

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.

THE INFLUENCE OF WEATHER ON
DAIRY PRODUCTION

(An Analysis of the Relationship Between
Meteorological Variations and Fluctuations
in Dairy Production in the Manawatu
1939 - 1970)

A Thesis Presented in Partial Fulfilment
of the Requirements for the Degree of
Master of Arts in Geography at
Massey University

by

ALAN RICHARD TAYLOR

1972

M A S S E Y
U N I V E R S I T Y

STRIKE OUT THE SENTENCE OR PHRASE WHICH DOES NOT APPLY

1. (a) I give permission for my thesis, entitled
THE INFLUENCE OF ^{WEATHER} ~~TEMPERATURE~~ ON
DAIRY PRODUCTION
.....
- to be made available to readers in the Library under the conditions determined by the Librarian.
- (b) I agree to my thesis, if asked for by another institution being sent away on temporary loan under conditions determined by the Librarian.
- (c) I also agree that my thesis may be microfilmed for Library use.

2. I do not wish my thesis, entitled
.....
.....
.....
to be made available to readers or to be sent to other institutions without my written consent within the next two years.

Signed: A. R. Taylor

Date: 1/12/72

PREFACE

In recognition of New Zealand's pastoral potential Sears (1961:65) wrote:

"New Zealand has a tremendous climatic advantage for grassland agriculture, ...

"This is very simply because of New Zealand's great climatic advantage for cheap high-productivity pastures, ...

"New Zealand's continued, but not extreme, soil moisture, moderate temperatures, and adequate sunlight are all of great value to high-production pasture growth. ... The New Zealand climate is also very suitable for the continued outdoor husbandry of European breeds of sheep and cattle."

It would seem, however, that too few studies have been made of the relationship between climatic situations and primary production in New Zealand.

One might offer, in justification of an inquiry into the relationship between climate and dairy production, the importance of dairying to the New Zealand economy. The initial impetus to investigate this relationship was motivated by the author's interest in the farming scene and an appreciation of the importance of climate and weather in agricultural practices.

This thesis is essentially an exercise in applied climatology and makes no claim to be anything more. The study is aimed primarily at investigating the impact of measured physical parameters on an agricultural activity. It is hoped that some of the results might be valuable, even if only to stimulate further research into a situation which has been rather too blithely accepted.

ACKNOWLEDGEMENTS

In preparing this thesis I was fortunate to receive assistance from many people. In particular I wish to acknowledge:

The staff of the Palmerston North Branch of the New Zealand Government Valuation Department for making their maps available.

The staff of the Wellington-Hawkes Bay Herd Improvement Association for permitting access to herd testing records.

The staff of the New Zealand Meteorological Service for allowing access to meteorological records and making computer time available for the running of the water balance programme. Dr W.J. Maunder and Mr J.D. Coulter deserve special acknowledgement for their valued assistance.

The staff of the Massey University Computer Unit, especially Dr C.R. Boswell, for their instructions on running the regression programme and for punching the initial data.

Messrs M.W. Gradwell, J.D. Cowie, and J.A. Pollock, soil scientists, are gratefully acknowledged for their assistance with respect to problems encountered over soil matters.

Dr J.L. McArthur whose supervision and helpful criticism during the course of the project was most appreciated.

Mrs R. McGee for typing the final thesis copy.

TABLE OF CONTENTS

	Page
PREFACE	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	v
LIST OF FIGURES	viii
Chapter One	1
INTRODUCTION	
Chapter Two	6
THE AREA STUDIED	
Section A: The Area Defined	6
Section B: The Region's Physical Characteristics	9
Geology	9
Relief	11
Soils	12
Climate	20
Section C: Farm Location and Climatic Interpolation	36
Chapter Three	42
THE DATA	
A. The Butterfat Variable	42
B. The Meteorological Variables	44
Water Balance	46
Solar Radiation	53
Temperature	56
C. The Time Variable	61
Chapter Four	66
THE AGROCLIMATOLOGICAL MODEL	
Chapter Five	77
RESULTS OF THE ANALYSIS	
Case One	81
Case Two	86
Case Three	90
Case Four	95
Chapter Six	101
CONCLUSIONS	
APPENDICES	115
BIBLIOGRAPHY	131

LIST OF TABLES

		Page
TABLE I	Thunder, Hail, Ground Frost, and Cloud Data for Various Manawatu Climatological Stations	23-24
TABLE II	Precipitation for Manawatu Rainfall Stations (inches)	26-27
TABLE III	Mean Daily Temperature for Manawatu Climatological Stations ($^{\circ}\text{C}$)	30
TABLE IV	Mean Daily Maximum Temperature for Manawatu Climatological Stations ($^{\circ}\text{C}$)	31
TABLE V	Mean Daily Minimum Temperature for Manawatu Climatological Stations ($^{\circ}\text{C}$)	32
TABLE VI	Mean Daily Grass Minimum Temperature for Manawatu Climatological Stations ($^{\circ}\text{C}$)	33
TABLE VII	Hours of Bright Sunshine for Manawatu Climatological or Sunshine Stations	34
TABLE VIII	Mean Daily Relative Humidity for Manawatu Climatological Stations (per cent)	35
TABLE IX	Wind Data for Manawatu Climatological Stations	37
TABLE X	Meteorological Stations From Which Data Used in the Analyses Were Taken	45
TABLE XI	The Meteorological Variables Used in the Analysis	74
TABLE XII	The Four Case Studies Made	77
TABLE XIII	Case One: Summary Statistics for Sample Butterfat Data and Meteorological Data Recorded at Palmerston North D.S.I.R. (1939 - 1970)	82
TABLE XIV	Case One: Matrix of Simple Correlation Coefficients; Sample Butterfat Data and Meteorological Data for Palmerston North D.S.I.R. (1939 - 1970)	83
TABLE XV	Case One: Results of Regression Analysis Between Sample Butterfat Data and Meteorological Data Recorded at Palmerston North D.S.I.R. (1939 - 1970)	84

TABLE XVI	The Variation Explained at Each Step in the Multiple Regression Analysis: Palmerston North D.S.I.R. Case	85
TABLE XVII	Case Two: Summary Statistics for Sample Butterfat Data and Meteorological Data Recorded at Ohakea (1955 - 1969)	87
TABLE XVIII	Case Two: Matrix of Simple Correlation Coefficients; Sample Butterfat Data and Meteorological Data for Ohakea (1955 - 1969)	88
TABLE XIX	Case Two: Results of Regression Analysis Between Sample Butterfat Data and Meteorological Data Recorded at Ohakea (1955 - 1969)	89
TABLE XX	The Variation Explained at Each Step in the Multiple Regression Analysis: Ohakea Case	90
TABLE XXI	Case Three: Summary Statistics for Sample Butterfat Data and Meteorological Data Recorded at Foxton - Waitarere Forest (1962 - 1969)	91
TABLE XXII	Case Three: Matrix of Simple Correlation Coefficients; Sample Butterfat Data and Meteorological Data For Foxton - Waitarere Forest (1962 - 1969)	92
TABLE XXIII	Case Three: Results of Regression Analysis Between Sample Butterfat Data and Meteorological Data Recorded at Foxton - Waitarere Forest (1962 - 1969)	93
TABLE XXIV	The Variation Explained at Each Step in the Multiple Regression Analysis: Foxton - Waitarere Forest Case	94
TABLE XXV	Case Four: Summary Statistics for Sample Butterfat Data and Meteorological Data Averaged From Cases One, Two, and Three (1962 - 1969)	96
TABLE XXVI	Case Four: Matrix of Simple Correlation Coefficients; Sample Butterfat Data and Meteorological Data Averaged From Cases One, Two, and Three (1962 - 1969)	97
TABLE XXVII	Case Four: Results of Regression Analysis Between Sample Butterfat Data and Meteorological Data Averaged From Data Recorded in Cases One, Two, and Three (1962 - 1969)	98

TABLE XXVIII	The Variation Explained at Each Step in the Multiple Regression Analysis: Averaged Meteorological Data Case	99
TABLE XXIX	The Effect of a Meteorological Variation One Standard Deviation From Average Upon Butterfat Production: Foxton - Waitarere Forest Case	105
TABLE XXX	The Effect of a Meteorological Variation One Standard Deviation From Average Upon Butterfat Production: Ohakea Case	106
TABLE XXXI	The Effect of a Meteorological Variation One Standard Deviation From Average Upon Butterfat Production: Averaged Meteorological Data Case	107
TABLE XXXII	The Effect of a Meteorological Variation One Standard Deviation From Average Upon Butterfat Production: Palmerston North D.S.I.R. Case	108
TABLE XXXIII	Significant ($\alpha = 0.05$) Variables According to Maunder (1968)	112

LIST OF FIGURES

		Page
FIGURE 1	The Relationship Between Physical Factors and Dairy Production	3
FIGURE 2	Location	8
FIGURE 3	Soil Types	13-14
FIGURE 4	Annual Rainfall Distribution	28
FIGURE 5	Soil Moisture Capacity and Sample Location	38
FIGURE 6	Specific Plant-Available Water Capacities	52