this high sample wastage and it was shown that as the result of land transactions made during the ten year period, only 25% of farms had experienced complete ownership changes and the majority of these had occurred following the repeal of the Land Sales Act, 1949. Further, it was shown that only twelve of the original 400 farms had not been dairy-farms throughout the ten year period. Both of these findings were considered indicative of the prosperous state of the Dairy Industry.

For the mean sample farm it appeared that between 1941 and 1950, seasonal climatic changes were responsible for the principal variations in "production per acre", "production per cow" and "percentage of grassland cut for hay".

Cropping was never considered of major importance in the Waipa County, but, in 1944, the introduction of a subsidy which really amounted to an incentive payment and its subsequent removal in 1947, accounted for the early increase and later, the decrease, in both the area cropped and the number of farmers cropping.

Towards the end of the decade an increase was noted in "the percentage of grassland cut for silage" and this was attributed to a genuine rise in the popularity of this form of supplementary feed.

Trends in the area topdressed were affected by wartime restrictions and in all probability, the nature and extent of these changes would have been different under other circumstances.

Improvements in "carrying capacity" (cows per 100 acres) were obtained on the mean sample farm as the result of additions to the average herd size and despite small increases in the average "cultivated area". The proportion of dairy young-stock per 100 cows in milk remained relatively constant from year to year, but there was a reduction in the number of dry animals carried. This was probably the result of a more extensive utilization of veterinary services and the wider use of measures for the control of mastitis and contagious abortion. The overall result of these changes, however, produced scarcely any alterations in "carrying capacity" when the latter was expressed as "stock units" per acre.

Data on farm machinery, although limited in nature, showed that a remarkable increase had been effected in the ratio of tractors to farms. It was unfortunate that there was very little information available on both labour and

machinery since ultimately the size of the labour force places a limit on total farm production, and the degree of farm mechanization can have a marked influence on the level at which this restriction is imposed. The information which was available indicated a decrease in the average number of workers per farm between 1947 and 1950. Greatest losses were noted for those sections of the farm labour force concerned with routine milking. Thus, although it was anticipated that time saving procedures such as doubling-up on milking units had compensated for these losses to a certain extent, it was concluded that the maintenance of production was requiring increased effort from those workers who remained in dairying.

Future developments in farm mechanization, which may be confidently expected in the near future, may effect a partial solution to this problem. Certainly the present conditions must be considered conducive to a large expansion in farm mechanization. Even in the existing types of tractors and tractor-drawn implements there is room for considerable improvement and a greater degree of standard-ization of farm implements and tractor fittings.

Apart from the desirability of improving the efficiency and adaptability of farm equipment, greater emphasis on the mechanical aspect of farming can assist farmers in recruiting adequate labour and since the present farm labour supply situation cannot be viewed with any complacency this may constitute a very important feature of future farming trends.

Among the results presented previously for the mean sample farm, it was noted that both "production per acre" and "production per cow" showed very little change during the ten years and that seasonal variations were responsible for most of the differences recorded from year to year. In the

analysis of the results for individual farms therefore, an attempt was made to discount the effects of climate on various inputs and outputs by calculating for each, the averages for the first three and last three years. When the returns were averaged in this way, increases were apparent in both "production per acre" and "production per cow" during the ten year period. By grouping farms according to the nature and extent of changes in "production per acre", "production per cow" and "carrying capacity" between 1941 and 1950, it was shown that more farmers had recorded gains than losses in each of these indices. Nevertheless the number of farmers included in the latter group was sufficiently large to constitute a disturbing feature of these results.

The nature of the trends for groups of farms which showed losses orgains in efficiency was such as to suggest that these were the expression of the two opposite phases which usually occur in a farming cycle. For the farms on which greatest losses were recorded (in "production per acre", "production per cow" and "carrying capacity") the returns had been comparatively high at the commencement of the ten year period, whereas the most notable increases occurred on farms which were producing well below average in 1941.

These results were suggestive of a situation which could be explained satisfactorily on the one hand, in terms of the young, newly-established farmer, encumbered with certain financial commitments, and on the other, in terms of the not-so-young but well-established owner, content with procuring a comfortable living without undue effort. For the latter, the decline noted for "production per acre" might be explained as the expression of adaptations made by the farm operator in accord with what he considered were his physical capabilities.

A peculiar anomoly in this theory was suggested, however, by the discovery that there was a regular increase in "cultivated area" coincident with the decline in yield per acre. Since there was associated with this increase a fall in total farm production, it was concluded that this extraordinary trend in farm area probably represented a means whereby some farmers were avoiding certain taxation payments.

Trends for farms recording the greatest losses and gains in "production per acre" during the ten years were unidirectional throughout and this emphasized the difficulty of attempting to predict future changes in this indice on the mean sample farm. There was nothing to suggest from the data available, however, that during the next few years any changes in "production per acre" would be other than seasonal in origin.

By successively grouping farms according to within-farm changes in "production per acre", "production per cow" and "carrying capacity", three series of results were obtained all of which were essentially similar. It was of interest to note that by grouping farms according to the nature and extent of alterations in individual herd averages and thereafter analysing data within these groups, although a strong relationship appeared between "production per cow" and "production per acre", the corresponding changes in "carrying capacity" contributed very little to the increases in "production per acre". Alternatively, by grouping farms according to alterations in "carrying capacity" between 1941 and 1950, a strong relationship was revealed between the latter and "production per acre" and in this analysis since the changes in "production per cow" were comparatively small, the effect of the latter on "production per acre" was correspondingly reduced. These

results demonstrated an unsound feature of a rather popular method of presenting data indicating the relative importance of "production per cow" and "carrying capacity".

The practice of grouping farms according to changes which occurred on individual properties was extended to include the inputs "percentage of grassland cut for hay" and "percentage of grassland topdressed". As a result it was shown that the small year to year and overall changes in the "percentage of grassland cut for hay" which were noted for the mean sample farm were typical of the majority of individual farms. It was also shown that although between 1941 and 1950 some farmers had restricted their topdressing programmes, the majority had increased their use of artificial fertilizers and consequently an upward trend in the area topdressed was noted for the mean sample farm.

The remainder of the trends study involved the observation of within-group changes and between-group differences for various inputs and outputs when the sample farms were classed on the same bases as in the management survey. A limited number of variables, viz., "carrying capacity", "production per cow", "percentage of grassland topdressed" and "cultivated area", were used as the bases for classifying farms. Little additional information was provided from these analyses but some useful data was obtained concerning the influence of climatic conditions on farms producing at different efficiency levels.

It was difficult to compare the results of the trends study with those of the management survey, since the objectives of each method differed. However, it might have been anticipated that some evidence of the application of practices similar to those suggested in the recommendations

following the survey analysis would have been apparent for farms on which, between 1941 and 1950 farm efficiency had increased. There was, however, no evidence provided by this particular section of the trends study to suggest that changes in those inputs which the management survey had indicated as important were responsible for the large increases in "production per acre" noted on certain farms.

The particular merit of the trends study was that it provided several seasons' data concerning a constant area of land and this information was particularly useful when studied in conjunction with returns for the whole of the Dominion.

Between 1941 and 1950 the percentage increase for the Dominion's total butterfat production (N.Z. Dairy Board Report, 1951) was approximately one half that recorded for the sample employed for this study. In both cases, the percentage increases in the cultivated areas were similar but on the mean sample farm for the group of dairy-farms included in the present study, a slight reduction was noted for "production per acre".

In the case of Dominion production returns, the magnitude of the absolute figures tends to mask the proportionality of increases and it is not until a sample, small enough to permit the study of individual farms, is considered, that it is realized how small are the individual increases. Undoubtedly the development of virgin land for dairying will add to New Zealand's total butterfat production, but since there is an ultimate limit to the amount of land which can be utilized for dairying, the finding that during the space of ten years, in an established dairying district such as the Waipa County there was so little change in the general standard of farming efficiency, is a matter of considerable importance.

Although it was appreciated that within the sample considered, a number of farmers had effected notable improvements in "production per acre", their contributions had not materially influenced the sample average. Should this situation be confirmed as representative of conditions prevailing in all established dairying districts and as the fate of dairy-farming once the developmental stage is passed, then under circumstances similar to those existing at present, a ceiling will be placed on the Dominion's total butterfat production, which will be considerably below the potential output of the land involved. Such a possibility as this should receive close consideration, because there are some areas at present used for dairy-farming where the advantages of dairying scarcely outweigh those associated with fat lamb farming. Slight changes in economic conditions can so alter this balance as to favour meat and wool in preference to dairy products and under such circumstances, land would be lost to dairying. It is obvious therefore, that the responsibility of maintaining and increasing the Dominion's total butterfat production must rest mainly with farms located on land especially suited for dairying. The results of this study, however, indicate that in one such area, almost as many farmers had recorded losses as had effected gains in total output.

Suggested reasons for this unsatisfactory situation include the following:-

(a) Some aspects of the existing systems of land tenure.

(b) High costs of production.

(c) Shortages of labour and materials.

(d) The existing system of a guaranteed payment for dairy produce.

(e) The present system of taxation.

The attitude which a farmer adopts towards his farm as a productive unit can have an appreciable effect on the efficiency with which the property is managed. Naturally, the farmer's attitude will be tempered by his financial position and an indirect measure of the security of farmers included within this sample was provided by data which showed that 75% of the original 400 sample farms remained as within-family properties during the period 1941 to 1950. From some observations on the individual farms which changed ownership during this period and comprised a part of the final sample, it appeared that, in general, substantial increases in "production per acre" occurred following the year of the transaction.

Since in the corresponding years comparable increases were not apparent for the remaining farms in the sample, it appeared that on many holdings the sound financial position of the operator, which was partly a consequence of longevity of tenure, provided little incentive for increasing efficiency of land utilization.

Whether or not future investigations will show that these findings, which admittedly refer to a limited number of farms, are correct, it is clear that a large number of farmers made little effort to increase the productivity of their farms beyond standards achieved in 1941. Under conditions existing in 1950, the opportunities for expansion of output were much greater than they were in the early 1940's when restrictions were imposed on certain

important agricultural requirements. Admittedly a definite problem is constituted by the limited availability of farm labour and a marked increase in the cost of materials has been experienced in recent years, but, in spite of these difficulties, it was shown that between 1947, when the original sample of farms was drawn, and 1950, only two farms changed from dairying into other types of farming. It can be assumed therefore, that most of those who are dairy-farming are obtaining adequate monetary returns and for some, prosperity must come rather easily. This could be a consequence of the present guaranteed price system which, it is suggested, is founded on a much outdated cost of production basis. The results of the present survey indicate that by existing standards, the average farm for which costs were calculated in 1934 was not particularly efficient and was well below the mean farm for the sample of Waipa dairy-farms selected for this study. Since it has been customary to make annual adjustments to these original cost of production estimates which were calculated before the guaranteed price was introduced, the present system of guaranteed payments must be permitting many farmers to continue producing at below average efficiency.

Should this opinion prove correct and some organization be appointed to abolish such an anomoly, any move to lower the standard payout would undoubtedly meet with strenuous opposition. It is suggested, however, that if it was found impracticable by such means to stimulate increased farm production, then by widening the existing scales of payments for dairy products of different grades, an incentive could be supplied for the production of higher quality products.

While the present systems of private ownership of farms and guaranteed prices are maintained, however, whether or not a farmer decides to increase the output of his farm depends in most cases, on him alone. However, because of the peculiarly favourable conditions existing at the present time, under which farmers can sell their products on a non-competitive basis, at a guaranteed price, the farming community has the opportunity of meeting its responsibilities to the nation, by taking fullest advantage of the period of prosperity to accumulate reserves against the possibility of future price depressions. The co-operation of all farmers in an effort to increase total production could provide a contribution which could do much to ensure New Zealand's future economic stability.

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

B I B L I O G R A P H Y

AEREBOE, FRIEDRICH. 1919. Allgemeine landwirtschaftliche Betriebslehre 4. Neubearb. Aufl. Berlin.

ASHBY, A.W. 1934. "Efficiency in dairying and some economic results." Journ. Brit. Dairy-Farmers Association. 46: 32-48.

ASHBY, A.W. 1937. "Discussion on efficiency standards." Journ. of the Agr. Economics Soc. 5: No. 1. 67.

BRODY, S. 1945. Bioenergetics and Growth, Reinhold N.Y.

DICK, I.D. 1950. "The use of confluence analysis in Agro-economic surveys." N.Z.J. of Sc. & Tech. B.31 (6) 1.

DOIG, W.T. 1940. "Standards of Life of New Zealand Dairy-Farmers." N.Z. Dept. of Sc. & Ind. Res. Bull. No. 75.

DUCKMAN, A.N. 1930. "The Comprehensive Farm Survey." Proc. Int. Conf. of Agr. Economics, 2nd Conf. 459.

DWYER, P.S. 1942. "Recent Developments in Correlation Technique." Journ. of the American Stat. Ass'n. 37: No.220, 441.

DWYER, P.S. 1945. "The Square Root Method and its Use in Correlation and Regression." Journ. Am. Stat. Ass'n. 40: Part I, 493.

ECKLES, C.H. and GULLICKSON, T.W. 1931. "Nutrient Requirements for Normal Growth of Dairy Cattle." J. Agr. Res. 42: 603.

FAWCETT, E.J. 1929. "Dairy-Farm Management." N.Z. Dept. of Agr. Bull. No. 138.

FAWCETT, E.J. 1932. "Butterfat Production in New Zealand." N.Z. Journ. of Agriculture, 44: 235.

GAINES, W.L. 1928. "The Energy Basis of Measuring Milk Yields in Dairy Cows." Ill. Agr. Exp. Sta. Bull. 308: 403-438.

GRANGE, I.L. TAYLOR, N.H., SUTHERLAND, C.F. DIXON, J.K., HODGSON, L., KIDSON, E., CRANWELL, L.M., SMALLFIELD, P.W., 1939. "Soils and Agriculture of Part of Waipa County." N.Z. Dept. of Sc. & Ind. Res., Bull. 76.

HAMILTON, W.M. 1944. "The Dairy Industry in New Zealand." Council of Scientific & Ind. Res., Bull. 89: 148.

HAMILTON, W.M. 1944. Unpublished data.

HAMILTON, W.M. 1947. "The Effect of Soil Type on Productivity in Whangarei County." Proc. 7th Annual Conf. N.Z. Soc. of Animal Production. 137.

HAMILTON, W.M. 1949. "Farm Surveys as a Basis for Land Classification." Proc. 7th Pacific Sc. Congress. (In Press)

HAMILTON, W.M. 1952. Private Communication.

HAMILTON, W.M. and WARD, A.H., 1951. "Production per Cow and Production per Acre." Massey Agricultural College Dairy-Farming Annual.

HUTTON, J.B. and WRIGHT, M., 1952. "A Study in Dairy-Farming Trends in the Waipa County 1941-1950." Proc. 12th Annual Conf. N.Z. Soc. of An. Prod.

JENSEN, E., KLEIN, J.W., RAUCHENSTEIN, E., WOODWARD, T.E. AND SMITH, R.H., 1942. "Input - Output Relationships in Milk Production." U.S. Dept. Agr. Tech. Bull. No.815.

MASSEY AGRICULTURAL COLLEGE, 1951. Unpublished data. UNIVERSITY OF NEW ZEALAND.

MILLIKEN, M. 1948. "A Survey of Certain Aspects of the Share-milking Inudstry in the Waikato." Unpublished thesis.

MITCHELL, H.H.1929. "The Minimum Protein Requirements for Cattle." U.S. National Res. Council Bull. No. 67.

MITCHELL K.J. 1948. Unpublished Survey data.

MITCHELL, K.J.1948. "Some Farming Trends in Whangarei County 1940-41 to 1946-47." Proc. 8th Annual Conf. N.Z. Soc. of Animal Prod.

MITCHELL, K.J. and HAMILTON, W.M., 1950. "Dairy-farming in Waipa County." Massey Agr. College Dairy-farming Annual.

MORRISON, F.B.1950. "Feeds and Feeding." 20th and 21st Edns. Ithaca N.Y.

MYERS, W.I. 1930. "Results of Farm Management Research in the Northeastern United States." Proc. 2nd Int. Conf. of Agr. Ec. 841.

NEW ZEALAND DAIRY BOARD REPORTS 1941 to 1952 - Published annually.

NEW ZEALAND DEPT. OF AGRICULTURE ANNUAL REPORTS 1946 & 1947. Govt. Printers, Wellington.

NEW ZEALAND AGRICULTURAL & PASTORAL STATISTICS 1941 to 1952. Published annually - Govt. printer; Wellington.

NEW ZEALAND DEPT. OF SCIENTIFIC & INDUSTRIAL RESEARCH ANNUAL REPORT 1931. Govt. Printer; Wellington.

NEW ZEALAND GAZETTE 1941 to 1950. Published monthly - Govt. Printer; Wellington.

NEW ZEALAND OFFICIAL YEAR BOOK 1938-1951. Published annually - Govt. Printer; Wellington.

PHILPOTT, H.G. 1937. "A History of the New Zealand Dairy Industry 1840 - 1935." Govt. Printer; Wellington.

PLUM, MOGENS., 1935. "Causes of Differences in Butterfat Production of Cows in Iowa Cow Testing Associations." Journ. of Dairy Science 18: No.12, 811.

POND, G. and WILCOX, W.W. 1932. "Study of the Human Factor in Farm Management" Journ. of Farm Economics 14: 470.

REPORT OF THE DAIRY INDUSTRY COMMISSION 1934. Govt. Printer; Wellington.

REPORT OF THE U.S. RESEARCH COUNCIL COMMITTEE ON ANIMAL NUTRITION 1950.

ROWLANDS, A. 1951. Private Communication.

SNEDECOR, G.W. 1940. "Statistical Methods." Iowa State College Press.

STEPHENS, C. 1951. Private Communication.

WALLACE, L.R. 1948. "The Growth of Lambs Before and After Birth in Relation to the Level of Nutrition." J. Agr. Sc. 38: 367.

WALLACE, L.R and MCMEEKAN, C.P. 1951. Private Communication.

WARD, A.H. 1953. "Level of Phosphate Application and Butterfat Production per Acre." Proc. 13th. Annual Conf. N.Z. Soc. of Animal Prod. (in press).

WESTERMARCK, N. 1951. "The Human Factor and Success in Farming." Acta. Agriculturae Scandinavica, 1: 2.

WILD, G.V. 1953. "Secondary School Agricultural Education." Proc. 13th Annual Conf. N.Z. Soc. of Animal Prod. (in press).

Thomas AB 1947 "Theobald Memorial Lecture"
MASSEY AGRICULTURAL COLLEGE LIBRARY PALMERSTON NORTH, N.Z.
Journ. N.Z. I.C. 11 No 4

A C K N O W L E D G E M E N T S

The writer wishes to record his indebtedness to Dr. W.M. Hamilton for having made available the data upon which the present study was based. Especial thanks are due to the following, who helped either in the analysis of the data, or in the presentation of the results:-

Mr. J.N. Hodgson, Dr. A. Stewart and Professor I.L. Campbell for their helpful suggestions and criticisms;

Mr. A. Glenday for his advice and aid in the application of statistical methods;

Miss Margery Wright and Mr. E.B. May for assistance in the preparation of the diagrams;

Dr. W.A. McGillivray for photographing the diagrams;

and Mr. I.J. Inkster and Mr. K.F. O'Connor who provided assistance in a variety of ways.

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

INDEX OF APPENDICES.

Appendix Number		Page Number
i.	Summary of data for single soil type farms	(1)
ii.	Waipa Soil Types: 80 ch. Map . .	(2)
	Supplementary information required for the calculation of stock units	(3) - (12)
iii.	Wallace's (1948) data (Border Leicester X Cheviot)	(8)
iv.	Massey College "Tuapaka" Romney Flock.	(8)
v.	Weights of Romney ewes at Ruakura (1950-51)	(8)
vi.	Dairy cow requirements according to Morrison, and Gullickson & Eckles (diagram).	(13)
vii.	Stock Conversion Factors - From Morrison's Feeding Standards. .	(14)-(15)
viii.	Average Liveweights and feed requirements of female dairy cattle from birth to 2 years of age . . .	(16)
ix.	Growth curve of Jersey bulls (Ruakura data) (diagram) . . .	(17)
x.	Growth curve of Beef heifers (Ruakura data) (diagram) . . .	(18)
xi.	Average liveweights and feed requirements for Jersey bulls from birth to 2 years of age	(19)
xii.	Average liveweights and feed requirements of beef heifers from birth to 2 years of age	(20)
xiii.	Growth curve of beef steers (Ruakura data) (diagram)	(21)
xiv.	Daily requirements of beef cattle (Morrison's data) (diagram) . .	(22)
xv.	Average liveweights and feed requirements of beef steers from birth to 2 years of age	(23)
xvi.	Dairy cow conversion factors corrected for variations in"production per cow"	(24) & (25)
xvii.	Daily requirements of lambs (Morrison's data) (diagram)	(26)

Appendix Number		Page Number
xviii.	Growth curves of Border-Leicester X Cheviot lambs and of Romney lambs (diagram)	(27)
xix.	Average liveweights and feed requirements of sheep from birth to one year of age	(28)
xx.	Correction table for estimating "at the pail" production	(29)
xxi.	Gross correlations as determined by Hamilton (1944) and Mitchell (1948).	(30)
xxii.	The abbreviated Doolittle Solution for determining both R^2 and the standard partial regression coefficients	(31)-(32)
xxiii.	Dwyer's method of inverting a symmetric matrix.	(33)
xxiv. to xlvi.	Groupings based on within-farm changes in "production per acre".	(34)-(49)
xlvii. to lxix.	Groupings based on between-farm differences in "carrying capacity" ("stock units" per acre) . . .	(50)-(65)
lxx. to lxxvii.	Groupings based on within-farm changes in "carrying capacity" ("stock units" per acre) . . .	(66)-(70)
lxxviii. to xcvii.	Groupings based on between-farm differences in "production per cow"	(71)-(85)
xcviii. to cv.	Groupings based on within-farm changes in "production per cow".	(86)-(90)
cvi. to cxxvii.	Groupings based on between-farm differences in "cultivated area".	(91)-(105)
cxxviii. to cxlv.	Groupings based on between-farm differences in "the percentage of grassland topdressed with artificial fertilizers"	(106)-(121)
cxlvi. to cliv.	Groupings based on within-farm changes in "the percentage of grassland topdressed with artificial fertilizers"	(122)-(127)
clv. to clxiii.	Groupings according to within-farm changes in "the percentage of grassland cut for hay"	(128)-(133)

Appendix Number		Page Number
clxiv.	Temperature and rainfall data for the months December to February (1941-50)	(134)
clxv. to clxiii.	Trends for the mean sample farm (1941 - 1950)	(135)
clxvii.	Trends in the number of farms concerned in certain farm practices (1941-50) .	(136)
clxviii.	Changes in areas for the mean sample farm expressed as percentage changes.	(136)
clxix.	Analysis according to lbs. of butterfat per cow	(137)
clxx.	Analysis according to lbs. of butterfat per acre	(137)
clxxi.	Analysis according to carrying capacity (cows per 100 acres)	(138)
clxxii.	Analysis according to carrying capacity ("stock units" per acre)	(138)
clxxiii.	Analysis according to "the percentage of grassland cut for hay"	(138)
clxxiv.	Analysis according to "the percentage of grassland cut for silage" . . .	(139)
clxxv.	Analysis according to "cultivated area"	(139)
clxxvi.	Analysis according to "percentage of 'cultivated area' cropped"	(139)
clxxvii.	Analysis according to "percentage of grassland topdressed"	(140)
clxxviii.	Analysis according to "percentage of grassland limed"	(140)
clxxix.	Analysis according to size of herd . .	(141)
clxxx.	Analysis according to "the number of replacements per 100 'cows in milk'".	(141)
clxxxi.	Analysis according to "butterfat per labour unit"	(142)
clxxxii.	Analysis according to "soil rating". .	(142)
clxxxiii.	Analysis according to "cows milked per labour unit"	(143)
clxxxiv.	Analysis according to "stock units" per labour unit"	(143)

APPENDIX i

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

SUMMARY OF DATA FOR SINGLE SOIL TYPE FARMS

	No.of Farms	Carrying Capacity (Stock Units per Acre)		Cows per 100 acres	Butterfat Production	
		Av.	Standard Deviation		Per Cow	Per Acre
Hamilton Clay Loam	20	3.56	± 0.79	65	244	168
Horotiu Complex (Sandy Phase)	12	3.23	± 0.46	59	259	160
Horotiu Complex (Meadow Phase)	6	4.12	± 0.58	78	270	218
Horotiu Complex (Peaty Phase)	16	3.42	± 0.50	61	264	170
Puniu Silt Loam	28	3.69	± 0.62	67	272	191
Ohaupo Silt Loam	32	3.70	± 0.58	67	261	185
Whatawhata Clay Loam	10	3.45	± 0.64	64	239	161
Kaipaki Peaty Loam, & Loamy Peat.	15	2.38	± 0.58	41	208	90
Otorohanga Silt Loam	20	3.30	± 0.47	58	255	155
Otorohanga Silt Loam (inc. Hill Soils)	3	2.61		44	258	116
Tirau Sandy Loam (incl. Hill Soils)	Sheep Farms Only.					
Taupo Sandy Silt Loam (Shallow phase)						

APPENDIX ii

WAIPA SOIL TYPES : 80 CH. MAP.

Type Number	Type Symbol	Soil Rating	Name	Parent Material
18a-18H.	T-TH	6	Taupo sandy silt-shallow phase (Incl. Hill soils.)	3-9" Taupo on Tirau Ash.
48b	Hc	7	Horotiu complex, sandy loam, clay loam, and peaty sandy loam (Note: Split to peaty, sandy and meadow phases).	Rhyolite alluvium.
57-57H	Ti-TiH	6	Tirau Sandy Loam (Incl. Hill soils.)	Tirau Ash.
59	O	8	Ohaupo Silt Loam.	Mairoa Ash.
59a	Ot	7	Otorohanga Silt Loam.	" "
59a-59aH	Ot-OtH	6	Otorohanga Silt Loam. (Incl. Hill soils)	" "
59b	Ota	7	Otorohanga Silt Loam - Compact subsoil phase.	" "
60H	Ku	4	Te Kuiti Silt Loam & Clay Loam (Hill Soils)	Mairoa Ash & Rhyolite
60eH	Pa	4	Pukerata silt loam and clay loam.	Mairoa Ash on Greywacke.
83	Hm	8	Hamilton Clay Loam	Hamilton Ash.
87eH	Ka	4	Kakepuku Clay loam and silt loam. (Hill Soils)	Basaltic andesite and volcanic ash.
98b	Wh	7	Whatawhata clay loam and sandy clay loam.	Alluvium from volcanic ash & sedimentary rock.
98c	Pu	8	Puniu silt loam, clay loam and sandy loam.	Alluvium from volcanic ash.
105a	TR	6	Te Rapa Peaty sand and peaty silt.	Pumiceous sands and peat.
108a	K	5	Kaipake peaty loam and loamy peat.	Peat plus some alluvium.
110	R	2	Rukuhia Peat.	Peat.
110	Mt	2	Moanatuatau Peat.	"
130c	Ki	3	Karioi rocky and bouldery silt loam and clay loam.	Basaltic andesite plus Mairoa Ash.

SUPPLEMENTARY INFORMATION REQUIRED FOR THE CALCULATION OF "STOCK UNITS".

For a full understanding of the assumptions made in defining "average farm stock" and in determining the average annual feed requirements for the different classes of stock considered, some elaboration of the details provided in Appendix vii is required. This section should be read in conjunction with the relevant tables and figures dealing with growth rates which are included in this portion of the appendix. The various species and classes of livestock are considered in the same sequence as adopted in the presentation of Appendix vii.

A. DAIRY STOCK.

1. Dairy Cow. Dairy cow liveweights were supplied by Ruakura Animal Research Station. Liveweights recorded at two-weekly intervals, from birth to 312 weeks of age, were obtained for cows born in 1944 and 1945. The basic data were derived from high and low plane feeding trials and consisted of two series of liveweights supplied by the "high-high" and "low-low" groups. (New Zealand Department of Agriculture Annual Report (1946 & 1947.))

It was considered that neither weight series provided the best available measure of average growth rates for dairy cattle under Waipa farming conditions. Rather it was felt that by averaging the two sets of data, a more accurate series of approximations would be obtained. (Refer Appendix viii.)

The average liveweight for "cows in milk" was calculated after certain assumptions had been made concerning the age composition of the "average dairy herd". It was estimated that the distribution of "cows

in milk" within the age groupings 2 - 3 years, 3 - 4 years, and over 4 years was in the proportion 20: 15: 65 respectively. The respective liveweights for these age classes, viz., 726 lbs., 815 lbs., and 894 lbs., were derived from information considered previously. Thus, an average weight of 850 lbs. was computed as applicable to all"cows in milk".

From the herd average for the mean sample farm, the average annual milk production per cow was computed. For this purpose it was assumed that since the Jersey breed was predominant in the Waikato, the average milk-fat test would be in the vicinity of 5%.

In the computation of feed requirements from Morrison's tables, the average of the range in daily requirements was used in most cases. During pregnancy an extra allowance was provided for dairy cows for a period of 84 days.

2. and 3. Dry Dairy Stock. (2-3 yrs. and 3 yrs. & over)

Because there was no information available concerning the weights of dry dairy cows the conversion factor adopted was based on advice contained in a United States Research Council Report (1950). Herein the requirements of an adult dry cow were stated as 90%, those deemed necessary for a mature bull in regular service.

4. Yearlings (1-2 yrs.)

There were no additional complications involved in the calculation of "stock units" for yearlings.

5. Calf (birth - 1 yr.)

From the estimate of the T.D.N. supplied by pasture and pasture supplements for the maintenance and growth of calves, the contribution in the dam's milk must be subtracted, since, in assessing the requirements of

"the average dairy cow", an allowance was made for milk production.

The quantities of skim and whole milk used for calf raising under average farming conditions, and the time during which they were fed were estimated as follows:-

(i) Calf on whole milk for 14 days consumes 8 gallons.

(ii) Calf on ½ whole and ½ skim for 14 days consumes 6 gallons of whole milk and 6 gallons of skim.

(iii) Calf fed 1½ gallons of skim per day for 90 days consumes 135 gallons of skim milk.

Total skim used = 141 gallons.

Total whole milk used = 14 gallons of 5% milk.

Gaine's formula (1928) was used for the conversion of milk of different fat tests to 4% fat corrected milk (FCM).

$$F.C.M. = 0.4\ M + 15\ F.$$

M and F are the weights of milk and fat respectively, and are expressed in the same units. In this way it was calculated that 750 lbs. of F.C.M. was supplied to the calf in the form of whole and skim milk. The T.D.N. required to produce this milk was computed from the first part of Brody's (1945) three factor regression equation.

i.e. T.D.N. = 0.305 x F.C.M.

∴ T.D.N. required for the production of 750 lbs. of F.C.M. = 229 lbs.

This fraction when subtracted from the annual requirements as calculated from Morrison's tables, leaves 1,765 lbs. of T.D.N. as the contribution of grass and its products towards the needs of the calf (Appendix viii).

6. Mature Dairy Bull.

The weights for all bulls were obtained by taking the means of the monthly average liveweights for bulls fed under high and low plane conditions at the A.I. Centre, Ruakura.

7. and 8. Bull Calves and Yearling Bulls.

With the exception of the correction which involved subtracting 229 lbs. of T.D.N. from the total estimates as in sub-section 5 above, no additional complications affected the computation of the "stock units" for bull calves and yearling bulls.

9. Bulls (birth - 2 yrs)

Inclusion of the class "Bulls, birth - 2 yrs." was necessitated by the wording of the questionnaire. The specific"stock unit"is calculated as the average of the requirements for calves and yearlings.

B. BEEF STOCK.

1. Youngstock.

(a) Information on heifer and steer weights recorded at monthly intervals from birth was supplied by the Dept. of Agriculture's Animal Research Station at Ruakura (Appendices x to xv).

(b) In the calculation of the total yearly requirements for bull and heifer calves, allowance had to be made for the quantity of T.D.N. in the milk supplied by the dam.

Since allocations were made in the rations for breeding stock to cover the extra demands of lactation, it was necessary to adjust the estimated requirements of the calf by subtracting from the total, the T.D.N. concerned in the production of milk ingested by the growing youhg. Calves are weaned when about seven months old and until that time it is estimated that their dams secrete 315 gallons of 3.9% milk. When this was converted to lbs. of F.C.M., application of Brody's (1945) regression equation indicated that 946 lbs. of T.D.N. were required to produce this quantity of milk.

2. Breeding Stock.

In the estimation of total annual requirements for cows and heifers, an extra allowance to cover the last 16 weeks of pregnancy, was included.

3. Mature Fattening Stock.

It was assumed that the maintenance requirements of mature steers were approximately the same as those for dairy bulls of comparable weights. As the periods of maximum killing of fat beef stock are March, April and May, (Rowlands 1951) an allowance has been made in the rations to include a fattening period of 8 weeks. Under New Zealand conditions this coincides with the late spring and early summer flush of grass growth.

C. DIFFERENCES IN FEED REQUIREMENTS BASED UPON DIFFERENCES IN "PRODUCTION PER COW".

It was assumed that the average dairy cow producing 253 lbs. of butterfat was equivalent to 6.00 "stock units". The amount of T.D.N. required to feed this 850 lb. cow = 4,639 lbs. per year. From Morrison's tables, an increase amounting to 0.36 lbs. of T.D.N. for each lb. of 5% milk is indicated. Thus, according to these estimates, an increase in per cow production of 1 lb. of butterfat requires an additional allowance of 7.2 lbs. of T.D.N. This is sufficient to increase the value of the "stock unit" by .01 over the range 253-254 lbs. of butterfat per cow. As a result, corrections were applied to the average conversion factor so that adjustments affected all herds averaging between 140 lbs. of butterfat and 380 lbs. of butterfat per cow. Appendix xvi consists of this complete series of "stock unit" conversion factors.

C. SHEEP.

1. From Appendices iii, iv & v the average weight of a breeding ewe was deduced as 120 lbs.

APPENDIX iii. Wallace's (1948) Data. (Border Leicester X Cheviot)

No. of Ewes	Year	Weight (lbs.) during		
		Maintenance	Fattening	Lactation
13	1943	120.6	120.9	122.6
13	1944	117.4	120.3	121.8

APPENDIX iv. Massey College "Tuapaka" Romney Flock.

Date of Birth	No. of Ewes	Average Weight (lbs.)	
		1948	1949
1942	11	135.9	
1943	17	129.9	123.7
1944	45	127.7	129.2
1945	39	117.8	125.6
1946	(14 (29	110.4	119.6

APPENDIX v. Weights of Romney ewes at Ruakura (1950-51).

4 ewes per acre		6 ewes per acre		8 ewes per acre	
No. of Ewes	Average Weight (lbs.)	No. of Ewes	Average Weight (lbs.)	No. of Ewes	Average Weight (lbs.)
981	120.3	1,608	116.1	2,252	105.5

2. Rams.

The ram weight which was taken as representative was obtained as the average of 39 Southdown rams used at Ruakura farm and the experimental hill farm at Whatawhata.

3. Lambs Recorded at the 30th April.

The liveweights for "lambs at the 30th April" were obtained from three seasons' data (1936-37-38) supplied from the Massey College Romney flock (Appendix xix).

4. The Feed Requirements of Sheep.

The assumptions made in applying Morrison's (1950) tables to the various classes of sheep stock are as follows:-

(i) Breeding ewes - 218 days maintenance.
35 " extra allowance for the latter part of pregnancy.
112 days extra allowance for ewes nursing lambs.

(ii) Rams, wethers and dry ewes.
As no tables had been compiled specifically for rams, wethers and dry ewes, the tables of requirements for pregnant ewes of similar weight were used. The lower extreme of the range suggested was considered adequate.

(iii) Lambs at the 30th April.
For "lambs at the 30th April", 79 lbs. of T.D.N. in the form of 155 lbs. of milk was estimated as the ewe's contribution to the lamb's yearly requirements.

5. Estimation of Maintenance and Production Requirements of Sheep (according to Wallace (1948))

An alternative method to Morrison's (1950) method of estimating the requirements of sheep for maintenance

and production was provided by Wallace (1948).

(a) Maintenance.

Maintenance requirements were calculated from the regression of daily gross digestible energy (G.D.E.) intake on live weight. This was expressed by the equation :-

$$Y = 0.003523\ X + 0.9523 \quad \ldots\ldots\ldots (1)$$

where Y = the daily increment of G.D.E.

X = average liveweight of ewe.

(b) Production- requirements for milk production and lamb growth.

Wallace (1948) quotes a "low-high" group where lambs reached 67.1 lbs. at 16 weeks which was thought to be a reasonable approximation to New Zealand conditions. To attain a liveweight of 67.1 lbs. in 16 weeks, the lambs ingested 155 lbs. of milk and 80 lbs. of G.D.E. as concentrates in the period up to weaning.

The regression of daily G.D.E. consumption on daily milk production and liveweight is given by the equation:-

$$Y = 0.4965\ X' + 0.01497X - 0.147 \quad \ldots\ldots (2)$$

where Y = daily increment of G.D.E.

X' = weight of milk secreted per day (lbs.)

X = liveweight of the ewe (lbs.)

By these methods the annual maintenance and production requirements for a ewe were determined as 499 lbs. of G.D.E. and 107 lbs. of G.D.E. respectively.

Since 1 lb. of G.D.E. = 1,707 calories

and 1 lb. of T.D.N. = 1,814 "

the total requirement of 606 lbs. of G.D.E. is readily convertable to lbs. of T.D.N.

Feed requirements for the ram, wether and fat lamb were computed from equation (1).

6. Feed Requirements of "Lambs at the 30th April"

Because the growth curves for the Massey College Romneys and Wallace's Border Leicester X Cheviot sheep were very similar (Appendix xviii), it was considered that the feed intakes of the latter, listed in the Appendix to Wallace's (1948) thesis, were applicable to "lambs returned at the 30th April". As these requirements were expressed in lbs. of G.D.E., conversion to T.D.N. involved an adjustment identical with that already mentioned.

7. The Derivation of a Conversion Factor for Sheep Returned as "Sheep Shorn".

No indication is given in the return for "sheep shorn" of the proportions of age classes within each flock. Many farms recorded "sheep shorn" and "lambs tailed", but often there was no indication of their presence on the 30th April of the same year. When such situations occurred repeatedly, it was assumed that the disposal of stock regularly preceded the 30th April, whilst purchases were always made subsequent to this date.

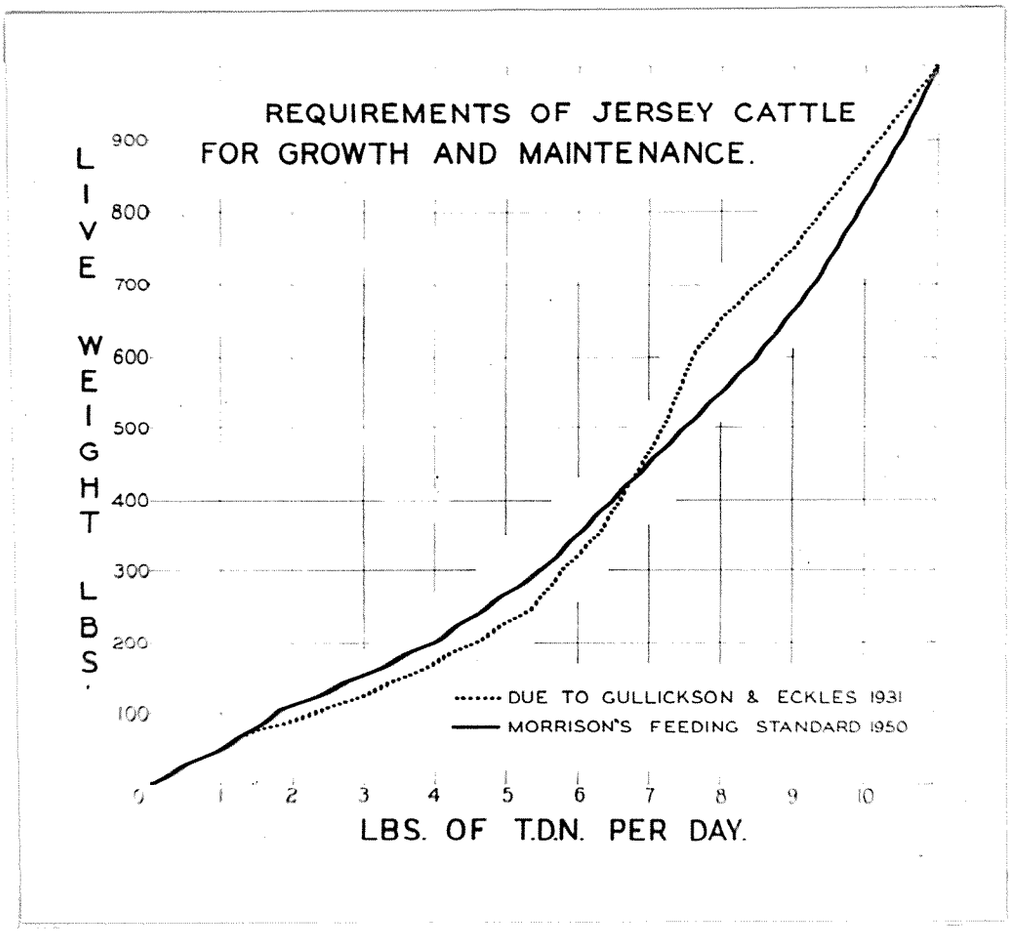
Where "sheep shorn" and "lambs tailed" were returned in the same year, it was supposed that at least a proportion of the former consisted of breeding ewes. As no indication was supplied concerning the exact number of breeding ewes, it was considered desirable to discover whether a"stock unit"which was reasonable repeatable for any year, could be computed for the term "sheep shorn".

From information supplied by 51 sheep farms in Waipa County, a comparison was made between stock tallies at lambing and shearing and those recorded for the 30th April in the same year. As a result it was made clear that

stock returned as "sheep shorn" could not be accorded the same "stock unit" value as breeding ewes. In every year, the difference between the number of sheep returned at the 30th April and the number shorn could be accounted for by the disposal of all lambs in the interim period. Thus, by excluding lambs returned at the 30th April, converting all other sheep listed at this time to "stock units" and dividing the computed total by the number of "sheep shorn", an estimate was obtained of the number of "stock units" per "sheep shorn". As the survey data permitted comparisons to be made in each of six seasons, it was possible to measure the repeatability of this estimate. The six independent calculations obtained were 0.86; 0.87; 0.87; 0.86; 0.85 and 0.87 "stock units".

0.86 "stock units" constituted the average of these six estimates, but suffered from the disadvantage that it was derived from returns covering a complete year. On dairy farms sheep stock are carried only when feed supply determines that it is convenient, and under these conditions, sheep are run in conjunction with the herd for only part of the year. Because of this complication the estimated conversion factor was reduced by 0.11 "stock units" and individual "sheep shorn" were represented by 0.75 "stock units".

APPENDIX VI.


REQUIREMENTS OF JERSEY CATTLE
FOR GROWTH AND MAINTENANCE.
LIVE WEIGHT LBS.
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
6
7
8
9
10
LBS. OF T.D.N. PER DAY.
DUE TO GULLICKSON & ECKLES 1931
MORRISON'S FEEDING STANDARD 1950

APPENDIX vii

STOCK CONVERSION FACTORS

(Derived from Morrison's Feeding Standards)

	Annual Feed Requirements (lbs. of T.D.N.)	Stock Units
A. DAIRY CATTLE		
1. Dairy Cow (850 lbs. liveweight producing 506 gallons 5% milk per annum)	4639	5.64
2. Dry Cow 2 yrs +		4.44
3. Dry 2 yr. old (2-3 yrs.)		4.44
4. Yearling (1-2 yrs.) L.W.=(391-655 lbs.)	2838	3.45
5. Calf (birth - 1 yr.) L.W.= (60-391 lbs)	1360	1.65
6. Bull (2 yrs. +) L.W. = 1300 lbs.	4015	4.88
7. Bull calves (birth - 1 yr.) L.W. =(60-524 lbs)	1765	2.15
8. Bulls (1-2 yrs.) L.W.= (524-900 lbs.)	3743	4.55
9 Bulls (- 2 yrs.) L.W.= (60-900 lbs.)	2754	3.35
B. BEEF CATTLE.		
1. Breeding bulls (2 yrs. +) L.W. = 1300 lbs.	4015	4.88
2. Cows & heifers 2 yrs. + (1150 lbs. L.W. producing 315 gals. of 3.9% milk per annum.)	4210	5.12
3. Heifers (1-2 yrs.) L.W.= (565-803 lbs.)	3717	4.52
4. Calf (birth-1 yr.) L.W.= (80-565 lbs)	1105	1.34
5. Steers (2yrs.+) L.W. =(1250-1300 lbs)	4298	5.23
6. Bulls (1-2 yrs) L.W.= (605-966 lbs.)	3974	4.83
7. Bull calves (birth-1 yr.) L.W.= (80-605 lbs)	1262	1.54

(Cont. overleaf)

APPENDIX vii (Contd.)

		Annual Feed Requirements (lbs. of T.D.N.)	Stock Units
C.	SHEEP.		
1.	Breeding ewe (L.W. 120 lbs.)	822	1.00
2.	Ram (L.W. 152 lbs.)	767	0.93
3.	Wether (L.W. 130 lbs.)	694	0.84
4.	Dry Ewe (L.W. 100 lbs.)	548	0.67
5.	Lambs as at 30th April (L.W. 12-80 lbs.)	427	0.52

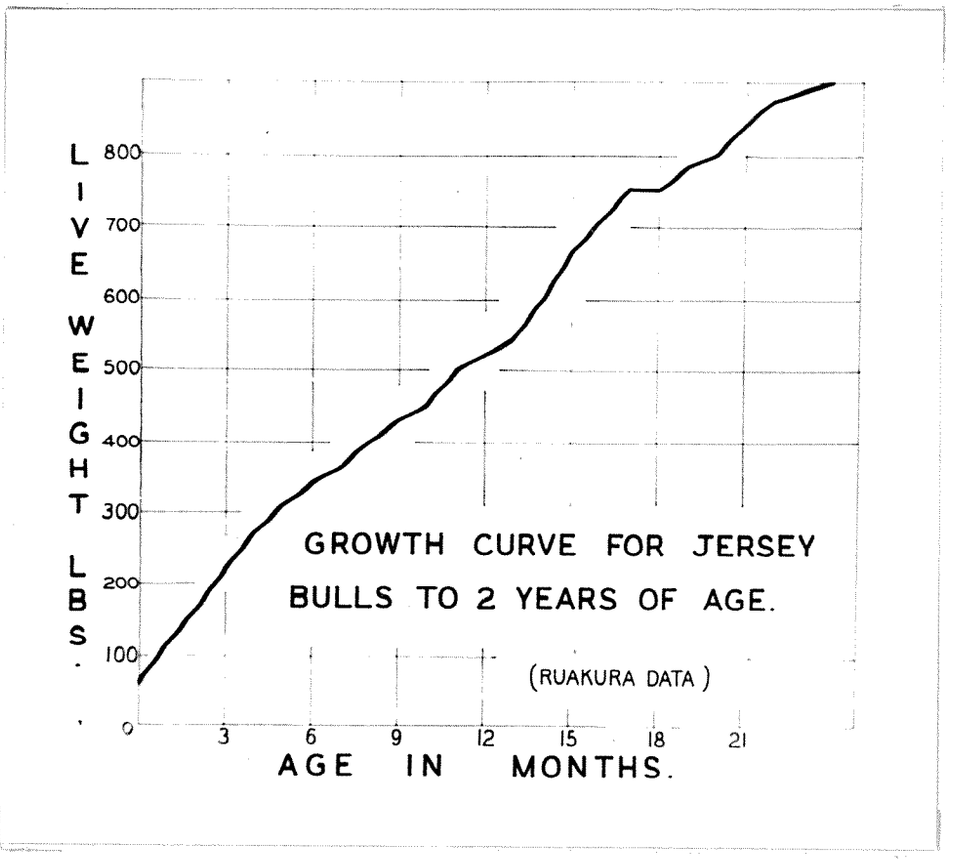
APPENDIX viii

AVERAGE LIVEWEIGHTS AND FEED REQUIREMENTS OF FEMALE DAIRY CATTLE FROM BIRTH TO 2 YEARS OF AGE.

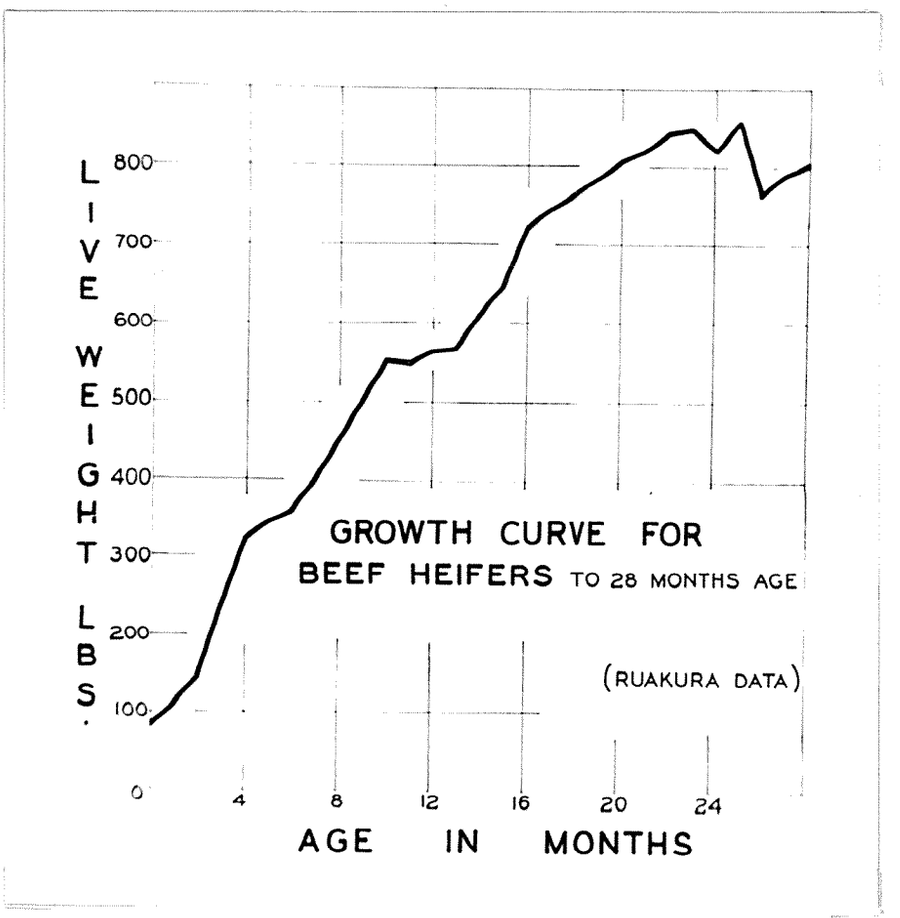
Age (months)	Weight (lbs.)	Feed Requirement for Maintenance and Growth (lbs. of T.D.N.)	
		Average Per Day	Total Per Month
Birth to 1	68	1.50	45.0
1 - 2	101	1.75	52.5
2 - 3	140	2.75	82.5
3 - 4	181	3.60	108.0
4 - 5	216	4.25	127.5
5 - 6	247	4.70	141.0
6 - 7	275	5.10	153.0
7 - 8	299	5.45	163.5
8 - 9	320	5.70	171.0
9 - 10	336	5.85	175.5
10 - 11	353	6.10	183.0
11 - 12	370	6.20	186.0
12 - 13	384	6.35	190.5
13 - 14	400	6.50	195.0
14 - 15	427	6.80	204.0
15 - 16	465	7.15	214.5
16 - 17	509	7.60	228.0
17 - 18	552	8.05	241.5
18 - 19	558	8.40	252.0
19 - 20	610	8.60	258.0
20 - 21	630	8.70	261.0
21 - 22	639	8.80	264.0
22 - 23	639	8.80	264.0
23 - 24	649	8.85	265.5

The liveweights were supplied by Ruakura Animal Research Station and are the averages of two sets of data, the one referring to cattle fed on a "high-high" plane of nutrition, the other to cattle fed on a "low-low" diet.

APPENDIX ix.


LIVE WEIGHT LBS.
800
700
600
500
400
300
200
100
0
3
6
9
12
15
18
21
AGE IN MONTHS.
GROWTH CURVE FOR JERSEY
BULLS TO 2 YEARS OF AGE.
(RUAKURA DATA)

APPENDIX X.


LIVE WEIGHT LBS.
800
700
600
500
400
300
200
100
0
4
8
12
16
20
24
AGE IN MONTHS
GROWTH CURVE FOR
BEEF HEIFERS TO 28 MONTHS AGE
(RUAKURA DATA)

APPENDIX xi

AVERAGE LIVEWEIGHTS AND FEED REQUIREMENTS FOR JERSEY BULLS FROM BIRTH TO TWO YEARS OF AGE.

Age (Months)	Weight (lbs.)	Feed Requirement for Maintenance and Growth (lbs. of T.D.N.)		
		Per Day	Average per Day during the month.	Total per Month
Birth	60	0.9		
			1.40	42.00
1	115	1.9		
			2.45	73.50
2	165	3.0		
			3.60	108.00
3	220	4.2		
			4.60	138.00
4	271	5.0		
			5.35	160.50
5	310	5.7		
			5.90	177.00
6	340	6.1		
			6.25	187.50
7	363	6.4		
			6.65	199.50
8	398	6.9		
			7.05	211.50
9	428	7.2		
			7.35	220.50
10	451	7.5		
			7.75	232.50
11	499	8.0		
			8.10	243.00
12	524	8.2		
			8.30	249.00
13	543	8.4		
			8.70	261.00
14	600	9.0		
			9.30	279.00
15	665	9.6		
			9.80	294.00
16	708	10.0		
			10.25	307.50
17	754	10.5		
			10.50	315.00
18	752	10.5		
			10.65	319.50
19	784	10.8		
			10.85	325.50
20	800	10.9		
			11.15	334.50
21	844	11.4		
			11.55	346.50
22	876	11.7		
			11.80	354.00
23	889	11.9		
			11.90	357.00
24	900	11.9		

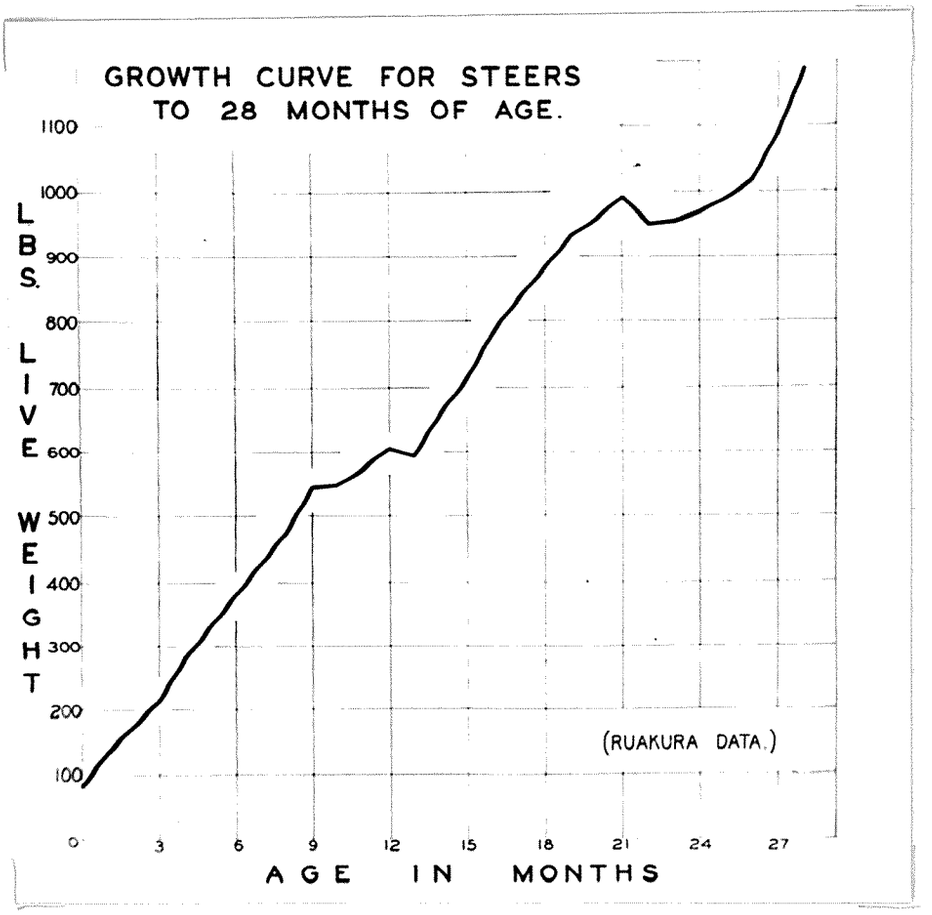
The liveweights were obtained from two sets of data recorded for Jersey bulls at Ruakura A.I. centre. The figures used represent averages of weights recorded for bulls on high plane and low plane experiments. Morrison's (1950) feeding standards were used for calculating the daily T.D.N. requirement.

AVERAGE LIVEWEIGHTS AND FEED REQUIREMENTS OF BEEF HEIFERS FROM BIRTH TO 2 YEARS OF AGE.

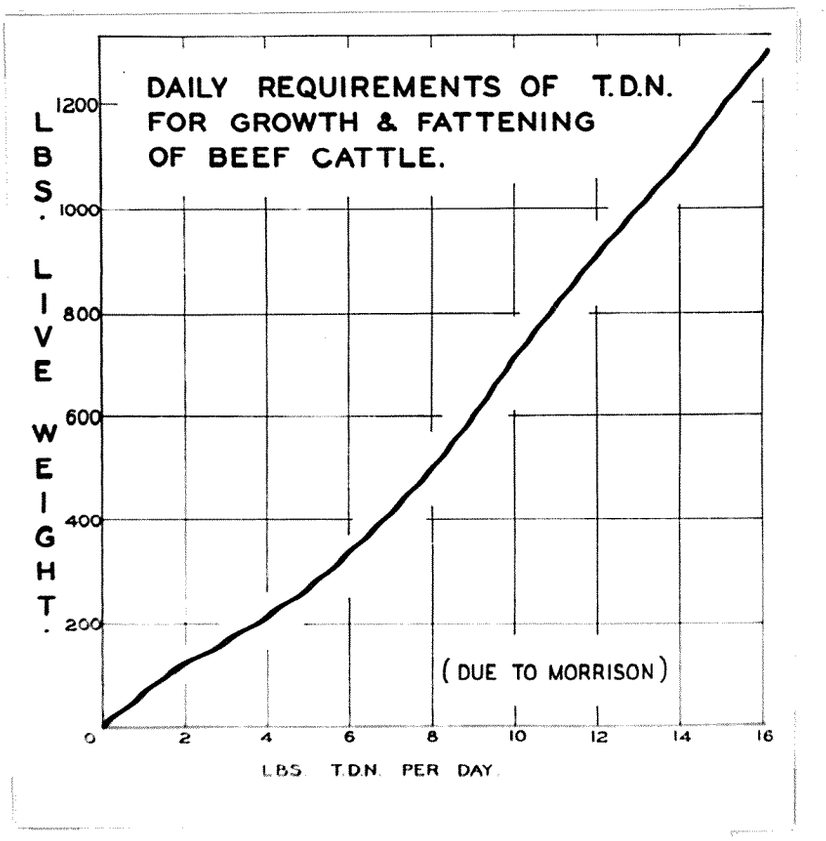
Age (Months)	Weight (lbs.)	Feed Requirements for Maintenance and Growth (lbs. of T.D.N.)		
		Average Per Day	Average per Day during the Month	Total per Month
Birth	80	1.3		
			1.55	46.5
1	110	1.8		
			2.20	66.0
2	146	2.6		
			3.50	105.0
3	237	4.4		
			5.15	154.5
4	325	5.9		
			6.05	181.5
5	345	6.2		
			6.30	189.0
6	362	6.4		
			6.65	199.5
7	400	6.9		
			7.20	216.0
8	450	7.5		
			7.75	232.5
9	500	8.0		
			8.25	247.5
10	550	8.5		
			8.50	255.0
11	549	8.5		
			8.60	258.0
12	565	8.7		
			8.70	261.0
13	569	8.7		
			8.90	267.0
14	611	9.1		
			9.30	279.0
15	649	9.5		
			9.80	294.0
16	721	10.1		
			10.25	307.5
17	745	10.4		
			10.50	315.0
18	765	10.6		
			10.70	321.0
19	785	10.8		
			10.90	327.0
20	805	11.0		
			11.05	331.5
21	820	11.1		
			11.20	336.0
22	842	11.3		
			11.35	340.5
23	847	11.4		
			11.25	337.5
24	821	11.1		

The liveweights were supplied by Ruakura Animal Research Station and refer to Aberdeen Angus heifers.

APPENDIX xiii.



APPENDIX xiv.



APPENDIX xv

AVERAGE LIVEWEIGHTS AND FEED REQUIREMENTS OF BEEF STEERS FROM BIRTH TO TWO YEARS OF AGE.

Age (Months)	Weight (lbs.)	Feed Requirement for Maintenance and Growth (lbs. of T.D.N.)		
		Average Per Day	Average per Day during the Month	Total per Month
Birth	80	1.3		
			1.85	55.50
1	135	2.4		
			2.80	84.00
2	175	3.2		
			3.65	109.50
3	215	4.1		
			4.65	139.50
4	280	5.2		
			5.60	168.00
5	330	6.0		
			6.35	190.50
6	380	6.7		
			7.00	210.00
7	430	7.3		
			7.55	226.50
8	476	7.8		
			8.10	243.00
9	543	8.4		
			8.45	253.50
10	548	8.5		
			8.65	259.50
11	574	8.8		
			8.95	268.50
12	605	9.1		
			9.00	270.00
13	592	8.9		
			9.25	277.00
14	659	9.6		
			9.80	294.00
15	711	10.0		
			10.40	312.00
16	785	10.8		
			11.05	331.50
17	837	11.3		
			11.50	345.00
18	881	11.7		
			11.95	358.50
19	930	12.2		
			12.35	370.50
20	957	12.5		
			12.70	381.00
21	989	12.9		
			12.70	381.00
22	952	12.5		
			12.50	375.00
23	955	12.5		
			12.60	378.00
24	966	12.7		

The liveweights were supplied by Ruakura Animal Research Station and refer to Aberdeen Angus Steers. Weights from birth to four months of age were not available but Mitchell (1929) provided data which satisfactorily covered this period.

APPENDIX xvi

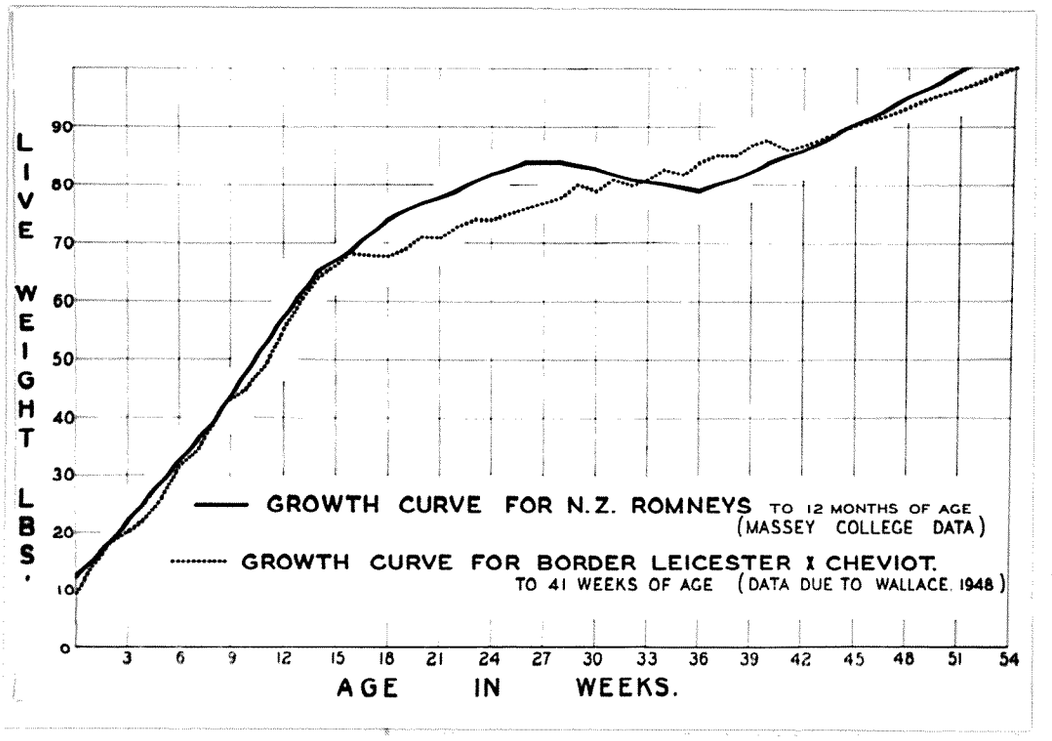
DAIRY COW CONVERSION FACTORS CORRECTED FOR VARIATIONS IN PRODUCTION PER COW.

Butterfat Per cow(lbs)	Stock Units	Butterfat Per cow(lbs)	Stock Units	Butterfat Per cow(lbs)	Stock Units
140	5.01	191	5.45	242	5.90
141	5.01	192	5.46	243	5.91
142	5.02	193	5.47	244	5.92
143	5.03	194	5.48	245	5.93
144	5.04	195	5.49	246	5.94
145	5.05	196	5.50	247	5.95
146	5.06	197	5.51	248	5.96
147	5.07	198	5.52	249	5.96
148	5.08	199	5.52	250	5.97
149	5.08	200	5.53	251	5.98
150	5.09	201	5.54	252	5.99
151	5.10	202	5.55	253	6.00
152	5.11	203	5.56	254	6.01
153	5.12	204	5.57	255	6.02
154	5.13	205	5.58	256	6.03
155	5.14	206	5.59	257	6.04
156	5.15	207	5.60	258	6.04
157	5.16	208	5.60	259	6.05
158	5.16	209	5.61	260	6.06
159	5.17	210	5.62	261	6.07
160	5.18	211	5.63	262	6.08
161	5.19	212	5.64	263	6.09
162	5.20	213	5.65	264	6.10
163	5.21	214	5.66	265	6.11
164	5.22	215	5.67	266	6.11
165	5.23	216	5.67	267	6.12
166	5.23	217	5.68	268	6.13
167	5.24	218	5.69	269	6.14
168	5.25	219	5.70	270	6.15
169	5.26	220	5.71	271	6.16
170	5.27	221	5.72	272	6.17
171	5.28	222	5.73	273	6.18
172	5.29	223	5.74	274	6.18
173	5.30	224	5.74	275	6.19
174	5.30	225	5.75	276	6.20
175	5.31	226	5.76	277	6.21
176	5.32	227	5.77	278	6.22
177	5.33	228	5.78	279	6.23
178	5.34	229	5.79	280	6.24
179	5.35	230	5.80	281	6.25
180	5.36	231	5.81	282	6.26
181	5.37	232	5.82	283	6.26
182	5.38	233	5.82	284	6.27
183	5.38	234	5.83	285	6.28
184	5.39	235	5.84	286	6.29
185	5.40	236	5.85	287	6.30
186	5.41	237	5.86	288	6.31
187	5.42	238	5.87	289	6.32
188	5.43	239	5.88	290	6.33
189	5.44	240	5.89	291	6.33
190	5.45	241	5.89	292	6.34

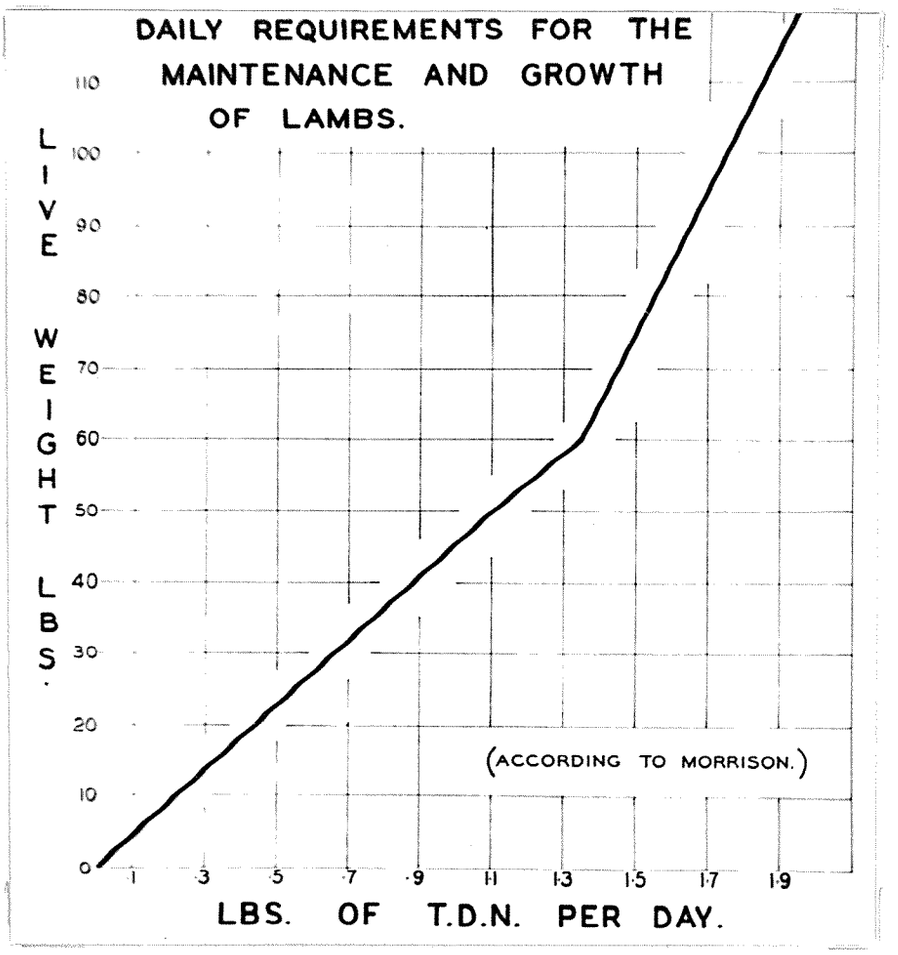
APPENDIX xvi (Contd.)

Butterfat Per cow (lbs.)	Stock Units	Butterfat Per cow (lbs.)	Stock Units	Butterfat Per cow (lbs.)	Stock Units
293	6.35	320	6.59	347	6.83
294	6.36	321	6.60	348	6.84
295	6.37	322	6.61	349	6.84
296	6.38	323	6.62	350	6.85
297	6.39	324	6.62	351	6.86
298	6.40	325	6.63	352	6.87
299	6.40	326	6.64	353	6.88
300	6.41	327	6.65	354	6.89
301	6.42	328	6.66	355	6.90
302	6.43	329	6.67	356	6.91
303	6.44	330	6.68	357	6.92
304	6.45	331	6.69	358	6.93
305	6.46	332	6.70	359	6.93
306	6.47	333	6.70	360	6.94
307	6.48	334	6.71	361	6.95
308	6.48	335	6.72	362	6.96
309	6.49	336	6.73	363	6.97
310	6.50	337	6.74	364	6.98
311	6.51	338	6.75	365	6.99
312	6.52	339	6.76	366	6.99
313	6.53	340	6.77	367	7.00
314	6.54	341	6.77	368	7.01
315	6.55	342	6.78	369	7.02
316	6.55	343	6.79	370	7.03
317	6.56	344	6.80	371	7.04
318	6.57	345	6.81	372	7.05
319	6.58	346	6.82	373	7.06
				374	7.06
				375	7.07
				376	7.08
				377	7.09
				378	7.10
				379	7.11

APPENDIX xviii



APPENDIX xvii.



APPENDIX xix

AVERAGE LIVEWEIGHTS AND FEED REQUIREMENTS OF SHEEP FROM BIRTH TO ONE YEAR OF AGE.

Age (Weeks)	Weight (lbs.)	Feed Requirements for Maintenance and Growth (lbs. of T.D.N.)	
		Average per day	Average per day during the month
Birth	12	0.26	
			.41
4	25	0.56	
			.71
8	39	0.86	
			1.07
12	57	1.28	
			1.36
16	69	1.44	
			1.48
20	77	1.52	
			1.55
24	82	1.58	
			1.59
28	84	1.60	
			1.58
32	81	1.56	
			1.55
36	79	1.54	
			1.57
40	84	1.60	
			1.62
44	89	1.64	
			1.67
48	95	1.70	
			1.73
52	101	1.76	

The liveweights were for Romneys of the Massey College flock and were collected over the period 1936 to 1938.

APPENDIX xx

CORRECTION TABLE FOR ESTIMATING "AT THE FAIL" PRODUCTION.

AVERAGE OF FIVE YEARS 40/41 TO 44/45.

Size of Herd	Correction per Cow. (lbs.B/Fat)	Add. to Factory Supply (lbs. B/Fat)	Size of Herd.	Correction per Cow. (lbs.B/Fat)	Add. to Factory Supply. (lbs. B/Fat)
2	53	106	37	33.6	1,243
3	52.5	158	38	32.8	1,246
4	51.6	206	39	32.0	1,248
5	50.5	253	40	31.4	1,256
6	50	300	41	30.9	1,267
7	50	350	42	30.4	1,277
8	54	432	43	30.0	1,290
9	57	513	44	29.6	1,302
10	60	600	45	29.2	1,314
11	61	671	46	28.9	1,329
12	61	732	47	28.6	1,344
13	60.4	785	48	28.2	1,354
14	59.7	836	49	27.8	1,362
15	58.8	882	50	27.4	1,370
16	57.8	925	51	27.0	1,377
17	57	969	52	26.6	1,383
18	56	1,008	53	26.2	1,389
19	55	1,045	54	25.9	1,399
20	54	1,080	55	25.6	1,408
21	53	1,113	56	25.3	1,417
22	52	1,144	57	25.0	1,425
23	50.4	1,159	58	24.7	1,433
24	49	1,176	59	24.4	1,440
25	47	1,175	60	24.1	1,446
26	45	1,170	61	23.8	1,452
27	43.6	1,177	62	23.6	1,463
28	42.2	1,182	63	23.4	1,474
29	40.8	1,183	64	23.2	1,485
30	39.4	1,182	65	23.0	1,495
31	38.3	1,187	66	22.8	1,505
32	37.2	1,190	67	22.6	1,514
33	36.6	1,208	68	22.4	1,523
34	35.8	1,217	69	22.2	1,532
35	35.0	1,225	70 & over	22.0	1,540
36	34.2	1,231			

APPENDIX xxi

GROSS CORRELATIONS AS DETERMINED BY HAMILTON (1944) AND MITCHELL (1948).

	Log. Cult. Area	No. of Cows in Milk	% of Cult. Area Cropped.	% of Grassland Cut for Hay or Silage	% of Grassland Limed	Carrying Capacity (S.U. per acre)	% of Grassland Topdressed	B/Fat Per Cow	B/Fat Per Acre	Labour Units Per Acre	Cows per Labour Unit	B/Fat per Labour Unit
Soil Rating	-.38* -.28** -.13+ -.06x	- - - .08	- .23 .10 -.14	.54 .40 .26 .20	- - - .01	.56 .33 .34 .34	.39 .31 .10 .13	.55 .27 .17 .17	.64 .37 .37 .31	.1654	.0157	.0813
Log. Cult. Area.		.76 .74 .77 .83	-.29 -.27 -.06 .10	-.32 -.35 -.10 .01	- -.25 -.12 -.02	-.65 -.64 -.52 -.33	-.23 -.35 -.16 -.07	-.28 -.28 -.13 -.19	-.60 -.63 -.50 -.37	-.5547	.3348	.2502
No.of cows in Milk.										-.3449	.3874	.3569
Percentage of Cult. Area Cropped					.08	.42 .32 .16 -.07	.07	.15 .14 .07 .00	.43 .51 .39 -.09	-.0514	-.0316	-.0270
Percentage of Grassland Cut for Hay or Silage					.11	.43 .51 .35 .24	.24 .41 .22 .11	.50 .31 .31 .10	.43 .51 .39 .20	.0589	.0536	.0922
Percentage of Grassland Limed.						- .41 .10 .11	.48 .57 .41 .39	.11	.11	.0936	-.0425	-.0050
Carrying Capacity (S. U. per acre)							.46 .57 .31 .21	.52 .42 .29 .38	.94 .93 .91 .86	.4451	.0620	.2235
Percentage of Grassland Topdressed.								.34 .32 .25 .16	.51 .58 .35 .23	.1158	-.0011	.0689
Butterfat Per Cow.									.67 .60 .54 .65	.2395	-.1345	.2795
Butterfat Per Acre										.4531	.0503	.3269
Labour Units per Acre											-.7168	-.6048
Cows per Labour Unit.												.9016
B/Fat per Labour Unit												

(1) Correlations for 73 Farms Mainly Hilly Whangarei *
(2) Correlations for 175 Farms Mainly Plowable Whangarei * *
(3) Correlations for 510 Farms All Plowable Whangarei +
(4) Correlations for 850 Farms All Plowable WAIPA x

APPENDIX xxii

THE ABBREVIATED DOOLITTLE SOLUTION FOR DETERMINING BOTH R^2 AND THE STANDARD PARTIAL REGRESSION COEFFICIENTS.

Consider the variables x_1, x_2, x_3, x_4 where x_4 is the dependent variable.

Row					$\sum_{i=1}^{4} a_{i.1}$ = check column.
1	$a_{1.1}$	$a_{2.1}$	$a_{3.1}$	$a_{4.1}$	$a_{5.1}$
2	$(a_{1.2})$	$a_{2.2}$	$a_{3.2}$	$a_{4.2}$	$a_{5.2}$
3	$(a_{1.3})$	$(a_{2.3})$	$a_{3.3}$	$a_{4.3}$	$a_{5.3}$
4	$a_{1.1}$	$a_{2.1}$	$a_{3.1}$	$a_{4.1}$	$a_{5.1}$
5	1	$b_{2.1}$	$b_{3.1}$	$b_{4.1}$	$b_{5.1}$
6		$a_{22.1}$	$a_{32.1}$	$a_{42.1}$	$a_{52.1}$
7		1	$b_{32.1}$	$b_{42.1}$	$b_{52.1}$
8			$a_{33.12}$	$a_{43.12}$	$a_{53.12}$
9			1	$b_{43.12}$	$b_{53.12}$
10	$\beta'_{41.23}$	$\beta'_{42.13}$	$\beta'_{43.12}$	$i\, a_{44.123}$	
11	$\beta_{51.23}$	$\beta_{52.13}$	$\beta_{53.12}$		

a_{ij} = the correlation coefficient between i and j.

Rows 1,2 and 3 therefore form the correlation matrix.

Row 4. The values for a_{ij} are identical with those in Row 1.

Row 5. Divide Row 4 by $a_{1.1}$. Then $b_{i.1} = \frac{a_{i.1}}{a_{1.1}}$

Check column $= \frac{\sum_i a_{i.1}}{a_{1.1}}$

Row 6. $a_{i2.1} = a_{i.2} - a_{i.1}\, b_{i.1}$

i.e. $a_{22.1} = a_{2.2} - a_{2.1}\, b_{2.1}$; $a_{32.1} = a_{32} - a_{3.1}\, b_{2.1}$; etc.

$a_{52.1}$ = check.

Row 7. $b_{i2.1} = \frac{a_{i2.1}}{a_{22.1}}$

APPENDIX xxii (Contd.)

Row 8. $a_{i3.12} = a_{i.3} - a_{i.1}\, b_{3.1} - a_{i2.1}\, b_{32.1}$

i.e. $a_{33.12} = a_{3.3} - a_{3.1}\, b_{3.1} - a_{32.1}\, b_{32.1}$

$a_{43.12} = a_{4.3} - a_{4.1}\, b_{3.1} - a_{42.1}\, b_{32.1}$

Row 9. $b_{i3.12} = \dfrac{a_{i3.12}}{a_{33.12}}$

This is continued until all predicting variables are eliminated and is the abbreviated form of the forward Doolittle Solution.

In the present example $R^2 = a_{44.123}$

Row 10. Gives the standard partial regression coefficients, determined as follows (Back Solution).

$x_3 \ldots\ldots\ldots\ldots \beta'_{43.12} = b_{43.12}$ of Row 9.

$x_2 \ldots\ldots\ldots\ldots \beta'_{42.13} = b_{42.1} - b_{32.1}\beta'_{43.12}$ (Equation of Row 7)

$x_1 \ldots\ldots\ldots\ldots \beta'_{41.23} = b_{41} - b_{31}\beta'_{43.12} - b_{21}\beta'_{42.13}$ (Equation of Row 5)

Row 11. Check of back solution should be Row 10 + 1.

APPENDIX xxiii

DWYER'S METHOD OF INVERTING A SYMMETRIC MATRIX.

The variables are x_1, x_2, x_3 and x_4 which is the dependent.

$a_{1.1}$	$a_{2.1}$	$a_{3.1}$	$a_{4.1}$	$a_{5.1}$			
	$a_{2.2}$	$a_{3.2}$	$a_{4.2}$		$a_{6.2}$		
		$a_{3.3}$	$a_{4.3}$			$a_{7.3}$	
			$a_{4.4}$				$a_{8.4}$
$S_{1.1}$	$S_{2.1}$	$S_{3.1}$	$S_{4.1}$	$S_{5.1}$			
	$S_{2.2}$	$S_{3.2}$	$S_{4.2}$	$S_{5.2}$	$S_{6.2}$		
		$S_{3.3}$	$S_{4.3}$	$S_{5.3}$	$S_{6.3}$	$S_{7.3}$	
			$S_{4.4}$	$S_{5.4}$	$S_{6.4}$	$S_{7.4}$	$S_{7.5}$
				$b_{5.5}$	$b_{6.5}$	$b_{7.5}$	$b_{8.5}$
					$b_{6.6}$	$b_{7.6}$	$b_{8.6}$
						$b_{7.7}$	$b_{8.7}$
							$b_{8.8}$

$a_{i.j}$ = the sums of squares and cross products for each independent variable.

$$\left.\begin{matrix} a_{5.1} \\ a_{6.2} \\ a_{7.3} \\ a_{8.4} \end{matrix}\right\} = 1$$

$$S_{j.j} = \sqrt{\left[a_{jj} - S_{j1}^2 - S_{j2}^2 - S_{j3}^2 - \ldots\ldots - S_{j(j-1)}^2\right]}$$

$$S_{i.j} = \frac{a_{ij} - S_{i1}S_{j1} - S_{i2}S_{j2} - S_{i3}S_{j3} - \ldots\ldots - S_{i(j-1)}S_{j(j-1)}}{S_{jj}}$$

The Inverse Matrix is given by the b's where $b_{s.t} = \sum_i S_{s.i}S_{t.i}$

The check on these results is obtained from the equation

$$(b_{s.t.})\,(a_{ij}) = 1$$

DAIRY FARMING TRENDS IN WAIPA COUNTY FOR THE TEN YEARS 1940 - 41 to 1949 - 50.

GROUPINGS ARE BASED ON WITHIN-FARM DIFFERENCES IN AVERAGE "PRODUCTION PER ACRE" (LBS. OF BUTTERFAT "AT THE PAIL") BETWEEN THE FIRST THREE AND LAST THREE YEARS OF THE PERIOD.

APPENDIX xxiv.

PRODUCTION PER COW (LBS. OF BUTTERFAT "AT THE PAIL").

No.of Farms	7	16	48	59	62	39	22
Production per acre diff.(lbs. of B.F.)(First 3 & last 3 yrs)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	301	298	296	297	283	283	268
1941 - 42	271	279	275	273	254	260	241
1942 - 43	253	269	254	250	244	245	231
1943 - 44	228	272	257	254	246	251	260
1944 - 45	270	288	280	280	277	288	276
1945 - 46	226	227	224	227	230	236	230
1946 - 47	244	271	251	270	265	268	280
1947 - 48	199	247	250	260	263	270	286
1948 - 49	239	261	267	283	290	299	316
1949 - 50	244	265	258	275	273	286	308

APPENDIX xxv.

PRODUCTION PER ACRE (LBS. OF BUTTERFAT "AT THE PAIL").

No.of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	240	189	196	189	171	159	164
1941 - 42	213	181	185	173	155	148	147
1942 - 43	194	175	167	160	147	138	145
1943 - 44	169	168	165	161	150	143	165
1944 - 45	203	181	181	182	176	173	183
1945 - 46	159	135	142	143	146	140	157
1946 - 47	158	147	157	168	166	163	187
1947 - 48	135	128	160	163	168	174	201
1948 - 49	162	136	169	180	185	194	229
1949 - 50	155	145	165	179	180	191	234

APPENDIX xxvi

CARRYING CAPACITY (COWS PER 100 ACRES)

No.of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	80	63	66	64	61	56	61
1941 - 42	79	65	67	63	61	57	61
1942 - 43	77	65	66	64	60	56	63
1943 - 44	73	62	64	63	61	57	63
1944 - 45	75	63	65	65	64	60	66
1945 - 46	71	59	64	63	63	59	68
1946 - 47	65	54	63	62	63	61	67
1947 - 48	68	52	64	63	64	64	70
1948 - 49	68	52	63	64	64	65	72
1949 - 50	64	55	64	65	66	66	76

APPENDIX xxvii

PRODUCTION OF BUTTERFAT ("AT THE PAIL") PER FARM.

No.of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	17212	19166	17489	18037	17014	18317	12865
1941 - 42	16234	18314	16452	16554	15431	17143	11491
1942 - 43	15192	17799	14981	15335	14699	16000	11371
1943 - 44	13246	17799	14854	15447	15111	16496	12951
1944 - 45	16105	18619	16307	17549	17708	20078	14386
1945 - 46	13069	13908	12876	13823	14633	16216	12329
1946 - 47	13127	15775	14385	16285	16680	18767	14673
1947 - 48	11414	14476	14681	15869	16882	19773	15712
1948 - 49	14264	15339	15581	17585	18704	22150	17876
1949 - 50	13773	16352	15350	17493	18046	21795	18298

APPENDIX xxviii

AVERAGE CULTIVATED AREA (ACRES.)

No.of Farms	7	16	48	59	62	39	22
Production per acre difference (lbs.of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	72	101	89	95	99	115	78
1941 - 42	76	101	89	96	100	116	78
1942 - 43	78	102	90	96	100	116	79
1943 - 44	79	103	90	96	100	116	79
1944 - 45	79	103	90	97	101	116	79
1945 - 46	82	103	90	97	101	116	79
1946 - 47	83	107	92	97	101	115	79
1947 - 48	84	113	92	97	101	114	78
1948 - 49	88	113	92	98	101	114	78
1949 - 50	89	113	93	98	101	114	78

APPENDIX xxix

AVERAGE NUMBER OF COWS IN MILK.

No.of Farms	7	16	48	59	62	39	22
Production per acre diff.(lbs. of B.F.(First & last 3 yrs)	-50 3 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	57	64	59	61	60	65	48
1941 - 42	60	66	60	61	61	66	48
1942 - 43	60	66	59	61	60	65	49
1943 - 44	58	63	58	61	61	66	50
1944 - 45	60	65	58	63	64	70	52
1945 - 46	58	61	58	61	64	69	54
1946 - 47	54	58	57	60	63	70	52
1947 - 48	57	59	59	61	64	73	55
1948 - 49	60	59	58	62	64	74	57
1949 - 50	56	62	60	64	66	75	59

APPENDIX xxx.

AVERAGE NUMBER OF DAIRY HEIFERS (1 - 2 YRS)

No.of Farms	7	16	48	59	62	39	22
Production per acre diff.(lbs. of B.F.)(First 3 & last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	(6)* 10	(11) 11	(42) 9	(44) 10	(48) 11	(30) 17	(14 15
1941 - 42	(5) 10	(14) 11	(38) 10	(44) 11	(51) 12	(30) 16	(13 9
1942 - 43	(4) 6	(13) 9	(35) 11	(32) 9	(40) 10	(25) 14	(16 7
1943 - 44	(6) 13	(9) 9	(35) 11	(49) 10	(50) 12	(29) 13	(16 12
1944 - 45	(4) 14	(11) 10	(40) 12	(46) 10	(44) 14	(31) 12	(14 13
1945 - 46	(4) 14	(14) 13	(34) 12	(44) 13	(45) 13	(28) 15	(13 10
1946 - 47	(5) 18	(13) 17	(35) 11	(47) 10	(50) 12	(30) 17	(17 8
1947 - 48	(5) 11	(12) 11	(38) 9	(48) 11	(52) 12	(32) 16	(15 10
1948 - 49	(6) 12	(12) 13	(41) 10	(50) 11	(52) 12	(34) 12	(15 8
1949 - 50	(6) 12	(13) 12	(40) 12	(50) 11	(55) 13	(35) 15	(18 9

* Figures in brackets refer to the number of farms where dairy heifers formed a part of the total farm livestock.

APPENDIX xxxi

AVERAGE AREA IN CROPS (ACRES)

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.P.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	(2)* 8.0	(7) 3.8	(19) 3.7	(23) 3.9	(22) 4.6	(17) 4.7	(9) 6.9
1941 - 42	(2) 3.0	(6) 4.6	(10) 3.4	(20) 3.4	(17) 5.1	(14) 4.6	(7) 4.4
1942 - 43	(2) 4.5	(6) 6.3	(14) 3.8	(17) 4.9	(17) 5.3	(14) 6.7	(8) 5.6
1943 - 44	(1) 4.0	(4) 6.4	(16) 3.8	(22) 4.7	(21) 4.9	(13) 7.9	(10) 10.0
1944 - 45	(3) 7.8	(3) 7.0	(19) 4.0	(30) 5.0	(25) 6.7	(19) 4.8	(12) 6.8
1945 - 46	(1) 10.0	(4) 9.3	(18) 4.6	(26) 5.1	(22) 6.5	(18) 6.1	(9) 6.9
1946 - 47	(3) 2.5	(10) 6.2	(24) 4.1	(28) 4.9	(25) 7.1	(19) 9.6	(12) 6.4
1947 - 48	(1) 3.0	(5) 6.2	(21) 3.4	(22) 4.0	(26) 7.6	(14) 7.8	(12) 3.3
1948 - 49	(3) 3.3	(6) 5.0	(18) 4.2	(14) 6.3	(18) 5.3	(18) 7.0	(11) 3.1
1949 - 50	(3) 3.3	(7) 5.5	(17) 4.6	(16) 5.3	(17) 4.7	(17) 8.4	(12) 3.8

* Figures in brackets refer to the number of farms where crops were actually grown.

APPENDIX xxxii

AVERAGE AREA OF GRASSLAND CUT FOR HAY (ACRES)

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	(5)* 14	(14) 19	(48) 15	(58) 18	(58) 16	(37) 18	(19 11
1941 - 42	(5) 14	(16) 16	(47) 15	(58) 18	(59) 17	(38) 16	(22 12
1942 - 43	(5) 13	(14) 17	(48) 15	(57) 17	(56) 16	(34) 20	(22 14
1943 - 44	(5) 23	(15) 15	(48) 15	(59) 19	(59) 17	(37) 20	(21 14
1944 - 45	(6) 12	(15) 17	(46) 16	(59) 19	(58) 18	(37) 22	(20 14
1945 - 46	(7) 12	(13) 13	(46) 15	(56) 16	(55) 16	(36) 18	(20 11
1946 - 47	(6) 13	(15) 16	(46) 16	(57) 19	(55) 18	(36) 22	(22 14
1947 - 48	(6) 14	(14) 17	(46) 17	(57) 16	(58) 18	(36) 20	(21 14
1948 - 49	(6) 16	(13) 16	(48) 17	(57) 18	(60) 17	(36) 21	(22 14
1949 - 50	(6) 16	(14) 18	(46) 16	(55) 17	(57) 17	(36) 23	(22 14

* Figures in brackets refer to the number of farms on which hay was made.

APPENDIX xxxiii

CARRYING CAPACITY (STOCK UNITS PER ACRE)

No.of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	5.8	4.7	4.9	4.7	4.6	4.4	4.6
1941 - 42	5.5	4.7	4.8	4.6	4.5	4.4	4.5
1942 - 43	5.4	4.6	4.7	4.5	4.3	4.3	4.4
1943 - 44	5.0	4.5	4.6	4.5	4.4	4.2	4.8
1944 - 45	5.2	4.8	4.8	4.7	4.6	4.5	4.8
1945 - 46	4.7	4.1	4.4	4.4	4.4	4.1	4.6
1946 - 47	4.6	4.2	4.4	4.4	4.4	4.4	4.6
1947 - 48	4.5	3.7	4.5	4.4	4.5	4.7	4.9
1948 - 49	4.6	3.7	4.6	4.6	4.7	4.8	5.2
1949 - 50	4.4	4.0	4.7	4.7	4.8	4.9	5.4

APPENDIX xxxiv

AVERAGE YIELD OF HAY (TONS)

No.of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	-9 to +9	+10 to +29	+30 to +49	+50 plus
1940 - 41	27	39	33	37	33	41	22
1941 - 42	26	31	31	36	34	34	24
1942 - 43	24	32	30	34	30	39	31
1943 - 44	63	29	30	37	34	39	28
1944 - 45	22	34	33	39	36	44	28
1945 - 46	20	24	24	27	27	30	19
1946 - 47	34	34	36	38	38	47	29
1947 - 48	26	36	34	33	38	40	27
1948 - 49	30	35	36	39	38	47	28
1949 - 50	36	50	34	38	34	44	30

APPENDIX xxxv

AVERAGE AREA OF GRASSLAND CUT FOR SILAGE (ACRES)

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	(4) * 21	(5) 10	(23) 8	(24) 10	(34) 12	(21) 13	(10 8
1941 - 42	(3) 22	(7) 9	(25) 10	(27) 9	(30) 10	(25) 13	(13 8
1942 - 43	(3) 16	(7) 9	(22) 9	(27) 8	(26) 10	(20) 11	(9 7
1943 - 44	(2) 15	(8) 9	(19) 8	(23) 10	(26) 11	(22) 10	(10 7
1944 - 45	(3) 23	(7) 12	(20) 8	(24) 10	(26) 11	(16) 12	(8 8
1945 -46	12(3)	(5) 11	(13) 8	(18) 10	(18) 11	(15) 13	(7 8
1946 - 47	(2) 18	(6) 12	(19) 7	(18) 11	(22) 10	(12) 8	(7 8
1947 - 48	(3) 10	(10) 9	(16) 7	(15) 9	(24) 9	(16) 11	(8 8
1948 - 49	(2) 28	(9) 9	(22) 8	(23) 12	(29) 10	(18) 13	(13 8
1949 - 50	(3) 22	(6) 9	(26) 9	(27) 12	(31) 12	(18) 18	(13 9

* Figures in brackets refer to the number of farms where silage was made.

APPENDIX xxxvi

AVERAGE YIELD OF SILAGE (TONS)

No. of Farms	7	16	48	59	62	39	22
Production per acre diff.(lbs. of B.F.)(First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	75 4	38 5	30 23	36 24	39 34	47 21	33 10
1941 - 42	94 3	32 7	39 25	34 27	35 30	46 25	25 12
1942 - 43	62 3	36 7	29 22	28 27	29 26	40 20	18 9
1943 - 44	46	27	26	34	33	36	28
1944 - 45	85	36	25	34	35	49	32
1945 - 46	41	38	18	30	34	39	23
1946 - 47	78	50	28	38	40	33	27
1947 - 48	45 3	37 10	22 16	37 15	36 24	48 16	25 8
1948 - 49	105 2	43 9	28 22	48 23	41 29	47 18	32 10
1949 - 50	85 3	49 6	39 26	54 27	66 31	75 18	42

APPENDIX xxxvii

FARM MACHINERY - RATIO OF TRACTORS PER FARM.

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41		(4)* 0.3	(3) 0.1	(8) 0.1	(17) 0.3	(6) 0.2	(2) 0.1
1941 - 42		(3) 0.2	(3) 0.1	(11) 0.2	(19) 0.3	(8) 0.2	(2) 0.1
1942 -45	Not available						
1945 - 46	(1) 0.1	(5) 0.3	(10) 0.2	(19) 0.3	(19) 0.3	(15) 0.4	(4) 0.2
1946 - 47	(2) 0.3	(6) 0.4	(13) 0.3	(21) 0.4	(21) 0.4	(15) 0.4	(4) 0.2
1947 - 48	(1) 0.1	(4) 0.3	(14) 0.3	(24) 0.4	(26) 0.4	(14) 0.4	(6) 0.3
1948 - 49	(2) 0.3	(6) 0.4	(18) 0.4	(33) 0.6	(39) 0.6	(17) 0.4	(7) 0.3
1949 - 50	(3) 0.4	(9) 0.6	(18) 0.4	(34) 0.6	(45) 0.8	(22) 0.6	(10) 0.5

* Figures in brackets refer to the number of farmers who possessed tractors.

APPENDIX xxxviii

TRENDS IN THE YIELD OF HAY PER ACRE (TONS)

No.of Farms	7	16	48	59	62	39	22
Prod. per Acre diff. (lbs. of B.F.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1941 - 43	1.9	2.0	2.1	2.1	2.0	2.1	2.1
1944 - 46	2.1	1.9	1.9	1.9	1.9	1.9	1.9
1948 - 50	2.0	2.3	2.1	2.1	2.1	2.0	2.0

APPENDIX xxxix

WEIGHT OF HAY PER COW (TONS)

1941 - 43	.31	.47	.53	.57	.50	.54	.51
1944 - 46	.48	.41	.49	.55	.48	.52	.46
1948 - 50	.45	.57	.57	.56	.53	.54	.49

APPENDIX xl

TRENDS IN YIELDS OF SILAGE PER ACRE (TONS)

1941 - 43	3.9	3.8	3.7	3.6	3.3	3.7	3.4
1944 - 46	3.5	3.1	3.1	3.2	3.2	3.6	3.6
1948 - 50	3.9	4.7	4.0	4.2	4.7	4.0	4.2

APPENDIX xli

WEIGHT OF SILAGE PER COW (TONS)

1941 - 43	.62	.21	.27	.24	.28	.38	.26
1944 - 46	.38	.22	.15	.20	.20	.27	.20
1948 - 50	.49	.37	.23	.28	.34	.34	.31

APPENDIX xlii

AVERAGE AREA TOPDRESSED WITH ARTIFICIAL FERTILIZERS (ACRES).

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	-9 to +9	+10 to +29	+30 to +49	+50 plus
1940 - 41	(6)* 48	(15) 100	(45) 82	(53) 87	(58) 88	(38) 107	(21 70
1941 - 42	(6) 70	(15) 85	(44) 77	(54) 83	(59) 78	(39) 100	(18 69
1942 - 43	(7) 44	(15) 94	(43) 65	(55) 78	(53) 66	(39) 85	(22 61
1943 - 44	(6) 47	(15) 90	(43) 66	(56) 71	(56) 64	(38) 82	(21 50
1944 - 45	(7) 49	(14) 92	(46) 68	(58) 73	(58) 79	(38) 90	(22 59
1945 - 46	(7) 54	(14) 89	(44) 68	(55) 68	(59) 74	(36) 82	(20 56
1946 - 47	(7) 62	(13) 90	(44) 73	(56) 75	(55) 86	(34) 95	(20 62
1947 - 48	(7) 68	(14) 86	(45) 81	(56) 79	(58) 86	(38) 93	(21 70
1948 - 49	(7) 78	(13) 99	(46) 82	(58) 89	(58) 93	(39) 99	(21 71
1949 - 50	(7) 74	(15) 97	(48) 86	(58) 90	(60) 93	(39) 103	(22 74

* Figures in brackets refer to the number of farms where topdressing was practised.

APPENDIX xliii

AVERAGE AREA LIMED (ACRES).

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	(2)* 26	(8) 79	(27) 64	(35) 77	(36) 76	(27) 96	(12 64
1941 - 42	(4) 39	(11) 90	(31) 58	(45) 71	(41) 72	(28) 100	(14 64
1942 - 43	(6) 36	(14) 91	(33) 65	(46) 73	(50) 63	(27) 82	(12 61
1943 - 44	(7) 53	(12) 90	(39) 58	(46) 72	(45) 70	(27) 87	(14 55
1944 - 45	(7) 54	(12) 85	(36) 59	(45) 75	(49) 75	(27) 82	(17 50
1945 - 46	(3) 28	(14) 75	(34) 55	(43) 70	(42) 76	(24) 78	(15 57
1946 - 47	(3) 27	(11) 79	(28) 50	(42) 55	(37) 74	(22) 78	(14 52
1947 - 48	(5) 39	(7) 58	(30) 63	(38) 58	(40) 64	(26) 78	(14 68
1948 - 49	(4) 55	(7) 66	(27) 67	(37) 66	(38) 71	(28) 83	(15 74
1949 - 50	(5) 43	(6) 60	(25) 73	(30) 76	(28) 68	(23) 73	(10 72

* Figures in brackets refer to the number of farms whereliming was practised.

APPENDIX xliv

FARM MACHINERY - MILKING MACHINES.

AVERAGE NUMBER OF BAILS.

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 years.)	-50 plus	-30 to -49	-10 to -29	-9 to +9	+10 to +29	+30 to +49	+50 plus
1940 - 41	3.4	3.4	3.3	3.6	3.7	3.9	3.2
1941 - 42	3.3	3.4	3.4	3.6	3.7	3.9	3.2
1942 - 45		Not available					
1945 - 46	3.3	3.7	3.5	3.7	3.8	4.1	3.3
1946 - 47	3.3	3.6	3.6	3.7	4.1	4.1	3.4
1947 - 48	3.3	4.1	3.6	4.1	4.3	4.3	3.5
1948 - 49	3.9	4.1	3.7	4.3	4.3	4.8	4.0
1949 -50	4.0	4.3	4.1	4.5	4.5	5.2	4.6

APPENDIX xlv

THE FARM LABOUR FORCE.

1. FULL TIME MALE WORKERS.

(a) Total number of men employed.

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	-9 to +9	+10 to +29	+30 to +49	+50 plus
1946 - 47	(6)* 7	(16) 20	(44) 58	(58) 83	(58) 80	(22) 53	(22 26
1947 - 48	(7) 9	(16) 22	(48) 70	(59) 83	(61) 94	(39) 63	(22 30
1948 - 49	(7) 8	(16) 22	(48) 70	(57) 80	(61) 95	(39) 63	(22 34
1949 - 50	(7) 9	(15) 20	(48) 66	(58) 85	(62) 91	(39) 60	(21 31

(b) Total number of boys employed.

1946 - 47	(2) 2	(4) 5	(15) 18	(11) 12	(15) 17	(11) 14	(6 8
1947 - 48	(2) 3	(4) 5	(10) 10	(12) 15	(14) 19	(13) 15	(5 9
1948 - 49	(2) 3	(4) 5	(8) 8	(16) 17	(15) 18	(9) 11	(5 7
1949 - 50	(2) 3	(3) 4	(5) 5	(13) 16	(10) 11	(9) 13	(4 6

APPENDIX xlvi

2. FULL-TIME FEMALE WORKERS.

(a) Total number of women employed.

No. of Farms	7	16	48	59	62	39	22
Production per acre diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	-9 to +9	+10 to +29	+30 to +49	+50 plus
1946 - 47	(1)* 1	(5) 5	(9) 9	(8) 8	(12) 14	(3) 3	(1) 1
1947 - 48	(2) 2	(3) 3	(10) 10	(14) 15	(15) 19	(4) 5	(3) 3
1948 - 49	(1) 1	(1) 1	(12) 14	(10) 11	(16) 21	(6) 6	(1) 1
1949 - 50		(1) 1	(6) 7	(2) 3	(2) 2		(2) 2

(b) Total number of girls employed.

1946 - 47	(1) 1	(1) 1	(1) 2	(3) 4	(6) 7		
1947 - 48	(1) 2	(1) 1	(2) 2	(2) 4	(2) 2	(2) 2	
1948 - 49			(2) 2	(3) 5	(4) 5	(2) 3	
1949 - 50			(1) 2	(3) 3			

* Figures in brackets refer to the number of farms where the different classes of labour were employed.

DAIRY FARMING TRENDS IN WAIPA COUNTY

FOR THE TEN YEARS 1940 - 41 to 1949 - 50

GROUPINGS ARE BASED ON BETWEEN-FARM DIFFERENCES IN "CARRYING CAPACITY" (STOCK UNITS PER ACRE).

APPENDIX xlvii

PRODUCTION PER COW (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	266	270	288	289	294	315	310
1941 - 42	242	238	262	267	270	292	302
1942 - 43	219	228	242	251	256	273	286
1943 - 44	219	233	247	258	257	282	268
1944 - 45	242	251	276	286	291	303	284
1945 - 46	202	212	218	237	233	251	237
1946 - 47	239	244	257	271	274	283	267
1947 - 48	231	234	257	265	271	276	266
1948 - 49	230	267	285	292	287	303	279
1949 - 50	243	259	270	277	286	303	272

APPENDIX xlviii

PRODUCTION PER ACRE (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	116	130	169	188	208	241	260
1941 - 42	107	123	156	172	192	222	259
1942 - 43	96	117	141	161	182	215	240
1943 - 44	97	110	144	165	186	221	222
1944 - 45	108	134	166	189	210	239	261
1945 - 46	88	114	129	153	167	191	213
1946 - 47	103	125	150	174	195	215	218
1947 - 48	95	129	153	175	195	214	224
1948 - 49	94	149	170	194	209	231	241
1949 - 50	103	148	167	191	204	232	246

APPENDIX xlix

CARRYING CAPACITY (COWS PER 100 ACRES)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre.	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	44	48	59	65	71	76	84
1941 - 42	44	52	59	64	71	76	86
1942 - 43	44	51	58	64	71	79	84
1943 - 44	44	47	58	64	72	78	83
1944 - 45	45	53	60	66	72	79	92
1945 - 46	44	54	60	66	72	79	92
1946 - 47	43	51	59	64	71	76	82
1947 - 48	41	55	60	66	72	77	84
1948 - 49	41	56	60	66	73	76	86
1949 - 50	42	57	62	69	71	76	90

APPENDIX l

TOTAL BUTTERFAT "AT THE PAIL"

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	12395	14753	18469	18156	17331	18669	12125
1941 - 42	11443	14267	17006	16611	16002	17250	12086
1942 - 43	10395	13524	15483	15674	15297	16672	11222
1943 - 44	10515	12788	15779	16118	15567	17140	10394
1944 - 45	11876	15639	18281	18494	17593	18555	12238
1945 - 46	9748	13299	14224	15012	14052	14824	10002
1946 - 47	11675	14534	16696	17095	16418	16733	10245
1947 - 48	11260	15137	17023	17149	16426	16638	10483
1948 - 49	11144	17693	18963	19108	17760	18030	11196
1949 - 50	12122	17545	18697	18751	17451	18065	11448

APPENDIX 1i

TOTAL STOCK UNITS PER FARM.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	334	420	477	479	441	444	295
1941 - 42	327	442	469	466	431	437	308
1942 - 43	324	416	464	451	425	443	293
1943 - 44	327	414	457	455	432	436	312
1944 - 45	329	445	482	474	454	465	319
1945 - 46	317	423	458	439	415	412	287
1946 - 47	356	419	464	450	425	428	275
1947 - 48	326	435	473	461	427	432	291
1948 - 49	328	478	486	474	447	447	300
1949 - 50	350	486	500	488	447	452	313

APPENDIX 1ii

CARRYING CAPACITY (STOCK UNITS PER ACRE)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	3.12	3.70	4.37	4.96	5.31	5.72	6.31
1941 - 42	3.06	3.82	4.30	4.81	5.17	5.63	6.60
1942 - 43	2.99	3.60	4.24	4.63	5.07	5.70	6.29
1943 - 44	3.00	3.56	4.17	4.65	5.15	5.62	6.67
1944 - 45	2.99	3.82	4.38	4.84	5.41	5.99	6.82
1945 - 46	2.86	3.64	4.15	4.48	4.92	5.31	6.11
1946 - 47	3.15	3.59	4.18	4.58	5.04	5.49	5.86
1947 - 48	2.76	3.69	4.26	4.70	5.05	5.55	6.23
1948 - 49	2.77	4.03	4.36	4.81	5.26	5.74	6.45
1949 - 50	2.97	4.09	4.47	4.97	5.21	5.80	6.73

APPENDIX 1111

AVERAGE NUMBER OF DAIRY HEIFERS PER FARM.(1-2 yrs.)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5-3.99	4.0-4.49	4.5-4.99	5.0-5.49	5.5-5.99	6.0 plus
1940 - 41	(10)* 7	(15) 15	(50) 11	(69) 13	(32) 11	(14) 8	(5) 8
1941 - 42	(8) 7	(15) 12	(47) 12	(76) 13	(31) 10	(13) 9	(5) 10
1942 - 43	(10) 9	(14) 10	(39) 13	(63) 9	(25) 9	(9) 15	(5) 8
1943 - 44	(11) 8	(20) 12	(47) 10	(68) 12	(30) 11	(11) 10	(7) 15
1944 - 45	(7) 9	(16) 11	(48) 10	(65) 13	(34) 13	(14) 10	(6) 8
1945 - 46	(9) 8	(15) 12	(47) 14	(63) 14	(31) 12	(11) 12	(6) 8
1946 - 47	(10) 16	(19) 12	(48) 12	(66) 13	(35) 11	(13) 10	(6) 7
1947 - 48	(12) 7	(17) 10	(51) 13	(68) 14	(36) 11	(13) 8	(5) 7
1948 - 49	(9) 12	(19) 13	(49) 12	(73) 11	(40) 10	(14) 11	(6) 9
1949 - 50	(10) 11	(20) 14	(50) 13	(78) 13	(38) 12	(14) 11	(7) 8

* Figures in brackets refer to the number of farms where dairy heifers formed a part of the total farm livestock.

APPENDIX liv

DAIRY HEIFERS (1 - 2 YRS) PER 100 COWS IN MILK.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	10	19	15	16	12	12	15
1941 - 42	9	14	15	18	11	13	18
1942 - 43	13	10	14	10	8	14	15
1943 - 44	14	19	16	14	12	12	38
1944 - 45	9	13	15	15	16	15	15
1945 - 46	11	13	18	15	13	14	16
1946 - 47	23	17	16	15	13	14	16
1947 - 48	13	12	17	16	14	11	13
1948 - 49	16	16	16	13	14	16	20
1949 - 50	16	18	16	16	16	16	18

APPENDIX lv

DAIRY HEIFERS (1 - 2 YRS) PER 100 ACRES.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	4	9	9	10	9	9	13
1941 - 42	4	7	9	12	8	10	15
1942 - 43	6	5	8	6	6	11	13
1943 - 44	6	9	9	9	8	9	32
1944 - 45	4	7	9	9	11	12	14
1945 - 46	5	7	11	10	9	11	14
1946 - 47	10	9	9	9	10	11	13
1947 - 48	5	6	10	11	10	8	11
1948 - 49	7	9	9	9	10	12	17
1949 - 50	7	11	10	11	11	13	17

APPENDIX lvi

AVERAGE CULTIVATED AREA.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre.	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	107	114	109	97	83	78	47
1941 - 42	107	116	109	97	83	78	47
1942 - 43	109	115	109	98	84	78	47
1943 - 44	109	116	110	98	84	78	47
1944 - 45	110	117	110	98	84	78	47
1945 - 46	111	116	110	98	84	78	47
1946 - 47	113	117	111	98	84	78	47
1947 - 48	118	118	111	98	84	78	47
1948 - 49	118	119	112	99	85	78	47
1949 - 50	118	119	112	98	86	78	47

APPENDIX lvii

AVERAGE NUMBER OF COWS IN MILK.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	47	55	64	63	59	59	39
1941 - 42	47	60	65	62	59	59	40
1942 - 43	48	59	64	62	60	61	39
1943 - 44	48	55	64	63	61	61	39
1944 - 45	49	62	66	65	61	61	43
1945 - 46	48	63	65	63	60	59	42
1946 - 47	49	60	65	63	60	59	38
1947 - 48	49	65	66	65	61	60	39
1948 - 49	48	66	67	65	62	60	40
1949 - 50	50	68	69	68	61	60	42

APPENDIX lviii

AVERAGE AREA CROPPED (ACRES)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	(10)* 3.7	(9) 4.8	(24) 4.6	(29) 5.5	(20) 3.9	(5) 2.3	(2) 2.4
1941 - 42	(8) 5.0	(10) 4.5	(23) 3.6	(20) 5.5	(9) 3.3	(5) 1.1	(1) 3.0
1942 - 43	(8) 4.7	(6) 7.3	(15) 4.8	(30) 6.2	(12) 4.3	(5) 2.3	(2) 4.9
1943 - 44	(7) 5.3	(12) 6.6	(17) 4.7	(32) 5.9	(14) 6.1	(4) 5.3	(1) 8.3
1944 - 45	(9) 6.3	(14) 5.1	(25) 5.6	(39) 5.3	(18) 6.0	(4) 5.1	(2) 4.5
1945 - 46	(8) 8.1	(11) 6.0	(21) 5.0	(34) 5.9	(17) 6.5	(5) 5.3	(2) 3.4
1946 - 47	(7) 17.0	(13) 5.9	(27) 5.3	(45) 5.6	(19) 4.6	(7) 4.5	(3) 4.0
1947 - 48	(7) 9.3	(12) 4.4	(22) 6.4	(36) 5.9	(15) 3.3	(6) 3.3	(3) 4.1
1948 - 49	(6) 6.3	(13) 6.8	(21) 4.9	(32) 5.2	(12) 3.9	(2) 4.5	(2) 2.9
1949 - 50	(5) 6.8	(14) 7.7	(19) 5.1	(35) 5.0	(10) 3.9	(3) 6.1	(3) 2.8

* Figures in brackets refer to the number of farms where crops were grown.

APPENDIX lix

AVERAGE AREA CUT FOR HAY (ACRES)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5-3.99	4.0-4.49	4.5-4.99	5.0-5.49	5.5-5.99	6.0 plus
1940 - 41	(11)* 17	(21) 18	(55) 18	(88) 17	(42) 14	(15) 14	(7) 9
1941 - 42	(12) 17	(21) 18	(56) 17	(87) 17	(46) 15	(16) 12	(7) 9
1942 - 43	(13) 14	(21) 17	(53) 17	(84) 17	(43) 15	(16) 12	(6) 11
1943 - 44	(13) 18	(21) 16	(56) 19	(87) 17	(45) 17	(16) 15	(6) 13
1944 - 45	(13) 18	(21) 22	(54) 20	(87) 19	(46) 15	(15) 14	(5) 9
1945 - 46	(12) 14	(20) 14	(51) 17	(85) 16	(44) 14	(15) 12	(6) 10
1946 - 47	(12) 17	(21) 23	(53) 22	(85) 17	(43) 16	(16) 13	(7) 13
1947 - 48	(11) 16	(21) 22	(54) 19	(87) 17	(42) 16	(16) 13	(7) 10
1948 - 49	(12) 17	(20) 20	(55) 20	(88) 17	(44) 16	(16) 14	(7) 11
1949 - 50	(11) 16	(21) 22	(51) 19	(87) 17	(44) 16	(15) 15	(7) 13

* Figures in brackets refer to the number of farms on which hay was made.

APPENDIX lx

AVERAGE AREA CUT FOR SILAGE (ACRES)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	(5)* 8.2	(8) 9.5	(30) 9.5	(43) 11.9	(20) 12.7	(10) 10.2	(5) 6.0
1941 - 42	(4) 8.0	(11) 9.1	(31) 11.0	(42) 9.5	(27) 10.4	(10) 13.3	(5) 7.8
1942 - 43	(4) 9.8	(11) 7.0	(32) 8.9	(33) 9.4	(23) 9.5	(6) 13.3	(5) 8.4
1943 - 44	(4) 7.3	(9) 8.2	(29) 9.4	(42) 10.5	(16) 10.1	(6) 8.8	(4) 7.8
1944 - 45	(3) 14.0	(6) 9.0	(29) 9.6	(33) 10.6	(21) 11.5	(8) 9.0	(4) 9.5
1945 - 46	(3) 9.3	(8) 9.8	(19) 11.7	(24) 12.0	(19) 9.1	(5) 7.6	(1) 3.0
1946 - 47	(2) 4.5	(4) 17.0	(20) 10.3	(30) 8.9	(19) 9.9	(9) 8.1	(2) 5.5
1947 - 48	(3) 6.3	(4) 7.0	(20) 9.9	(32) 9.8	(23) 8.5	(7) 8.4	(3) 6.0
1948 - 49	(2) 18.5	(8) 10.1	(22) 10.1	(45) 10.8	(26) 10.0	(10) 8.0	(3) 8.0
1949 - 50	(3) 18.3	(7) 12.0	(31) 12.3	(44) 12.1	(26) 11.9	(10) 9.8	(3) 9.3

* Figures in brackets refer to the number of farms where silage was made.

APPENDIX lxi

AVERAGE YIELD OF HAY (TONS)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	33	40	38	35	31	31	18
1941 - 42	29	36	34	36	30	25	19
1942 - 43	26	35	34	35	30	25	21
1943 - 44	33	31	37	35	37	30	24
1944 - 45	33	42	39	38	31	28	18
1945 - 46	21	24	25	29	26	21	18
1946 - 47	32	47	44	37	33	29	27
1947 - 48	33	41	40	34	33	27	19
1948 - 49	29	42	42	38	37	32	24
1949 - 50	28	44	38	36	38	35	24

APPENDIX lxii

AVERAGE YIELD OF SILAGE (TONS)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	21.4	43.3	38.2	39.7	48.3	32.5	20.0
1941 - 42	25.0	39.6	47.2	32.8	33.7	50.8	23.8
1942 - 43	27.5	24.6	32.5	29.1	30.9	48.0	32.6
1943 - 44	13.8	26.0	34.4	35.3	31.9	28.0	20.0
1944- 45	39.7	36.2	37.6	37.2	38.0	25.4	28.0
1945 - 46	14.7	31.8	36.2	36.5	24.6	22.4	6.0
1946 - 47	7.0	66.3	42.1	33.6	36.8	30.0	20.0
1947 - 48	17.3	29.8	41.1	39.5	32.2	24.7	18.0
1948 - 49	38.0	35.3	38.8	45.5	42.1	33.1	28.0
1949 - 50	47.0	45.9	57.6	56.5	66.5	39.9	35.3

APPENDIX lxiii

AVERAGE AREA OF GRASSLAND TOPDRESSED WITH ARTIFICIAL FERTILIZERS (ACRES)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	(13)* 84	(21) 93	(54) 102	(84) 89	(42) 79	(15) 75	(7) 44
1941 - 42	(13) 69	(21) 96	(51) 98	(85) 82	(45) 75	(13) 78	(7) 42
1942 - 43	(9) 78	(20) 81	(55) 86	(85) 74	(43) 65	(15) 72	(7) 42
1943 - 44	(11) 76	(20) 60	(52) 78	(86) 73	(44) 56	(16) 68	(6) 41
1944 - 45	(11) 65	(20) 71	(56) 83	(90) 79	(44) 69	(15) 73	(7) 43
1945 - 46	(11) 69	(20) 70	(52) 84	(85) 71	(46) 62	(15) 71	(6) 44
1946 - 47	(12) 85	(20) 81	(52) 92	(83) 80	(40) 70	(16) 68	(6) 46
1947 - 48	(12) 80	(22) 92	(52) 94	(84) 85	(46) 71	(16) 73	(7) 44
1948 - 49	(11) 92	(20) 104	(56) 102	(87) 90	(46) 75	(15) 78	(7) 45
1949 - 50	(12) 87	(22) 105	(57) 104	(90) 91	(45) 81	(16) 76	(7) 45

* Figures in brackets refer to the number of farms where topdressing was practised.

APPENDIX lxiv

AVERAGE AREA LIMED (ACRES)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	(8)* 90	(15) 83	(29) 75	(53) 84	(28) 70	(9) 50	(5) 42
1941 - 42	(11) 83	(15) 83	(39) 73	(61) 80	(34) 70	(9) 39	(5) 39
1942 - 43	(10) 77	(16) 79	(41) 86	(66) 77	(38) 56	(12) 69	(5) 43
1943 - 44	(8) 94	(14) 70	(45) 74	(69) 74	(37) 59	(13) 61	(4) 42
1944 - 45	(10) 65	(16) 65	(45) 78	(71) 77	(34) 59	(12) 58	(5) 46
1945 - 46	(10) 76	(13) 81	(41) 80	(65) 72	(32) 51	(10) 48	(4) 37
1946 - 47	(7) 85	(16) 75	(41) 66	(56) 64	(24) 49	(9) 53	(4) 45
1947 - 48	(7) 45	(15) 68	(35) 76	(62) 63	(27) 59	(10) 56	(4) 36
1948 - 49	(9) 50	(15) 78	(38) 81	(52) 75	(29) 63	(10) 59	(3) 34
1949 - 50	(7) 49	(14) 94	(28) 84	(46) 69	(24) 59	(5) 57	(3) 31

* Figures in brackets refer to the number of farms where liming was practised.

APPENDIX lxv

FARM MACHINERY

(a) AVERAGE NUMBER OF TRACTORS PER FARM.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1940 - 41	(5)* 0.36	(3) 0.14	(12) 0.21	(12) 0.13	(5) 0.13	(3) 0.19	
1941 - 42	(5) 0.36	(3) 0.14	(13) 0.25	(14) 0.16	(6) 0.13	(3) 0.19	(2) 0.29
1942 - 45	Not available						
1945 - 46	(6) 0.50	(5) 0.23	(20) 0.37	(23) 0.26	(12) 0.26	(4) 0.25	(3) 0.43
1946 - 47	(6) 0.50	(7) 0.32	(19) 0.33	(29) 0.32	(15) 0.32	(3) 0.19	(3) 0.43
1947 - 48	(7) 0.57	(7) 0.32	(22) 0.40	(30) 0.33	(17) 0.38	(3) 0.19	(3) 0.43
1948 - 49	(8) 0.57	(10) 0.45	(28) 0.51	(43) 0.49	(24) 0.53	(6) 0.38	(3) 0.43
1949 - 50	(9) 0.64	(11) 0.50	(34) 0.61	(50) 0.58	(27) 0.60	(7) 0.44	(3) 0.57

* Figures in brackets refer to the number of farmers who possessed tractors.

(b) MILKING MACHINES - AVERAGE NUMBER OF BAILS.

1940 - 41	3.0	3.6	3.8	3.8	3.5	3.7	2.9
1941 - 42	3.3	3.7	3.6	3.8	3.5	3.6	2.9
1942 - 45	Not available						
1945 - 46	3.0	3.7	3.8	3.9	3.5	3.8	3.3
1946 - 47	3.2	4.1	3.9	4.0	3.6	3.8	3.1
1947 - 48	3.2	4.4	4.1	4.2	3.7	4.1	3.1
1948 - 49	3.6	4.8	4.4	4.3	3.9	4.1	3.1
1949 - 50	3.7	5.0	4.8	4.6	4.3	4.4	3.4

APPENDIX lxvi

TOTAL FARM LABOUR.

(1) MALES.

(a) Men.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1946 - 47	(14)* 17	(22) 28	(55) 83	(84) 117	(46) 55	(14) 20	(7) 7
1947 - 48	(14) 19	(22) 34	(57) 92	(89) 128	(47) 66	(16) 24	(7) 8
1948 - 49	(14) 17	(21) 34	(57) 91	(89) 132	(46) 67	(16) 24	(7) 7
1949 - 50	(13) 16	(22) 35	(56) 84	(90) 128	(47) 69	(15) 23	(7) 7

(b) Boys.

1946 - 47	(4) 5	(7) 8	(13) 15	(24) 27	(13) 17	(3) 4	
1947 - 48	(3) 4	(5) 7	(16) 17	(23) 33	(11) 13	(1) 1	(1) 1
1948 - 49	(4) 5	(2) 3	(17) 18	(21) 26	(12) 14	(1) 1	(2) 2
1949 - 50	(4) 5	(2) 3	(12) 14	(17) 20	(9) 13	(1) 1	(1) 2

(2) FEMALES.

(a) Women.

1946 - 47	(1) 1	(3) 3	(8) 8	(16) 18	(7) 7	(4) 4	
1947 - 48	(2) 2	(7) 7	(10) 11	(18) 23	(8) 8	(4) 4	(2) 2
1948 - 49	(3) 3	(7) 7	(11) 11	(17) 24	(2) 7	(2) 3	
1949 - 50			(4) 4	(4) 5	(2) 3	(3) 3	

(b) Girls.

1946 - 47				(7) 9	(1) 1	(4) 5	
1947 - 48			(3) 3	(3) 3	(2) 4	(2) 3	
1948 - 49		(2) 3	(1) 1	(3) 4	(1) 1	(4) 6	
1949 - 50		(1) 1	(1) 2		(1) 1	(1) 1	

* Figures in brackets refer to the number of farms where the different classes of labour were employed.

APPENDIX lxvii

TOTAL LABOUR UNITS.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1946 - 47	22.5	37.5	102.0	157.5	76.0	28.5	7.0
1947 - 48	24.0	44.5	116.0	174.0	85.0	28.5	10.0
1948 - 49	23.5	42.0	115.0	172.0	85.0	29.5	9.0
1949 - 50	21.0	38.5	101.0	150.5	84.0	26.0	9.0

APPENDIX lxviii

LABOUR UNITS PER FARM.

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1946 - 47	1.6	1.7	1.8	1.8	1.6	1.8	1.0
1947 - 48	1.7	2.0	2.0	1.9	1.8	1.8	1.4
1948 - 49	1.7	1.9	2.0	1.9	1.8	1.8	1.3
1949 - 50	1.5	1.8	1.8	1.7	1.8	1.6	1.3

APPENDIX lxix

PRODUCTION PER LABOUR UNIT (LBS. OF BUTTERFAT)

No. of Farms	14	22	57	90	47	16	7
Stock units per acre	below 3.5	3.5- 3.99	4.0- 4.49	4.5- 4.99	5.0- 5.49	5.5- 5.99	6.0 plus
1946 - 47	7264	8527	9330	9769	10153	9394	10245
1947 - 48	6569	7483	8365	8870	9083	9340	7338
1948 - 49	6639	9268	9399	9998	9820	9779	8708
1949 - 50	8081	10025	10552	11213	9764	11117	8904

DAIRY FARMING TRENDS IN WAIPA COUNTY

FOR THE TEN YEARS 1940 - 41 to 1949 - 50.

GROUPINGS ARE BASED ON WITHIN-FARM DIFFERENCES IN "CARRYING CAPACITY" (STOCK UNITS PER ACRE) BETWEEN THE FIRST THREE AND LAST THREE YEARS OF THE PERIOD.

APPENDIX lxx

PRODUCTION PER COW

(LBS. OF BUTTERFAT "AT THE PAIL")

Carrying Capacity diff. (S.U.per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No. of Farms	22	54	85	68	24
1940 - 41	288	292	289	287	293
1941 - 42	268	269	267	259	259
1942 - 43	245	250	248	249	248
1943 - 44	262	253	250	253	257
1944 - 45	281	283	282	280	272
1945 - 46	223	226	232	229	231
1946 - 47	261	260	268	264	271
1947 - 48	247	257	263	262	263
1948 - 49	279	275	289	287	289
1949 - 50	268	273	279	276	273

APPENDIX lxxi

PRODUCTION PER ACRE

(LBS. OF BUTTERFAT "AT THE PAIL")

Carrying Capacity diff. (S.U.per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No. of Farms	22	54	85	68	24
1940 - 41	182	192	183	174	155
1941 - 42	176	177	170	156	143
1942 - 43	156	165	159	147	135
1943 - 44	161	157	161	154	144
1944 - 45	178	182	183	176	164
1945 - 46	133	142	149	143	141
1946 - 47	140	162	171	166	166
1947 - 48	128	158	171	173	174
1948 - 49	144	170	189	190	194
1949 - 50	142	172	187	186	191

APPENDIX lxxii CARRYING CAPACITY

(COWS PER 100 ACRES)

Carrying Capacity diff. (S.U. per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No. of Farms	22	54	85	68	24
1940 - 41	63	66	63	61	53
1941 - 42	66	66	64	60	55
1942 - 43	64	66	64	59	55
1943 - 44	61	62	64	61	56
1944 - 45	63	65	65	63	60
1945 - 46	60	63	64	62	61
1946 - 47	53	62	64	63	61
1947 - 48	52	61	65	66	66
1948 - 49	52	62	65	66	67
1949 - 50	53	63	67	68	70

APPENDIX lxxiii CARRYING CAPACITY

(STOCK UNITS PER ACRE)

Carrying Capacity diff. (S.U.per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No. of Farms	22	54	85	68	24
1940 - 41	4.87	4.99	4.76	4.50	4.04
1941 - 42	4.76	4.95	4.70	4.36	3.95
1942 - 43	4.72	4.88	4.56	4.19	3.81
1943 - 44	4.38	4.57	4.57	4.37	4.24
1944 - 45	4.53	4.83	4.72	4.67	4.29
1945 - 46	4.22	4.41	4.39	4.35	4.11
1946 - 47	3.97	4.49	4.45	4.52	4.30
1947 - 48	3.55	4.38	4.53	4.73	4.68
1948 - 49	3.65	4.45	4.70	4.87	5.01
1949 - 50	3.71	4.61	4.80	4.93	5.17

APPENDIX lxxiv

AVERAGE BUTTERFAT "AT THE PAIL"

Carrying Capacity diff. (S.U.per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No. of Farms	22	54	85	68	24
1940 - 41	16925	17647	18027	17640	13579
1941 - 42	16474	16232	16857	15877	12490
1942 - 43	14780	15334	15825	14951	11897
1943 - 44	15323	14591	16031	15664	12681
1944 - 45	17248	16991	18336	18007	14421
1945 - 46	13167	13262	14907	14539	12375
1946 - 47	14373	15126	17108	16889	14535
1947 - 48	13884	14891	17142	17432	15167
1948 - 49	15928	16150	18954	19239	16899
1949 - 50	15701	16321	18746	18783	16707

APPENDIX lxxv

AVERAGE NUMBER OF STOCK UNITS PER FARM

Carrying Capacity diff. (S.U.per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No. of Farms	22	54	85	68	24
1940 - 41	453	459	469	457	354
1941 - 42	447	454	465	444	347
1942 - 43	447	452	453	427	334
1943 - 44	418	425	455	446	373
1944 - 45	439	450	472	477	377
1945 - 46	419	412	438	443	361
1946 - 47	409	421	446	460	377
1947 - 48	385	413	454	477	408
1948 - 49	404	422	471	494	438
1949 - 50	411	438	482	499	451

APPENDIX lxxvi

AVERAGE NUMBER OF COWS IN MILK.

Carrying capacity diff. (S.U.per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No. of Farms	22	54	85	68	24
1940 - 41	59	60	62	61	46
1941 - 42	62	60	63	61	48
1942 - 43	60	61	64	60	48
1943 - 44	58	58	64	62	49
1944 - 45	61	60	65	64	53
1945 - 46	59	59	64	63	54
1946- 47	55	58	64	64	54
1947 - 48	56	58	65	66	58
1948 - 49	57	59	66	67	58
1949 - 50	59	60	67	68	61

APPENDIX lxxvii

AVERAGE CULTIVATED AREA (ACRES)

Carrying Capacity diff. (S.U.per acre) (First 3 and last 3 yrs.)	-0.75 plus	-0.74 to -0.25	-0.24 to +0.24	+0.25 to +0.74	+0.75 plus
No.of Farms	22	54	85	68	24
1940 - 41	93	92	98	102	88
1941 - 42	94	92	99	102	88
1942 - 43	95	93	99	102	88
1943 - 44	95	93	100	102	88
1944 - 45	97	93	100	102	88
1945 - 46	99	93	100	102	88
1946 - 47	103	94	100	102	88
1947 - 48	108	94	100	101	87
1948 - 49	111	95	100	101	87
1949 - 50	111	95	100	101	87

DAIRY FARMING TRENDS IN WAIPA COUNTY

FOR THE TEN YEARS 1940 - 41 to 1949 - 50

GROUPINGS ARE BASED ON BETWEEN-FARM DIFFERENCES IN "PRODUCTION PER COW "(LBS. OF BUTTERFAT "AT THE PAIL").

APPENDIX lxxviii

PRODUCTION PER ACRE (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	131	150	180	187	219	223
1941 - 42	118	138	165	174	201	213
1942 - 43	108	130	153	165	185	196
1943 - 44	101	132	156	166	188	206
1944 - 45	125	148	177	192	215	230
1945 - 46	106	117	141	157	169	183
1946 - 47	113	129	165	181	195	209
1947 - 48	112	131	168	179	194	211
1948 - 49	123	149	182	197	214	231
1949 - 50	121	152	177	197	207	236

APPENDIX lxxix

AVERAGE BUTTERFAT PRODUCTION "AT THE PAIL"

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	13576	15396	18129	18639	17198	18118
1941 - 42	12175	14316	16554	17448	15789	17313
1942 - 43	11160	13774	15430	16608	14507	15904
1943 - 44	10459	13990	15755	16797	14860	16780
1944 - 45	13010	15785	17855	19410	17016	19126
1945 - 46	11019	12490	14204	15858	13384	15475
1946 - 47	11845	13997	16588	18266	15515	17705
1947 - 48	11866	14622	16864	18059	15487	17798
1948 - 49	13207	16763	18351	19930	17044	19586
1949 - 50	13064	16921	17829	19922	16515	20011

APPENDIX lxxx

PRODUCTION PER COW (LBS. OF BUTTERFAT "AT THE PAIL").

No. of Farms	21	39	73	67	38	15
Production per cow (lbs. of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	242	257	288	293	331	332
1941 - 42	213	236	261	271	303	323
1942 - 43	195	223	245	256	285	295
1943 - 44	194	223	249	262	290	312
1944 - 45	221	243	274	296	321	343
1945 - 46	183	198	223	246	256	276
1946 - 47	205	227	259	281	300	332
1947- 48	202	226	254	275	301	313
1948 - 49	226	256	275	301	320	346
1949 - 50	226	255	260	292	302	340

APPENDIX lxxxi

CARRYING CAPACITY. (COWS PER 100 ACRES)

No.of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 Plus
1940 - 41	54	58	63	64	66	67
1941 - 42	55	58	63	64	66	66
1942 - 43	56	58	62	64	65	67
1943 - 44	52	59	63	63	65	66
1944 - 45	57	61	65	65	67	67
1945 - 46	58	59	63	64	66	66
1946 - 47	55	57	64	64	65	63
1947 - 48	55	58	66	65	65	67
1948 - 49	55	58	66	65	67	67
1949 - 50	53	60	68	67	68	69

APPENDIX lxxxii

AVERAGE NUMBER OF DAIRY HEIFERS.

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	(14)* 10	(34) 14	(59) 11	(50) 12	(28) 10	(10) 10
1941 - 42	(14) 12	(31) 14	(56) 11	(53) 12	(29) 10	(12) 9
1942 - 43	(14) 11	(29) 12	(46) 9	(41) 10	(25) 10	(10) 14
1943 - 44	(19) 9	(35) 14	(51) 12	(51) 11	(29) 11	(9) 12
1944 - 45	(14) 12	(32) 13	(56) 12	(49) 13	(28) 10	(11) 10
1945 - 46	(15) 11	(33) 15	(53) 12	(46) 12	(27) 11	(8) 25
1946 - 47	(18) 16	(32) 17	(60) 11	(51) 10	(26) 8	(10) 13
1947 - 48	(19) 11	(35) 15	(59) 12	(51) 11	(27) 9	(11) 11
1948 - 49	(17) 13	(36) 11	(57) 11	(59) 11	(30) 10	(11) 13
1949 - 50	(18) 14	(37) 14	(62) 11	(58) 12	(31) 11	(11) 13

* Figures in brackets refer to the number of farms where dairy heifers formed a part of the total farm livestock.

APPENDIX lxxxiii

AVERAGE NUMBERS OF HEIFERS PER 100 COWS IN MILK.

No. of Farms	21	39	73	67	38	15
Production per cow (lbs. of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	12	20	14	14	14	13
1941 - 42	13	18	14	15	15	13
1942 - 43	12	14	9	9	12	17
1943 - 44	16	20	13	14	16	13
1944 - 45	14	16	14	14	15	14
1945 - 46	13	20	14	13	15	24
1946 - 47	23	23	14	12	11	16
1947 - 48	17	21	15	13	12	14
1948 - 49	17	15	13	14	16	17
1949 - 50	20	20	14	15	17	16

APPENDIX lxxxiv

AVERAGE NUMBER OF COWS IN MILK.

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	56	60	63	64	52	55
1941 - 42	57	61	63	64	52	54
1942 - 43	57	62	63	65	51	54
1943 - 44	54	63	63	64	51	54
1944 - 45	59	65	65	66	53	56
1945 - 46	60	63	64	65	52	56
1946 - 47	58	62	64	65	52	53
1947 - 48	59	65	66	66	51	57
1948 - 49	58	65	67	66	53	57
1949 - 50	58	66	69	68	55	59

APPENDIX lxxxv

AVERAGE NUMBER OF STOCK UNITS.

No.of Farms	21	39	73	67	38	15
Production per cow (lbs. of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940-41	409	451	467	485	398	420
1941-42	414	446	456	474	392	422
1942-43	405	436	453	457	379	421
1943-44	377	455	445	468	383	405
1944-45	407	465	470	486	407	434
1945-46	411	433	470	445	371	422
1946-47	419	439	446	460	377	414
1947-48	397	454	462	465	379	421
1948-49	407	468	473	486	404	437
1949-50	408	481	483	500	410	450

APPENDIX lxxxvi

AVERAGE CULTIVATED AREA (ACRES)

No.of Farms	21	39	73	67	38	15
Production per cow (lbs. Of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940-41	103	102	101	100	79	81
1941-42	104	104	100	100	79	81
1942-43	103	106	101	101	79	81
1943-44	103	106	101	101	79	81
1944-45	104	107	101	101	79	83
1945-46	104	107	101	101	79	85
1946-47	105	109	101	101	80	85
1947-48	106	111	100	101	80	85
1948-49	107	112	101	101	80	85
1949-50	108	111	101	101	80	85

APPENDIX lxxxvii

AVERAGE AREA CROPPED (ACRES)

No.of Farms	21	39	73	67	38	15
Production per cow (lbs. of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	(10)* 4.2	(18) 5.5	(27) 5.0	(24) 4.6	(18) 3.2	(2) 1.3
1941 - 42	(8) 2.9	(14) 6.5	(22) 4.6	(17) 4.2	(11) 1.7	(4) 2.3
1942 - 43	(8) 4.6	(12) 8.0	(27) 4.5	(16) 6.4	(10) 4.8	(5) 1.8
1943 - 44	(7) 5.5	(18) 5.8	(22) 5.9	(23) 6.5	(13) 4.2	(4) 6.1
1944 - 45	(9) 4.6	(23) 6.9	(33) 4.8	(25) 6.3	(16) 4.4	(5) 4.6
1945 - 46	(7) 5.8	(19) 8.7	(25) 4.8	(25) 6.2	(16) 3.8	(6) 6.0
1946 - 47	(11) 5.4	(24) 7.6	(34) 4.6	(27) 9.0	(18) 3.3	(7) 2.7
1947 - 48	(10) 5.0	(21) 7.3	(31) 5.1	(20) 6.3	(15) 3.7	(4) 1.9
1948 - 49	(7) 5.3	(22) 6.1	(23) 4.9	(18) 6.3	(13) 3.7	(5) 2.1
1949 - 50	(7) 6.8	(21) 6.2	(21) 4.7	(20) 6.3	(15) 3.8	(5) 3.8

* Figures in brackets refer to the number of farms where crops were grown.

APPENDIX lxxxviii

AVERAGE AREA CUT FOR HAY (ACRES.)

No.of Farms	21	39	73	67	38	15
Production per cow (lbs. of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	20 (17)*	16 (36)	18 (68)	15 (67)	13 (37)	16 (14)
1941 - 42	19 (18)	15 (37)	18 (72)	16 (66)	13 (37)	15 (15)
1942 - 43	17 (18)	16 (38)	17 (69)	16 (61)	13 (36)	15 (14)
1943 - 44	21 (18)	17 (39)	19 (71)	17 (63)	15 (38)	14 (15)
1944 - 45	22 (19)	17 (38)	19 (67)	19 (65)	15 (38)	14 (14)
1945 - 46	17 (18)	14 (38)	18 (70)	15 (58)	13 (36)	12 (13)
1946 - 47	23 (16)	19 (37)	20 (71)	17 (62)	15 (36)	14 (15)
1947 - 48	21 (18)	18 (35)	20 (71)	17 (64)	13 (35)	11 (15)
1948 - 49	22 (18)	17 (38)	19 (71)	17 (63)	14 (37)	16 (15)
1949 - 50	21 (17)	17 (38)	19 (67)	18 (64)	13 (35)	16 (15)

* Figures in brackets refer to the number of farms on which hay was made.

APPENDIX lxxxix

AVERAGE AREA CUT FOR SILAGE (ACRES).

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	(8)* 15.0	(19) 11.1	(30) 10.1	(38) 10.6	(21) 11.4	(5) 4.2
1941 - 42	(7) 18.6	(22) 9.4	(39) 8.0	(33) 11.8	(21) 11.3	(8) 6.4
1942 - 43	(8) 12.3	(16) 8.2	(33) 8.2	(29) 10.1	(21) 9.3	(7) 8.9
1943 - 44	(5) 13.8	(13) 11.0	(34) 8.8	(30) 9.7	(21) 9.4	(7) 9.2
1944 - 45	(5) 16.4	(14), 11.1	(33) 10.2	(25) 10.2	(18) 9.6	(9) 8.3
1945 - 46	(5) 12.6	(10) 11.8	(26) 9.7	(21) 11.2	(14) 10.0	(3) 7.0
1946 - 47	(4) 15.5	(8) 10.6	(30) 9.0	(21) 10.4	(18) 8.5	(5) 6.7
1947 - 48	(6) 13.8	(8) 10.3	(28) 7.8	(28) 9.6	(16) 8.1	(6) 8.3
1948 - 49	(5) 12.5	(17) 12.1	(32) 10.3	(32) 10.1	(22) 9.5	(7) 7.9
1949 - 50	(7) 10.7	(20) 15.1	(31) 11.4	(31) 12.3	(23) 11.1	(8) 9.2

* Figures in brackets refer to the number of farms where silage was made.

APPENDIX xc

AVERAGE YIELD OF SILAGE

No.of Farms	21	39	73	67	38	15
Production per cow (lbs.ofB.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	43.5	39.1	36.5	38.6	45.5	17.8
1941 - 42	64.0	34.6	30.4	41.3	46.4	22.3
1942 - 43	36.5	29.0	25.9	32.8	37.2	28.3
1943 - 44	37.2	30.9	30.7	32.3	36.2	24.3
1944 - 45	66.2	34.4	35.9	34.1	40.3	21.3
1945 - 46	33.6	32.6	28.6	33.9	31.8	17.3
1946 - 47	60.0	37.8	32.3	41.8	34.1	26.8
1947 - 48	50.3	39.5	28.4	35.9	37.6	34.0
1948 - 49	48.8	41.8	42.0	39.7	39.2	42.6
1949 - 50	48.0	64.0	53.7	56.3	54.2	60.3

APPENDIX xci

AVERAGE YIELD OF HAY (TONS)

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	45	32	40	32	27	35
1941 - 42	35	30	37	33	27	29
1942 - 43	31	33	35	33	27	30
1943 - 44	42	34	37	33	31	28
1944 - 45	41	36	39	39	28	29
1945 - 46	23	24	31	25	22	23
1946 - 47	44	40	42	36	30	30
1947 - 48	38	37	41	34	27	22
1948 - 49	44	36	42	37	31	36
1949 - 50	39	33	42	37	29	37

APPENDIX xcii

AVERAGE AREA TOPDRESSED WITH ARTIFICIAL FERTILIZERS (ACRES).

No.of Farms	21	39	73	67	38	15
Production per cow (lbs. of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	79 (19)*	92 (36)	92 (68)	93 (64)	75 (35)	78 (14)
1941 - 42	82 (20)	85 (36)	87 (67)	88 (62)	70 (36)	73 (14)
1942 - 43	70 (15)	68 (36)	81 (71)	80 (61)	67 (36)	69 (15)
1943 - 44	50 (17)	64 (35)	79 (72)	69 (62)	65 (36)	62 (13)
1944 - 45	65 (18)	72 (38)	85 (72)	77 (64)	69 (36)	60 (15)
1945 - 46	65 (19)	66 (37)	79 (66)	72 (62)	65 (38)	69 (13)
1946 - 47	77 (18)	78 (37)	88 (67)	77 (59)	72 (35)	72 (13)
1947 - 48	74 (20)	88 (38)	89 (68)	85 (63)	70 (36)	73 (14)
1948 - 49	85 (16)	96 (39)	95 (70)	91 (65)	71 (38)	82 (14)
1949 - 50	84 (19)	96 (39)	94 (73)	96 (66)	74 (38)	82 (14)

* Figures in brackets refer to the number of farms where topdressing was practised.

APPENDIX xciii

AVERAGE AREA LIMED (ACRES)

No. of Farms	21	39	73	67	38	15
Production per cow (lbs. of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	(9)* 54	(23) 84	(39) 83	(40) 83	(27) 65	(9) 55
1941 - 42	(11) 67	(28) 84	(47) 77	(49) 77	(30) 60	(9) 55
1942 - 43	(12) 79	(30) 78	(52) 74	(50) 81	(32) 62	(12) 55
1943 - 44	(13) 59	(23) 77	(60) 75	(54) 69	(31) 66	(9) 50
1944 - 45	(17) 50	(28) 81	(55) 74	(50) 67	(31) 66	(12) 57
1945 - 46	(12) 61	(27) 74	(53) 76	(42) 70	(31) 56	(10) 64
1946 - 47	(12) 59	(24) 61	(47) 68	(39) 64	(25) 61	(10) 52
1947 - 48	(12) 54	(23) 63	(48) 76	(44) 63	(25) 53	(8) 50
1948 - 49	(16) 51	(24) 80	(44) 76	(38) 77	(25) 63	(9) 58
1949 - 50	(14) 56	(23) 85	(36) 74	(24) 73	(23) 63	(7) 51

* Figures in brackets refer to the number of farms where liming was practised.

APPENDIX xciv

FARM MACHINERY

(a) AVERAGE NUMBER OF TRACTORS.

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1940 - 41	(8)* 0.38	(4) 0.10	(12) 0.16	(11) 0.16	(1) 0.03	(4) 0.27
1941 - 42	(8) 0.38	(7) 0.18	(15) 0.22	(9) 0.13	(3) 0.08	(4) 0.27
1942 - 45	Not available					
1945 - 46	(8) 0.43	(9) 0.23	(27) 0.38	(15) 0.22	(10) 0.26	(4) 0.27
1946 - 47	(9) 0.48	(12) 0.31	(29) 0.40	(18) 0.27	(11) 0.29	(3) 0.20
1947 - 48	(10) 0.52	(13) 0.33	(31) 0.44	(20) 0.31	(13) 0.34	(2) 0.13
1948 - 49	(12) 0.57	(17) 0.44	(34) 0.49	(33) 0.51	(20) 0.53	(6) 0.40
1949 - 50	(14) 0.67	(20) 0.54	(40) 0.58	(41) 0.64	(20) 0.53	(6) 0.40

(b) MILKING MACHINES - AVERAGE NUMBER OF BAILS.

1940 - 41	3.4	3.7	3.7	3.7	3.1	3.3
1941 - 42	3.4	3.7	3.7	3.7	3.2	3.3
1942 - 45	Not available					
1945 - 46	3.4	3.9	3.8	3.9	3.2	3.5
1946 - 47	3.5	4.1	3.9	4.0	3.3	3.7
1947 - 48	3.7	4.2	4.2	4.2	3.3	3.9
1948 - 49	3.7	4.5	4.3	4.5	3.6	3.7
1949 - 50	3.9	4.8	4.8	4.7	4.0	3.9

* Figures in brackets refer to the number of farmers who possessed tractors.

APPENDIX xcv

TOTAL FARM LABOUR

(1) MALES.

(a) Men.

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.ofB.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1946 - 47	(21)* 26	(35) 48	(70) 90	(65) 94	(36) 46	(15) 23
1947 - 48	(21) 30	(39) 59	(72) 105	(67) 102	(38) 53	(15) 22
1948 - 49	(20) 27	(38) 54	(73) 108	(66) 106	(38) 56	(15) 21
1949 - 50	(20) 28	(39) 53	(72) 103	(67) 104	(38) 53	(14) 21

(b) Boys.

1946 - 47	(7) 7	(16) 18	(18) 23	(16) 19	(6) 7	(1) 2
1947 - 48	(5) 6	(10) 13	(18) 19	(17) 25	(9) 11	(1) 2
1948 - 49	(5) 6	(14) 16	(17) 19	(14) 17	(6) 7	(3) 4
1949 - 50	(5) 6	(9) 12	(16) 20	(8) 11	(4) 5	(4) 4

(2) FEMALES.

(a) Women.

1946 - 47	(4) 4	(4) 6	(15) 15	(11) 11	(5) 5	
1947 - 48	(6) 6	(9) 11	(16) 20	(12) 12	(7) 7	(1) 1
1948 - 49	(7) 7	(8) 10	(18) 22	(9) 11	(4) 4	(4) 1
1949 - 50		(2) 2	(3) 3	(7) 9		(1) 1

(b) Girls.

1946 - 47	(1) 1	(4) 4	(1) 1	(2) 3	(2) 4	(2) 2
1947 - 48	(2) 3	(1) 1	(2) 3	(2) 2	(1) 1	(2) 3
1948 - 49	(1) 2	(3) 4	(3) 4	(1) 1	(2) 2	(1) 2
1949 - 50		(2) 3	(1) 1			(1) 1

* Figures in brackets refer to the number of farms where the different classes of labour were employed.

APPENDIX xcvi

TOTAL LABOUR UNITS.

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1946 - 47	35.5	71.0	121.0	120.0	57.5	26.0
1947 - 48	40.5	78.0	135.5	134.0	68.0	26.0
1948 - 49	37.5	77.0	140.0	129.0	66.0	26.5
1949 - 50	34.0	67.5	125.0	119.5	58.0	26.0

APPENDIX xcvii

AVERAGE LABOUR UNITS.

No. of Farms	21	39	73	67	38	15
Production per cow (lbs.of B.F.)	219 & below	220-239	240-259	260-279	280-299	300 plus
1946 - 47	1.7	1.8	1.7	1.8	1.5	1.7
1947 - 48	1.9	2.0	1.9	2.0	1.8	1.7
1948 - 49	1.8	2.0	1.9	1.9	1.7	1.8
1949 - 50	1.6	1.7	1.7	1.8	1.5	1.7

DAIRY FARMING TRENDS IN WAIPA COUNTY

FOR THE TEN YEARS 1940 - 41 to 1949 - 50.

GROUPINGS WERE BASED ON WITHIN-FARM DIFFERENCES IN "PRODUCTION PER COW"(LBS. OF BUTTERFAT "AT THE PAIL") BETWEEN THE FIRST THREE AND LAST THREE YEARS OF THE PERIOD.

APPENDIX xcviii

PRODUCTION PER COW (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	8	23	50	68	61	30	13
Production per cow diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	309	315	299	295	283	279	240
1941 - 42	291	286	275	268	260	252	223
1942 - 43	257	270	259	254	242	232	222
1943 - 44	256	264	255	254	252	251	236
1944 - 45	265	272	282	284	284	281	263
1945 - 46	208	216	230	227	233	238	230
1946 - 47	243	248	264	262	267	281	267
1947 - 48	225	233	254	257	267	281	276
1948 - 49	236	260	265	286	293	306	318
1949 - 50	238	248	257	273	287	292	312

APPENDIX xcix

PRODUCTION PER ACRE (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	8	23	50	68	61	30	13
Production per cow difference (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	165	202	190	180	177	169	162
1941 - 42	162	188	176	164	161	160	142
1942 - 43	142	174	168	154	149	147	140
1943 - 44	154	168	164	153	152	158	148
1944 - 45	155	185	184	179	179	179	169
1945 - 46	118	148	147	142	145	146	143
1946 - 47	139	161	170	159	168	171	156
1947 - 48	134	161	166	157	169	177	174
1948 - 49	144	178	174	175	186	196	206
1949 - 50	149	171	173	171	184	195	207

APPENDIX c

CARRYING CAPACITY
(COWS PER 100 ACRES)

No. of Farms	8	23	50	68	61	30	13
Production per cow diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	53	64	64	61	63	61	67
1941 - 42	56	66	64	61	62	63	64
1942 - 43	55	64	65	60	62	63	63
1943 - 44	60	64	65	61	60	63	63
1944 - 45	58	68	65	63	63	63	64
1945 - 46	57	69	64	63	62	61	62
1946 - 47	57	65	64	60	63	61	58
1947 - 48	59	69	66	61	63	63	63
1948 - 49	61	69	66	61	63	64	65
1949 - 50	63	69	68	63	64	67	66

APPENDIX ci

CARRYING CAPACITY
(STOCK UNITS PER ACRE)

No. of Farms	8	23	50	68	61	30	13
Production per cow diff. (lbs. of B.F.) First 3 and last 3 yrs.	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	3.93	4.90	4.82	4.70	4.64	4.63	4.6
1941 - 42	3.99	4.83	4.75	4.57	4.57	4.55	4.4
1942 -43	3.83	4.63	4.71	4.43	4.39	4.42	4.5
1943 - 44	3.89	4.56	4.65	4.47	4.36	4.57	4.3
1944 - 45	3.93	4.88	4.84	4.70	4.66	4.52	4.6
1945 - 46	3.67	4.47	4.42	4.35	4.35	4.31	4.3
1946 - 47	4.18	4.46	4.55	4.31	4.56	4.32	4.1
1947 - 48	3.84	4.73	4.54	4.31	4.59	4.46	4.5
1948 - 49	4.15	4.75	4.66	4.44	4.72	4.67	4.8
1949 - 50	4.04	4.74	4.80	4.54	4.85	4.81	4.9

APPENDIX ciii

AVERAGE PRODUCTION OF BUTTERFAT "AT THE PAIL"

No. of Farms	8	23	50	68	61	30	13
Production per cow diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	16974	15907	16969	16664	18424	19428	14854
1941 - 42	16673	14799	15712	15275	16904	18375	13126
1942 - 43	14568	13695	15062	14396	15723	16966	12987
1943 - 44	15806	13251	14736	14505	16021	18197	13811
1944 - 45	15957	14669	16510	16935	18951	20801	15693
1945 - 46	12179	11752	13225	13439	15262	17056	13314
1946 - 47	13774	12814	15407	15205	17804	20020	14508
1947 - 48	12867	12932	15114	15281	17919	20626	16075
1948 - 49	13887	14315	15996	17009	19860	23074	19003
1949 - 50	14335	13796	15927	16630	19685	22999	19112

APPENDIX ciii

AVERAGE CULTIVATED AREA (ACRES)

No. of Farms	8	23	50	68	61	30	13
Production per cow diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	103	79	90	93	104	115	92
1941 - 42	103	79	89	93	105	115	92
1942 - 43	103	79	90	94	106	115	93
1943 - 44	103	79	90	94	106	115	93
1944 - 45	103	79	90	95	106	116	93
1945 - 46	103	79	90	95	106	117	93
1946 - 47	99	80	91	96	106	117	93
1947 - 48	96	80	91	97	106	117	93
1948 - 49	96	80	92	97	107	118	92
1949 - 50	96	81	92	97	107	118	92

APPENDIX civ

AVERAGE NUMBER OF COWS IN MILK.

No. of Farms	8	23	50	68	61	30	13
Production per cow diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	55	50	57	57	65	70	62
1941 - 42	57	52	57	57	65	73	59
1942 - 43	57	51	58	57	65	73	58
1943 - 44	62	50	58	57	64	72	58
1944 - 45	60	54	59	60	67	74	60
1945 - 46	59	55	58	59	66	72	58
1946 - 47	57	52	58	58	67	71	54
1947 - 48	57	56	60	60	67	73	58
1948 - 49	59	55	60	59	68	75	60
1949 - 50	60	56	60	61	69	79	61

APPENDIX cv

AVERAGE STOCK UNITS PER FARM.

No. of Farms	8	23	50	68	61	30	13
Production per cow diff. (lbs. of B.F.) (First 3 and last 3 yrs.)	-50 plus	-30 to -49	-10 to -29	+9 to -9	+10 to +29	+30 to +49	+50 plus
1940 - 41	405	386	432	435	483	531	422
1941 - 42	411	380	425	425	479	523	411
1942 - 43	395	364	422	415	463	510	419
1943 - 44	400	360	417	421	461	527	406
1944 - 45	404	386	434	445	492	526	433
1945 - 46	377	355	398	412	459	503	403
1946 - 47	414	356	413	414	482	506	386
1947 - 48	369	380	413	420	486	520	423
1948 - 49	399	381	428	433	504	550	444
1949 - 50	388	382	441	441	519	566	452

DAIRY FARMING TRENDS IN WAIPA COUNTY

FOR THE TEN YEARS 1940 - 41 to 1949 - 50.

GROUPINGS ARE BASED ON BETWEEN-FARM DIFFERENCES
"IN CULTIVATED AREA." (SIZE OF FARM)

APPENDIX cvi

AVERAGE NUMBER OF STOCK UNITS.

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1940 - 41	225	297	413	567	795
1941 - 42	221	296	407	555	781
1942 - 43	221	287	394	549	758
1943 - 44	217	279	396	551	776
1944 - 45	227	302	420	578	791
1945 - 46	203	278	392	531	757
1946 - 47	212	287	398	541	777
1947 - 48	222	293	409	547	772
1948 - 49	226	306	424	560	818
1949 - 50	234	308	427	582	840

APPENDIX cvii

PRODUCTION PER ACRE (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1940 - 41	221	196	180	174	167
1941 - 42	201	183	165	158	157
1942 - 43	195	172	155	149	142
1943 - 44	196	169	157	153	143
1944 - 45	223	198	181	172	166
1945 - 46	172	156	145	138	137
1946 - 47	196	183	162	156	159
1947 - 48	201	186	167	157	153
1948 - 49	214	202	184	172	173
1949 - 50	214	193	181	173	170

APPENDIX cviii

CARRYING CAPACITY (COWS PER 100 ACRES)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	70	66	63	61	58
1941 - 42	70	67	64	61	59
1942 - 43	72	67	64	60	59
1943 - 44	70	64	64	61	58
1944 - 45	71	69	66	62	60
1945 - 46	70	68	64	61	60
1946 - 47	67	67	64	60	59
1947 - 48	70	69	66	62	59
1948 - 49	71	70	66	61	60
1949 - 50	74	70	66	63	62

APPENDIX cix

CARRYING CAPACITY (STOCK UNITS PER ACRE)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	5.2	4.9	4.7	4.7	4.5
1941 - 42	5.1	4.9	4.6	4.5	4.4
1942 - 43	5.1	4.7	4.4	4.4	4.2
1943 - 44	5.0	4.6	4.4	4.5	4.3
1944 - 45	5.2	5.0	4.7	4.7	4.4
1945 - 46	4.7	4.6	4.4	4.3	4.2
1946 - 47	4.8	4.7	4.4	4.4	4.2
1947 - 48	5.0	4.8	4.6	4.4	4.1
1948 - 49	5.1	5.0	4.7	4.5	4.3
1949 - 50	5.2	5.0	4.8	4.7	4.5

APPENDIX cx

AVERAGE BUTTERFAT PRODUCTION "AT THE PAIL"

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1940 - 41	9484	11900	16007	21211	29533
1941 - 42	8632	11084	14731	19342	27968
1942 - 43	8412	10442	13792	18337	25511
1943 - 44	8491	10240	14024	18927	25790
1944 - 45	9717	12028	16213	21196	29967
1945 - 46	7493	9506	12961	17004	24928
1946 - 47	8644	11234	14510	19333	29252
1947 - 48	8889	11425	14931	19410	28587
1948 - 49	9529	12421	16439	21361	32493
1949 - 50	9568	11915	16150	21523	32003

APPENDIX cxi

PRODUCTION PER COW (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1940 - 41	314	298	285	286	285
1941 - 42	287	273	259	260	266
1942 - 43	272	257	244	248	242
1943 - 44	278	264	247	252	248
1944 - 45	313	287	275	279	275
1945 - 46	247	227	226	227	230
1946 - 47	291	272	254	260	272
1947 - 48	285	270	255	256	260
1948 - 49	303	290	277	282	289
1949 - 50	291	277	272	275	274

APPENDIX cxii

AVERAGE NUMBER OF COWS IN MILK.

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1940 - 41	30	40	56	74	104
1941 - 42	30	41	57	74	105
1942 - 43	31	41	57	74	105
1943 - 44	31	39	57	75	104
1944 - 45	31	42	59	76	109
1945 - 46	30	42	57	75	108
1946 - 47	30	41	57	74	108
1947 - 48	31	42	59	76	110
1948 - 49	31	43	59	76	112
1949 - 50	33	43	59	78	117

APPENDIX cxiii

AVERAGE NUMBER OF STOCK UNITS.

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1940 - 41	225	297	413	567	795
1941 - 42	221	296	407	555	781
1942 - 43	221	287	394	549	758
1943 - 44	217	279	396	551	776
1944 - 45	227	302	420	578	791
1945 - 46	203	278	392	531	757
1946 - 47	212	287	398	541	777
1947 - 48	222	293	409	547	772
1948 - 49	226	306	424	560	818
1949 - 50	234	308	427	582	840

APPENDIX cxiv

AVERAGE NUMBER OF DAIRY HEIFERS (1 - 2 YRS)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	(25)* 5	(35) 6	(55) 10	(53) 15	(27) 22
1941 - 42	(27) 5	(35) 7	(50) 10	(54) 16	(29) 19
1942 - 43	(21) 6	(26) 8	(47) 9	(47) 13	(24) 14
1943 - 44	(26) 5	(35) 9	(53) 10	(49) 14	(31) 20
1944 - 45	(24) 5	(30) 9	(54) 10	(54) 15	(28) 19
1945 - 46	(24) 5	(20) 7	(59) 10	(54) 17	(25) 22
1946 - 47	(25) 5	(30) 7	(59) 10	(55) 16	(28) 20
1947 - 48	(27) 6	(31) 6	(62) 10	(54) 16	(28) 19
1948 - 49	(26) 5	(36) 7	(59) 10	(59) 14	(30) 19
1949 - 50	(27) 5	(37) 8	(62) 11	(61) 15	(30) 21

* Figures in brackets refer to the number of farms where dairy heifers formed a part of the total farm livestock.

APPENDIX cxv

AVERAGE CULTIVATED AREA (ACRES)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	43.0	60.8	88.8	121.6	177.2
1941 - 42	43.0	60.6	89.0	122.2	177.8
1942 - 43	43.0	60.7	89.1	123.3	179.2
1943 - 44	43.4	60.7	89.1	123.5	180.0
1944 - 45	43.6	60.8	89.4	123.5	180.9
1945 - 46	43.5	61.0	89.5	123.7	181.5
1946 - 47	44.0	61.6	89.5	123.7	183.5
1947 - 48	44.3	61.5	89.3	123.3	187.3
1948 - 49	44.5	61.4	89.6	124.3	188.2
1949 - 50	44.6	61.6	89.4	124.4	188.3

APPENDIX cxvi

AVERAGE AREA CROPPED - ACRES (SAMPLE AVERAGE)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	0.4	1.1	1.5	2.8	2.8
1941 - 42	0.2	0.7	1.1	1.9	2.1
1942 - 43	0.3	1.5	0.9	2.6	3.2
1943 - 44	0.9	1.2	1.8	2.6	3.7
1944 - 45	0.9	1.9	2.4	3.2	3.5
1945 - 46	1.0	1.6	2.2	2.8	3.9
1946 - 47	0.7	2.0	2.4	3.6	6.0
1947 - 48	0.6	1.5	1.9	2.8	4.5
1948 - 49	0.5	1.2	1.0	3.1	3.6
1949 - 50	0.9	0.9	1.4	2.7	3.9

APPENDIX cxvii

AVERAGE AREA CUT FOR HAY (ACRES)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50–74	75–99	100–149	150 plus
1940 – 41	(36)* 8	(42) 11	(68) 15	(60) 19	(33) 30
1941 – 42	(36) 8	(45) 11	(69) 15	(62) 18	(33) 29
1942 – 43	(36) 8	(41) 10	(70) 16	(57) 19	(32) 29
1943 – 44	(36) 8	(44) 13	(70) 17	(61) 20	(33) 31
1944 – 45	(36) 8	(42) 12	(69) 18	(63) 20	(31) 34
1945 – 46	(33) 7	(40) 10	(69) 15	(59) 19	(32) 24
1946 – 47	(36) 8	(41) 12	(69) 18	(60) 22	(31) 31
1947 – 48	(36) 8	(41) 11	(72) 17	(57) 21	(32) 28
1948 – 49	(36) 8	(43) 12	(72) 17	(61) 22	(30) 28
1949 – 50	(35) 8	(41) 11	(69) 16	(59) 20	(32) 35

* Figures in brackets refer to the number of farms on which hay was made.

MASSEY AGRICULTURAL COLLEGE
LIBRARY PALMERSTON NORTH, N.Z.

APPENDIX cxviii

AVERAGE AREA CUT FOR SILAGE (ACRES)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50–74	75–99	100–149	150 plus
1940 – 41	(10)* 5.8	(20) 8.2	(35) 9.1	(36) 11.1	(20) 18.0
1941 – 42	(13) 5.7	(17) 8.1	(35) 10.1	(40) 9.5	(25) 15.4
1942 – 43	(10) 5.7	(18) 7.8	(30) 7.0	(36) 9.8	(20) 14.6
1943 – 44	(10) 5.4	(13) 7.9	(35) 7.5	(34) 10.6	(18) 15.6
1944 – 45	(9) 6.1	(16) 7.3	(31) 7.9	(32) 12.7	(16) 15.8
1945 – 46	(5) 3.7	(9) 8.1	(20) 8.4	(28) 11.9	(17) 13.9
1946 – 47	(9) 4.1	(8) 6.7	(28) 7.7	(29) 12.0	(12) 14.1
1947 – 48	(9) 3.9	(13) 6.0	(24) 7.0	(30) 10.5	(16) 14.5
1948 – 49	(13) 4.2	(17) 6.1	(34) 7.0	(36) 13.7	(16) 19.0
1949 – 50	(10) 5.5	(21) 7.9	(36) 9.2	(40) 15.5	(17) 18.5

* Figures in brackets refer to the number of farms where silage was made.

APPENDIX cxix

AVERAGE YIELD OF SILAGE (TONS)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	21.6	33.5	31.8	42.4	58.7
1941 - 42	21.2	31.5	34.8	36.4	57.2
1942 - 43	20.8	30.3	24.0	30.8	47.9
1943 - 44	16.8	29.1	25.0	35.3	50.6
1944 - 45	20.1	27.3	28.0	42.5	57.7
1945 - 46	11.8	23.8	20.8	39.1	39.1
1946 - 47	11.6	19.5	27.0	47.9	60.8
1947 - 48	15.6	23.2	22.4	43.1	59.4
1948 - 49	15.9	23.9	28.4	51.8	82.8
1949 - 50	25.4	38.7	46.8	70.4	82.3

APPENDIX cxx

AVERAGE YIELD OF HAY (TONS)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	17	22	33	39	65
1941 - 42	16	21	32	38	60
1942 - 43	15	20	33	38	55
1943 - 44	16	24	33	40	62
1944 - 45	15	24	37	41	67
1945 - 46	11	17	24	32	45
1946 - 47	17	25	37	47	63
1947 - 48	17	23	37	41	56
1948 - 49	18	27	37	48	61
1949 - 50	18	24	33	44	67

APPENDIX cxxi

AVERAGE AREA TOPDRESSED (ACRES)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41	(37)* 41	(42) 50	(66) 79	(62) 108	(29) 170
1941 - 42	(35) 38	(43) 49	(67) 77	(58) 104	(32) 156
1942 - 43	(35) 36	(41) 47	(67) 67	(59) 90	(32) 144
1943 - 44	(33) 36	(42) 42	(69) 59	(59) 87	(32) 128
1944 - 45	(35) 34	(44) 47	(72) 69	(61) 94	(31) 141
1945 - 46	(35) 36	(43) 47	(68) 64	(58) 88	(31) 131
1946 - 47	(35) 38	(42) 49	(64) 71	(56) 100	(32) 146
1947 - 48	(34) 39	(47) 50	(68) 78	(59) 105	(31) 149
1948 - 49	(36) 40	(43) 54	(69) 81	(62) 111	(32) 166
1949 - 50	(38) 42	(46) 54	(70) 83	(63) 113	(32) 173

* Figures in brackets refer to the number of farms where topdressing was practised.

APPENDIX cxxii

AVERAGE AREA LIMED (ACRES)

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1940 - 41	(22)* 39	(22) 52	(41) 65	(40) 87	(22) 139
1941 - 42	(27) 40	(27) 43	(52) 67	(46) 89	(22) 136
1942 - 43	(28) 37	(32) 47	(53) 59	(46) 96	(29) 131
1943 - 44	(29) 36	(34) 42	(52) 65	(48) 89	(27) 118
1944 - 45	(24) 37	(35) 46	(59) 61	(51) 90	(24) 120
1945 - 46	(25) 34	(46) 28	(47) 59	(30) 136	(27) 114
1946 - 47	(22) 38	(27) 43	(42) 55	(44) 80	(22) 95
1947 - 48	(22) 38	(28) 40	(46) 57	(44) 82	(20) 101
1948 - 49	(23) 41	(28) 44	(45) 68	(40) 86	(20) 121
1949 - 50	(16) 38	(18) 48	(44) 67	(32) 87	(17) 106

* Figures in brackets refer to the number of farms where liming was practised.

APPENDIX cxxiii FARM MACHINERY

(a) AVERAGE NUMBER OF TRACTORS.

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50-74	75-99	100-149	150 plus
1940 - 41		(9) 0.19	(12) 0.17	(8) 0.13	(11) 0.33
1941 - 42	(2) 0.05	(10) 0.21	(12) 0.18	(10) 0.16	(12) 0.36
1942 - 45	Not available				
1945 - 46	(3) 0.08	(11) 0.23	(22) 0.32	(23) 0.39	(14) 0.42
1946 - 47	(3) 0.08	(14) 0.30	(26) 0.38	(23), 0.37	(16) 0.48
1947 - 48	(5) 0.13	(17) 0.36	(26) 0.38	(29) 0.49	(12) 0.36
1948 - 49	(7) 0.18	(23) 0.49	(32) 0.46	(41) 0.68	(19) 0.58
1949 - 50	(10) 0.26	(24) 0.53	(40) 0.56	(46) 0.76	(21) 0.70

(b) MILKING MACHINES - NUMBER OF BAILS.

1940 - 41	2.0	2.8	3.5	4.2	5.3
1941 - 42	2.1	2.8	3.5	4.3	5.3
1942 - 45	Not available				
1945 - 46	2.2	3.0	3.7	4.3	5.3
1946 - 47	2.3	3.1	3.7	4.5	5.6
1947 - 48	2.4	3.2	3.8	4.7	6.1
1948 - 49	2.5	3.3	3.9	5.1	6.3
1949 - 50	2.8	3.6	4.2	5.5	6.8

* Figures in brackets refer to the number of farmers who possessed tractors.

APPENDIX cxxiv

FARM LABOUR.

(1) MALES.

(a) Men.

No. of Farms	38	47	72	63	33
Size of Farms (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1946 - 47	(37)* 38	(47) 56	(66) 82	(61) 89	(31) 62
1947 - 48	(38) 41	(46) 55	(72) 96	(63) 108	(33) 71
1948 - 49	(38) 42	(46) 57	(71) 96	(63), 106	(32) 71
1949 - 50	(37) 38	(46) 55	(71) 98	(63) 100	(33) 71

(b) Boys.

1946 - 47	(2) 2	(3) 3	(25) 28	(20) 24	(14) 19
1947 - 48	(2) 2	(5) 7	(16) 18	(20) 22	(17) 27
1948 - 49		(8) 8	(22) 24	(16) 18	(13) 19
1949 - 50		(4) 5	(17) 19	(12) 13	(13) 21

(2) FEMALES.

(a) Women.

1946 - 47	(3) 3	(2) 2	(13) 13	(13) 13	(9) 10
1947 - 48	(4) 4	(8) 8	(17), 18	(12) 14	(10) 13
1948 - 49	(4) 4	(3) 3	(17) 18	(13) 15	(10) 15
1949 - 50	(1) 1	(1) 1	(6) 7	(4) 5	(1) 1

(b) Girls.

1946 - 47		(3) 4	(1) 1	(4) 5	(4) 5
1947 - 48		(3) 4	(2) 2	(3) 4	(2) 3
1948 - 49	(1) 1	(1) 2	(5) 7	(2) 3	(2) 2
1949 - 50		(2) 2		(2) 3	

* Figures in brackets refer to the number of farms where the different classes of labour were employed.

APPENDIX cxxv

(3) TOTAL LABOUR UNITS.

No. of Farms	38	47	72	63	33
Size of Farm (acres)	below 49	50- 74	75- 99	100- 149	150 plus
1946 - 47	41.5	62.0	117.0	122.0	88.5
1947 - 48	45.0	68.0	124.0	139.0	106.0
1948 - 49	44.5	67.5	132.5	133.0	98.5
1949 - 50	38.5	61.5	120.5	117.0	92.5

APPENDIX cxxvi

(4) AVERAGE LABOUR UNITS.

1946 - 47	1.1	1.3	1.6	1.9	2.7
1947 - 48	1.2	1.4	1.7	2.2	3.2
1948 - 49	1.2	1.4	1.8	2.1	3.0
1949 - 50	1.0	1.3	1.7	1.9	2.8

APPENDIX cxxvii

(5) PRODUCTION PER LABOUR UNIT (LBS. OF BUTTERFAT)

1946 - 47	7915	8516	8929	9983	10907
1947 - 48	7506	7897	8670	8797	8900
1948 - 49	8137	8648	8933	10118	10886
1949 - 50	9444	9105	9650	11589	11417

DAIRY FARMING TRENDS IN WAIPA COUNTY FOR THE TEN YEARS 1940 - 41 to 1949 -50.

GROUPINGS ARE BASED ON BETWEEN-FARM DIFFERENCES IN THE "PERCENTAGE OF GRASSLAND TOPDRESSED WITH ARTIFICIAL FERTILIZERS."

APPENDIX cxxviii

PRODUCTION PER COW (LBS. OF BUTTERFAT "AT THE PAIL")

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	236	286	285	281	285	289	299	299
1941 - 42	185	256	251	262	259	264	276	290
1942 - 43	163	228	229	240	245	250	260	261
1943 - 44	186	240	232	250	249	251	266	274
1944 - 45	215	241	272	278	276	281	293	286
1945 - 46	161	194	226	231	219	232	241	230
1946 - 47	229	243	248	263	260	266	277	266
1947 - 48	212	223	248	252	255	260	275	275
1948 - 49	232	268	271	282	281	278	301	281
1949 - 50	214	250	272	276	274	272	284	272

APPENDIX cxxix

PRODUCTION PER ACRE (LBS. OF BUTTERFAT "AT THE PAIL")

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	113	159	161	168	181	176	195	208
1941 - 42	94	149	145	153	164	164	182	196
1942 - 43	85	132	128	143	154	154	172	178
1943 - 44	91	125	130	141	154	156	179	174
1944 - 45	115	146	155	168	174	179	200	191
1945 - 46	80	118	135	137	138	143	160	152
1946 - 47	108	145	142	154	162	163	182	177
1947 - 48	102	129	141	154	163	162	186	190
1948 - 49	122	159	151	172	181	174	204	197
1949 - 50	120	154	155	168	180	176	198	193

APPENDIX cxxx

CARRYING CAPACITY (STOCK UNITS PER ACRE)

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	3.33	4.00	4.18	4.57	4.75	4.66	4.89	5.3
1941 - 42	3.35	4.12	4.18	4.45	4.57	4.59	4.85	5.1
1942 - 43	3.59	3.89	3.94	4.18	4.49	4.48	4.77	5.1
1943 - 44	3.33	4.06	3.92	4.16	4.51	4.50	4.78	4.7
1944 - 45	3.46	4.08	4.24	4.49	4.63	4.67	5.02	4.8
1945 - 46	3.06	3.89	4.06	4.10	4.39	4.26	4.65	4.7
1946 - 47	3.27	4.43	4.03	4.20	4.44	4.37	4.69	4.6
1947 - 48	3.40	3.74	3.94	4.32	4.45	4.44	4.83	4.9
1948 - 49	3.60	3.98	4.10	4.42	4.60	4.57	5.01	4.9
1949 - 50	3.85	4.09	4.23	4.48	4.74	4.68	5.08	5.0

APPENDIX cxxxi

CARRYING CAPACITY (COWS PER 100 ACRES)

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	48	56	56	60	64	61	65	70
1941 - 42	51	58	58	58	63	62	66	67
1942 - 43	52	58	56	58	63	61	66	68
1943 - 44	49	52	56	56	62	62	67	64
1944 - 45	53	61	57	60	63	64	68	67
1945 - 46	50	61	60	59	63	62	67	66
1946 - 47	47	60	57	59	62	61	66	67
1947 - 48	48	58	57	61	64	62	67	69
1948 - 49	52	59	56	61	64	63	68	70
1949 - 50	56	62	57	61	66	65	70	71

APPENDIX cxxxii

AVERAGE FARM PRODUCTION ("BUTTERFAT AT THE PAIL")

No. of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	8794	15973	13904	16278	17850	17376	19365	13887
1941 - 42	7093	14767	12846	14926	16221	16208	18110	13064
1942 - 43	6160	13700	11520	14002	15233	15315	17115	11898
1943 - 44	6560	13021	11749	13868	15347	15542	17753	11682
1944 - 45	8287	15211	13971	16613	17460	17883	19968	12813
1945 - 46	5994	12225	12178	13610	13843	14290	15963	10222
1946 - 47	8172	15439	12896	15231	16258	16473	18186	11887
1947 - 48	7691	13689	12814	15341	16422	16548	18534	12704
1948 - 49	9162	16861	13659	17208	18412	17914	20441	13226
1949 - 50	8996	16525	14138	16795	18250	18084	19852	12944

APPENDIX cxxxiii

AVERAGE NUMBER OF STOCK UNITS.

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	258	401	361	442	469	460	486	357
1941 - 42	252	409	370	433	452	455	481	344
1942 - 43	259	404	354	409	444	446	474	347
1943 - 44	241	423	355	410	448	449	475	317
1944 - 45	250	425	383	444	464	466	500	326
1945 - 46	231	404	367	408	441	425	462	316
1946 - 47	249	471	365	416	447	441	468	314
1947 - 48	256	398	357	430	449	454	481	330
1948 - 49	271	423	371	443	467	469	501	331
1949 - 50	289	439	385	449	480	482	508	337

APPENDIX cxxxiv

AVERAGE NUMBER OF COWS IN MILK.

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	37	56	49	58	63	60	65	46
1941 - 42	38	58	51	57	63	61	66	45
1942 - 43	38	60	50	57	62	61	66	46
1943 - 44	35	54	51	55	62	62	67	43
1944 - 45	39	63	51	60	63	64	68	45
1945 - 46	37	63	54	59	63	62	66	45
1946 - 47	36	63	52	58	63	62	66	45
1947 - 48	36	61	52	61	65	64	67	46
1948 - 49	40	63	50	61	65	64	68	47
1949 - 50	42	66	52	61	67	66	70	48

APPENDIX cxxxv

AVERAGE NUMBER OF DAIRY HEIFERS (1 - 2 yrs)

No. of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	(2)* 5	(5) 8	(15) 9	(25) 11	(43) 10	(47) 14	(52) 11	(6) 10
1941 - 42	(1) 5	(4) 9	(16) 10	(26) 10	(44) 11	(45) 13	(52) 13	(7) 11
1942 - 43	(2) 5	(6) 8	(13) 11	(17) 8	(36) 11	(41) 9	(43) 12	(7) 10
1943 - 44	(3) 6	(6) 12	(16) 10	(24) 12	(46) 13	(45) 11	(47) 12	(7) 10
1944 - 45	(2) 9	(4) 11	(14) 15	(26) 13	(47) 12	(43) 11	(48) 13	(6) 11
1945 - 46	(2) 3	(4) 8	(11) 13	(25) 11	(43) 16	(43) 12	(47) 13	(7) 11
1946 - 47	(3) 9	(3) 29	(13) 10	(28) 11	(48) 12	(46) 13	(51) 12	(5) 9
1947 - 48	(4) 9	(3) 6	(16) 8	(30) 12	(48) 11	(46) 14	(50) 13	(5) 11
1948 - 49	(3) 10	(2) 11	(16) 10	(30) 12	(47) 11	(51) 11	(56) 12	(5) 9
1949 - 50	(4) 6	(2) 16	(15) 13	(29) 14	(50) 11	(54) 12	(56) 13	(7) 8

* Figures in brackets refer to the number of farms where dairy heifers formed a part of the total farm livestock.

APPENDIX cxxxvi

AVERAGE CULTIVATED AREA.

No. of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	78	100	86	97	99	99	99	67
1941 - 42	75	99	88	97	99	99	99	67
1942 - 43	72	104	90	98	99	100	99	67
1943 - 44	72	104	90	102	99	100	99	67
1944 - 45	72	104	90	102	100	100	100	67
1945 - 46	75	104	90	102	100	100	99	67
1946 - 47	76	106	91	99	101	101	100	67
1947 - 48	75	106	91	102	101	102	100	67
1948 - 49	75	106	91	103	102	103	100	67
1949 - 50	75	107	91	103	101	103	100	67

APPENDIX cxxxvii

AVERAGE AREA SOWN IN CROPS

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	(2)* 6.5	(3) 2.6	(8) 4.3	(12) 4.4	(19) 4.6	(24) 4.2	(30) 4.9	(1 2.0
1941 - 42	(1) 2.0	(3) 3.5	(5) 4.6	(13) 3.6	(14) 5.0	(17) 4.0	(23) 4.3	
1942 - 43		(3) 4.2	(4) 6.9	(11) 7.3	(18) 6.0	(19) 4.1	(23) 4.6	
1943 - 44		(4) 3.4	(8) 4.4	(13) 4.6	(16) 8.3	(17) 5.4	(28) 5.9	(1 2.5
1944 - 45		(3) 4.3	(10) 5.5	(16) 4.6	(23) 5.1	(25) 4.9	(32) 6.9	(2 3.5
1945 - 46		(2) 4.5	(9) 7.5	(14) 5.5	(22) 6.1	(21) 5.1	(28) 6.3	(2 2.3
1946 - 47	(1) 12.0	(1) 3.5	(7) 5.5	(18) 8.2	(28) 5.6	(29) 6.3	(32) 5.4	(5 1.5
1947 - 48	(1) 4.0	(3) 6.0	(6) 8.4	(11) 4.0	(20) 4.6	(29) 5.1	(27) 6.6	(4 3.8
1948 - 49	(1) 4.0	(2) 3.5	(6) 8.3	(14) 6.0	(17) 4.9	(25) 4.6	(19) 5.4	(4 2.8
1949 - 50		(1) 4.0	(8) 7.4	(14) 6.5	(22) 5.7	(23) 4.6	(18) 4.8	(3 2.7

* Figures in brackets refer to the number of farms where crops were grown.

APPENDIX cxxxviii

AVERAGE AREA CUT FOR HAY.

No.of Farms	4	7	18	34	58	58	66	8
% area Topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	(1)* 5	(7) 20	(17) 14	(32) 16	(55) 16	(56) 17	(64) 17	(7) 9
1941 - 42	(3) 7	(7) 16	(16) 14	(31) 15	(56) 18	(58) 16	(66) 16	(8) 14
1942 - 43	(3) 10	(7) 16	(17) 13	(31) 16	(53) 16	(53) 17	(64) 17	(8) 11
1943 - 44	(2) 6	(7) 18	(17) 13	(33) 20	(57) 18	(57) 17	(63) 18	(8) 12
1944 - 45	(3) 7	(6) 22	(16) 17	(33) 18	(56) 19	(55) 18	(64) 19	(8) 3
1945 - 46	(2) 12	(4) 16	(15) 13	(31) 16	(52) 16	(56) 14	(65) 17	(8) 11
1946 - 47	(2) 19	(5) 16	(16) 15	(32) 19	(53) 19	(58) 19	(64) 18	(7) 14
1947 - 48	(2) 21	(5) 21	(17) 16	(31) 17	(52) 16	(57) 18	(66) 18	(8) 14
1948 - 49	(3) 12	(6) 17	(16) 17	(33) 18	(57) 18	(55) 18	(64) 18	(8) 14
1949 - 50	(2) 17	(5) 21	(17) 16	(31) 20	(55) 17	(55) 16	(63) 18	(8) 13

* Figures in brackets refer to the number of farms on which hay was made.

APPENDIX cxxxix

AVERAGE AREA CUT FOR SILAGE.

No. of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41		(2) 13	(4) 10	(17) 12	(28) 10	(31) 10	(33) 12	(6) 9
1941 - 42	(1)* 8	(3) 10	(6) 11	(16) 12	(24) 10	(37) 9	(39) 11	(4) 7
1942 - 43		(4) 9	(5) 7	(16) 10	(24) 8	(29) 8	(32) 11	(4) 9
1943 - 44		(3) 13	(4) 8	(14) 10	(24) 9	(30) 9	(31) 11	(4) 10
1944 - 45	(1) 15	(3) 15	(4) 10	(14) 12	(22) 8	(28) 10	(27) 11	(5) 10
1945 - 46		(2) 18	(3) 13	(11) 10	(15) 10	(23) 9	(23) 11	(2) 13
1946 - 47		(2) 8	(2) 13	(9) 8	(17) 9	(25) 9	(27) 11	(4) 8
1947 - 48		(3) 11	(2) 12	(8) 10	(18) 9	(28) 8	(30) 9	(3) 8
1948 - 49	(1) 7	(2) 9	(3) 11	(14) 14	(25) 10	(30) 10	(38) 10	(3) 9
1949 - 50	(1) 5	(3) 10	(5) 10	(15) 13	(28) 11	(35) 12	(34) 13	(3) 11

* Figures in brackets refer to the number of farms where silage was made.

APPENDIX cxl

AVERAGE YIELD OF HAY.

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	12	40	30	34	35	36	37	18
1941 - 42	14	26	31	29	37	33	34	26
1942 - 43	21	28	27	28	34	34	35	21
1943 - 44	11	31	26	40	37	33	36	23
1944 - 45	13	41	31	36	38	37	38	26
1945 - 46	18	16	23	24	28	25	29	19
1946 - 47	36	27	34	37	39	39	39	31
1947 - 48	43	39	34	32	34	35	37	28
1948 - 49	22	38	39	36	38	37	40	30
1949 - 50	31	40	31	35	36	35	42	29

APPENDIX cxli

AVERAGE YIELD OF SILAGE.

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41		45	41	43	37	37	39	40
1941 - 42	30	43	35	42	35	33	44	28
1942 - 43		30	17	39	27	24	38	34
1943 - 44		37	20	32	30	30	36	35
1944 - 45	60	41	26	46	31	34	38	39
1945 - 46		27	45	31	26	28	34	50
1946 - 47		19	50	29	32	35	44	33
1947 - 48		44	28	47	36	30	35	40
1948 - 49	14	28	63	43	40	45	38	45
1949 - 50	45	37	73	45	62	49	63	61

APPENDIX cxlii

AVERAGE AREA TOPDRESSED.

No. of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	(2)* 26	(5) 88	(17) 63	(30) 89	(52) 87	(56) 92	(66) 95	(8) 66
1941 - 42	(2) 35	(7) 71	(15) 59	(32) 81	(49) 80	(57) 87	(65) 94	(8) 67
1942 - 43	(2) 42	(5) 39	(12) 39	(31) 59	(54) 71	(56) 83	(66) 91	(8) 67
1943 - 44	(1) 29	(7) 44	(16) 37	(30) 46	(50) 66	(57) 73	(66) 89	(8) 66
1944 - 45	(2) 35	(5) 49	(17) 38	(33) 56	(56) 73	(56) 86	(66) 92	(8) 66
1945 - 46	(3) 52	(5) 53	(17) 43	(29) 45	(52) 72	(55) 73	(66) 90	(8) 66
1946 - 47	(2) 45	(6) 54	(15) 56	(28) 63	(50) 79	(55) 84	(65) 94	(8) 66
1947 - 48	(3) 40	(5) 44	(17) 63	(31) 70	(55) 85	(56) 89	(64) 94	(8) 65
1948 - 49	(1) 10	(6) 51	(16) 68	(32) 88	(57) 90	(56) 95	(66) 96	(8) 65
1949 - 50	(3) 52	(6) 77	(18) 78	(33) 89	(58) 93	(57) 94	(66) 96	(8) 66

* Figures in brackets refer to the number of farms where topdressing was practised.

APPENDIX cxliii

AVERAGE AREA LIMED.

No. of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39	40-49	50-59	60-69	70-79	80-89	90-99	100
1940 - 41	(1)* 45	(2) 91	(13) 44	(19) 81	(28) 76	(33) 78	(43) 87	(8) 56
1941 - 42	(1) 40	(6) 92	(9) 56	(24) 70	(37) 74	(38) 76	(51) 78	(8) 55
1942 - 43	(2) 87	(3) 78	(9) 52	(24) 55	(48) 73	(43) 72	(51) 89	(8) 67
1943 - 44	(2) 75	(5) 60	(10) 45	(24) 55	(43) 67	(42) 67	(56) 87	(8) 65
1944 - 45	(3) 63	(4) 41	(10) 46	(26) 52	(46) 69	(44) 73	(53) 87	(7) 56
1945 - 46	(3) 60	(5) 64	(9) 39	(21) 46	(37) 71	(38) 67	(54) 84	(8) 65
1946 - 47	(1) 65	(3) 64	(10) 50	(24) 51	(31) 60	(39) 58	(44) 77	(5) 81
1947 - 48	(3) 56	(3) 18	(12) 46	(19) 46	(37) 64	(37) 52	(43) 90	(6) 68
1948 - 49	(4) 42	(2) 12	(13) 63	(19) 79	(35) 64	(39) 67	(39) 89	(5) 55
1949 - 50	(2) 15	(1) 58	(10) 57	(19) 62	(29) 75	(29) 72	(33) 80	(4) 57

* Figures in brackets refer to the number of farms where liming was practised.

APPENDIX cxliv

FARM MACHINERY

(a) AVERAGE NUMBER OF TRACTORS.

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	10
1940 - 41	(2)* 0.5	(2) 0.3	(2) 0.1	(4) 0.1	(9) 0.2	(10) 0.2	(10) 0.2	(1 0.1
1941 - 42	(2) 0.5	(2) 0.3	(3) 0.2	(4) 0.1	(10) 0.2	(12) 0.2	(11) 0.2	(2 0.3
1942 -45	Not available							
1945 - 46	(2) 0.8	(2) 0.3	(5) 0.3	(6) 0.2	(18) 0.3	(16) 0.3	(20) 0.3	(4 0.5
1946 - 47	(2) 0.8	(2) 0.3	(5) 0.3	(12) 0.4	(20) 0.3	(19) 0.3	(18) 0.3	(4 0.5
1947 - 48	(3) 1.0	(2) 0.3	(8) 0.4	(13) 0.4	(20) 0.4	(18) 0.3	(22) 0.3	(3 0.4
1948 - 49	(3) 0.8	(3) 0.4	(9) 0.5	(16) 0.5	(34) 0.6	(25) 0.4	(28) 0.4	(4 0.5
1949 - 50	(4) 1.0	(3) 0.6	(10) 0.6	(21) 0.6	(33) 0.6	(33) 0.6	(33) 0.5	(4 0.5

FARM MACHINERY

(b) MILKING MACHINES - AVERAGE NUMBER OF BAILS.

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	10(
1940 - 41	2.8	3.7	3.3	3.6	3.5	3.7	3.6	2.9
1941 - 42	3.0	3.7	3.5	3.6	3.5	3.6	3.8	2.(
1942 - 45	Not available							
1945 - 46	2.8	3.9	3.4	3.6	3.7	3.7	3.9	3.(
1946 - 47	2.8	3.9	3.7	3.7	4.0	3.8	4.0	3.(
1947 - 48	2.8	3.9	3.7	4.0	4.1	4.0	4.3	3.(
1948 - 49	2.8	3.6	3.7	4.4	4.2	4.1	4.5	3.(
1949 - 50	3.8	4.3	3.8	4.6	4.6	4.5	4.9	3.4

* Figures in brackets refer to the number of farmers who possessed tractors.

APPENDIX cxlv

TOTAL FARM LABOUR

1. MALE

(a) Men.

No.of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1946 - 47	(4) 5	(7) 9	(18) 23	(32) 42	(56) 81	(55) 74	(63) 85	(7 8
1947 - 48	(4) 5	(7) 9	(18) 24	(34) 54	(57) 87	(58) 79	(66) 102	(8 11
1948 - 49	(4) 5	(7) 9	(16) 22	(34) 55	(58) 87	(57) 82	(66) 103	(8 9
1949 - 50	(3) 4	(7) 10	(18) 23	(34) 50	(57) 83	(57) 80	(66) 103	(8 9

(b) Boys.

1946 - 47		(2) 2	(3) 3	(9) 10	(16) 18	(14) 20	(17) 20	(3) 3
1947 - 48		(4) 7	(4) 6	(8) 11	(13) 14	(12) 15	(18), 22	(1) 1
1948 - 49		(4) 5	(3) 4	(10) 14	(16) 16	(9) 11	(14) 16	(3) 3
1949 - 50		(2) 2	(2) 2	(8) 10	(14) 18	(9) 14	(10) 11	(1) 1

2. FEMALE.

(a) Women.

1946 - 47		(2) 2	(2) 2	(7) 7	(2) 2	(12) 14	(14) 14	
1947 - 48	(1) 1	(1) 1	(2) 2	(7) 7	(12) 14	(12) 15	(15) 16	(1) 1
1948 - 49	(1) 1	(2) 2	(4) 5	(5), 5	(12) 14	(11) 13	(12) 15	
1949 - 50			(1) 2	(1) 1	(3) 4	(6) 6	(2) 2	

APPENDIX cxlv (contd.)

TOTAL FARM LABOUR (CONTD.)

2. FEMALE.

(b) Girls.

No. of Farms	4	7	18	34	58	58	66	8
% area topdressed	-39%	40-49	50-59	60-69	70-79	80-89	90-99	100
1946 - 47		(2) 3	(1) 2	(2) 2	(1) 1	(2) 2	(4) 5	
1947 - 48				(2) 3	(2) 2	(4) 5	(2) 3	
1948 - 49			(1) 2	(2) 2	(1) 2	(3) 3	(4) 6	
1949 - 50				(1) 2	(1) 1	(1) 1	(1) 1	

* Figures in brackets refer to the number of farms where the different classes of labour were employed.

DAIRY FARMING TRENDS IN THE WAIPA COUNTY FOR THE TEN YEARS 1940-1 TO 1949-50.

FARMS GROUPED ACCORDING TO THE DIFFERENCES IN THE "% AREA OF GRASSLAND TOPDRESSED WITH ARTIFICIAL FERTILISERS", BETWEEN THE FIRST THREE YEARS AND THE LAST THREE YEARS OF THE PERIOD.

APPENDIX cxlvi

PRODUCTION PER COW (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	28	19	80	51	32	22	21
Diff. in % area T.D. (first 3 & last 3 years.)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35 plu
1940 - 41	280	299	295	284	286	291	287
1941 - 42	253	286	270	257	263	265	262
1942 - 43	243	259	255	245	242	244	244
1943 - 44	250	269	254	256	241	250	250
1944 - 45	280	300	283	282	268	270	283
1945 - 46	220	242	231	232	226	221	227
1946 - 47	268	285	269	261	260	253	256
1947 - 48	258	282	266	258	254	245	253
1948 - 49	266	305	289	288	289	271	266
1949 - 50	268	289	281	269	278	264	274

APPENDIX cxlvii

PRODUCTION PER ACRE (LBS. OF BUTTERFAT "AT THE PAIL")

No. of Farms	28	19	80	51	32	22	21
Diff.in % area T.D.(first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35% plus
1940 - 41	178	192	182	173	177	185	175
1941 - 42	165	184	168	163	158	165	159
1942 - 43	154	168	157	156	146	149	149
1943 - 44	156	175	155	162	148	149	151
1944 - 45	183	191	181	184	167	170	171
1945 - 46	141	152	141	149	140	141	143
1946 - 47	162	178	165	167	162	156	157
1947 - 48	150	173	170	168	164	153	161
1948 - 49	159	195	185	186	188	170	169
1949 - 50	162	200	182	182	182	172	169

APPENDIX cxlviii

CARRYING CAPACITY (COWS PER 100 ACRES)

No. of Farms	28	19	80	51	32	22	21
Diff.in % area T.D. (first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35% plus
1940 - 41	64	64	62	61	62	64	61
1941 - 42	65	64	62	63	60	62	61
1942 - 43	63	65	62	64	60	61	61
1943 - 44	62	65	61	63	61	60	60
1944 - 45	65	64	64	65	62	63	60
1945 - 46	64	63	61	64	62	64	63
1946 - 47	60	62	61	64	62	62	61
1947 - 48	58	62	64	65	64	63	64
1948 - 49	60	64	64	65	65	63	64
1949 - 50	61	69	65	68	65	65	62

APPENDIX cxlix

CARRYING CAPACITY (STOCK UNITS PER ACRE)

No. of Farms	28	19	80	51	32	22	21
Diff.in % area T.D. (first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35% plus
1940 - 41	4.56	4.76	4.67	4.70	4.57	4.91	4.6
1941 - 42	4.66	4.72	4.59	4.64	4.51	4.58	4.3
1942 - 43	4.38	4.75	4.47	4.63	4.24	4.42	4.2
1943 - 44	4.28	4.59	4.41	4.64	4.56	4.39	4.3
1944 - 45	4.75	4.64	4.67	4.84	4.50	4.73	4.3
1945 - 46	4.35	4.39	4.25	4.47	4.26	4.37	4.4
1946 - 47	4.36	4.44	4.42	4.47	4.39	4.41	4.4
1947 - 48	3.98	4.43	4.58	4.58	4.46	4.52	4.4
1948 - 49	4.14	4.66	4.70	4.69	4.75	4.55	4.5
1949 - 50	4.25	4.99	4.73	4.84	4.75	4.73	4.6

APPENDIX cl.

AVERAGE NUMBER OF COWS IN MILK.

No. of Farms	28	19	80	51	32	22	21
Diff.in % area T.D.(first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35% plus
1940 - 41	55	64	62	61	60	62	49
1941 - 42	57	64	63	64	58	61	49
1942 - 43	56	64	62	64	59	60	50
1943 - 44	55	65	62	64	60	59	49
1944 - 45	58	64	65	66	62	62	50
1945 - 46	57	64	62	65	62	64	51
1946 - 47	55	64	62	65	62	62	50
1947 - 48	56	63	64	66	65	63	52
1948 - 49	57	65	64	66	66	64	52
1949 - 50	59	70	65	69	66	66	50

APPENDIX cli

AVERAGE CULTIVATED AREA

No. of Farms	28	19	80	51	32	22	21
Diff.in % area T.D. (first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35% plus
1940 - 41	87.2	100.3	100.4	100.1	96.3	97.5	80.1
1941 - 42	87.1	99.6	100.6	100.7	96.9	97.5	81.(
1942 - 43	87.8	99.3	100.8	101.2	98.4	98.8	81.(
1943 - 44	88.1	99.2	101.1	101.4	98.6	98.8	81.(
1944 - 45	88.4	100.7	101.2	101.6	99.1	98.8	81.(
1945 - 46	88.4	101.5	101.2	101.8	99.1	99.3	81.(
1946 - 47	90.8	101.9	101.0	101.9	99.6	100.7	81.(
1947 - 48	95.4	101.9	100.5	101.5	100.3	100.6	81.(
1948 - 49	96.0	102.1	100.6	102.2	101.1	101.6	81.(
1949 - 50	96.9	101.6	100.8	101.9	101.4	101.6	80.8

APPENDIX cliii

AVERAGE NUMBER OF STOCK UNITS PER FARM.

No. of Farm	28	19	80	51	32	22	21
Diff.in % area T.D. (first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35% plus
1940 - 41	397	477	469	470	440	479	374
1941 - 42	406	470	462	467	437	446	354
1942 - 43	385	471	450	469	417	436	347
1943 - 44	377	455	446	470	449	434	350
1944 - 45	420	467	473	492	446	467	353
1945 - 46	385	445	430	455	422	434	359
1946 - 47	396	453	446	456	438	444	358
1947 - 48	380	451	460	465	448	454	361
1948 - 49	397	475	473	479	480	462	372
1949 - 50	412	507	477	493	482	480	379

APPENDIX cliii

AVERAGE BUTTERFAT "AT THE PAIL"

No. of Farms	28	19	80	51	32	22	21
Diff.in % area T.D. (first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35% plus
1940 - 41	15,513	19,258	18,250	17,336	17,080	18,063	14,033
1941 - 42	14,387	18,368	16,856	16,424	15,276	16,121	12,843
1942 - 43	13,550	16,697	15,791	15,747	14,371	14,720	12,086
1943 - 44	13,712	17,376	15,720	16,474	14,563	14,686	12,197
1944 - 45	16,196	19,256	18,309	18,706	16,519	16,768	13,837
1945 - 46	12,455	15,400	14,320	15,197	13,894	14,042	11,574
1946 - 47	14,670	18,143	16,635	17,037	16,159	15,725	12,682
1947 - 48	14,312	17,659	17,101	17,098	16,448	15,411	13,058
1948 - 49	15,227	19,934	18,653	19,051	19,018	17,309	13,769
1949 - 50	15,720	20,270	18,331	18,513	18,465	17,466	13,681

APPENDIX cliv

AVERAGE AREA TOPDRESSED WITH ARTIFICIAL FERTILIZERS (ACRES)

No. of Farms	28	19	80	51	32	22	21
Diff.in % area T.D. (first 3 & last 3 years)	-15% plus	-5 to -14%	-4 to +4%	+5 to +14%	+15 to +24%	+25 to +34%	+35 plu
1940 - 41	(28)* 84	(18) 93	(79) 95	(49) 93	(29) 84	(16) 79	(17 58
1941 - 42	(28) 77	(19) 92	(79) 92	(50) 88	(30) 76	(16) 74	(13 44
1942 - 43	(28) 69	(19) 83	(78) 90	(48) 73	(29) 55	(20) 71	(12 44
1943 - 44	(26) 60	(17) 81	(75) 82	(50) 67	(30) 59	(19) 62	(18 48
1944 - 45	(27) 64	(18) 73	(76) 86	(50) 78	(32) 72	(20) 70	(20 58
1945 - 46	(27) 65	(19) 78	(71) 79	(46) 70	(31) 69	(21) 67	(20 57
1946 - 47	(23) 70	(17) 86	(73) 81	(48) 83	(29) 76	(19) 88	(20 68
1947 - 48	(21) 61	(19) 73	(77) 90	(49) 89	(30) 81	(22) 86	(21 70
1948 - 49	(21) 69	(18) 90	(79) 92	(50) 94	(32) 93	(22) 91	(20 74
1949 - 50	(26) 82	(17) 95	(80) 94	(51) 94	(32) 91	(22) 92	(21 74

* Figures in brackets refer to the number of farms where topdressing was practised.

DAIRY FARMING TRENDS IN THE WAIPA COUNTY

FOR THE TEN YEARS 1940 - 41 to 1949 - 50.

FARMS GROUPED ACCORDING TO THE DIFFERENCES IN THE "PERCENTAGE AREA OF GRASSLAND CUT FOR HAY" BETWEEN THE FIRST THREE AND LAST THREE YEARS OF THE PERIOD.

APPENDIX clv

AVERAGE PRODUCTION PER COW (LBS. OF B.F. "AT THE PAIL").

No. of Farms	19	43	92	62	37
Diff.in % area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	300	290	294	285	280
1941 - 42	261	270	267	263	258
1942 - 43	250	254	251	245	240
1943 - 44	251	257	255	254	245
1944 - 45	272	279	283	278	285
1945 - 46	220	235	231	225	228
1946 - 47	263	271	270	257	260
1947 - 48	259	268	260	255	262
1948 - 49	275	288	289	279	285
1949 - 50	268	276	278	271	277

APPENDIX clvi

AVERAGE PRODUCTION PER ACRE (LBS. OF B.F. "AT THE PAIL")

No. of Farms	19	43	92	62	37
Diff.in % area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	177	183	187	175	167
1941 - 42	157	167	170	164	160
1942 - 43	154	153	159	154	148
1942 - 44	162	159	158	156	149
1944 - 45	172	172	185	178	180
1945 - 46	134	145	146	140	147
1946 - 47	155	165	168	159	166
1947 - 48	147	163	169	164	168
1948 - 49	158	179	188	180	184
1949 - 50	156	177	184	178	186

APPENDIX clvii

AVERAGE CARRYING CAPACITY.

(COWS IN MILK PER 100 ACRES)

No. of Farms	19	43	92	62	37
% diff.in area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	59	63	64	62	60
1941 - 42	60	62	64	62	62
1942 - 43	62	60	63	63	62
1943 - 44	64	62	62	61	61
1944 - 45	63	62	65	64	63
1945 - 46	61	62	63	62	65
1946 - 47	59	61	63	62	64
1947 - 48	57	61	65	64	64
1948 - 49	57	62	65	64	65
1949 - 50	58	64	66	66	67

APPENDIX clviii

AVERAGE CARRYING CAPACITY.

(STOCK UNITS PER ACRE)

No. of Farms	19	43	92	62	37
% diff.in area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	4.38	4.78	4.74	4.70	4.52
1941 - 42	4.31	4.59	4.68	4.61	4.50
1942 - 43	4.29	4.41	4.54	4.50	4.40
1943 - 44	4.68	4.51	4.50	4.41	4.35
1944 - 45	4.62	4.55	4.74	4.73	4.60
1945 - 46	4.36	4.36	4.34	4.29	4.38
1946 - 47	4.26	4.40	4.41	4.44	4.51
1947 - 48	4.02	4.30	4.58	4.57	4.51
1948 - 49	4.12	4.46	4.72	4.69	4.72
1949 - 50	4.19	4.63	4.78	4.78	4.87

APPENDIX clix

AVERAGE NUMBER OF COWS IN MILK.

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	54	66	59	58	61
1941 - 42	55	64	60	58	64
1942 - 43	57	63	60	59	64
1943 - 44	60	65	59	58	63
1944 - 45	59	65	62	61	65
1945 - 46	57	66	60	59	67
1946 - 47	57	65	60	59	66
1947 - 48	58	65	62	60	66
1948 - 49	58	67	62	61	67
1949 - 50	59	68	64	62	70

APPENDIX clx

AVERAGE CULTIVATED AREA (ACRES).

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	91	104	94	93	102
1941 - 42	91	104	94	94	103
1942 - 43	93	105	94	94	103
1943 - 44	93	105	94	94	103
1944 - 45	93	106	95	95	103
1945 - 46	93	106	95	95	103
1946 - 47	96	106	95	95	103
1947 - 48	102	107	95	94	103
1948 - 49	102	107	96	95	104
1949 - 50	102	107	96	94	104

APPENDIX clxi

AVERAGE NUMBER OF STOCK UNITS PER FARM.

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	397	499	444	440	462
1941 - 42	392	478	439	433	463
1942 - 43	397	462	428	423	455
1943 - 44	435	474	425	416	448
1944 - 45	430	481	450	448	473
1945 - 46	406	463	413	406	450
1946 - 47	411	469	420	422	464
1947 - 48	409	461	437	430	463
1948 - 49	420	478	453	444	488
1949 - 50	428	496	459	451	506

APPENDIX clxii

AVERAGE BUTTERFAT "AT THE PAIL."

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	16,064	19,114	17,462	16,387	17,122
1941 - 42	14,280	17,378	15,961	15,390	16,486
1942 - 43	14,245	16,057	14,989	14,423	15,302
1943 - 44	14,995	16,728	14,946	14,693	15,324
1944- 45	16,000	18,191	17,499	16,842	18,537
1945 - 46	12,459	15,438	13,868	13,243	15,164
1946 - 47	14,961	17,563	16,051	15,103	17,081
1947 - 48	14,954	17,471	16,142	15,402	17,314
1948 - 49	16,028	19,164	18,037	17,023	19,029
1949 - 50	15,922	18,915	17,656	16,819	19,334

APPENDIX clxiii

AVERAGE AREA OF GRASSLAND CUT FOR HAY.

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	(19)* 19.5	(42) 18.5	(88) 16.1	(58) 13.5	(32) 16.3
1941 - 42	(19) 20.0	(43) 20.0	(90) 15.9	(59) 13.4	(34) 14.1
1942 - 43	(19) 19.5	(42) 18.7	(87) 15.5	(56) 14.2	(32) 16.0
1943 - 44	(18) 18.5	(41) 18.4	(89) 16.6	(60) 15.8	(36) 20.0
1944 - 45	(18) 16.4	(41) 18.6	(89) 17.2	(59) 16.8	(34) 22.1
1945 - 46	(15) 15.8	(41) 14.7	(85) 14.5	(56) 15.0	(36) 18.4
1946 - 47	(18) 15.6	(42) 17.9	(84) 17.9	(60) 17.1	(33) 22.5
1947 - 48	(12) 15.4	(42) 13.3	(87) 17.1	(60) 17.2	(37) 21.9
1948 - 49	(15) 11.8	(41) 16.7	(88) 16.1	(61) 17.8	(37) 24.0
1949 - 50	(12) 11.4	(40) 14.6	(89) 15.7	(59) 17.5	(36) 26.8

* Terms in brackets refer to the number of dairyfarmers actually making hay.

APPENDIX clxiv

TEMPERATURE AND RAINFALL DATA FOR THE MONTHS DECEMBER - FEBRUARY (1941 - 1950)

Season	December			January			February		
	Temp. (°F.)	Rainfall (ins.)	No. of Wet Days	Temp. (°F.)	Rainfall (ins.)	No. of Wet Days	Temp. (°F.)	Rainfall (ins.)	No. of Wet Days
1940-41	62.0	3.90	8	64.8	5.90	13	63.0	1.63	4
1941-42	61.2	2.73	19	61.2	1.94	14	62.0	1.36	9
1942-43	61.1	3.36	9	63.7	2.76	9	63.6	1.17	9
1943-44	62.6	1.37	11	-	-	-	65.2	5.80	13
1944-45	58.4	4.08	18	64.3	7.16	13	63.6	4.14	9
1945-46	56.0	1.92	13	61.8	1.43	9	65.4	0.25	3
1946-47	59.2	3.56	17	60.6	2.25	10	62.0	1.03	6
1947-48	61.6	1.61	11	63.7	2.64	8	63.2	3.04	8
1948-49	60.2	2.31	14	61.4	2.04	15	63.9	2.86	13
1949-50	58.0	2.79	13	62.2	0.95	8	61.8	5.58	6

DAIRY FARMING TRENDS IN THE WAIPA COUNTY

FOR THE TEN YEARS 1940 - 41 to 1949 - 50.

FARMS GROUPED ACCORDING TO THE DIFFERENCES IN THE "PERCENTAGE AREA OF GRASSLAND CUT FOR HAY" BETWEEN THE FIRST THREE AND LAST THREE YEARS OF THE PERIOD.

APPENDIX clv

AVERAGE PRODUCTION PER COW (LBS. OF B.F. "AT THE PAIL").

No. of Farms	19	43	92	62	37
Diff.in % area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	300	290	294	285	280
1941 - 42	261	270	267	263	258
1942 - 43	250	254	251	245	240
1943 - 44	251	257	255	254	245
1944 - 45	272	279	283	278	285
1945 - 46	220	235	231	225	228
1946 - 47	263	271	270	257	260
1947 - 48	259	268	260	255	262
1948 - 49	275	288	289	279	285
1949 - 50	268	276	278	271	277

APPENDIX clvi

AVERAGE PRODUCTION PER ACRE (LBS. OF B.F. "AT THE PAIL")

No. of Farms	19	43	92	62	37
Diff.in % area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	177	183	187	175	167
1941 - 42	157	167	170	164	160
1942 - 43	154	153	159	154	148
1942 - 44	162	159	158	156	149
1944 - 45	172	172	185	178	180
1945 - 46	134	145	146	140	147
1946 - 47	155	165	168	159	166
1947 - 48	147	163	169	164	168
1948 - 49	158	179	188	180	184
1949 - 50	156	177	184	178	186

APPENDIX clvii

AVERAGE CARRYING CAPACITY.

(COWS IN MILK PER 100 ACRES)

No. of Farms	19	43	92	62	37
% diff.in area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	59	63	64	62	60
1941 - 42	60	62	64	62	62
1942 - 43	62	60	63	63	62
1943 - 44	64	62	62	61	61
1944 - 45	63	62	65	64	63
1945 - 46	61	62	63	62	65
1946 - 47	59	61	63	62	64
1947 - 48	57	61	65	64	64
1948 - 49	57	62	65	64	65
1949 - 50	58	64	66	66	67

APPENDIX clviii

AVERAGE CARRYING CAPACITY.

(STOCK UNITS PER ACRE)

No. of Farms	19	43	92	62	37
% diff.in area cut for hay.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	4.38	4.78	4.74	4.70	4.52
1941 - 42	4.31	4.59	4.68	4.61	4.50
1942 - 43	4.29	4.41	4.54	4.50	4.40
1943 - 44	4.68	4.51	4.50	4.41	4.35
1944 - 45	4.62	4.55	4.74	4.73	4.60
1945 - 46	4.36	4.36	4.34	4.29	4.38
1946 - 47	4.26	4.40	4.41	4.44	4.51
1947 - 48	4.02	4.30	4.58	4.57	4.51
1948 - 49	4.12	4.46	4.72	4.69	4.72
1949 - 50	4.19	4.63	4.78	4.78	4.87

APPENDIX clix

AVERAGE NUMBER OF COWS IN MILK.

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	54	66	59	58	61
1941 - 42	55	64	60	58	64
1942 - 43	57	63	60	59	64
1943 - 44	60	65	59	58	63
1944 - 45	59	65	62	61	65
1945 - 46	57	66	60	59	67
1946 - 47	57	65	60	59	66
1947 - 48	58	65	62	60	66
1948 - 49	58	67	62	61	67
1949 - 50	59	68	64	62	70

APPENDIX clx

AVERAGE CULTIVATED AREA (ACRES).

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	91	104	94	93	102
1941 - 42	91	104	94	94	103
1942 - 43	93	105	94	94	103
1943 - 44	93	105	94	94	103
1944 - 45	93	106	95	95	103
1945 - 46	93	106	95	95	103
1946 - 47	96	106	95	95	103
1947 - 48	102	107	95	94	103
1948 - 49	102	107	96	95	104
1949 - 50	102	107	96	94	104

APPENDIX clxi

AVERAGE NUMBER OF STOCK UNITS PER FARM.

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	397	499	444	440	462
1941 - 42	392	478	439	433	463
1942 - 43	397	462	428	423	455
1943 - 44	435	474	425	416	448
1944 - 45	430	481	450	448	473
1945 - 46	406	463	413	406	450
1946 - 47	411	469	420	422	464
1947 - 48	409	461	437	430	463
1948 - 49	420	478	453	444	488
1949 - 50	428	496	459	451	506

APPENDIX clxii

AVERAGE BUTTERFAT "AT THE PAIL."

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	16,064	19,114	17,462	16,387	17,122
1941 - 42	14,280	17,378	15,961	15,390	16,486
1942 - 43	14,245	16,057	14,989	14,423	15,302
1943 - 44	14,995	16,728	14,946	14,693	15,324
1944- 45	16,000	18,191	17,499	16,842	18,537
1945 - 46	12,459	15,438	13,868	13,243	15,164
1946 - 47	14,961	17,563	16,051	15,103	17,081
1947 - 48	14,954	17,471	16,142	15,402	17,314
1948 - 49	16,028	19,164	18,037	17,023	19,029
1949 - 50	15,922	18,915	17,656	16,819	19,334

APPENDIX clxiii

AVERAGE AREA OF GRASSLAND CUT FOR HAY.

No. of Farms	19	43	92	62	37
Diff. in % area cut for hay between first 3 and last 3 yrs.	-8% plus	-3 to -7%	-2 to +2%	+3 to +7%	+8% plus
1940 - 41	(19)* 19.5	(42) 18.5	(88) 16.1	(58) 13.5	(32) 16.3
1941 - 42	(19) 20.0	(43) 20.0	(90) 15.9	(59) 13.4	(34) 14.1
1942 - 43	(19) 19.5	(42) 18.7	(87) 15.5	(56) 14.2	(32) 16.0
1943 - 44	(18) 18.5	(41) 18.4	(89) 16.6	(60) 15.8	(36) 20.0
1944 - 45	(18) 16.4	(41) 18.6	(89) 17.2	(59) 16.8	(34) 22.1
1945 - 46	(15) 15.8	(41) 14.7	(85) 14.5	(56) 15.0	(36) 18.4
1946 - 47	(18) 15.6	(42) 17.9	(84) 17.9	(60) 17.1	(33) 22.5
1947 - 48	(12) 15.4	(42) 13.3	(87) 17.1	(60) 17.2	(37) 21.9
1948 - 49	(15) 11.8	(41) 16.7	(88) 16.1	(61) 17.8	(37) 24.0
1949 - 50	(12) 11.4	(40) 14.6	(89) 15.7	(59) 17.5	(36) 26.8

* Terms in brackets refer to the number of dairyfarmers actually making hay.

APPENDIX clxiv

TEMPERATURE AND RAINFALL DATA FOR THE MONTHS DECEMBER - FEBRUARY (1941 - 1950)

Season	December			January			February		
	Temp. (°F.)	Rainfall (ins.)	No. of Wet Days	Temp. (°F.)	Rainfall (ins.)	No. of Wet Days	Temp. (°F.)	Rainfall (ins.)	No. of Wet Days
1940-41	62.0	3.90	8	64.8	5.90	13	63.0	1.63	4
1941-42	61.2	2.73	19	61.2	1.94	14	62.0	1.36	9
1942-43	61.1	3.36	9	63.7	2.76	9	63.6	1.17	9
1943-44	62.6	1.37	11	-	-	-	65.2	5.80	13
1944-45	58.4	4.08	18	64.3	7.16	13	63.6	4.14	9
1945-46	56.0	1.92	13	61.8	1.43	9	65.4	0.25	3
1946-47	59.2	3.56	17	60.6	2.25	10	62.0	1.03	6
1947-48	61.6	1.61	11	63.7	2.64	8	63.2	3.04	8
1948-49	60.2	2.31	14	61.4	2.04	15	63.9	2.86	13
1949-50	58.0	2.79	13	62.2	0.95	8	61.8	5.58	6