THE POTENTIAL

FOR INCREASED PRODUCTION

ON SHEEP FARMS IN

WAIROA COUNTY

by

R.W. CARTWRIGHT

Thesis Presented in Partial Fulfilment

of the Requirements for the

Degree of Master of Agricultural Science

in Massey University

January, 1967.

ACKNOWLEDGEMENTS

The author wishes to thank Professor W.V. Candler for his advice and encouragement during this study. The author benefited from several discussions with Messrs. J.N. Hodgson and N. Watson.

The efforts of the many people who assisted with this study, are appreciated. Special thanks are due to many farmers in Wairoa County for their unstinting co-operation during the Farm Survey.

During the early part of this study, the author was employed by the New Zealand Department of Agriculture which also met the full cost of the Farm Survey. This support is gratefully acknowledged, as is the financial assistance provided by scholarships from the Bank of New South Wales and the New Zealand Wool Board.

Thanks are due to Mesdames M. Clifford and A. Smith, who typed this thesis and to Mrs. J. Cartwright who traced the figures and assisted with proof-reading. Thanks are also due to the library staff for their assistance in obtaining references.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND THESIS GUIDE

1.1 Introduction

Wairoa County, which lies over the boundary of Hawkes Bay and Gisborne Land Districts, on the east coast of the North Island, covers 878,700 acres. This area includes 654,000 acres of steep hills and high plateau land. Substantially similar hill country, estimated to cover 525,000 acres, lies outside the northern and south western County boundaries.[1] The locations of these areas are shown in the map in Figure 2.1.

Farming in the County is predominantly pastoral. This area of more than half a million acres of hill country clearly warranted a farm management study, since little was known about the possible increases in production, the farming problems on which further research was needed, or the requirements for the additional resources, extension activities and incentives necessary for the attainment of potential production increases.

A farm management study of Wairoa County was originally suggested by the executive of the East Coast Farmers' Fertiliser Co.Ltd. On being approached, farmer organisations in the County expressed interest and support for the proposed study.

Subsequently, the New Zealand Department of Agriculture became concerned with the study and agreed to sponsor it by providing the author's salary, accommodation, and transport. Work on the study commenced in April, 1965.

---

1. Areas of land classes were derived from maps found in reference [1].

The original proposition called for a study of all farming in Wairoa County. There is, however, a distinct difference between the dairy and fat lamb farming systems followed on the flat and rolling areas, and the management of sheep/cattle breeding farms on the steeper hill country.

It was decided to carry out a reasonably comprehensive study of the hill country farming, rather than make a more superficial appraisal of all farming systems in the County.

1.2 Objectives of the Study

The study had three main objectives. The first was to estimate the potential production of the hill country in Wairoa County. The second was to clarify any technical or managerial farming problems which might justify further research. The third was suggestion of a regional development scheme to achieve the potential production suggested by the survey. A study such as this should be regarded as only the first stage of a continuing programme aimed at increasing production and, therefore, this thesis can do no more than report the results of the study and suggest subsequent activity for consideration.

The first step in estimating potential production levels was to obtain an understanding of the farming environment, which involved the natural features of climate, topography and soil types, and also of the auxiliary services, including topdressing, transport, credit, farm supply firms and farm advisory services. Secondly, current farm management practices were studied, including levels of production and incomes, and the nature and importance of technical production problems. Thirdly, the efforts being made by farmers to increase production, and the development methods in use, were reviewed. Information on the apparent attitude of farmers to increasing production, farm investment, and borrowing, inevitably resulted from the study. While discussion with farmers gave some indication of these attitudes, the writer did not pretend or indeed attempt, to obtain a full understanding of them.

Identification of some technical problems suggested the need for further research projects. Exact details of these projects are given in the body of the thesis.

As a final step in estimating potential production levels, the writer considered the results of experiments and farmer innovation outside the County. This review suggested that several techniques not currently in general use in Wairoa could be applied to increase production on Wairoa hill country.

The first two objectives sought to assess the feasibility of increasing production in Wairoa County. The third objective was to identify the steps necessary to attain these production increases. In an exercise of this nature an assessment of the expected profitability of increasing production, is obviously crucial. These estimates were made in two ways. Development programmes that had actually been followed by farmers were evaluated. However, none of the observed case programmes were approaching what the author believes to be the potential level of production. In addition, the author believes that profitable improvements could be made to the programmes actually being followed. Hence, a hypothetical farm development programme was constructed and evaluated. In each case, profitability was estimated both before and after tax thus allowing a comparison of the expected profitability to individual farmers, with benefits to the Nation.

Estimates of the additional resources necessary for the County, as a whole, to attain the potential increases, and the drawing up of a development scheme suggesting further research and extension work, completed the study.

1.3 Sources of Information

The study is based upon an interview survey of two groups of farmers in the County. Survey techniques and results are discussed in Chapter 3.

Information allowing an understanding of the farming environment was obtained from the sources indicated in Table 1.1.

Table 1.1 Sources of Background Information

Information	Source
Natural Features	Soil Bureau (D.S.I.R.) N.Z.Meteorological Service
Land Use	N.Z.Dept. of Lands & Survey
Land Tenure	N.Z.Valuation Department
Transport Services	N.Z.Transport Department
State Development Finance	N.Z.Dept. of Lands & Survey State Advances Corporation
General Information	N.Z.Department of Agriculture East Coast Farmers' Fertiliser Co. Ltd. Swift (N.Z.) Ltd. Cookson Air Services Ltd. Banks Stock and Station Agents

Information which proved useful in estimating potential production levels was obtained from the supervisors of Department of Agriculture Soil Conservation farms at Tangoio and Waerenga-o-kuri.

References are made throughout the thesis to papers and publications which have been helpful and instructive to the writer.

1.4 Thesis Guide

This section outlines the contents of the remaining chapters in the thesis.

The hill country farming environment of Wairoa County is described and discussed in Chapter 2. Chapter 3 is devoted to a discussion of the place of farm surveys in farm management research, and includes a review of the literature on survey techniques and experience. This chapter also describes the procedure used in carrying out the Wairoa Survey.

Chapter 4 contains a resumé of production and incomes on Wairoa hill country farms. The chapter begins by reporting the tenure arrangements, topography, and land use found on farms in the Survey, and a section is devoted to farm labour in the County. Later sections examine stocking rates, production levels, incomes, and capital structures, and the chapter concludes with a review of recent production increases in the County and farmer's attitudes to increasing production.

The managerial aspects of hill country farming in Wairoa are discussed in Chapter 5. Attention is first focussed on management practices used to sustain production levels, but the discussion subsequently passes to the management practices used by Wairoa farmers to increase production. The chapter concludes with a review of high production on hill country outside Wairoa County.

The first part of Chapter 6 introduces the concept of farm development programmes and discusses the importance of evaluating them. This is followed by a description of the actual procedures used to evaluate the development programmes appearing in later chapters. Chapter 7 contains descriptions and evaluations of the development programmes undertaken by five farmers in Wairoa County, while Chapter 8 proposes a 'model' development programme for developing Wairoa hill country. The latter programme is, in fact, a summary of the author's preferred development techniques. The model programme is evaluated over ranges of prices and costs by means of derived 'budgetary response functions'. To the author's knowledge, this analytical technique has not previously been used.

Chapter 9 examines the impact of taxation on the profitability of developing hill country. The author's estimates of potential production increases in Wairoa County and adjacent districts, are presented in Chapter 10. The extra resources required to attain and sustain the potential are also estimated, and the chapter contains a rough assessment of the overseas exchange that New Zealand is foregoing by not developing Wairoa County.

The important findings of the study are summarised in Chapter 11.

Throughout the ensuing chapters, references to the bibliography are made thus: [0].

CHAPTER 2

WAIROA COUNTY

2.1 Introduction

This chapter describes the features of Wairoa County that are important to hill country farm management. These features include the location of the County, its natural features, land use and tenure, and the state of the auxiliary services, such as topdressing, transport, credit, farm supply and advisory services.

In short, this chapter presents an outline of the farm environment in Wairoa County.

2.11 Location

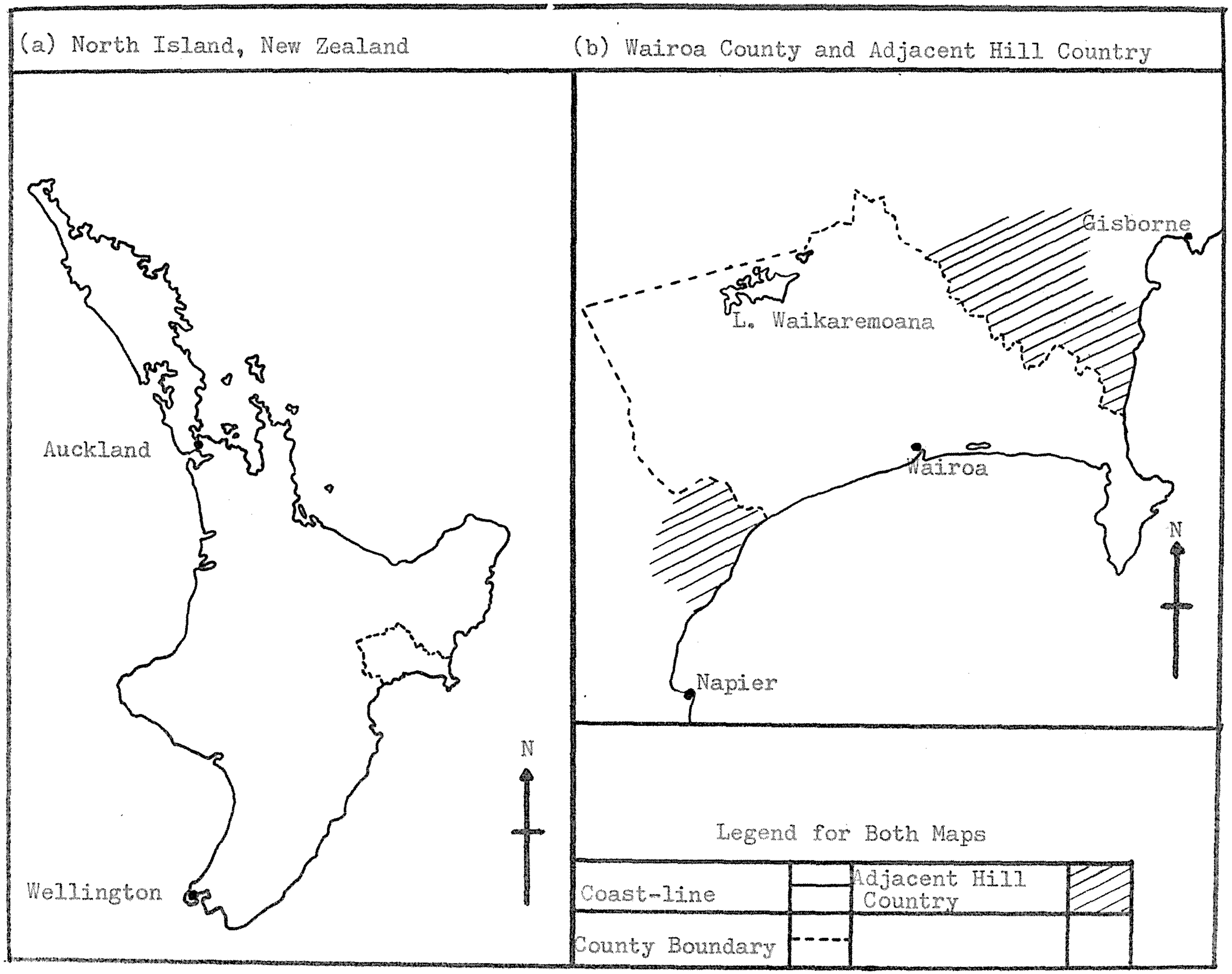
Wairoa County is a coastal district on the eastern coast of the North Island of New Zealand. Its exact location is indicated by the map in Figure 2.1. It has a coastal boundary along some fifty miles of northern Hawkes Bay, the Mahia Peninsula and six miles north of Mahia. The County extends inland approximately thirty-three miles from the coast to Lake Waikaremoana. Parts of Hawkes Bay, Auckland, and Gisborne Land Districts are included in the County.

2.2 Natural Features

2.21 Topography

In Wairoa County one minor and two major topographical land classes may

Figure 2.1 Location of Wairoa County



be distinguished. The two major land classes are the uplifted and dissected hill country masses, and the flat and terraced river valleys which vary considerably in width and separate the hill country masses. The hill country is mainly of steep contour, but there are many small areas of rolling land on hilltops. A dominant feature of the County is the tilting of the hill country masses, which have very steep north-eastern aspects and relatively gentle slopes facing the south-west. The minor topographical land class is a narrow coastal belt of sand dunes extending from Whakaki to Mahia Beach. South of Whakaki the hill country extends to the coast.

More detailed descriptions of the topography found on individual farms will be found in Chapter 4.

2.22 Soil types[1]

Hill country soils in Wairoa County have been derived from both sedimentary rock and volcanic ash. The volcanic ash overlies the rock in many places and can reach a maximum depth of three feet. Rock types grade from the hard greywacke sandstone of the ranges bounding the County to the west through small areas of brittle argillite, to the interbedded mudstones and sandstones which underlie virtually all land suitable for pastoral farming. The steeper slopes have soils derived directly from the sedimentary rock parent materials, but the rolling hill tops have retained covers of volcanic ash which form the parent materials of soils on these contours.

---

1. All information appearing in this section was obtained from references [1], [2], [3].

Valley floor soils typically consist of alluvium composed of either the ash that has eroded from the fragments, or a mixture of these materials.

Thus, hill country soils tend to be very variable with areas of uniform soil unlikely to cover more than one hundred acres. While individual farms have 'patchwork-quilt' soil patterns, it is important to note that in general, all farms have this feature so that, for the purposes of farm management, inter-farm soil differences are typically slight.

Five soil forming volcanic ash showers can be distinguished in Wairoa County. These are:

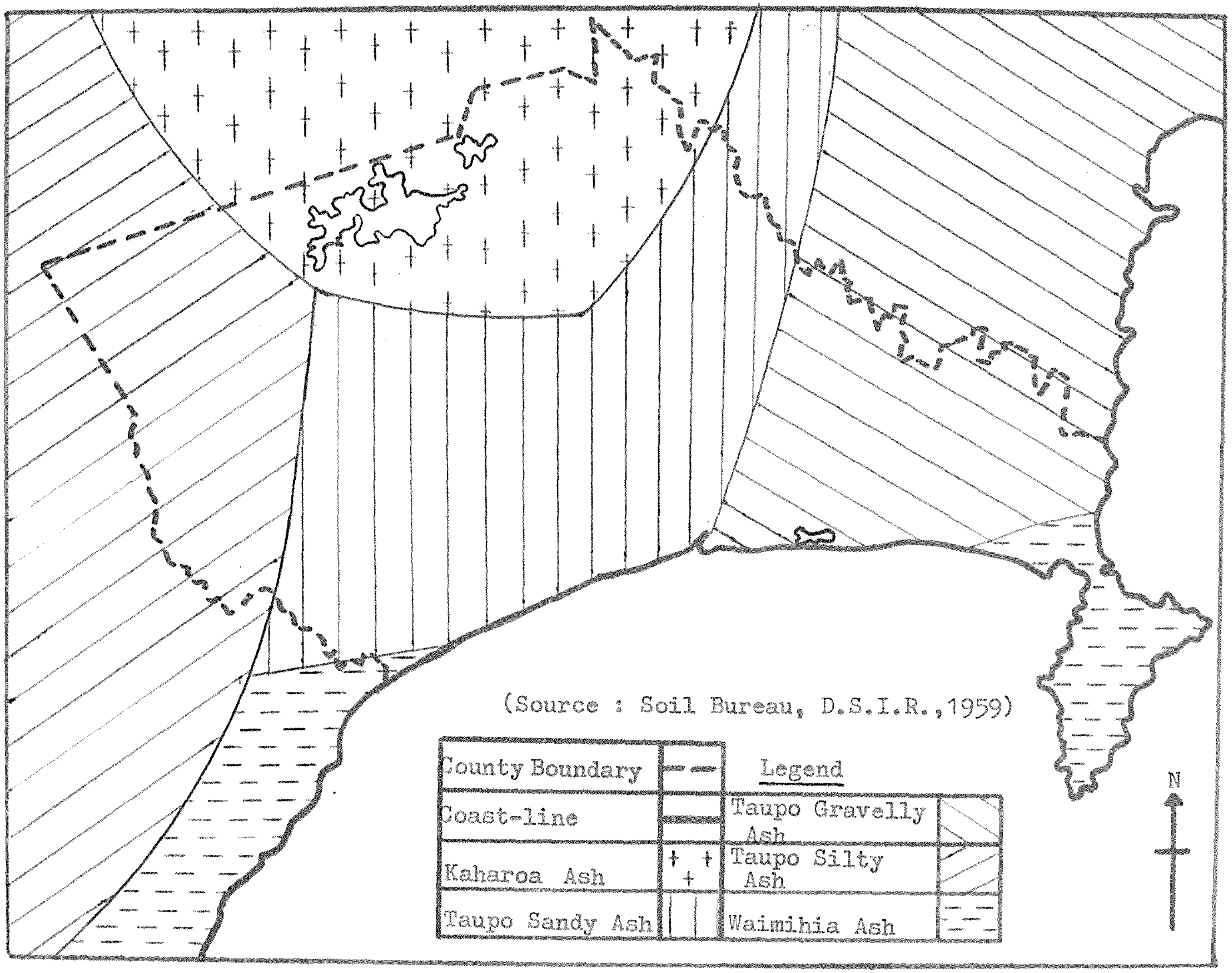
(i) Waimihia ash, a fine pumice sand,
(ii) Taupo gravelly ash, a little-weathered pumice gravel,
(iii) Taupo sandy ash,
(iv) Taupo silty ash, which is generally finer than Taupo sandy ash, and
(v) Kaharoa ash, a pumice sand.

The surface distribution of these deposits is indicated in Figure 2.2 in which boundaries represent the outer limit of three inches of ash as estimated from soil deposits on flattish land. Within such boundaries there are many slopes where the ash is shallower or is absent as a result of erosion.

The Soil Bureau of the N.Z.Department of Scientific and Industrial Research has identified forty different soil types on farmable land in the County.

The following sub-section lists and briefly discusses the soil types which are important to hill country farm management. For a more comprehensive description the reader is referred to [1].

Figure 2.2 Ash Showers of Gisborne-Wairoa District



2.221 Main soil types[2]

(i) Taupo sandy silts (18, 18H, 18aH)

These soils, which are formed from Taupo sandy ash and Taupo silty ash, are found on easy rolling, rolling and moderately steep hills in the western part of the County. The area of Taupo sandy silts is estimated at 160,000 acres, and they have generally good drainage although water supply can be unreliable. After application of superphosphate these soils will support high producing pastures, but these will revert rapidly to scrub if phosphate supplies are inadequate.

(ii) Ngaroma sandy silts (19, 19H)

These soils are generally similar to Taupo sandy silts, except that they are found on higher hill masses. Contours range from rolling, to broken and moderately steep. Streams often provide a good water supply. The area of Ngaroma sandy silts is estimated at 57,000 acres.

(iii) Mahoenui, Hangaroa, Whangamomona and Moumahaki soils (115, 115b, 116, 117)

Soils in this group are found in all steep to very steep regions in the County. Parent materials are basically banded mudstone and sandstone, but pockets of ash occur frequently, with Taupo sandy ash predominating in the western hill country and both Taupo gravelly ash and Waimihia ash present in the eastern part of the County. Approximately 125,000 acres are covered by these soils which tend to have low natural fertility, including

---

2. The soil reference numbers quoted are standard for New Zealand soil maps.

a markedly poor supply of phosphates. The dissected topography often makes access to this country difficult.

(iv) Wangaehu, Taihape, Turakina, and Waitaha silty and sandy loams (114, 114a, 114b, 114c)

These soils, which are estimated to cover 250,000 acres are, for purposes of farm management, very similar to those described in the previous paragraph, but these soils are more susceptible to summer dryness and water supply can be poor. Reversion of pastures to manuka scrub and bush is rapid when a sward of vigorous high-fertility grasses and clovers is not maintained.

(v) Gisborne, Patoka, and Tutira sandy loams (21H, 49H, 49aH)

Approximately 22,000 acres are covered by these soils which are derived from Waimihia ash on moderately steep hills in the eastern part of the County. These soils are seriously undersupplied with phosphate and reversion to scrub is rapid when stocking rates are low and superphosphate not applied. These soils are generally poorly supplied with water.

(vi) Manawatu, Waipunga, Kairanga, Gisborne and Mohaka silt and sandy loams (1, 1a, 2, 21, 21a)

Most hill country farms include small areas of alluvial river flats and river terraces. The soils named above predominate on this land type and are estimated to cover 75,000 acres. These soils include heavy, poorly drained soils of high natural fertility, lighter, freer draining, less fertile land, and light, poorly watered, low fertility high terraces (particularly soils 21 and 21a).

It will be appreciated that one feature common to all soils is a poor natural supply of phosphates. Although dissected topography and unreliable water supplies also influence farm management, the requirement for phosphates in the establishment and maintenance of high producing pastures is the most important single implication for farm management of soils found in the County.

Soil types, their reference numbers, and estimated areas in Wairoa County are summarised in Table 2.1.

Table 2.1 Major Soil Types in Wairoa County

Name	Reference Nos.	Estimated Area (acres)
Taupo sandy silts	18, 18H, 28aH	160,000
Ngaroma sandy silts	19, 19H	57,000
Mohoenui, Hangaroa, Whangomomona and Moumahaki soils	115, 115b, 116, 117	125,000
Wangaehu, Taihape, Turakina, and Waitaha silty and sandy loams	114, 114a, 114b, 114c	250,000
Gisborne, Patoka, and Tutira sandy loams	21H, 49H, 49aH	22,000
Manawatu, Waipunga, Kairanga, Gisborne, and Mohaka silt and sandy loams	1, 1a, 2, 21, 21a	75,000

2.23 Climate

This section describes the rainfall, temperature, and wind conditions found in Wairoa County.

2.231 Rainfall

The mean annual rainfall over the period 1921-50 in the County and adjoining district is illustrated in Figure 2.3. It can be seen that mean annual rainfall ranges from less than 45 inches on the coastal region south-west of Wairoa Borough to over 125 inches near Lake Waikaremoana and on the Wharerata hills north of Nuhaka. However, it is also clear that a large part of the County has an average rainfall of between 50 and 70 inches.

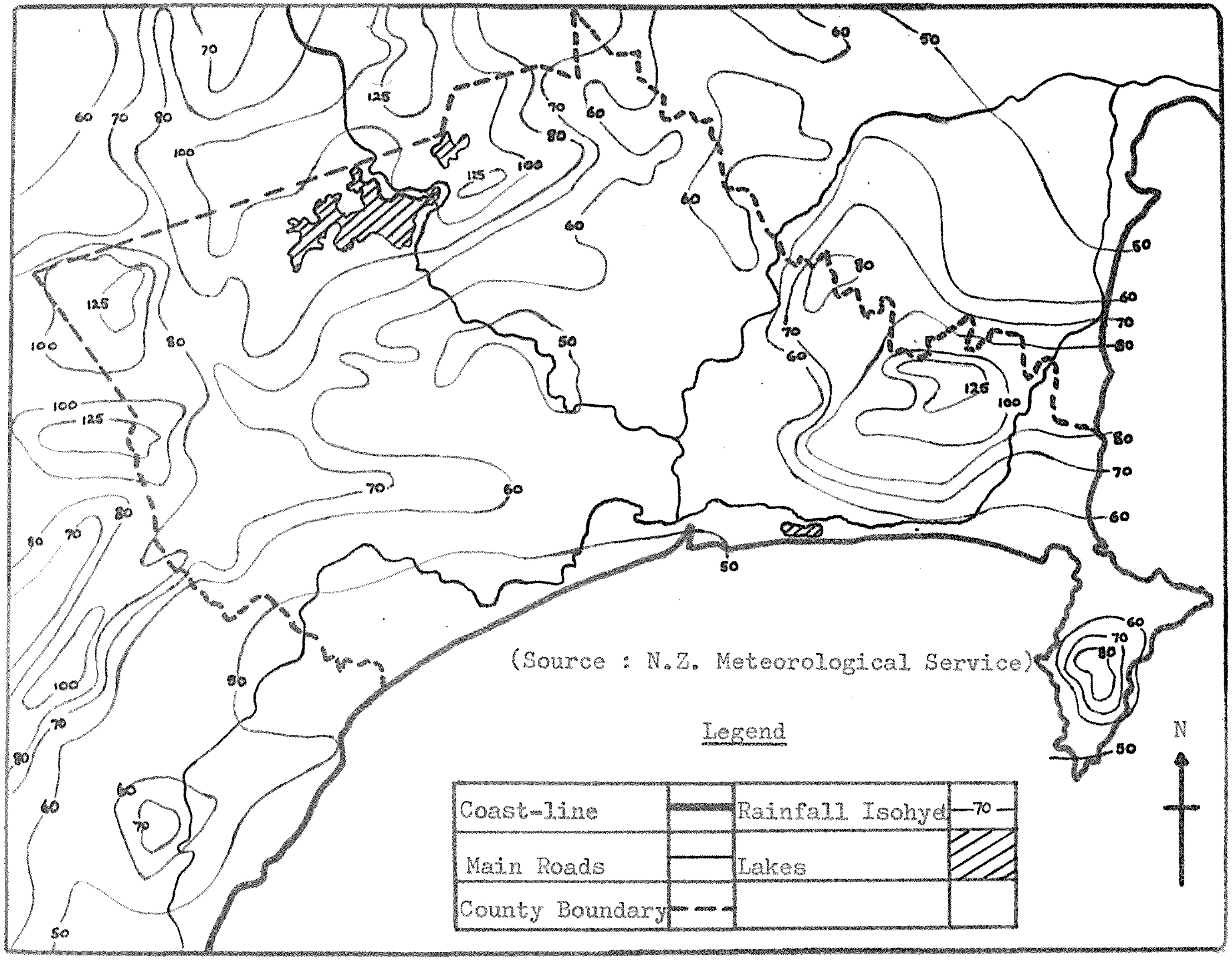
Spread of rainfall throughout each year is typically quite even. Table 2.2. illustrates this point, although there is a noticeable maximum in winter and a minimum in summer. December is usually the driest month and May the wettest.

Table 2.2 Mean Monthly Rainfall 1921 to 1950 (inches)

Month	At Lake Waikaremoana	At Wairoa
January	8.0	3.8
February	7.8	4.3
March	7.8	4.3
April	8.5	4.6
May	11.0	6.4
June	9.3	5.3
July	10.0	5.0
August	8.9	4.0
September	7.8	3.8
October	7.0	3.4
November	6.7	3.1
December	6.1	2.8

Source: Records of the N.Z.Meteorological Service

Figure 2.3 Mean Annual Rainfall in Wairoa County 1921-50



One important feature of rainfall distribution not indicated by mean annual figures is the consistency of rainfall. While the author was unable to obtain any comprehensive records showing the distribution and variance of rainfall in the County, it is probable that Table 2.2 indicates an unrealistically favourable annual spread of rainfall.

Summer dry periods are expected by most farmers in the coastal hill country south-west of Wairoa, but serious droughts are infrequent. Over the remainder of the County, short dry spells may occur at any time during the year. Reduced pasture production at these times is almost invariably compensated by later increases in production.

2.232 Temperature

Warm summers are usual throughout the County, but the severity of winters tends to increase from generally mild conditions in coastal districts to cold weather in the higher inland areas. These locational differences in winter climate are seldom great enough to require substantial changes in stock or pasture management.

2.233 Wind conditions

The topography of the County affords considerable natural shelter from the prevailing north-westerly winds, but the tilted hill masses are frequently exposed to winter and spring storms which usually approach from the south and south-west. Compared with many other hill country areas in the North Island, wind velocities in Wairoa County are moderate.

2.3 Land Use and Tenure

Wairoa County covers 878,120 acres. In Tables 2.3 and 2.4 tenure is classified into two categories:

(a) Land held for pastoral farming purposes, and

(b) Land held for purposes other than farming.

The total area of land owned by Europeans could not be obtained, and this area was estimated by computing the difference between the total area of the County and the sum of all other areas stated in the tables. Land occupied by roads and streams is therefore included in this residual area and also in the "Total Area of Land Held for Pastoral Farming Purposes". These areas are consequently slightly inflated. No information concerning land use within the area held for pastoral farming purposes could be obtained, but indications of this were derived from the farm survey, the results of which appear in Chapter 4.

Table 2.3 Tenure of Land Held for Pastoral Farming Purposes

Tenure (1965)	Area (acres)
Crown Land:	
Private leasehold (permanent)	116,635
Private leasehold (temporary)	2,022
Under development by Crown	43,393
Potentially productive land not under development	8,246
Total Pastoral Crown Land	170,296
Land Owned by Maoris:	
Privately owned	30,927
Incorporated blocks	65,417
Trusts (supervised by Department of Maori Affairs)	5,015
Leased to Europeans	13,915
Total Area Owned by Maoris	115,274
Land Owned by Europeans	348,196
Total Area of Land Held for Pastoral Farming Purposes	633,766

Sources: N.Z.Department of Lands and Survey,
Farm Advisory Division, N.Z.Department of Agriculture

Table 2.4 Tenure of Land Held for Purposes other than Pastoral Farming

Tenure (1965)		Area (acres)
Crown Land:		
State Forest		78,109
Scenic Reserves		1,545
National Park		163,300
Urban Settlements:		
(Wairoa Borough)		1,400
	Total	244,354

Source: N.Z.Department of Lands and Survey

2.4 Auxiliary Services

This section considers the state and apparent adequacy of services supporting hill country farming in Wairoa County.

2.41 Roads

Roads are generally of poor quality, being frequently narrow and steep with poor surfaces. This has several important implications for farm management. First, the enforced slow travel over most roads accentuates the isolation of many districts, which can result in greater difficulties in obtaining farm labour and the payment of higher wages to hold labour. Secondly, poor roads increase the cost of maintaining vehicles. This has two implications - farm labour is justified in claiming greater car allowances, and road transport firms are faced with higher operating costs which are inevitably reflected in higher charges to farmers.

2.42 Telegraphic services

The author gained an impression that the telegraphic services in

Wairoa County were unreliable; many branch lines are privately owned and maintained, party lines tend to be very crowded, and breakdowns seem to be frequent.

While many farmers tolerate these difficulties, breakdowns in communication must frequently interfere with the management of hill country farms by hindering arrangements for buying and selling stock and acquiring farm supplies.

2.43 Transport services

In the opinion of the majority of farmers and mercantile people with whom the author had contact, road transport services in the County were adequate and generally reliable. In September 1965, 42 operators based on 12 centres were licensed to operate 113 trucks.[3]

2.44 Agricultural contracting services

This heading refers to aerial topdressing services and to contractors employing heavy machinery for land clearing, land cultivation and the construction of farm tracks and dams.

Hill country farmers are adequately supplied with both services. Several well-established firms skilfully operate heavy crawler tractors, with the result that most farmers rely on contractors for work suited to these machines. Two aerial topdressing firms operate in the County. During 1965 they operated six aircraft, all designed to operate from farm airstrips. While the services are generally reliable and prompt, wet weather occasionally resulted in fertiliser trucks being unable to reach airstrips.

---

3. Source: No. 5A Transport Licensing Authority, Napier.

A projected service involing a large aircraft operating from Wairoa airfield promises to remove previous reliance on farm airstrips as well as offering an alternative to hauling fertiliser over poor roads. Whether a large aircraft will be as suitable as the smaller machines for actually spreading fertiliser in Wairoa is a question on which no experience is currently available.

2.45 Farm supply and trading services

Five stock and station firms[4/] situated in Wairoa provide adequate farm supply and sale-yard facilities.

Most fertiliser applied in the County is supplied by the East Coast Farmers' Fertiliser Company, Awatoto. Virtually all of this fertiliser is railed to nine sidings between Raupunga and Kopuawhara. In 1964/65, 16,446 tons of fertiliser were railed to the County. Some 60.4% of the total was delivered via the bulk store at Wairoa. Eight types of fertiliser were supplied, and Table 2.5 indicates their relative popularity.

---

4. The Stock and Station firms are :

    Hawkes Bay Farmers' Co-op. Assn. Ltd.

    Williams and Kettle Ltd.

    Wright, Stephenson and Co.Ltd.

    Dalgety and New Zealand Loan Ltd.

    de Pelichet, McLeod and Co.

Table 2.5 Proportions of Different Bulk Fertilisers Railed to Wairoa Bulk Stores (1964/65)[a]

Type	Proportion (% of total)
Superphosphate	46.6
Aerial superphosphate	24.4
Serpentine superphosphate	2.8
Cobaltised superphosphate	19.5
30% lime/superphosphate	3.5
Boronated superphosphate	0.4
Copperised superphosphate	2.4
Crop manure	0.4

Note:

a. The proportions shown ignore 'Special Mixes' which amounted to 9% of the total fertiliser railed to the County. The table also ignores DDT fertiliser which must be bagged. (DDT fertiliser was, however, included in the total of 16,446 tons).

The Awatoto Fertiliser Works does not supply lime-reverted superphosphate, and to meet farmers' demand for this fertiliser, a reverting plant commenced operations in Wairoa during 1965. The plant reverts Awatoto superphosphate with lime quarried on Mahia Peninsula, and can produce 1,500 tons of reverted superphosphate per year.

On several occasions in recent years, seasonal demand for fertiliser has exceeded supply. Farmers holding sufficient shares in the East Coast Farmers' Fertiliser Company to cover their fertiliser requirements, generally suffered shorter delays in delivery than those farmers whose requirements had expanded faster than their holdings in the Company.[5]

5. During fertiliser shortages farmers without shares in the Company invariably suffered delayed deliveries.

2.46 Stock slaughtering and meat freezing facilities

The Wairoa premises of Swift (N.Z.) Ltd., provide adequate slaughtering and meat freezing services. Some farmers at the northern and southern extremities of the County send their stock to freezing works at Gisborne or Whakatu (Napier), but the author heard no serious complaints about the service offered by the Wairoa Works.

2.47 Sources of farm credit

Three trading banks[6] have branches in Wairoa, and these, together with the stock firms referred to above, provide short-term current account credit.

The credit policies of these banks usually encourage rapid reduction of overdrafts. While this facility is adequate for most seasonal requirements for credit, it is generally unsuitable for financing hill country development, because this usually involves a lag of several years between an investment and its subsequent return. A few farmers have obtained long term credit for farm development in the form of flat mortgages from banks and stock firms, but this service is not regularly available. In recent years farmers have relied heavily on the State Advances Corporation for provision of finance for farm development.

---

6. The trading banks are :

Bank of New Zealand

Bank of New South Wales

Commercial Bank of Australia Ltd.

Marginal Lands assistance has not been extensively sought in the County. Since the inception of the scheme in 1950, Marginal Lands advances have totalled £26,800 to eleven farmers. In the three years 1962/63 to 1963/64 only four applications for assistance were received, two of which were rejected, while the remaining two were still being considered at the time of the farm survey.

State Advances Corporation finance is the main source of credit for farm purchase and farm development in the County. In the two years ended 30 June, 1965, 17 farmers received advances totalling approximately £112,000.

The author was unfortunately unable to classify these advances into those for purchase and those for land development. All advances for development were made on current account, the loans being converted to table mortgage on attaining advance limits.

2.48 Farm advisory services

Three main types of advice can be offered to farmers. These are:

(i) Managerial advice,

(ii) Financial advice, and

(iii) Technical advice.

The following three sections describe the advisory services currently available to farmers in Wairoa County.

2.481 Managerial advice

Advice based upon financial analysis of previous management and evaluation of proposed changes to management systems is not a dominant feature of advice offered. This is exemplified by the absence of both Farm Improvement Club and Private Consultant advisors. The Department of Agriculture's advisory service has, in the past, provided very little management advice because the Farm Advisory Officer in Wairoa has tended to concentrate on technical advice concerning inter alia weed and pest control, soil testing and pasture establishment.

Some degree of managerial advice is provided by the State Advances Corporation but this is, of course, primarily aimed at protecting the Corporation's investments and the service is not available to farmers who are not clients.

Advisors employed by stock firms also offer managerial advice to their clients. Once again, however, the emphasis appears to be on protecting the firms' investments and the amount of advice offered tends to be proportional to the degree of insecurity of investments. In addition, these advisors are resident in Napier, thus reducing their accessability to farmers in Wairoa County.

2.482 Financial advice

In general, farmers can obtain financial advice from farm accountants, trading banks, and stock firms. The last two institutions usually confine their advice to the implications of farmers accepting credit from them, but farm accountants can be expected to offer a wider range of services. The most important type of advice forthcoming from farm accountants concerns the minimization of farmers' taxation liabilities. Such advice might include suggestions of times to purchase or sell stock, or to incur farm development expenditure. It might also include advice on possible changes in farm tenure, such as the formation of farm companies to reduce income tax, and the formation of companies or trusts to avoid estate duties.

Financial advice of this kind is readily available in Wairoa. At least one accountancy firm also offers a budgetting service in which an annual current working budget is reviewed every two or three months. It is important to note that <u>this is not a managerial advisory service</u>. Management policy must still be formulated by farmers, after which the accountant prepares a forecast budget reflecting this policy. The service is, however, very useful in providing farmers with up-to-date evidence of the financial implications of their management policies.

2.483 Technical advice

Reference has already been made to the largely technical nature of the advice offered in Wairoa by the Department of Agriculture. In addition, the Department has a Sheep and Wool Instructor and a Livestock Instructor stationed in Wairoa. Animal health problems are adequately handled by three veterinarians who are employed by the Gisborne Veterinary Club, but are based in Wairoa. Advice on pasture establishment and fertilisers is also offered by an agronomist employed by Swift (N.Z.) Ltd.

CHAPTER 3

FARM MANAGEMENT RESEARCH AND FARM SURVEYS

3.1 Introduction

This chapter has three main parts. The first is a brief review of the major characteristics of farm management research. This section also identifies the place of farm surveys within the general context of farm management research.

The second part of the chapter examines in greater detail the main types of farm survey in use. Particular attention is paid to their suitability for investigation of farm management problems and new management practices.

The final section describes the farm survey carried out by the author in Wairoa County.

3.2 Farm Management Research

Any farm management problem may be classified according to whether or not it arises as a result of changing technology. Thus one problem may be concerned with adjusting farm operations optimally to a given technology, while another problem arises from attempts to adjust to a change in technology.[1] In a dynamic agriculture most farm management problems are likely to derive from changing technology, and farm management research

---

1. In production economics parlance the first type of problem is described as re-allocating resources to attain the optimum point on a given production function. The second problem concerns movement to a second, 'higher', production function.

workers will be concerned principally with foreseeing, evaluating and testing new management practices. Methodological research, which involves the development of new ways of analysing management problems, is an integral part of farm management research.

Thus, it is possible to identify four main fields on which farm management research may concentrate. These are:

(i) Evaluation of results from technical experiments

This concerns the evaluation of technological information generated at experiment stations, and integration of this information into farm management systems. Simple budgetting or more sophisticated mathematical programming may be used to suggest the outcome of incorporating new technology into management systems.[2] Where a complete change in management is suggested by a new technology, a small farm experiment may be necessary to evaluate the system before it can be recommended to farmers.

Alternatively, research may be aimed at transforming technical information into a form that is intelligible to farm managers. An example of this type of research is Townsley's [6] derivation of a technical production function from pig-feeding data.

Two major difficulties are associated with this field of farm management research. The first is that information obtained from experiments designed to answer 'technical' questions may be in a form which does not lend itself to management interpretation. Dillon [7] has described

---

2. Linear programming has been used by Frampton [5] to estimate the outcome of adopting a sugar-beet enterprise on mixed farms in Southland.

the contrast between the approach to experimental design that is taken by technical research workers, who seek to establish 'significant differences' between responses to a few discrete levels of inputs, and the approach favoured by farm management research workers, whose interest lies in estimating response surfaces over ranges of inputs. The second difficulty is that experiments conducted under controlled environments may not closely approximate on-farm conditions. This problem has been discussed by Swanson [8].

(ii) Small farm experiments

The use of small farm experiments in farm management research has also been discussed by Brougham, Candler, and Wright [9], and by the Southern Farm Management Research Committee [10]. Further discussion of small farm experiments in this thesis is deferred to Chapter 11.

(iii) Methodological research

This may involve new ways of analysing management problems or it may be concerned with the apprlication of new computational techniques to established analytical procedures.[3] Production-recording and budgetting by electronic computer are examples of the latter type.

(iv) Collection and analysis of data from farms

Research of this type is generally described as a farm survey. The various types of farm surveys are examined in more detail in the next section, but it is relevent to note here that they may form the basis of farm recording studies, project evaluation, evaluation of new

---

3. The study of grazing management simulation reported by Arcus [11] is an example of 'applied' methodological research. The work of Candler and Townsley [12] in the field of quadratic programming could, on the other hand, be regarded as 'pure' or 'non-applied' methodological research.

technology in farming, and the study of barriers to increased production. Thus, farm surveys occupy an important place in farm management research. They may be of importance per se, or they may suggest the need for technical experimentation, or that particular management practices should be tested on small management farms. Moreover, scope always exists for improvement in the methodology of farm surveys. Candler [13] emphasised the importance of farm surveys when he stated:

> 'Farm Surveys may be the best, indeed the only way of collecting information on the success of new practices at the farm level'.

3.3 Farm Surveys

The farm survey research technique is not a modern development. Indeed, considerable experience with farm surveys was obtained in the U.S.A. prior to World War I. The principal survey-type studies during this formative period were:[4]

(i) The Cornell Cost Studies, published in 1902 and 1903, which investigated costs on poultry farms.

(ii) The Minnesota Cost-route Studies, inaugurated in 1906.

(iii) The use of Farm Record and Farm Account books, introduced by the U.S. Department of Agriculture in 1911. The main purposes of this recording was to secure regular and general collection of information for demonstration work.

(iv) Farm Management surveys, undertaken by workers at Cornell University, beginning in 1911. Many of the techniques developed in these surveys, for which Warren [5] was principally responsible, are still in general use today.

---

4. A comprehensive description of the history and development of farm surveys will be found in Case and Williams [14]. Wesney [15] has prepared a detailed summary and review of the history of farm surveys.

5. See reference [16].

Warren and Livermore [17] defined the basis of the farm survey research technique as follows:

> 'Agricultural survey work in its various phases is a recognition of the immense fund of information that has been secured as a result of experience and experiment on farms. It is an attempt to make use of this knowledge and to separate the truths from the superstitions' .

Warren [16] was even more explicit when he wrote:

> 'Every farm is an experiment station and every farmer a director thereof.'

The farm survey technique established by these early workers has evolved into two quite disparate groups of survey types. Surveys in the first group are variously known as descriptive or exploratory surveys[5/], enumerative surveys[6/], and farm recording surveys. This group is described in Section 3.31. The other group contains the so-called 'interview' or management surveys. These are discussed in Section 3.32.

3.31 Descriptive or recording surveys

The principal feature of these surveys is that they are designed to obtain information about farms and farmers. The information required is rigidly defined before the survey commences. Each farm visit or interview is restricted to the questions appearing on a prepared questionnaire. The last point implies that provided the interviewer is instructed on how to put each question to farmers he need not be trained in either agriculture or farm management. This possibility of performing descriptive surveys with clerical workers is the main feature distinguishing them from interview surveys.

Within this survey group there are two distinct sub-classes. Candler [18] has termed one sub-class as Descriptive or Exploratory Surveys.

---

5. This terminology has been used by Candler [18].
6. Schapper [19] has used this term.

Here, surveys are conducted on an ad hoc basis because there is a felt need for 'more information' about a particular topic. There is no clear indication of where the information will be used, or who will use it. Consequently, there is no clear guide as to what information should be collected, or how the data collected should be analysed.

The second sub-class, Farm Recording Surveys, have been used extensively in New Zealand and in the United Kingdom.[7] They differ from the descriptive surveys described above solely because they are conducted on a continuing basis. That is, particular classes of information are regularly sought from particular classes of farms.

An insight into farmers' management practices and problems can be gained only after discussion with farmers. Since descriptive and recording surveys adhere to a fixed questionnaire, unusual farm management practices are unlikely to be gathered by them. Indeed, if clerical staff is used for interviewing, any 'asides' by the farmer concerning his management will be lost.

The pitfalls inherent in obtaining farm records without reference to the management system from which they were derived, and the use of this data without implicit knowledge of the underlying management problems, have been discussed by Candler and Sargent [21].

3.32 Interview or management surveys

Schapper [19] has defined interview surveying as a technique ....

> '... to obtain subjective data such as attitudes, intentions, expectations, and motivations. In this type of survey a high degree of interviewing skill and appreciation of interviewing as a scientific procedure are pre-requisites for reliable results.'

---

7. See reference [20].

This definition is narrow because it ignores the possibility of obtaining objective information (on inter alia stock numbers, stock performance, sales, purchases, crop yields, fertiliser usage, labour requirements, and financial data) concurrently with the subjective data. Schapper's second point is, however, of the first importance, as Candler [18] has also argued. Clearly, the interviewer must be trained in technical agriculture and farm management. Without this training the interviewer cannot acquire the necessary deep understanding of each farmer's management system.

In interview surveying there can be no fixed interviewing pattern; the interview must be of the 'free-form' type with discussion allowed to move freely from topic to topic. The interviewer must, of course, ensure that all important topics are discussed. This form of surveying implies that the interviewer must gain the farmer's confidence.[8/] In this respect, inspection of the farm is helpful.[9/] Thus the free form style of interviewing tends to be very time-consuming and in practice a full day is set aside for each interview.[10/]

The last point introduced another important feature of this surveying technique; that only a small sample of farmers can be visited in a reasonable space of time when the aim is to learn from farmers rather than about

---

8. This point was established by Warren, who reported that it was essential to have rapport between the research worker and the farmer. Warren suggested that an effective way of enlisting a farmer's co-operation was to assist him with his farm chores before starting the survey interview.

9. Of course, an inspection of the farm is also essential if an adequate understanding of management practices is to be obtained.

10. This is in contrast to the time required for 'farm recording' interviews, the duration of which is dependent only on the length of the questionnaire. Up to five interviews may be completed in a day.

them.[11/] A further justification for the 'small sample' survey is the need for the research worker to be able to visualise the farm (and farmer) when analysing the records of an interview, possible several months later.

Candler [18] has identified three types of management survey, which differ only in their objectives. The types are:

(i) Research or Pre-release surveys, where the investigator has a definite change in management practice in mind, but as yet no farmers have made the change. There is therefore no possibility of learning from farmers' experience. In this case, the management survey will be used to give a clear picture of what farmers are currently doing. The research worker then attempts to synthesise a picture of a management system incorporating the change, and to estimate the profitability of farming with the new practice.[12/] Frampton's [5] study of the economics of establishing a sugar beet industry in Southland included a good example of a Pre-release farm survey.

(ii) Post-release or Early-adoption surveys, which are used when we are interested in farmers' experience with a new practice. It is important to time the survey so that a few farmers have useful experience but before a majority of farmers have made the change. Once again the objective is to estimate the profitability of the new management system, but at the same time the research worker attempts to define exactly what pre-conditions are

---

11. This feature of modern interview surveying contrasts markedly with Warren's technique, which involved large samples, usually in excess of 500 farms. Warren held that data from a large sample would 'bury' any atypical management features of any one farm. Modern interview surveys, by searching for unusual management systems, and analysing them in detail, take a directly opposite approach.

12. The concept of 'profitability' is defined and discussed in Section 3.532.

necessary for success and what associated management changes are necessary.[13]

It is important that the innovating farmers need not be in the region or district being surveyed. It is of course, desirable that the farming environment[14] facing farmers in the region is similar to that faced by innovating farmers. For slight disparaties, the research worker can make subjective adjustments, but should he not be confident in this, or if environmental differences are large, a management experiment farm may be set up in the surveyed region to test the new management system under the conditions prevailing in the region.

(iii) Non-adoption or Behaviourist surveys in which we are interested to know what some farmers continue to refrain from adopting a new management practice.[15]

3.4 The Wairoa County Farm Survey

In the following sections the nature of the survey (that is, its definition in terms of the descriptions appearing in Section 3.3), and its organisation are described. A final section outlines the way in which data obtained in the survey was analysed.

3.41 The nature of the survey

The objectives of the study, stated in Chapter 1, implied that the survey was primarily concerned with examining hill country farm management practices

---

13. Graham's /22/ study of the economics of high rates of fertiliser on South Taranaki dairy farms was based on an Early-adoption survey.

14. 'Farming environment' is defined in Section 2.1.

15. Cronin's /23/ current study of the factors inhibiting high production on some dairy farms on the Rangitaiki Plains, is based on a Non-adoption survey.

and problems. This requirement obviously ruled out a descriptive or enumerative survey. The interview survey carried out cannot be classified precisely according to the definitions in Section 3.3. While principally of the Early-adoption type, the survey had some aspects in common with Behaviourist surveys.

Thus the survey sought to establish a clear picture of popular management practices in the County and to identify any new practices being followed by innovating farmers (farmers developing their properties) both in the County and on comparable country outside the County. In addition, the survey was designed to identify any strongly and widely held farmer attitudes that were precluding farm development.

3.42 Selection of farms

As described in the last paragraph two distinct types of management information were required; that pertaining to the popular management practices in use to maintain production levels (that is, 'bench mark' management practices), and the information associated with management changes on farms that were increasing production rapidly. Thus it was necessary to select two groups of farms; a Random Group to examine bench-mark management and a Purposively Selected Group to investigate the experiences of farmers who had attempted to increase production rapidly.

3.43 Selection of Random Group farms

Farms in the Random Group (henceforth referred to as 'Random Farms') were selected from registers held by the Valuation Department. The 'field slips' filed by this Department were found to be the only list of holdings that identified hill country farms adequately.

The Valuation Department classifies sheep farms into "grazing" and "fattening" units with the "grazing" class corresponding closely to the author's definition of hill country farms.[16]

Field slips are grouped according to the eight ridings of the County. Before a sample was drawn from each riding, ineligible holdings were excluded on the following basis:

(a) All holdings not being used for pastoral farming were identified and excluded. These holdings included properties supporting forest and bush of commercial value, and residential sections.

(b) All dairying holdings were excluded.

(c) All Maori land held under multiple ownership, trusts, or as incorporations was excluded. This was done for two reasons. First, it was often found to be impossible to aggregate Maori holdings into farm units for sampling purposes, and secondly, it was felt that farm management on these holdings was influenced by problems peculiar to these forms of tenure. While it is thought that increased production on these properties would probably involve management changes similar to those necessary on other farms, an investigation of the special problems associated with Maori land tenure was felt to be beyond the resources of this study. The development of Maori-farmed land could well be the subject of a later separate study.

(d) All remaining "fattening" units were examined, and those not corresponding to the author's definition of hill country farms were excluded.

---

16. The author is aware that the definition of a 'hill country farm' must necessarily be arbitrary. For the purposes of this study a hill country farm was defined as one on which land of steep ploughable and unploughable contour totals at least two-thirds of the area.

(e) Finally, some holdings still included were classified by the Valuation Department as "uneconomic". This classification was found to be rather arbitrary, because it included small self-contained farms as well as "run-off" holdings, and small areas of waste land. All such field slips were examined and any holdings which did not represent a self-contained hill country farm or part of one, were excluded. This criterion excluded all holdings of less than 10 acres which were owned by wage or salary earners who spasmodically grazed a few head of stock.

The 304 field slips remaining represented hill country holdings in at least nominal pastoral production and either leased or owned by Europeans or farmed by owner-operator Maoris.[17/]

A sample representing selection of one in every twelve eligible farms was then drawn by the following procedure:

(1) field slips were suffled thoroughly, followed by

(2) the assembly of slips into stacks of twelve,

(3) one marble was drawn at random, from a group of twelve, and

(4) the farm corresponding to the drawn marble was selected from each stack of slips.

This procedure resulted in selection of twenty-five farms of which

---

17. This number of remaining field slips agreed closely with the number of hill country farms identified from the records of a stock and station firm. This informal 'census' taken during preliminary discussions about the farm survey, yielded 286 farms.

twenty were actually surveyed.[18] Table 3.1 indicates the fate of the original selections.

Table 3.1 Fate of Random Selections

	Number of farms
Farms surveyed	20
Non-co-operative owners	2
Owner could not be located	1
Records unavailable (ownership recently transferred)	2
Total	25

Farmer co-operation was excellent. Both "non-co-operative" owners were keen to have the author inspect their farms, but due to aspects of their financial arrangements did not feel able to provide the required financial information.

3.44 Selection of Purposively Selected farms

Selection of these farms (henceforth referred to as 'Purposive Farms') rested on the criterion that attempts were being made to increase production at a rate that was high in relation to County practice. The aim of the survey was to take a census of farms on which notable development had taken

18. Had wide variations in 'standard' management practice been evident, a further sample could have been taken in order to examine all important practices. Conversely, in a case where all farms had near-identical management, a small sample would be satisfactory.

place, or had been attempted, in recent years.

A tentative list of such farms was first obtained during discussion with Mr E.S.Ayson, the Farm Advisory Officer of the Department of Agriculture, stationed at Wairoa.[19] Subsequent discussion with stock firm managers, bank managers and Federated Farmers helped to confirm or reject some of the original nominees.

Some difficulty was initially encountered in identifying farmers in this group, the main problem being the confusion of relatively prosperous farmers maintaining production at static levels (which were sometimes high and sometimes low), with those who had actually increased production or were planning to do so. This difficulty resolved itself as the survey progressed. As the author became more familiar with the County and heard the opinions of more farmers and businessmen, farmers engaged in developing their properties, were gradually identified and visited.

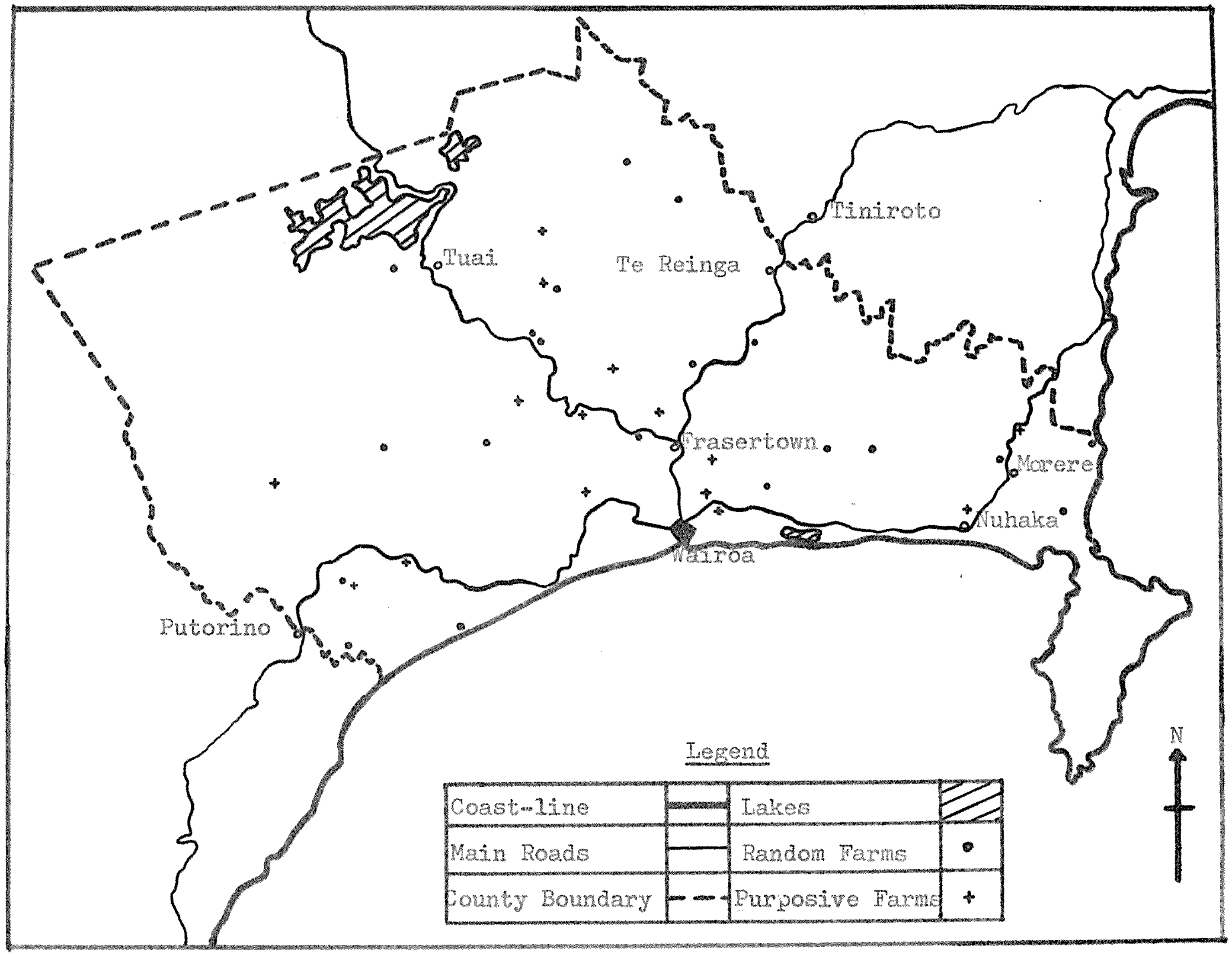
The writer is confident that few, if any, farms on which notable efforts to increase production have been made in recent years, were omitted from the sixteen 'purposively selected' farms surveyed.

There was not, of course, any necessity to identify all Purposive Farms at the beginning of the survey. In fact, had the author heard of additional farms after the survey had been otherwise completed, they would have been visited.

---

19. Shortly after this discussion, Mr Ayson transferred from Wairoa, but at the time he had had eight years' experience in Wairoa County.

Figure 3.1 Location of Farms in the Survey



3.45 Interviewing procedure and experience

First contact with farmers was made by a letter sent one to three weeks before the intended visit. The letter, which was identical for all farmers, was intended to explain briefly the nature and purpose of the survey, to request co-operation, and stated that farmers would be contacted by telephone within two weeks. The letter is reproduced in Appendix A.

Telephone calls, aimed primarily at fixing suitable times for farm visits, were made at least two days prior to each visit.

In nearly all cases farmers showed interest and enthusiasm during the telephone call, and were pleased to co-operate. All farmers were prepared to devote at least half a day to the interview, while many agreed to provide a full day.

The nature of the free-form interviews varied widely, although each consisted of two main parts, these being an inspection of the farm, and a period spent recording data. Free-ranging discussions with the farmer usually continued throughout the interview.

In the author's experience, rapport with the farmer was more rapidly established when out on the farm. Efforts were therefore made to open each interview with a farm inspection. Of prime importance in each interview was an effort to encourage the farmer to feel confident in discussing his opinions and problems as early as possible.

Many farmers had copies of stock and production records and farm accounts in their homes. When time permitted, these were examined and summarised during the interview. Otherwise, they were borrowed, or where necessary, authorities to visit accountants were obtained.

Free-form interviews cannot be conducted according to a pre-designed questionnaire. In this survey a "data sheet" was used. This incorporated a section facilitating rapid transcription of data from accounts and stock records. A second section consisted of broad headings concerning the topics likely to be discussed. These provided an orderly format for post-interview notes and their recollection constituted a mental check list during interviews. A facsimile of the data sheet used appears in Appendix B.

The general pattern of interviews closely paralleled experiences reported by Graham [22] and Wright [24].

3.5 Analysis of Survey data

This section contains brief outlines of the methods used to analyse the survey data.

3.51 Basic information

Basic data concerning farm size, tenure, responsibility for management, topography, land use, stocking levels, and production levels, was collated directly from interview records. This information appears in Chapter 4.

3.52 Management practices

Details of stock management and pasture management practices on every farm surveyed, were recorded. These records were condensed to the discussion contained in Chapter 5. Similarly, details of land development methods and other management changes associated with increasing production were obtained from the survey of Purposive Farms. Wherever appropriate, development methods were budgetted. Comparative budgets are included in the discussion of land development methods in Chapter 5.

3.53 Financial analysis

Analysis of the survey data included both the estimation of the current financial position of Random Farms and an estimation of the profitability of developing farms by the methods being followed in Wairoa County. Some aspects of the rationale of these analytical procedures merit particular attention.

3.531 Standardised costs and prices

As explained in Chapter 7, all financial analyses were made using standardised prices and costs. That is, particular price and cost levels assumed by the author were applied to the physical production data recorded in the survey. This procedure has two main advantages. First, the misleading results which could be obtained from the survey as a whole by adopting actual prices and costs when these are inflated or deflated by atypical short-term market forces, are avoided. By adopting the prices and costs thought most likely to recur in the future the results of analyses can be regarded as "those most likely to occur in the future given the observed production relationships". Secondly, standardisation of costs and prices prevents the analysis of one farm being biassed with respect to other farms by virtue of receiving high or low prices by chance. Thus it is likely that corresponding financial features of different farms can be more meaningfully compared when standardisation is used.

There are some disadvantages of price and cost standardisation. For example, the procedure may obliterate the genuine premiums obtained by farmers with higher than average skill in trading stock, although the survey interviewer should be able to 'allow for' this.[20] Further, it may be claimed that the researcher's price and cost forecasts are 'poor'. Once again, he must be relied upon to produce a reasonable estimate.[21] In any case, recourse may be made to repeated analyses at several discrete price and cost assumptions,[22] or by estimating variations over ranges in prices and costs (as is done in Chapter 8). By using more than one price the sensitivity of outcomes to different prices may be estimated.

3.532 Profits and profitability

While most readers will feel that the general meanings of 'profit' and 'profitability' are obvious, their precise connotations in the context of this study, merit discussion.

---

20. No farmers in the survey were sufficiently atypical to warrant special modification of the assumed costs and prices.

21. It is certainly difficult to claim that any 'actual' price levels are more likely to recur in the future than those assumed after reference to price trends.

22. This implies use of the techniques of 'parametric budgetting' suggested by Candler [25].

In particular, it is important to appreciate that profit may accrue to farmers in two forms; as cash, and as additions to capital value (asset increments). Further, the effects of taxation on profits must be recognised. This introduces the notion that the net benefits accruing to the Nation[23] from a farm's operation may differ from the benefits received by the farm operator.

Profit may be defined in general terms as the excess of revenue over expenditure in a given time period. Note that no reference is made to the form of revenue or expenditure. It then follows that profitability refers to the inherent ability of an enterprise to generate profit in a given time period.

However, farm revenue has two separate components; cash, and increments to capital value, which give rise to corresponding components of profits. These components are, of course, quite different in their utility or 'usefulness' to the farmers receiving them.[24] Cash profits are immediately available for consumption by the farmer, or for investment on or off the farm. Asset increments, on the other hand, are 'tied up' in the farm and can be released for consumption or alternative investment only when the farm is sold or when a mortage is raised with the farm as security.[25]

Turning now to the effects of taxation on farm profits, an immediate observation is that cash profits and asset increments are taxed differently, with respect to the timing of liability, the rate of taxation, and the concessions and strategies available to reduce liability. This ensures that

23. 'Nation' is here synonymous with 'community', or 'the country as a whole'.

24. On the other hand, asset increments can be expressed in terms of additional cash profits, as is demonstrated in Chapter 6.

25. Of course, asset increments may well add to non-economic satisfactions based on price of acquisition, immediately after they are obtained.

farmers with different family structures and tenure arrangements will differ in their preferences for cash profits or asset increments. However, no matter how taxation is exacted, it is clear that the cash profits accruing to the Nation will exceed a farmer's profits by the amount of current taxation paid.[26] This point, while doubtless obvious, has some implications that are less obvious, but very important. They are discussed in detail in Chapter 9.

A similar, though more obscure, argument applies to asset increments. The Nation is 'interested' only in the productive value (that is, the future pre-tax profitability) of new assets, but an individual farmer is more concerned with the market value of any new assets. Two observations emerge. The first is that 'potential taxation' is an integral part of any farm sold, so that the market value of a farm should be expected to be lower than its productive value to the Nation. Secondly, receipts from the sale of a farm are almost invariably liable to estate duty at a future point in time. Thus, taking both effects into account, the value of asset increments to a farmer is in most circumstances likely to be lower than their value to the Nation.

3.533 Ex poste and ex ante analysis of profitability

An ex poste analysis of profitability is performed on historical data derived from a case-study. That is, information concerning the actual production on a farm in past years is collected (perhaps by an interview farm survey) and the profitability of undertaking this production is analysed. Two conventions with respect to prices and costs are possible. The use of

---

26. This gives meaning to the terms 'pre-tax cash profits' and 'post-tax cash profits'.

actual prices and costs (converted to real terms) enables the research worker to make statements such as, 'this was the profitability of this enterprise to this farmer'. Alternatively, the use of standardised prices and costs [27/] allows a statement of what the profitability of the enterprise could be expected to be if it were undertaken now.

By contrast, an ex ante analysis of profitability is performed on forecasted production situations using forecasted prices and costs.

The plausibility of forecasted production situations analysed ex ante may always be questioned simply by virtue of the fact that they 'have not happened'. However, ex ante evaluations are useful in examining the effect of hypothetical changes in established management practices.[28/]

By contrast, provided that it is accurately recorded, the validity of data for ex poste studies cannot be questioned, although it may reflect management decisions that were made in the light of peculiar conditions. For example, very high wool prices or a very severe drought, neither of which are expected to recur with regularity, may be responsible for exceptional management practices. In an ex ante analysis using standardised prices, these would be replaced by more 'normal' practices.

In the author's view, both approaches have a place in a study such as the present one. Ex poste evaluations are necessary to demonstrate the profitability of currently popular practices, although care must be exercised in avoiding as far as possible the analysis of practices that

---

27. See Section 3.531

28. It is noteworthy that evaluations of forecast budgets will allow no more than the formulation of hypotheses, which should then be tested in practice.

were prompted by atypical climatic or economic conditions.

Ex ante studies are then required to evaluate suggested improvements to management systems. If no one farmer has yet used all of the management practices in the way that the research worker feels would be most profitable, the *only* way for the worker to evaluate his ideas immediately, is by the use of an *ex ante* budget.

In cases where development work is incomplete, an evaluation may include both *ex poste* analysis of the records available and an *ex ante* appraisal of anticipated management.

If the objective of a study is to provide management advice for farmers, there is little point in evaluating historical data unless the analysis suggests how the corresponding practices could be expected to perform in the future. For this reason, standardised prices are more relevant than actual prices in *ex poste* analyses.

Examples of *ex ante* and combined *ex poste-ex ante* analyses will be found in evaluations of case development programmes in Chapter 7. The model programme in Chapter 8 is an example of pure *ex ante* analysis.

3.54 Attitudes to development

During discussions with farmers in the survey the author formed some strong impressions concerning farmers' attitudes to various aspects of farm development. While it is not claimed that these impressions are strictly valid, it is felt that they provide a guide to farmers' attitudes in Wairoa. They are recorded in Chapter 5.

CHAPTER 4

PRODUCTION AND INCOMES ON WAIROA HILL COUNTRY FARMS

4.1 Introduction

The ensuing section gives an account of the major features of the organisation of farms on Wairoa hill country. This section considers all farms in the survey. Further sections deal with some aspects of farm labour, topography land use, stocking rates, production levels, and incomes. The data in these sections was derived mainly from the survey of Random Farms. Finally, production increases on Wairoa hill country are discussed. This discussion includes a review of recent production increases, reports farmers' estimates of production increases, and outlines some farmers' attitudes to farm development.

4.2 Farm Organisation

This section reports the size, tenure, and form of management, on each farm in the survey.

4.21 Size of farms

Farm size in Wairoa County varies widely. Farms in the survey ranged from 420 to 10,735 acres. The areas of individual farms are given in Tables 4.1 and 4.2.

Four (20%) of the Random Farms covered less than 1,000 acres, while 50% had areas between 1,000 and 2,000 acres. Three of the remaining farms covered just over 2,000 acres, while the larger farms in the County were represented by units of 3,021 acres, 5,650 acres and 10,735 acres. Thus the survey suggested that over half of the hill country farms in the County cover less than 2,000 acres.

Table 4.1 Size, Tenure, and Responsibility for Management of Random Farms

Farm Number	Total Area (acres)	Tenure	Responsibility for Management
1	1,038	Crown Lease	Owner
2	1,398	Freehold	Owner
3	561	Freehold	Owner
4	3,021	Freehold	Owner
5	1,936	Freehold	Owner
6	786	Freehold	Owner
7	2,183	Freehold	Manager
8	10,735	Freehold	Owner
9	1,600	Freehold	Manager
10	2,343	Freehold: 966 acres Crown Lease: 1,377 acres	Owner
11	2,177	Freehold: 800 acres Crown Lease: 1,377 acres	Owner
12	1,140	Freehold	Owner
13	747	Freehold	Owner
14	1,111	Freehold	Manager
15	5,650	Freehold	Owner
16	1,300	Freehold 800 acres Crown Lease: 500 acres	Owner
17	1,757	Freehold	Owner
18	1,375	Freehold	Owner
19	1,019	Freehold	Owner
20	674	Freehold	Manager
Average	2,128		

Table 4.2 Size, Tenure, and Responsibility for Management of Purposive Farms

Farm Number	Total Area (acres)	Tenure	Responsibility for Management
21	350	Freehold	Owner
22	946	Freehold	Owner
23	781	Freehold	Owner
24	1,235	Freehold	Owner
25	2,854	Freehold	Manager
26	560	Freehold	Owner
27	1,078	Freehold	Owner
28	798	Freehold	Owner
29	900	Freehold	Owner
30	1,257	Freehold	Owner
31	820	Freehold	Owner
32	1,304	Freehold	Owner
33	428	Crown Lease	Owner
34	920	Freehold	Owner
35	560	Freehold	Owner
36	2,177	Freehold: 800 acres Crown Lease: 1,377 acres	Owner
Average	1,074		

NOTE: Purposive Farm No.36 also occurred as a Random Farm, where it appears as Farm No.11.

As a group, Purposive Farms were noticeably smaller than Random Farms. This could suggest that over recent years the owners of the smaller farms have made greater efforts to increase production than the owners of relatively larger farms have made.

4.22 Tenure of farms

Land tenure of farms in the survey is also listed in Tables 4.1 and 4.2 All farms were either freehold or leased from the Crown. Land held under Deferred Payment Licence was regarded as freehold.[1] Freehold tenure was predominant, accounting for 92.4% of the total area of Random Farms. Only one of the farms in this group had no freehold land.

Thirty-three year term renewable leases were the most common type of Crown Land tenure, but one farmer had non-renewable tenancy (reviewed every five years) over part of his farm.

Other forms of tenure that occur in the County include private leasehold of Maori land and various forms of private leasehold and grazing-rights to land held by Europeans. However, none of these systems appeared on farms in the survey.

---

1. Land which has been leased from the Crown with permanent rights of renewal may be freeholded over periods ranging from ten to thirty years. Freeholding involves a compulsory initial payment of at least 3% of the unimproved value of the land, followed by payment of the remainder on a 5% table mortgage. This procedure requires a Deferred Payment Licence, which may be obtained for a nominal sum.

4.23 Responsibility for management

Responsibility for important day-to-day management decisions on Random Farms was found to be taken by either resident owners or hired farm managers. The third column in each of Tables 4.1 and 4.2 illustrates this feature. Resident owners were found on sixteen (80%) of the farms. The remaining four farms were run by managers for absentee owners.

To obtain further information on the extent of absentee ownership, the writer sought assistance from a Wairoa stock and station firm. The manager of the firm was able to identify most farms that corresponded closely to the author's definition of a hill country farm. He was then able to state whether or not these farms had absentee owners. Farms identified in this (possibly inaccurate) way totalled 286, of which 76 (27%) had absentee owners. It should be emphasised that these estimates were made on the basis of farm units. Since absentee ownership appeared to be more prevalent on larger farms, the author considers that more than 27% of the total area of hill country in the County is likely to have absentee owners.

Absentee ownership is not, of course, undesirable *per se*, since a hired manager may well have greater managerial ability than the non-resident owner. In spite of this, the author considers that resident owners are likely, by virtue of their more intimate association with their farms, to be more interested than absentee owners in increasing production.

4.3 Farm Labour in Wairoa County

This section begins with a description of the labour used on survey farms. This is followed by a more general discussion of the availability of farm labour in the County.

4.31 Labour used

In the Random Group, 16 farms (80%) had permanent employees. These ranged in ability from unskilled school-leavers, to experienced shepherds. Nineteen farmers employed contracted labour for shearing, and all farmers usually employed casual or contracted labour for fencing and scrubcutting.

One widely-recognised indicator of labour productivity on sheep farms is the ratio of breeding ewes wintered to permanent full-time labour units. This measure is, of course, only approximate because it fails to take account of the labour requirements of other stock classes. In effect, it is assumed that the supply of permanent labour always places an upper limit on the breeding ewe flock, while other stock classes never compete with breeding ewes for labour.

On Random Farms, the number of breeding ewes per full-time labour unit ranged from 500 to 1,306. The average was 800. On nine farms fewer than 700 ewes per labour unit were run, while the ratio exceeded 1,000 on only four farms.

The highest ratio observed on Purposive Farms was 1,530.

4.32 Availability of labour

At the time of the survey, only one farmer in the Random Group was actively enquiring for permanent labour. Although many other farmers claimed that there was a serious shortage of reliable labour in the County, none felt that they were understaffed at the time. However, several farms had relatively inexperienced shepherds in positions of responsibility. Numerous cases of experienced and able men leaving the land to take work in urban areas were reported to the author. Some movement of labour away from farming occupations should undoubtedly be expected when farm workers are mobile and financially independent, but the farm survey suggested that several specific factors currently conspire to encourage experienced farm workers to seek other occupations.

The most important of these factors are security of employment, security of residence, and problems with the secondary education of children. Farm workers should expect security of employment to result from their competence, and capacity for manual work, but the latter tends to decline with advancing age. The author believes that many experienced farm workers leave the land while they still feel young enough to master another occupation which promises to offer greater future security.

Insecurity of residency is likely to influence young, recently-married farm workers, who find that the opportunity to purchase urban dwellings (possibly by capitalising the family benefit), warrants the loss of satisfaction that may result from leaving rural employment.

Married farm workers often find it difficult to meet the cost of boarding children at secondary school. This is probably the foremost reason for the urban drift of experienced farm labour. In many hill country areas, transport services for secondary school children are either absent, or involve unacceptably arduous daily travelling. When they are unable to afford boarding fees, farm workers have no alternative to seeking employment closer to schools.

Apart from isolated examples of poor wage rates, remuneration to experienced farm workers was generally high, £18 to £25 per week plus a car allowance and a free house, being a typical wage. On the other hand, it was noticeable that in many instances, wages offered to relatively inexperienced young workers were not competitive with the rates offered by secondary and tertiary industries.

The requirement for casual labour was found to be generally well supplied in Wairoa County, although the availability of fencers and scrubcutters tended to decline during the summer and autumn due to seasonal demands for casual labour at the freezing works in Wairoa.

Most farmers in the survey reported the recent tendency for the Maori populations of rural villages to move to urban areas. This drift, which is apparently actively encouraged by the Department of Maori Affairs, has in some districts resulted in the apparently-permanent loss of reliable day-labourers employed on farms.

4.4 Farm Topography

In the farm survey, land was classified into the following topographical classes:

(i) Flat and rolling; contours over which a light wheel tractors can be safely driven,[2]

(ii) Steep ploughable; the remaining land negotiable by wheel or crawler tractor, and

(iii) Unploughable; land not negotiable by machinery.

Such a classification is necessarily arbitrary, and in the general absence of accurate farm maps, visual distinctions were made between classes.

The total area of Random Farms included 10% flat and rolling contour, 24% steep ploughable, and 66% unploughable.

Tables 4.3 and 4.4, in which a topographical analysis of all farms in the survey is tabulated, show that the topography of Purposive and Random Farms was not significantly different. The tables also show that there was considerable variability in the topography of individual farms. Excluding Farm No.34 (see the note in Table 4.4), the proportion of flat and rolling land on farms ranged from zero to 31%, while steep ploughable contours constituted from 3% to 51%, and unploughable areas ranged from 34% to 93%, of total areas.

Nine farms of the thirty-four that can be considered, had less than 25% of their areas ploughable, but only four had more than 50% of this contour.

---

2. The author emphasises that this topographical class is one over which he believes a light wheel tractor can be safely driven.

Table 4.3 Topography of Random Farms

Farm Number	Flat and Rolling	Steep Ploughable	Unploughable
1	11	29	60
2	7	14	79
3	29	9	62
4	5	33	62
5	23	43	34
6	Nil	13	87
7	Nil	27	73
8	5	18	77
9	6	25	69
10	Nil	21	79
11	15	23	62
12	4	26	70
13	20	27	53
14	4	40	56
15	27	18	55
16	2	23	75
17	Nil	11	89
18	7	35	58
19	21	39	40
20	6	25	69
Aggregate	10	24	66

Note: Topographical classes are expressed as percentages of total farm area

Table 4.4 Topography of Purposive Farms

Farm Number	Flat and Rolling	Steep Ploughable	Unploughable
21	Nil	51	49
22	16	3	81
23	26	38	36
24	12	30	58
25	5	24	71
26	7	11	82
27	11	28	61
28	19	26	55
29	Nil	7	93
30	24	24	52
31	31	24	45
32	27	12	61
33	21	24	55
34	43	46	11
35	Nil	11	89
36	15	23	62
Aggregate	16	21	63

Notes: 1. Farm No.34, while not a hill country farm by definition, was visited because notable development of steep hills had been done on it.

2. Topographical classes are expressed as percentages of total farm area.

4.5 Land Use on Farms

The land use categories used in this study were:

(i) Grazeable pasture; land that is accessible to stock and which supports grasses and herbaceous legumes,

(ii) Unproductive land capable of development; land that is infested with weeds or bush, but which could be developed to support grazeable pasture, and

(iii) Permanent waste-land; land that is occupied either by buildings and yards, or which could not possibly support grazeable pasture. Areas of gorges, streams, and scarps are included in this category.

Table 4.5 contains an analysis of land use on Random Farms.[3/] Accuracy in determining land areas suffered from the lack of reliable farm maps, and an additional difficulty was the need to estimate the extent of unproductive areas in paddocks supporting both pasture and scattered scrub. The areas finally assessed represented a concensus of the opinions of the farm owner or manager, Valuation Department field staff, and the author.

Sixty-five percent of the total area of Random Farms was grazeable pasture, while 31% was unproductive land capable of development, and 4% of the area was permanent waste-land. Thus 96% of the area of Random Farms was either in pasture or was capable of development.

---

3. Land use data for Purposive Farms was not included because land use is dependent on management, and these farms were selected on the basis of having better than average management. Their inclusion would therefore have biassed the required general appreciation of hill country land use in the County.

Table 4.5 Land Use on Random Farms

Farm Number	Grazeable Pasture	Unproductive - Capable of Development	Permanent Waste
1	76	19	5
2	78	18	4
3	99	Nil	1
4	40	57	3
5	75	23	2
6	76	17	7
7	83	12	5
8	62	32	6
9	65	32	3
10	40	56	4
11	88	9	3
12	92	5	3
13	67	30	3
14	54	35	11
15	56	42	2
16	47	51	2
17	68	29	3
18	78	19	3
19	94	5	1
20	91	7	2
Aggregate	65	31	4

Note : Classes are expressed as percentages of total area.

4.6 Farming Enterprises and Stocking Rates

All farms in the survey ran sheep and beef cattle. The variations in husbandry practices and stock policies, are discussed in Chapter 5. The following subsection describes the stocking rates on the Random Farms.

4.61 Stocking rates

Every farm in the survey was running several classes of both sheep and cattle. Since the feed requirements of the different types of stock obviously differed, a method for aggregating stocking classes was necessary. The co-efficients actually used to convert stock wintered into ewe equivalents (EE) are given in Table 4.6.

Table 4.6 Stock Conversion Coefficients for Stock Wintered

Stock Class	EE per Animal
Ewe Hogget	0.75
Wether Hogget	0.75
Adult Breeding Ewe (2th. and older)	1.00
Adult Ram (2th. and older)	1.00
Adult Wether (2th. and older):	
(i) When stocked at or below 3 EE per acre	0.50
(ii) When stocked at or above 6 EE per acre	0.75
Rising one-year cattle	3.00
Rising two-year cattle	4.00
Cattle two years and older	5.00

Note: A discussion in the text explains the variable coefficient for adult wethers.

The coefficients are substantially similar to those used by the N.Z. Department of Agriculture, and by Wright [24]. Exceptions to the Department's recommendations include the inflation of the hogget to 0.75 EE from 0.50 EE, and the assumption of a variable coefficient for adult wethers. Wright used the modified hogget coefficient, but assumed a fixed coefficient 1.00 for adult wethers. The author's assumption of a variable coefficient for adult wethers is based upon the views held by Mr J.N.Tripe, a leading farmer on Wanganui hill country. Mr Tripe believes that at a stocking rate of 3 EE per acre, three breeding ewes and six adult wethers have equivalent feed requirements, but that at a stocking rate of 6 EE per acre, six ewes and eight wethers have equivalent requirements for feed. That is, when stocking at 3 EE per acre, an adult wether represents 0.5 EE, but if it is stocking at 6 EE per acre, it represents 0.75 EE.

A more detailed analysis of this hypothesis appears in Appendix C. The hypothesis was accepted for use in this study because it appeared to be more reasonable than the constant conversion coefficients used by other workers. It should not, however, be regarded as the right method for converting adult wethers to EE; further empirical information could dictate a modification to it.

The critical feed period in Wairoa County occurs during late winter/early spring.[4] Consequently, the stocking rates on farms in the survey were calculated from winter stocking levels. The stocking rates for Random Farms are

---

4. Some farmers have occasionally been obliged to make unplanned sales of breeding stock during summer dry periods, but the author considers that these summer feed shortages were principally due to inflexible stock policies. This point is pursued further in Chapter 5.

shown in Table 4.7. No violent climatic fluctuations, which might have affected stocking rates, occurred in the year prior to the winter of 1965.

Table 4.7 Stocking Rates on Random Farms (Winter 1965)

Farm Number	Stocking Rates			Sheep EE per Productive Acre	Ratio: Sheep EE / Cattle EE
	EE per Productive Acre	EE per Potentially Productive Acre	EE per Acre of Total Area		
1	3.39	2.71	2.58	1.99	1.4
2	3.43	2.79	2.68	2.00	1.4
3	3.32	3.32	3.29	1.86	1.3
4	3.84	1.58	1.52	2.33	1.6
5	4.01	3.06	3.00	2.45	1.6
6	3.89	3.21	3.00	2.68	2.1
7	2.69	2.36	2.26	1.48	1.2
8	2.47	1.6[illegible]	1.54	1.37	1.2
9	2.59	1.74	1.69	1.83	2.4
10	3.18	1.32	1.26	2.05	1.9
11	2.14	1.94	1.90	1.41	1.9
12	3.07	2.90	2.81	1.90	1.6
13	3.31	2.28	2.22	2.28	2.2
14	2.90	1.76	1.57	2.08	2.5
15	2.47	1.43	1.40	1.45	1.4
16	2.32	1.12	1.09	1.26	1.2
17	2.20	1.54	1.50	1.43	1.8
18	2.56	2.06	2.01	1.53	1.5
19	2.98	2.84	2.81	1.84	1.6
20	2.91	2.69	2.65	1.98	2.1
Average	2.98	2.21	2.14	1.86	1.7

In Table 4.7 stocking rates are expressed in three forms. The first column indicates the stock that were being run on each acre of grazeable pasture. Only one farm was carrying more than 4 EE per acre, eight were carryying between 3 EE and 4 EE and eleven had not attained 3 EE per acre. The average for Random Farms was 2.98 EE per acre.

The second column expresses stocking levels with respect to areas that were potentially productive.[5] These figures allow meaningful comparison between present stocking rates and estimated potential rates. On this basis only three farms carried more than 3 EE per acre, while nearly half the farms had stocking rates of less than 2 EE per acre. The average was 2.21 EE per acre.

Stocking rates expressed in terms of total farm area, as indicated in the third column, are less meaningful because the farms had differing proportions of permanent waste.[6]

The column showing the rates at which sheep alone were stocked indicates that only seven farms were carrying more than 2 sheep EE per productive acre.

Considerable variability in the ratio of sheep EE to cattle EE is indicated in Table 4.7. No important conclusions can be drawn from these ratios though, in general, they are probably lower than in many other North Island hill country districts. Later chapters will suggest a new management system which would involve a substantial increase in the proportion of sheep to cattle.

---

5. This area was the sum of the grazeable area and the area that was unproductive but capable of development.

6. See Table 4.5

4.7 Production

Wool production, lambing and calving percentages, and lamb fattening performances on the Random Farms are shown in Table 4.8.

Wool production relates to the 1963/64 financial year, but lamb fattening, and calving and lambing percentages refer to the 1964 breeding season. In most cases these production periods were the most recent for which records were available. The coastal areas of the County suffered a mild drought during the summer of 1964, but the farmers in these areas did not think that this had greatly affected production.

In Table 4.8 production is expressed in three forms; as production per acre of grazeable pasture, production per acre of potentially productive land [7], and production per breeding ewe.

Lambing percentage is defined on the basis of lambs docked and ewes put to the ram, and calving percentage is defined on the basis of calves docked and cows put to the bull.

The wool production data revealed that fifteen farms were producing less than 20 lbs. per acre of grazeable pasture, and only one was producing more than 30 lbs. Wool production per acre of potentially productive land was, of course, even lower, 24 lbs.per acre being the highest recorded, while fifteen farms had failed to attain 17 lbs. per acre. The imputation of the whole wool clip to the breeding flock provides a somewhat misleading comparison of per animal production on different farms. This is due to variations in dry sheep stocking policies and shearing policies.

In spite of this analytical deficiency, the results illustrate that wool

---

7. See footnote No. 5.

Table 4.8 Stock Production on Random Farms

Farm Number	Wool Production (lbs.)			Lambing %	Calving %	Lamb Fattening Performance (% wether lambs fattened)
	Per Acre of Grazeable Pasture	Per Acre of Potentially Grazeable Pasture	Per Breeding Ewe			
1	20.7	15.5	15.1	90	95	75
2	17.2	14.0	12.1	93	97	95
3	19.0	18.8	10.6	96	N.A.	98
4	22.2	9.1	13.3	82	83	Nil
5	31.4	24.0	19.7	85	90	15
6	21.8	18.0	11.1	76	73	50
7	14.0	12.3	16.2	81	74	Nil
8	14.0	9.3	15.5	82	83	Nil
9	15.8	10.6	10.2	73	50	50
10	21.1	8.4	16.3	90	91	90
11	10.9	10.0	10.8	75	70	10
12	23.1	21.8	18.2	84	99	60
13	14.8	10.2	8.8	79	89	Nil
14	18.5	11.2	11.7	82	64	Nil
15	13.3	7.7	14.2	75	60	Nil
16	10.8	5.2	11.3	70	65	Nil
17	15.5	10.9	14.3	97	70	98
18	15.9	12.8	15.3	95	94	50
19	17.8	16.9	14.3	82	90	70
20	14.8	13.7	9.5	90	89	Nil
Average	17.6	13.0	14.3	84	80	N.A.

Note: 'N.A.' indicates 'not applicable'

production per animal was very low on several farms. There was no indication that low per animal production was associated with high stocking rates. The author believes that the low production was caused primarily by faulty stock management, particularly the underfeeding of ewe hoggets. This point is pursued further in Chapter 5.

Lambing and calving percentages varied widely, with many being very low, although some high percentages were being achieved. Only seven (35%) of the Random Farms had lambing percentages of 90% or greater. Relatively high percentages were observed on all major land types. This suggested that lambing and calving performances of between 90% and 100% could be attained throughout the County. High lambing and calving percentages tended to be associated with each other. The author considers that faulty management of pasture and stock together with the use of poor quality sires, probably accounts for most poor stock performances in the County.

Lamb fattening performances also varied considerably. The author believes that all farms should have been capable of fattening at least 50% of wether lambs but the table indicates that only half the farms had attained this performance. Of course, the failure to fatten lambs may have been due to a deliberate policy of store-lamb disposal, but the majority of farmers expressed a preference for a fattening policy.

4.8 Farm Incomes

This section presents the results of an analysis of the financial features of Random Farms.

The primary aim of the analysis was to gain some insight into the revenues and expenditures that were expected by hill country farmers in Wairoa County at the time of the survey. This information was expected to indicate current levels of investment in farm development, as well as providing a 'benchmark' with which potential income levels could be compared.

The physical inputs and outputs on Random Farms in the 1963/64 financial year were the basis for the information in Table 4.10. This was the most recent year for which complete information was available, and 1963/64 had the additional advantage that most districts in the County had generally normal weather conditions.[8] Accounting balance dates ranged from March 31 to June 30, with the latter date being the most popular. As no inter-farm comparisons were intended, any variations in balance date were of no consequence to the study.

A common set of standardised costs and prices[9] was applied to the observed inputs and production on each farm. It was considered that the costs and prices assumed approximated the average of future costs and prices. Thus the revenues and expenditures that were calculated in this manner, were those that would be most likely to recur in the future if production remained static at 1963/64 levels. The conventions assumed for costs and prices were:

(i) Costs

It was assumed that future costs would be constant at the levels ruling in 1963/64. This assumption was made because the author could define no more likely set of future costs.

---

8. Coastal districts in the County did, in fact, experience a mild drought in the summer of 1963/64, but all of the survey farms in the affected area had production levels that were higher than those in the previous year.
9. The rationale of standardising costs and prices is discussed in Section 3.531.

(ii) Prices

It was assumed that future prices for wool, fat stock and store stock would fluctuate about a mean corresponding to 1962/63 prices. To take account of differences in stock quality on different farms, upper and lower price limits were fixed, the author subjectively deciding whether a particular class of stock on a farm merited lower, modal, or upper prices. A single modal price was fixed for wool. The prices assumed are given in Table 4.9.

In Table 4.10, the aggregate of revenue from livestock and wool sales (valued at the prices shown in Table 4.9), and revenue accruing from investments outside each farm, appears under the heading Gross Cash Income.

The second column indicates Cash Expenditure, which includes all cash outgoings except taxation payments and capital repayments.

Taxation payments, which appear in the third column, were calculated using actual personal and family exemptions, the statutory or 'book' depreciation on assets, and the standard values on livestock actually used in each farmer's accounts. All eligible development expenditures were exampted, but no effort was made to reduce taxation by spreading the exemptions over future years.

The fourth column indicates Fixed Capital Repayments. These are payments which farmers were obliged to make, and do not include voluntary reductions in current account liabilities.

Column (5) shows Owner's Drawings which are equal to Gross Cash Income less the sum of Cash Expenditure, Taxation, and Fixed Capital Repayment. In terms of the column numbers in Table 4.10, the derivation of Owner's Drawings

Table 4.9 Expected Future Wool and Stock Prices

Product	Prices		
	Lower	Modal	Upper
Wool (per lb. greasy)	-	42.0d.(gross) 39.5d.(net)	-
Store Lambs: (i) ewes (ii) wethers	27/6 25/-	30/- 27/6	32/6 30/-
Fat Lambs	37/-	40/-	43/-
Fat Wethers (hgt./2th.)	35/-	40/-	45/-
2th. Ewes	60/-	65/-	70/-
C.F.A.4/5 yr. Ewes	35/-	40/-	45/-
C.F.A.5/6 yr. Ewes	20/-	25/-	30/-
Store Cattle:			
(i) Weaner steers	£15	£17	£20
(ii) Weaner heifers	£11	£12	£14
(iii) Rising 2 yr. steers	£21	£24	£27
(iv) Rising 3 yr. steers	£25	£28	£30
(v) Rising 2 yr. heifers	£15	£17	£20
(vi) Rising 3 yr. heifers	£22	£26	£30
(vii) Breeding Cows	£20	£25	£30
(viii) Potter Bulls	-	£35	-
Fat Cattle:			
(i) 2/2½ yr. steers & heifers	-	£40	-
(ii) Bullocks	-	£45	-
Fat C.F.A. Cows	-	£25	-

Note: Except where indicated, prices are net of selling charges.

Table 4.10 Analysis of Incomes on Random Farms

Farm Number	Section I (development expenditure recognised)						Section II (development expenditure ignored)					Section III
	1 Gross Cash Income (£)	2 Cash Expenditure (£)	3 Taxation (£)	4 Fixed Capital Repayments (£)	5 Owner's Drawings (£)	6 Capital Increment (£)	7 Gross Cash Income (£)	8 Static Cash Expenditure (£)	9 Taxation (£)	10 Fixed Capital Repayments (£)	11 Owner's Drawings (£)	12 Net Annual Investment (£)
1	7,012	5,475	145	140	1,252	829	7,012	4,646	413	140	1,813	561
2	7,709	6,902	24	226	557	1,269	7,709	5,633	269	226	1,581	1,024
3	7,480	5,478	272	Nil	1,730	380	7,480	5,098	421	Nil	1,961	231
4	11,555	8,867	182	Nil	2,506	320	11,555	8,547	272	Nil	2,736	230
5	13,543	9,849	1,048	Nil	2,646	732	13,543	9,117	1,486	Nil	2,940	294
6	5,629	4,914	35	53	627	603	5,629	4,311	104	53	1,161	534
7	8,650	9,132	N.A. (a)	Nil	N.A. (a)	2,525	8,650	6,607	N.A. (a)	Nil	N.A. (a)	N.A.
8	35,177	32,298	80	79	2,720	6,389	35,177	25,909	2,718	79	6,471	3,751
9	6,072	2,330	1,317	Nil	2,425	Nil	6,072	2,330	1,317	Nil	2,425	Nil
10	8,336	6,130	341	33	1,832	1,314	8,336	4,816	916	33	2,571	739
11	7,412	6,076	65	586	685	856	7,412	5,220	273	586	1,333	648
12	8,420	5,830	250	277	2,063	29	8,420	5,801	259	277	2,063	20
13	2,977	2,257	24	Nil	696	465	2,977	1,792	94	Nil	1,091	395
14	3,560	3,054	26	Nil	480	350	3,560	2,704	77	Nil	779	299
15	12,695	11,112	215 (c)	Nil	1,368 (d)	3,736	12,695	7,376	1,764 (c)	Nil	3,555 (d)	2,187
16	3,830	3,136	33	Nil	661	1,220	3,830	1,916	274	Nil	1,640	979
17	7,581	5,253	383	815	1,130	870	7,581	4,383	751	815	1,632	502
18	7,396	5,816	91	185	1,304	Nil	7,396	5,816	91	185	1,304	Nil
19	8,178	6,930	147	149	952	392	8,178	6,538	205	149	1,286	334
20	4,281	2,603	N.A. (b)	Nil	N.A. (b)	Nil	4,281	2,603	N.A. (b)	Nil	N.A. (b)	N.A.
Average (e)	9,143	7,317	260	141	1,425	1,098	9,143	6,220	650	141	2,132	707

Notes: 'N.A.' indicates 'not applicable'

(a) The owner of farm No. 7 derived part of his income from another separate property. Taxation and Owner's Drawings could not be calculated, but taxable income (before deduction of personal and family exemptions) was £160 if development expenditure was recognised, and £1,785 in the absence of development.

(b) For similar reasons to those given for farm No. 7, taxation could not be calculated for farm No. 20. Taxable income from this property (before personal and family exemptions) was £1,295. There was no development expenditure.

(c) Taxation for farm No. 15 was assessed at company rates.

(d) For farm No. 15 Owner's Drawings represents post-tax company profits in the hands of the shareholders.

(e) Averages were calculated on eighteen farms; farms No. 7 and No.20 were not included for the reasons outlined in notes (a) and (b) above.

may be expressed as :

<u>Owner's Drawings</u> (5) = (1) -((2) + (3) + (4)).

Thus Owner's Drawings represented the sum available to a farmer after he had paid all cash expenses which included taxation and fixed repayments. Owner's Drawings was the sum available for family consumption, the payment of life insurance premiums, and off-farm savings or investments.

Some expenditure on farm development was incurred on most Random Farms in 1963/64. Although the distinction between development and maintenance expenditure must be arbitrary to some extent [10], an attempt was made to identify development expenditure. The total development expenditure on each farm appears as <u>Capital Increment</u>, in column (6) of Table 4.10. Thus Capital Increment was the expenditure aimed at increasing farm output, or reducing the effort required to produce current output.

The items of expenditure included in Capital Increment were:

(i) Pasture renovation by cultivation or oversowing,

(ii) Establishment of new pastures from scrub or bush,

(iii) Manure in excess of the average of the previous two years,

(iv) <u>Additions</u> to vehicles and plant (as distinct from the replacement of existing assets),

(v) Fences erected in new positions,

(vi) Additional roading and tracking,

(vii) Additional water reticulation, and

(viii) Additional buildings.

---

10. This point is discussed at greater length in Chapter 6.

It is thought that the aggregate of these items provides an approximation of the increment to capital value obtained on each farm in 1963/64. This calculation would, of course, ignore any increment in capital value that could be attributed solely to inflation.

In order to indicate the cash income foregone while attaining these increments to capital value, Section II of Table 4.10 was calculated. Section II is a repetition of Section I, with the exception that the Cash Expenditure of Section I is re-defined as Static Cash Expenditure. This excluded all the items of development expenditure that are listed above. Taxation was recalculated. Thus Owner's Drawings were calculated on the assumption that there was no expenditure on farm development.

Net Annual Investment, appearing in Section III of the table, was calculated by subtracting Owner's Drawings in the 'real' situation, from the Owner's Drawings calculated in Section II, (that is, the 'no development' situation). Net Annual Investment then represented the capital which farmers had diverted from current consumption (or off-farm savings) after deciding to invest in farm development in 1963/64.[11] A worked example of the calulations used in deriving Table 4.10, appears in Appendix D.

No attempt will be made to draw the reader's attention to the variations in income on Random Farms. These variations are apparent in Table 4.10. It is worth noting that, on average, the Random Farms returned a Gross Cash Income of £9,143, which was offset by a Cash Expenditure of £7,317. After

11. For example, expenditure which was likely to result in a direct increase in the capital value of Farm No.1 totalled £829. In order to make these expenditures, the farmer had to forego £561 of current consumption. Hence his net investment was £561.

payment of £260 tax and £141 in capital repayments, Owner's Drawings of £1,424 remained. The average Capital Increment was £1,098 and this was obtained from a Net Annual Investment (that is, consumption foregone) of £707.

4.9 Capital Structure of Random Farms

An anlysis of the capital structure of Random Farms was made to provide some insight into the extent to which farmers in the County had invested capital outside their farms, and to show the general credit-worthiness of farmers.

The results of the analysis are presented in Table 4.11. The headings in the table may be defined as follows:

(i) Total Assets were given by the sum of the values of:

(a) Land and improvements (at Government Valuation, 1965),

(b) Plant and machinery (book value at balance date 1964),

(c) Livestock wintered in 1965 (valued at the prices appearing in Table 4.9; the fact that a proportion of the difference between market values and standard values of stock would, in the event of a realisation on assets, accrue to the Inland Revenue Department, has been ignoed in this analysis),

(d) Current account credits and debits, at balance date 1964, and

(e) Capital invested or held outside the farm.

(ii) Proportion of Assets Off-farm was calculated as the percentage of total assets that is represented by capital invested or held outside the farm.

(iii) Total Liabilities were the sum of:

(a) Long-term liabilities (that is, table and flat mortgages, and other loans not at call) at balance date 1964, and

(b) Short-term liabilities (that is, trading bank and stock firm current account deficits, and creditors' accounts) at balance date 1964.

(iv) Net Worth of each farm business was determined by the difference between Total Assets and Total Liabilities.

(v) Equity expressed Net Worth as a percentage of Total Assets. Thus Equity represents the proportion of total assets actually held by each farm business.

Two important facts emerged from the analysis, the first being that, on the majority of Random Farms, off-farm investment was slight. Only five farmers (25%) held more than 2% of their assets off their farms, and only three of these held more than 10% in this way. Only one farmer had invested outside New Zealand.

Secondly, although farmers' equity ranged from 21.6% to 100%, equity levels were generally high, only six farmers having less than 70% equity in their businesses. Average equity (calculated from average net worth and average total assets) was 81.3%. Thus most farmers were in a position to offer substantial security, if necessary, to creditors. These farmers could consequently be regarded as eligible, on security grounds, for large long-term loans for farm development.

Table 4.11 Capital Structure of Random Farms

Farm Number	Total Assets (£)	Proportion Assets Held Off-farm (%)	Total Liabilities (£)	Net Worth (£)	Equity (£)
1	31,726	20.3	11,608	20,118	63.4
2	37,958	0.4	12,471	25,487	67.1
3	34,888	16.6	Nil	34,888	100.0
4	52,046	0.1	6,165	45,881	88.2
5	63,465	Nil	7,641	55,824	88.0
6	20,341	1.1	13,224	7,117	35.0
7	39,020	0.1	489	38,531	98.7
8	180,008	0.4	23,880	156,128	86.7
9	31,738	Nil	Nil	31,738	100.0
10	33,905	10.9	13,926	19,979	58.9
11	52,536	0.3	14,838	37,698	71.8
12	43,206	5.4	10,303	32,903	76.2
13	17,735	0.4	1,598	16,155	91.0
14	14,194	0.1	10,494	3,700	26.1
15	71,819	0.3	10,120	61,699	85.9
16	11,137	Nil	8,736	2,401	21.6
17	28,376	1.1	715	27,661	97.5
18	36,451	4.1	6,057	30,394	83.4
19	42,333	0.5	3,559	38,774	91.6
20	20,769	0.7	5,357	15,412	74.2
Average	43,183	3.1	8,069	35,114	81.3

4.10 Recent Production Increases in Wairoa County

This section reviews recent rates of production increases on farms in Wairoa County.

In this section, it is assumed that changes in stocking rates provide a good approximation to production increases.[12]

Table 4.12 indicates recent increases in stocking rates on Purposive Farms. In the main body of the table the year-to-year increases in EE carried on each farm, are expressed as percentages of totals in immediately preceding years. The 'Average Change' was calculated by first finding the overall stock increase in E E, then expressing this as a percentage increase from the original stocking levels and, finally, dividing the percentage by the number of years over which the increase took place. 'Terminal Stocking Rate' is the stocking rate in the last year recorded.

The rate of change in stocking rates varied considerably between farms and, in many instances, between years on each farm. In some cases, this variability between years on particular farms illustrates a lack of long-range planning for development. This point was exemplified when the author found it impossible to discern any definite patterns of development on several farms. Variability between farms is indicated clearly by the average annual change in stocking rates. These figures are particularly interesting when it is realised that, of the fourteen farms analysed, only two (14%) had increased stock numbers at an average annual rate greater than 5%, while only four (29%) had exceeded a 4% growth rate, and seven (50%) had an average rate of less than 3%. It should be remembered that these were farms selected because they were thought to have the most rapid rates of increase in production in the County.

12. The author acknowledges that increase in stocking rate and production are unlikely to have a one-to-one relationship.

Table 4.12 Stocking Rate Increases on Purposive Farms

Farm Number	Period of Stock Increase				Average Change (per year)	Terminal EE per Grazeable Acre	Stocking Rate EE per Potentially Productive Acre
	1961/62	1962/63	1963/64	1964/65			
21	0	0	0	63.1	63.1	2.56	2.56
22	9.0	12.9	0	6.5	4.9	2.73	2.49
23	-0.8	-3.5	15.5	3.6	3.7	3.52	1.83
24	14.3	0	13.0	7.2	5.4	3.00	2.92
25	11.6	-6.1	8.4	-1.5	0.2	3.04	2.52
26	2.0	0	9.1	10.8	4.2	3.94	3.94
27	5.0	-11.8	19.2	-8.8	0.5	3.68	2.60
28	1.5	4.9	4.3	N.A.	3.7	2.94	2.94
29	0	0	4.3	N.A.	1.2	3.47	3.39
30	-13.2	-2.0	-9.1	4.3	-4.8	3.12	2.85
31	0	0	0	7.4	3.7	4.11	4.11
32	0.9	4.1	0	N.A.	1.7	4.15	3.97
33	-6.6	0	0	7.0	0	3.65	3.65
36	0	4.4	0.3	N.A.	2.4	3.18	1.32

Notes: 1. 'N.A.' indicates 'not available'

2. In spite of an overall reduction in stock number on Farm No.30, substantial land development had, in fact, been initiated in 1963/64, and this was reflected in the 4.3% increase in stock numbers in 1964/65. The reductions in previous years were largely due to the introduction of an A.A.stud.
3. The development programmes assocated with stock increases on Farms 21, 22, 24, 25, and 26, are decribed in Chapter 7.
4. As stated elsewhere, Farm No.34 was visited only to examine land development techniques. As it was not, in fact, a hill country farm, no stocking-rate information was recorded.
5. Farm No.35 was also visited primarily to examine land development techniques. The farm was so 'fragmented' that no meaningful stocking rate could be calculated.

The 'Terminal Stocking Rate' columns show that only one farm was carrying more than 4 EE per grazeable acre. The average stocking rates on Purposive Farms were 3.36 EE per grazeable acre, and 2.94 EE per potentially productive acre.[13/]

4.11 Future Levels of Production

In the farm survey, farmers were asked to comment on their plans for increasing production. From their replies, the author concluded that planned increases in stocking rates in the County as a whole, were likely to be slight. Of the twenty Random Farmers, eleven (55%) stated that they expected future increases in stocking rates and production to be very slow. An optimistic estimate of increases in stock numbers on these farms would be an average 1% per year. With current average stocking levels at 2.21 EE per acre, the absolute extra production envisaged by these farmers was slight.

Five of the remaining farmers expected stock numbers to increase at less than 5% per year (but this rate was still described by the farmers as 'rapid'), while four (20%) expected substantial increases (that is, in excess of 5% per year). It was notable that few of these latter four farmers had, in fact, started developing rapidly.

Most Purposive Farmers as well as several Random Farmers believed that County-wide stocking rates of 5 EE per acre were quite possible. Such contentions must be treated with some reserve because none of these farmers had even observed management on farms carrying stock at this rate. The most important point is that the more progressive farmers believed that substantial increases in production were possible.

13. The corresponding stocking rates on Random Farms were 2.98 EE per grazeable acre, and 2.21 EE per potentially productive acre.

4.12 Restraints on Production Increases

The actual reasons for farmers refraining from increasing production at rapid rates are exceedingly difficult to determine, even during an interview lasting several hours. For example, a farmer may contend that additional taxation would make production increases unprofitable, when in actual fact a lack of managerial confidence is his most important reason for not going ahead with development.[13]

Nevertheless, an attempt was made to shed some light on these reasons. The most important impressions that emerged from the survey were :

(i) Attitudes to profitability

The author's impression was that many farmers had only a vague idea of the distinction between profitable and unprofitable farm investment. The most common attitude (apparently held by eleven of the twenty Random Farmers) was to ignore any investment opportunities outside the farm, thus leading to the argument that any farm development which did not lose money, represented a sound investment. Eight of these eleven farmers assumed development to be profitable, but the other three stated that any considerations of profitability was irrelevant to decisions to develop their farms. The satisfaction of having a 'better' farm was presumably a sufficient reward. A further two farmers apparently held no opinions concerning the profitability of development, but five felt that development was definitely profitable. This contention appeared to be based more on intuition than empirical evidence. Two farmers maintained that off-farm investment was more profitable than farm

---

13. This statement does not mean to imply that the farmer's original contention was necessarily incorrect, only that he did not know it to be correct. This point was originally made by Candler [18].

development, but only one held a substantial portfolio of shares.[14]

Perhaps the crucial point was that for most of these farms, consideration of profitability was of little consequence, for they were secure in the knowledge that they did not intend to invest heavily in farm development.

Thus, the survey suggested that the expectation of unprofitability was not the key reason for refraining from increasing production. In spite of this, the author believes that a demonstration of the profitability of development would, in fact, stimulate interest in increasing production.

(ii) Attitudes to borrowing

Twelve of the twenty Random Farmers apparently held a marked aversion to debt. Attitudes ranged from a belief that indebtedness was a sign of managerial failure, to a feeling that borrowing for development should be unnecessary. Four other farmers could see nothing 'wrong' with borrowing, but could see no personal need for substantial borrowing. Only four farmers regarded extensive borrowing for development as a reasonable practice.

(iii) Other attitudes to development

Together with a reluctance to borrow, a lack of managerial ability, knowledge, and confidence is probably the major restraint to rapid development of the County. This impression gained by the author cannot be substantiated further except by reference to the marked propensity for farm managers to avoid financial planning. Nine (45%) of the Random Farmers did not use budgetting as an aid to management, while four others relied on rudimentary 'tobacco-packet' budgets. The author doubts whether managers who are unfamiliar with estimating the financial implications of their decision, can be expected to handle the initial planning and interim revision implicit in a serious

14. This farmer had invested in overseas industrial companies.

programme of development. Considerable scope clearly exists for intensive management advice to farmers in the County.

Nearly all farmers regarded progressive taxation as bad per se, and many claimed that the expectation of higher tax liabilities was deterring them from attempting substantial increases in production. While a minority of farmers clearly appreciated the general implications of taxation on development, it is noteworthy that these farmers were collectively more active in attempting development than the equally vocal, but less discerning, majority. The author's impression was that many farmers in this latter group paid lip service to taxation as a disincentive, in lieu of stating their true reasons for accepting static levels of production.[15] Probably important among these reasons was a low personal utility for additional income together with an unwillingness to accept further responsibility and/or manual work.

Thus, the reasons for farmers refraining from increasing production can only be described as complex.

4.13 Summary and Conclusions

The important findings reported in this chapter are :

(i) Farm sizes in the County vary widely, but the average sizes of Random Farms and Purposive Farms were 2,128 acres and 1,074 acres respectively.

(ii) A significant proportion of farms had absentee owners. The farm survey suggested that about 20% of farms had absentee owners, but another source of information suggested a higher proportion of at

15. This is not intended to imply that taxation is not a disincentive to farm development. In fact, taxation may be regarded as a serious disincentive, as reference to Chapter 9 will illustrate.

least 27%.

(iv) The number of breeding ewes handled by each permanent farm worker was found to be low in relation to numbers that are 'accepted' elsewhere. The average on Random Farms was 800 breeding ewes per man.

(v) Numerous examples of experienced shepherds moving from Wairoa farms to urban employment were reported to the author. Secondary education of children, housing, and insecurity of employment, appeared to be the important reasons for these shifts. The loss of reliable Maori day-labourers, who had moved to urban areas, was reported by several farmers.

(vi) According to the author's classification, 10% of the area of Random Farms was flat and rolling, while 24% was of steep ploughable contour, and 66% was unploughable.

(vii) The land use pattern on Random Farms included 4% permanent waste-land, 31% that was unproductive but capable of development, and 65% that supported grazeable pasture. Thus 96% of the total area of these farms was estimated to be potentially productive.

(viii) The stocking rates on Random Farms were low in relation to potential rates. On average, these farms carried 2.98 EE per grazeable acre, which was equivalent to 2.21 EE per potentially productive acre.

(ix) Production levels were correspondingly low. The average wool production on Random Farms was only 17.6 lbs. per grazeable acre. Average lambing and calving percentages were 84% and 80% respectively. Ten of the twenty farms fattened less than 15% of wether lambs.

(x) Farm incomes, and levels of investment in farm development, varied widely. Farmers' personal drawings ranged from £480 to £2,720, with an average of £1,424. Only five farmers spent more than £1,000 in farm development; nine farmers spent less than £500.

(xi) The majority of Random Farmers had invested less than 2% of their assets outside their farms. This suggested that most farmers had, in the past, invested a large part of their surplus income in their farms, although the analysis of farm incomes showed that these surpluses were usually relatively small.

(xii) Equity levels were generally high, indicating that most farmers would have no trouble in providing security for substantial credit, should they require it.

(xii) Recent production increases in the County were relatively low. Only four farms in the survey had an average annual increase in stock numbers greater than 4%. (It is thought that all rapidly-developing farms in the County were included in the survey).

(xiii) Production increases planned by farmers were very slight.

(xiv) The author gained the impression that a lack of confidence was the main reason for farmers refraining from increasing production, although aversion to debt and the impact of taxation on the profitability of farm development were also contributing factors. The author concluded that a demonstration of the feasibility and profitability of increasing production, would stimulate farmers' interest in farm development.

CHAPTER 5

MANAGEMENT PRACTICES ON WAIROA FARMS

5.1 Introduction

Chapter 4 was devoted mainly to a description of the levels of production and incomes on Wairoa hill country farms. The farm survey also investigated farm management practices, and this Chapter complements Chapter 4 by discussing the managerial aspects of farming in the County.

The chapter has six major sections. The first of these describes stock management practices in some detail, while the second deals with pasture management. Both of these sections are confined to management practices used to maintain production levels. The two subsequent sections enumerate the important weeds and pests in the County, and discuss the technical problems that face farm managers.

Section 5.6 contains a description and analysis of the management practices that were being used to increase production on farms in the survey. The greater part of this section is devoted to land development techniques.

The final section contains a review of high-producing hill country farms outside the County. The emphasis here is on identifying the management practices that are relevant to increasing production on Wairoa farms.

5.2 Stock Management

This section contains a review of the important stock management practices in Wairoa Country. The information was obtained from the farm survey. Although practices on both Random Farms and Purposive Farms are discussed, any comments concerning the relative popularity of practices are based on data from Random Farms.

The review takes the form of a calendar of management operations for each of the major stock classes. Initial comments stress the more popular management practices, but attention is also given to the less typical practices.

5.21 Breeding ewes

Romney breeding ewes were found on all farms. Three Random Farms had flocks that showed signs of Perendale ancestry and one other flock contained Romney-Border Leicester cross ewes. None of these crossbred flocks were less than 50% Romney and all of them had, in fact, reverted to the use of Romney rams.

On most farms, lambing began in mid-August with a peak occurring in the last week of that month. Two (10%) of the Random Farmers favoured an earlier starting date. Earlier lambing did not appear to have any advantages. Severe storms occasionally occur in early August, and these can result in appreciable lamb deaths. Later lambing usually coincided with the spring flush of pasture growth. The set stocking of ewes during lambing was a universal practice, with stocking rates ranging from 2 to 3 ewes per acre on flats and rolling land, and up to 2 ewes per acre on the steeper hills. Most farmers had not considered rotational grazing as an alternative to set stocking during lambing. Those who had heard of it felt that the cost of additional subdivision would probably make the practice less profitable than set stocking.

Set stocking was maintained from lambing until weaning on all Random Farms. This policy was not completely rigid, because farmers allowed for differential rates of pasture growth in different paddocks by intermittently moving small numbers of ewes and lambs between paddocks. Usual stocking rates during this period were from 150 to 200 ewes with lambs, per 100 acres. On some farms, ewes without lambs were drafted out during docking (that is, during September and early October), but another popular practice was to leave these ewes with the main flock until weaning. The former practice has the obvious advantage that it should make more feed available to ewes and lambs, while the dry ewes are maintained on a lower plane of nutrition.

On three Purposive Farms, ewes and lambs were rotationally grazed after lambing. On each of these farms, set stocking was maintained for as long as possible, but as the pasture growth rate declined in early summer, and as the pasture requirements of lambs increased, rotational grazing was initiated. The farmers felt that rotational grazing allowed lambs a higher plane of nutrition during the last two to four weeks before weaning.

Weaning dates ranged from early December to early February, with most farmers weaning between mid-December and mid-January. All farmers were aware that by advancing weaning dates they could alleviate summer feed shortages, but few farmers appeared to consistently apply this knowledge. Indeed, weaning dates were far more likely to be dictated by the time of ewe shearing. If weaning was done during shearing, one mustering operation sufficed for weaning, drafting lambs fat-off-mothers, and shearing the ewes and retained lambs. It is doubtful that the effort saved by this practice warrants the consequent loss of flexibility in stock and pasture management. Much of the difficulty in fattening lambs could be traced to ewes and lambs competing for feed for too long.

Most farmers culled mixed-age ewes during weaning. The criteria on which ewes were culled varied greatly, but all farmers were rightly concerned with ewes' ability to breed and rear a further lamb. Twelve of the Random Farmers culled all ewes that had not produced a lamb, irrespective of age. The other farmers were prepared to allow two-tooth, four-tooth, and six-tooth ewes 'another chance'. Few farmers culled mixed-age ewes for wool type or declining wool production, but two Random Farmers culled ewes primarily on fleece characteristics. Three farmers culled ewes strictly by age; as rising five year olds. On the remaining Random Farms, a general practice was for approximately two-thirds of the rising five year old flock to be culled. Most of the remaining ewes were then cast-for-age the following year. In general, ewes with poor teeth or severe footrot, were automatically culled. The general attitude of farmers to culling was that they wanted 'reasonable looking' sheep (in their own estimation), which they expected to produce a further lamb. Most cull ewes were sold directly to the freezing works, but two farmers had permanent arrangements to sell sound cast-for-age ewes to local fat-lamb farmers.

The post-weaning treatment of lambs was quite consistent. Except on farms where no lamb-fattening was attempted, ewe and wether lambs were separated, and while both groups were placed on the best available pasture, the wethers usually received preferential treatment. All lambs were usually drenched at weaning, and the wethers sometimes received further dosing when they were musteredfor fat lamb picking. On farms wherelambs were not fattened, wethers and ewes were sometimes separated to facilitate the mustering for sale of store wether lambs, but usually the two groups were treated similarly.

All farmers attempted to place their ewes on a lower plane of nutrition after weaning, but a lack of adequate fencing frequently foiled this attempt. Only six of the twenty Random Farmers had used large mobs of ewes in pasture improvement work, such as the preparation of poor quality pastures for oversowing. Four other farmers rotationally grazed their ewes in large mobs, but their main objective was to prevent the ewes from becoming over-fat. The remaining ten farmers set-stocked ewes at a rate of 1 to 2 per acre on their poorer pastures. On these farms, effective mob grazing was usually impossible for extended periods because most paddocks were too large.

Among the Purposive Farmers, recognition of the breeding ewe as a useful tool for farm development, was more general. Mob stocking during this period was the rule rather than the exception.

Management of ewes during tupping varied considerably. One practice was to 'flush' ewes by set-stocking them on saved pasture between one and three weeks before rams were put out. Two-tooth ewes were generally tupped separately. The most common variation to this basic system was a simplification in which ewes were not shifted to better pasture. The practice was usually found on farms were summer stock control was of the free-ranging type that required a minimum of management effoet. Under these conditions, which invariably implied a relatively low overall stocking rate, ewes usually approached tupping in a fat condition without flushing.

While research into the effects of flushing ewes has not yielded conclusive results,[1] it appears possible that the practice of flushing ewes, irrespective of post weaning management, may result in higher lambing percentages.

Twelve Random Farmers favoured between 3 and 4 rams per 100 ewes, while the other eight farmers preferred rates of from 2.5 to 3 per 100. No farmers used teaser rams or tupping crayon. Many farmers felt that it would be useful to accurately forecast lambing patterns, but the extensive nature of the tupping paddocks on most farms led farmers to believe that the extra effort involved in changing crayons would not be justified.

Less than half the farmers in the Random Group recognised the wisdom of mobbing-up ewes and rams every one or two days when tupping was carried out in large, lightly-stocked paddocks.

On all farms management from tupping to lambing had two distinct phases. Crutching usually took place during late July and this was usually the time for a change in management. Alternatively, the pre-crutching management pattern was continued until two or three weeks before lambing, when ewes were re-mustered for drafting into lambing mobs.

On fifteen Random Farms, management from tupping to crutching consisted of set-stocking at rates ranging from 1 to 3 per acre on lower-producing pastures. The other five farmers rotationally grazed their ewes in one mob.

---

1. Coop [26] has suggested that the probability of ewes producing twin lambs is increased by both:

   (i) Maintaining ewes at higher live weights, during the period from weaning and tupping, and

   (ii) The 'dynamic effect' of increasing live weights during the two to three weeks immediately prior to tupping.

   Under conditions of feed limitation, a modest weight loss after weaning, followed by flushing prior to tupping, is likely to be the best policy, provided that the feed saved after weaning can be used for flushing.

This practice quite evidently permitted closer control of ewe condition and pasture growth, in spite of the grazing intensity seldom rising above 12 ewes per acre. The winter labour available on all farms in the survey could have easily handled the slight additional work demanded by the more flexible rotational grazing policy.[2/]

No farmers consistently grew a winter crop for feeding ewes, although several reported that they had grown crops in some previous years.

On all farms, crutching or the subsequent drafting of ewes into lambing mobs signalled the movement of ewes onto better pastures. 'Early lambers' were typcally set-stocked on the flats and rolling land at rates ranging from 2 to 4 per acre. Later lambing mobs were set-stocked on the remaining easy country (if any) and the more productive hills, at slightly lower rates. This system took advantage of early spring pasture growth which normally commenced first and most vigorously on the higher fertility flats and rolling hills.

5.22 Hoggets

All but one of the surveyed farmers bred their own replacement breeding ewes, while several also wintered wether hoggets. On the exceptional farm, No.3, flock numbers were maintained by buying in two-tooth ewes. On this farm, all lambs were Romney-Southdown cross, and all were fattened. On nearly all Random Farms, hogget management followed what can be termed the 'old school' of thought. This system dictated that from weaning until early winter, all

---

2. The author did not obtain any idea of the value that surveyed farmers place on leisure, but it is possible that additional routine work during the winter would have been unacceptable to many farmers.

lambs should be grazed on the best available feed, any parasite infestations being controlled by drenching. From early winter, management changed to one of set stocking at low stocking rates on extensive paddocks that were preferably well-sheltered. Pasture quality was not felt to be important when compared to the need to spread the animals out over as wide an area as possible. This management frequently resulted in hoggets being run at less than 2 per acre, with rates seldom exceeding 3 per acre.[3] The system was sometimes modified to include a period spent on a winter crop, although the provision of an adequate area of pasture run-off was still important.

Management based on low stocking rates on relatively poor pasture usually persisted until the two-tooth sheep (ex-hoggets) were culled during their second summer.

This system was found to be firmly entrenched in Wairoa County, where seventeen of the nineteen hogget-rearing Random Farmers used it, or a slight modification of it.

On some farms this type of hogget management was undoubtedly successful in producing well grown two-tooth ewes, but on over half the Random Farms, the two-tooth ewes were of poor quality. To the author's eye, their main faults were small size and an apparent lack of vigour.

The author feels that faulty management of ewe hoggets was the central cause of these faults. Some ewe hogget flocks stocked at low rates in large paddocks, gradually lost control of their pastures, until during the most

---

3. Hoggets were often run with weaner cattle, the latter being stocked at approximately one beast to three acres.

severe periods in late winter and early spring, patch-grazing had reduced grazeable area to the point where the plane of nutrition was inadequate. The hoggets were, in fact, starving amidst plenty.

The more progressive farmers in the County, as well as some stock agents, believed that most low lambing percentages were caused more by low twinning rates and empty ewes, rather than by lamb deaths. This observation may well be explained by the breeding of small and unthrifty breeding ewes which are more prone than better grown animals to infertility and low twinning rates.[4]

The majority of the Purposive Farmers had departed to some degree from the established hogget rearing practices. They showed a tendency to stock hogget paddocks at higher rates - often approaching 5 hoggets per acre, and they frequently included with the hoggets greater numbers of cattle than was usual in established practice.

All farmers in the survey disposed of surplus female sheep as two-tooh ewes, typically by sale at fairs. Most farmers culled principally on 'constitution' (that is, teeth, feet, strong frame) and apparent breeding capability, (that is, well formed udders), with secondary consideration given to wool. No farmers selected ewes according to hogget fleece weights and any selection for wool was made according to farmers' visual appraisal of fleece weight and count.

5.23 Other dry sheep

No farmers were consistently farming dry sheep other than hoggets. Those

4. Coop /26/ suggested that poorly grown two-tooth ewes were likely to produce relatively low fleece weights and lambing percentages over their whole lifetimes.

farmers who wintered wether hoggets usually attempted to sell them in fat or forward store condition in the late spring, but some farmers occasionally kept a small proportion of them until the following autumn, or even through a second winter, but this practice was uncommon.

5.24 Breeding cows

Breeding cows played an important role in the management of all but one farm in the survey. Farmer No.3, the exception, had adopted a policy of purchasing weaner cattle which were sold fat at 24 or 30 months of age.

Aberdeen Angus and Hereford cows were encountered. There was only one herd of Hereford cows in the Random Group, but a majority of the other herds showed signs of Hereford ancestry. Several farmers did, in fact, have a policy of periodically introducing Hereford blood into their basically Aberdeen Angus herds. These farmers belived that the crossbred animals had more vigour and greater growth rates than pure Aberdeen Angus stock.

Breeding cow management generally followed accepted hill country practice. Calving typically commenced at approximately the same time as lambing, in mid-August. On all farms the herd was spread out over the paddocks containing breeding ewes. This general policy of grazing cows and calves on the better pastures continued until weaning, which took place in the late March-early April period.

Subsequent management invariably consisted of moving cows on to less productive pasture, where they remained until shortly before calving. Most farmers used their cows during this period to 'work' at controlling rank pasture, scrub or fern. Three Random Farmers deliberately used their cows in pasture improvement programmes, but the remaining farmers had no definite grazing plans; they merely grazed their cows on roughage because it was there. Five farmers, including the three referred to above, fed hay to their cows. This had a twofold purpose; it supplemented the cows' diet, and it was a (rather uncertain) method of oversowing pastures.

The very low calving percentages observed on some farms[5] were usually the result of identified disease, but in two notable cases, calving percentages had remained below 70% for several years with the farmers making little effort to identify or rectify the fault. Pregnancy testing was practised on 75% of the Random Farms. Empty cows were almost invariably culled directly to the freezing works.

Apart from infertile cows, culling was usually performed arbitrarily on age. Cows were usually culled when between six and ten years of age.

On many of the lower stocked farms, breeding cows were found to play a vital part in pasture management. This importance of breeding cows in traditional management systems has led to a belief, which amounts almost to folklore, that large numbers of mature cattle are an essential part of hill country farming in Wairoa County. The inflexibility of stock management that results from running large breeding herds has, in the past, had unfortunate consequences during the occasional summer droughts; in many instances, farmers have been forced to sell breeding cattle at very unattractive prices. Rather than suggesting that more flexible cattle policies might be more suited to Wairoa conditions, this experience has in fact encouraged farmers to reduce stocking

---

5. See Chapter 4, especially Table 4.8.

rates (or at least, refrain from increasing them as pastures have improved), so that a reserve of feed can be carried into every summer.

In most years, this practice has resulted in severe under-stocking. This has, in turn, increased the tendency for pasture to revert to manuka and blackberry, thus intensifying the requirement for heavy cattle. This circular pattern of cause and effect has not only suggested to farmers that breeding cows are essential, but it has also effectively prevented any rapid increase in stocking rates in general, and sheep numbers in particular.

Later chapters propose an alternative management system that involves substantially increasing stocking rates while reducing the risk of feed shortages by adopting more flexible cattle policies and increasing sheep numbers.

5.25 Dry cattle

On Random Farms cattle disposal patterns were extremely variable. Eight farmers sold weaner steers as established practice, and one other farmer sold them in most years. Three farmers carried steers over their first winter and sold them as yearlings in the spring. One farmer fattened steers at 2½ to 3½ years of age, while the remaining six farmers sold store steers and bullocks ranging from 20 months to 4½ years of age.[6]

Twelve farmers culled and sold surplus heifers at 2 years of age.[7] The other farmers sold surplus heifers as either weaners or yearlings. The foregoing illustrates the variability of dry stock policies. Many farmers

---

6. The reader is reminded that one farmer did not breed cattle.

7. Only two of these farmers attempted to fatten cull heifers.

seemed inclined to sell when they felt that prices were attractive, with scant thought to future stock requirements on their own farms.

The winter management of young cattle also varied greatly. The most popular practice was to set-stock, usually in association with hoggets, at rates approximating one beast to three acres. Three farmers using this system fed hay during winter, but the other farmers gave their young cattle no preferential treatment except by separating them from mature cattle and stocking them on generally well-sheltered paddocks.

5.26 An atypical cattle management system

An innovation in breeding cow management was found on one purposively selected farm. The farmer had developed autumn calving[8] as a standard practice and had, at the time of his interview, accumulated three years' experience with it.

The farmer felt that his system held several advantages over conventional spring calving practice. He considered that autumn calving resulted in a better environment for cows during late gestation because feed was generally more plentiful in February-March than in the corresponding spring-calving period of July-August. This usually resulted in the cows being in heavier condition at calving which, in turn, resulted in calves being fed better during their first three to four months.

Experience with the practice has shown that cows maintain their lactation

8. The five-week calving period usually commenced in mid-March, while calf marking took place in late May. Weaning occurred in November.

satisfactorily over winter and usually increase milk production during the subsequent spring.

Steers and surplus heifers were usually sold by private arrangement, but they could have been sold at the autumn weaner cattle fairs. If steers and surplus heifers are sold as yearlings, at autumn fairs, the autumn calving system would obviously have a greater feed requirement than the conventional spring calving alternative because steers and heifers would be grazed for five more months. Thus autumn calving would be one system that should utilise surplus feed during late winter, spring, and summer. A farmer considering a change from spring calving to autumn calving would need to ensure that the premium commanded by autumn born calves made this change at least as profitable as utilising feed by alternative changes to the existing management system, such as increasing breeding ewe numbers.

Autumn calving has not been widely adopted by farmers in Wairoa County. Two farmers encountered casually by the author had tried the system and while results had been satisfactory, these farmers did not feel that the possible advantages warranted a general change from spring calving. Several farmers interviewed in the survey were doubtful that autumn calving would be feasible on their properties, largely because they felt that if winters were more severe than those experienced on the innovator's property, cows could cease lactation.

The author believes that autumn calving shows promise of being more profitable than spring calving. To identify the conditions (if any) under which the system breaks down, it should be tested far more thoroughly than it has been to date. Moreover, demonstration of the feasibility and profitability of the system under severe winter conditions would be necessary to encourage adoption by farmers throughout the County. There is thus a clear case for farm-scale testing of the system. The test would be most useful if it took the form of a management demonstration. That is, the autumn calving system would be integrated into the overall management of a demonstration farm. The profitability of the management system incorporating autumn calving could then be compared with the profitability of a generally similar management system that used conventional spring-calving practices. If the demonstration farm was situated in a district with relatively severe winters, the currently doubted feasibility of autumn calving under those conditions, could be tested.

5.3 Pasture Management

Pasture management embraces all aspects of farm management that influence the production and utilisation of herbage from pasture plants.

It is convenient to discuss pasture management under the general headings of soil management and grazing management. On hill country farms, topdressing practices constitute the most important feature of soil management, while grazing management is concerned mainly with grazing techniques and the interaction of subdivision and stocking rates.

The important features of pasture management practices on Wairoa hill country are discussed in the following two sections. The information was obtained from the farm survey.

5.31 Topdressing practices

At the time of the farm survey topdressing was probably the aspect of farm management most discussed by farmers. The discussion of such a topic when increases in production were being nationally encouraged might. to the reader, be a promising sign. However, the author found that most discussion about topdressing concerned the type of fertiliser that should be used. Farmers appeared to be paying less attention to both the rates of fertiliser application, and the other resources that are complementary with fertiliser.

The author believes that much of the argument over the merits of slightly different fertiliser mixes may have been actually detrimental to the rate of production increases in the County. Pre-occupation with this argument could well have prevented otherwise progressive farmers from giving thought to more ambitious proposals such as increasing stocking rates and clearing scrub-land.

One of the hopes expressed in the original proposal for this study from the East Coast Farmers' Fertiliser Co.Ltd., was that the relative merits of different fertiliser might be clarified, allowing specific recommendations to be made.

The farm survey failed to resolve the problem as stated. However, a useful catalogue of farmers' experiences was compiled and it is clear that the use of a wide range of fertilisers is compatible with satisfactory pasture production.

As shown in Table 5.1, superphosphate was a substantial component of fertilisers used on the Random Farms. This fact, together with the absence of

Table 5.1 Fertiliser Usage on Random Farms (1964/65)

Farm Number	Fertiliser Type	Rate per Acre (cwt.)	Proportion of Farm Topdressed	
			Percentage of Grazeable Pasture	Percentage of Potentially Productive Area
1	50% superphosphate / 50% lime (86%) special mix - (14%)	4.0	39	49
2	50% superphosphate / 50% lime	3.0	58	71
3	Special Mix	2.5	80	80
4	Superphosphate	1.5	41	100
5	Superphosphate	2.0	77	100
6	Superphosphate	3.0	82	100
7	Superphosphate	3.0	25	29
8	Aerial superphosphate	2.0	66	100
9	Special Mix	1.5	21	31
10	Lime-reverted superphosphate	2.0	42	100
11	Superphosphate	2.0	38	42
12	Aerial superphosphate	2.0	47	49
13	Superphosphate	1.8	69	100
14	Superphosphate	2.0	61	100
15	Superphosphate	2.0	18	32
16	Superphosphate	2.0	9	19
17	Superphosphate	2.0	48	68
18	Superphosphate	1.0	80	100
19	Superphosphate	2.0	55	57
20	Nil	Nil	Nil	Nil

Notes: (1) Where more than one type of fertiliser was used, percentages indicate the proportion of each (by weight) in the total application.

(2) Special Mix fertilisers varied widely in composition. Most contained approximately equal proportions of superphosphate, lime, and dolomite, often fortified with sulphur at 12lb. per cwt. and occasionally including copper sulphate or ferrous sulphate as additives.

any really spectacular responses to the more exotic fertilisers being used, led the author to conclude that the rate of application of fertiliser, and the associated stock and pasture management, have a far greater impact on the profitability of topdressing than has the composition of the fertilisers used, provided that the fertiliser has a substantial superphosphate component.

This conclusion does not imply that the responses achieved from different fertilisers should not be investigated by experimental work. Such research, with particular respect to reverted superphosphate, is suggested in Chapter 11.

The actual usage of fertiliser on Random Farms in 1964/65 is shown in Table 5.1.[9/] It should be emphasised that the information in the table does not refer, in most cases, to fertiliser used with the intention of increasing pasture production above previous levels.

Fourteen farmers (70%) favoured either straight superphosphate or aerial superphosphate. Three other farmers used lime-reverted superphosphate or mixtures of lime and superphosphate, while only three farmers (15%) favoured Special Mix fertilisers. In general, the farmers using fertilisers other than superphosphate tended to be manure 'enthusiasts' in the sense that they paid a great deal of attention to apparent pasture responses from different fertilisers at different rates of application. The majority of these farmers tended to regard fertiliser application as an end in itself, rather than as a practice requiring complementary consideration of stock and grazing management. By contrast, most farmers favouring superphosphate used this fertiliser

---

9. Fertiliser was applied annually to 69% of the total grazeable pasture on Random Farms. Eight of the twenty farmers topdressed all grazeable pasture, but a further eight annually topdressed less than 50% of their grazeable pasture.

because their pastures apparently responded to it. These farmers were less interested in the possible merits of alternative fertilisers, and concentrated more attention on other aspects of farm management.

The farmers using fertiliser mixtures containing lime claimed that the pasture response to phosphate was superior to responses obtained without lime. These claims were based entirely on visual appraisal and often involved a comparison of response between years.

Visual appraisals of differences in pasture growth are, of course, quite meaningful when the differences are consistently very pronounced, but the author does not believe that the observations referred to in the last paragraph can give a reliable lead to improved farm practice. Conclusions reached in this way, however, may well merit examination by properly controlled experiments.

Many plot trials comparing different combinations of various fertiliser mixes and lime have been made in the County and these have resulted in a wide range of fertilisers being tried by farmers. Much of the credit for this experimentation must go to Mr W.Wilson, an agronomist employed by a meat freezing company in Wairoa. In general, this work has shown that no one fertiliser gives spectacularly better responses than can be obtained from other fertilisers.

There was considerable variation in the rates of fertiliser application on Random Farms. Rates ranged from zero to 4 cwt. per acre, but half the farmers favoured rates of the order of 2 cwt. per acre.

No farmer applied more than 2 cwt. of superphosphate per acre but twelve farmers (60%) were topdressing at that rate. This number included two farmers who applied superphosphate as a component of mixtures.

No Random Farmers topdressed land more than once per year, and although the majority favoured application during the February-April and August-November periods, significant quantities of fertiliser were actually applied in both mid-winter and mid-summer. Virtually all fertiliser was aerially spread, so that the occurrence of suitable conditions for flying and spreading was the greatest influence on time of application.

The need to incur fertiliser expenditure in particular financial years in order to reduce taxation occasionally dictated application of fertiliser during the weeks immediately prior to June 30.

5.32 Subdivision and grazing management

Land subdivision and grazing management cannot be discussed separately; a degree of subdivision that results in adequate pasture control when a grazing intensity of 15 EE is available when required, may be quite inadequate if grazing intensity never exceeds 3 EE per acre.

In the County, set stocking was the rule rather than the exception, with stocking rates ranging from 1 EE per acre on the poorest pastures, to slightly over 4 EE per acre on the better pastures of farms that had the highest overall stocking rates. A minority of farmers consistently used large mobs of dry ewes and cattle to control pastures by high-concentration, short-period grazing.

Allied to this pattern of grazing management was a typical policy of subdivision which involved up to six 'holding paddocks' of 30 acres to 80 acres each, with the remainder of the farm divided into paddocks ranging from 100 acres to 300 acres. Few farmers had attempted to assist pasture control by fencing shady from sunny faces, and steep hills from flats.

On all Random Farms, grazing intensity was low compared with potential levels. While some farmers practised summer mob stocking of breeding ewes at rates up to 12 EE per acre, very few paddocks regularly received this type of grazing. Set-stocked grazing at rates less than 4 EE per acre (occasionally reaching 8 EE per acre during the summer and autumn), was more usual.

In the author's opinion the majority of pastures in the County were chronically under-grazed. On most Random Farms pasture composition and productivity could have been substantially improved if at least 50% more stock had been consistently used to graze autumn pasture growth. Higher grazing intensity during periods of peak pasture growth would change the typical hill pastures composed of danthonia, browntop, ratstail, trefoil and subterranean clover, to higher-producing swards containing more perennial ryegrass, cocksfoot and white clover.

5.4 The Control of Weeds and Pests

This section describes the weeds and pests that influence the management of farms in Wairoa County. The methods of control (or lack of control) that were being used by farmers in the survey, are discussed.

5.41 Weeds

(i) Manuka (Leptospermum spp.) is the most prevalent weed. Virtually all of the unproductive land capable of development is infested with it. It is also found as isolated clumps and bushes on otherwise productive pasture. Manuka was being completely eradicated in the course of land development work on some of the farms in the survey, but on many farms faulty post-development pasture management (including insufficient grazing pressure and inadequate topdressing) had resulted in the need to control manuka re-growth. Such control was most popularly obtained by hand-cutting, although burning while standing was also practised.

(ii) Blackberry (Rubus spp.) is found throughout the County. Goats have traditionally been used to restrict the spread of the weed, albeit at the expense of considerable pasture consumption. While this practice has undoubtedly prevented some blackberry infestation, the resulting defoliation has intensified difficulties encountered in attempts to eradicate the weed with hormone herbicides. The almost complete absence of control of goats, and the widespread misuse of sprays by farmers, has resulted in a loss of confidence in spraying as a method of control. Many farmers consequently believe that discing and/or blading with heavy machinery is the only successful method for eradicating blackberry, and that goats provide the only method of control on unploughable land.

(iii) Tauhinu (Cassinia leptophylla) is present in most districts of the County. Infestations are, however, widely scattered, and the weed is typically found in association with manuka on lower-fertility land. Methods of control were similar to those used for manuka.

(iv) Niggerhead (Mariscus ustulatus) is found in scattered clumps on the wetter areas of pastures. While untidy in appearance, it does not typically cover appreciable areas, nor is it spreading rapidly. Many farmers made no effort to control or eradicate the weed. Where control was attempted, burning and oversowing was the most popular method, but farmers with the higher stocking rates had found the increasing grazing pressure together with greater pasture vigour tended to gradually 'choke-out' the weed.

(v) Rushes (Juncus spp.) is a common weed in pastures throughout the County. Rushes are generally more prevalent on the wetter, chronically understocked pastures. Under higher stocking rates, especially those including relatively high proportions of cattle, the vigour of rushes is noticeably reduced.

(vi) Thistles are found throughout the County. The most prevalent is Winged Thistle (Carduus tenuiflorus). Few farmers made any attempt to control this annual weed. There are other more scattered infestations of Variegated Thistle (Silybum marianum), Scotch Thistle (Cirsium lanceolatum) while Nodding Thistle (Carduus nutans) is becoming more widespread in the County.

5.42 Pests

Grass grub (Costelytra zealandia) has been observed in all districts in the County but little consideration has been given to its control. Only three farmers in the Random Group had applied DDT to any part of their farms during the three years prior to the survey. Few other farmers had even considered the possibility of their pastures being infested with the pest. The author concluded that many farmers in the County were not aware of the means of identifying and eradicating grass grub infestations.

The only other animal pest of consequence was the wild goat. The previous discussion of blackberry control indicated the value of wild goats to the County, but their disadvantages warrant further comment. Any accurate estimate of the goat population of the County was impossible, but many farmers believed that their concentration approximated 0.5 per acre over extensive areas. It was certain that goats were consuming appreciable quantities of pasture that would otherwise have been available to sheep and cattle.

5.5. Technical Problems Encountered by Wairoa Farmers

Two problems that have been faced by some farmers in the County are discussed in this section. They concern the unthriftiness or death of white clover, and copper deficiency in livestock.

5.51 'Clover ill-thrift'.

This disorder was regarded by Mr E.C.Ayson, the Department of Agriculture Farm Advisory Officer in Wairoa, as one of the most important deterrents to pasture improvement and production increases in the County. The symptoms were a loss of vigour or death of white clover plants during the first or second autumns following sowing after cultivation. The problem was confined to light pumice soils and therefore occurred only on flat or easy-rolling contours. Observations of the symptoms had been confined to isolated farms in the Putorino, Wairoa, Frasertown and Tiniroto districts. Each of these districts has pumice soils derived principally from Taupo sandy ash, and all have mean annual rainfalls of less than fifty inches.

At the time of the farm survey, the cause of the disorder was unknown. Plant parasites such as the White-fringe Weevil, the Clover-leaf Eelworm, and soil nematodes had been suggested as possible causes. It had been noted that all cases of the disorder had occurred on pumice soils ploughed for the first time. A rather cursory investigation carried out by the Research Division of the Department of Agriculture in early 1965 yielded no definite conclusions.

The author is doubtful that clover ill-thrift has very serious implications for the County as a whole, although for individual farmers it can obviously be a serious problem. Only three farmers in the thirty-six interviewed had been, or were, conscious of the problem on their own farms. On one of these farms, clover ill-thirft had tended to disappear when lime-reverted superphosphate was used instead of superphosphate. On both of the other farms, insufficient applications of superphosphate and the dominance of grasses, caused ny pastures becoming too long and rank between grazings, could well have contributed to clover disappearance.

5.52 Copper deficiency

Cases of mild Copper deficiency in cattle induced by excess soil Molybdenum, have been observed in the Frasertown, Nuhaka, and Waihua districts. Application of Copperised superphosphate has rectified all observed deficiencies.

As stocking rates increase, observable Copper deficiencies are likely to become more widespread, resulting in an increased requirement for Copperised superphosphate.

5.6 Farm Development Techniques in Wairoa County

A major objective of the farm survey was to identify and examine the methods used by Wairoa farmers to increase production. This section contains a purely descriptive account of these methods. Wherever appropriate, the technical performances of alternative methods are compared, and their costs are estimated. However, this section treats the farm development methods in isolation; no attempt is made to discuss their integration into overall development programmes. Actual development programmes (which include some of the methods described in this section) are described and analysed in Chapter 7. In this section, the author suggests no alternatives to the techniques that appeared on survey farms. Alternative techniques are, however, proposed in Chapter 8.

Most of the information on development techniques was obtained from Purposive Farms, although any farm development that had taken place on Random

Farms was also studied.

The following sub-sections deal principally with land development methods, but the stocking policies used during farm development, and the use of credit by Wairoa farmers for farm development, are also discussed.

5.61 Fencing techniques

The four main types of fence used in the County were:

(i) 'Conventional' fence with 7 wires, 4 or 5 posts per chain and battens. Up to 2 wires are barbed, the remaining wires are 8 gauge and the posts are usually concrete (regular or pre-stressed) or treated timber. On ridges and even lines, steel standards may replace up to 3 posts per chain.

(ii) 'Steel' fence with 8 wires, up to 4 posts per chain and no battens. All wires are usually 12½ gauge steel wire although one or two wires may be barbed. Posts are concrete or treated timber.

(iii) 'Hurricane' netting fence with concrete or treated posts.

(iv) Electric fence.

Many farmers could not provide reliable information concerning fencing material requirements or costs. Thus while the costs of erection shown in Table 5.2 are based upon information provided by farmers, gaps in costing information have been filled by the author.[10/]

---

10. Costs were extracted from reference [4].

Table 5.2 Estimated Costs of Fences (per mile)

	'Conventional'	'Steel'	'Hurricane'	Electric
Materials and Laying	£625	£390	£425	£230
Clearing Line	£ 25	£ 25	£ 40	£ 40
Erection	£280	£200	£200	£ 80
Total	£930	£615	£665	£350
Average Cost per Chain	£11.15.0	£7.14.0	£8.6.0	£4.8.0

Notes: 1. Materials include four gates per mile.

2. Costs for clearing the fence line take account of the fact that a smoother line is required to ensure that 'Hurricane' and electrice fences are stock proof.

3. Total costs are very dependent on cartage costs, difficulties of erection due to land contour, and the sources of supply of posts and battens.

Although the 'conventional' fence was in evident use (largely because the other types were relatively recent innovations), new fences of all four types were being erected in the County. Most farmers who favoured the rugged 'conventional' fence stated that they liked 'a solid job'.

In spite of this, farmers using 'steel' fences claimed them to be at least as stock-proof as 'conventional' fences. Although the longevity and maintenance requirements of the 'steel' fence is still uncertain, the author finds it difficult to justify the additional £200-£250 per mile cost of the 'conventional' fence. The 'Hurricane' fence is also considerably cheaper than the 'conventional' fence, but some farmers reported disappointment in its performance on broken contours. The new Ruakura electric fence is more reliable than previous electric fences, and its relatively low costs makes it very attractive for initial subdivision, especially when finance limits the rate of farm development. Its best use may well be as a temporary fence that would remain on a developed block for, say, two years. At the end of this time it would be shifted to a second block. Its place on the original block could be taken by a permanent fence or, alternatively, the fence line could be removed entirely.[11]

5.62 Pasture improvement by oversowing and topdressing

All farmers in the survey were aware that the productivity of pastures could be improved by oversowing them with clovers. Moreover, virtually all the farmers had used the technique, but, in spite of this, most farmers believed that only slight pasture improvement could result from it.

The author concluded that many farmers were using faulty oversowing procedures. In particular, few farmers realised the importance of grazing pastures very hard immediately before oversowing. Poor results from oversowing could usually be traced to farmers attempting to oversow areas

---

11. The latter policy would be wise only if sufficient grazing intensity could be maintained to ensure good pasture utilisation and to prevent the pasture reverting to scrub and blackberry.

that were too large in relation to the stock (heavy cattle and mature dry sheep) available to prepare them.[12] As a result, the typically well-established danthonia-browntop-ratstail sward remained too long and matted, so that a relatively small proportion of clover seed reached the soil, and even seed which did germinate, frequently succumbed.

However, on those farms where sound oversowing procedures had been used, results were spectacular.

Oversowing with clovers in the County typically costs approximately £3/10/- per acre, including £1/5/- for seed (3 lbs. of white clover and 2 lbs. of subterranean clover) and £2/5/- for superphosphate (applied at 3 cwt. per acre).

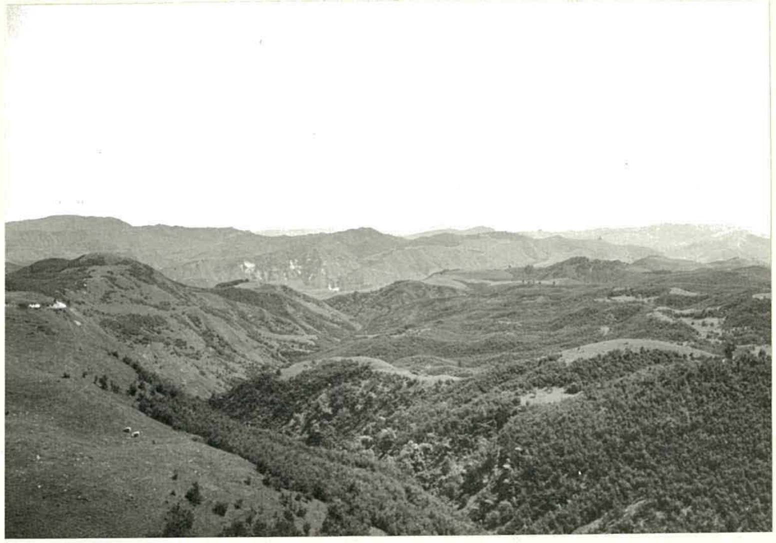
5.63 Establishment of pastures on unproductive land

Most of the unproductive land that was capable of supporting pasture was infested with manuka. A smaller proportion was covered with a tangled mixture of manuka, blackberry, and bracken fern. These weeds usually appeared on contiguous areas covering several acres. The clumps of blackberry that are found throughout the County also comprise a significant part of this class of land. The methods used by Wairoa farmers to establish pasture on unproductive land, are discussed in the following subsections.

---

12. The need for heavy mob-stocking, with grazing intensities of at least 15 sheep per acre, when preparing pastures for oversowing, is well recognised. Many farmers in the survey had attempted to prepare for oversowing by the use of less than half this grazing intensity. This was frequently caused by insufficient subdivision. See Suckling [28] for oversowing recommendations.

Figure 5.1 Land Development in Wairoa County



(a)

A common panorama in the County; dense scrub and low producing pastures on rolling to steep hills.

(b)

Very steep cultivation of light pumice.

(c)

A pasture 18 months after sowing following steep cultivation. Poor establishment on the steeper slopes is evident.

5.631 Development from manuka

Two distinct schools of thought concerning the development of pasture from manuka exist in the County. The most popular technique involves cultivation of all land accessible to heavy crawler tractors. The land is initially worked by tractors equipped with blades and giant discs, and subsequently with heavy harrows. Unploughable areas within cultivated blocks are either burned standing, cut by hand, or left unproductive.

The other technique, which predominates in other North Island hill country districts, consists of cutting the scrub by hand, followed by burning and aerial sowing and topdressing.

The farm survey yielded a number of examples of pasture development by both methods. It was not possible to obtain costs for all examples, but in the case examples which follow actual costs are used unless the contrary is indicated. Where privately owned machinery was used, costs are modified to contract rates. Similarly, fencing is standardised to one chain per acre of 'steel' fence (see Section 5.61 and Table 5.2). The author considers that land developed by either method should allow the farm to carry through the first winter and spring an additional 3 EE for each acre of developed land. If retained or purchased ewes are valued at £3.5.0 each, stocking charges can be estimated at £9.15.0 per acre. This charge has been included in the examples.

Case A (Farm No.30)

Heavy manuka was crushed and pushed into windrows with a crawler blade. After the windrows were burned, the whole area was heavy harrowed until a good seed-bed was obtained. Four harrowings were usually sufficient. Note that giant discs were not used. The pasture was sown down in late February with a roller drill. Superphosphate was applied at 3 cwt. per acre with the seed, and a further topdressing of 2 cwt. per acre was applied in the following spring. Annual maintenance dressing of 2 cwt. per acre commenced in the first autumn after sowing.

Costs per acre:	£
Tractor Work (6 hours @ £3 per hour)	18. 0. 0
Seed	4. 5. 0
Superphosphate (3 cwt at sowing, 2 cwt. following spring)	3.15. 0
Fencing	7.14. 0
Stock	9.15. 0
Total costs per acre	43. 9. 0

Case B (Farm No.8)

In this method, cultivation was started in the autumn with two cuts with giant discs, after which the land was fallowed until the following November, when cultivation was resumed in preparation for sowing in the second autumn. Superphosphate was applied at 4 cwt. per acre with the seed and a further 4 cwt. was topdressed in the following spring. Maintenance applications of 2 cwt. per acre began in the first autumn after sowing.

Costs per acre:

	£	£
Tractor Work:		
First cut with discs (1.3 hours @ £3 per hour)	3.18. 0	
Second cut with discs (1.0 hour @ £3 per hour)	3. 0. 0	
Third cut with discs (1.0 hour @ £3 per hour)	3. 0. 0	
One heavy harrowing (0.9 hour @ £3 per hour)	2.14. 0	
One double rolling (1.8 hours @ £3 per hour)	5. 8. 0	
		18. 0. 0
Fencing		7.14. 0
Water Supply (2 dams per 100 acres @ 10 hours per dam and £3 per hour)		12. 0
Seed		3.10. 0
Superphosphate (8 cwt.)		6. 0. 0
Stock		9.15. 0
Total costs per acre		41. 9. 0

Case D (Farm No.26)

In this development project, regrowth native bush was cut by hand during the winter, burnt during the following summer, and aerially oversown with seed and fertiliser immediately following the burn. 3 cwt. of superphosphate was flown on with the seed, with a further 3 cwt. applied the following spring.

Costs per Acre:

Felling Bush	13.10.0
Seed	4.12.0

		£
Superphosphate (6 cwt.)		4.10.0
Fencing		7.14.0
Stock		9.15.0
	Total costs per acre	40. 1.0

Case E

No particular farmer had well-recorded details of the costs involved in development by cutting and burning manuka, although the physical details of techniques were available from several farmers.

Estimated costs are incorporated in the following description of the most widely used technique of cutting and burning manuka.

Scrub was usually cut during late winter or early spring, this being the season in which labour was available.[13]

Irrespective of the time of cutting, burning invariably took place from late January to late February with aerial sowing of seed and fertiliser taking place soon after.

Costs per acre:

Scrub Cutting (contract or wages)		10. 0. 0
Seed		4.10. 0
Superphosphate (3 cwt. with seed and 3 cwt. in the following spring)		4.10. 0
Fencing		7.14. 0
Stock		9.15. 0
	Total costs per acre	36. 9. 0

13. On some farms, scrub was cut during summer by Fijian Indian labourers.

Although cases A, B, and C provide reasonable estimates of the costs of technically successful development methods, several farmers suggested that tractor charges could be as high as £25 per acre. While no reliable verification of this could be obtained, it is likely that at least some development of manuka by cultivation has, on the basis of the fencing and stocking costs assumed in the examples, costed in the region of £50 per acre.

The case examples also suggest that development of manuka by cultivation can be expected to cost between £5 and £10 per acre more than development by cutting and burning.

Most farmers who ventured opinions felt that pastures sown on cultivated land attained high production faster than those oversown on burns. While several of these farmers had had experience only with cultivation, the author's observations confirmed that this could be correct.

However, many examples of very slow pasture establishment after cultivation were also observed in the survey. This appeared to be mainly due to the following causes:

(i) Blading-off the topsoil to a depth of at least six inches, when either smoothing the terrain or uprooting scrub. This was very common.

(ii) Poor consolidation of the seed-bed, resulting in a dry, unstable topsoil. Erosion by water run-off was frequently noticeable on those areas, which because of their steepness, had been missed by the roller. In several instances, pastures had still not established on these areas after two years.

Thus, while cultivation possibly <u>can</u> offer quicker increases in pasture production, the claim that this is worth an additional £5 to £10 per acre, is at least open to question, especially when extensive deep blading is carried out and when consolidation is not possible.

Farmers might be wise to consider the benefits of increasing the cost of cutting and burning to parity with cultivation by spending the additional £5 to £10 per acre on 6 to 12 cwt. of additional fertiliser which would be applied over the first three years after sowing.

The case examples indicated considerable variation in the costs of seed mixtures. Rates of sowing varied between 20 lbs. and 40 lbs. per acre under both aerially sown and drilled-in conditions. In general, pasture establishment was more dependent upon the method of sowing and subsequent grazing management, than upon the rate of sowing. No particular mixture can be quoted as being 'typical'.

5.632 Development from manuka and blackberry

When these two weeds are together, cutting by hand is technically impossible and the use of machinery is currently the only means of obtaining a seed-bed. Costs can, in general, be expected to approximate the costs of developing manuka on its own with machinery, although considerably more blading may be required to uproot large clumps of well-established blackberry.

One well-documented case of this development was encountered in the County and details of it follow.[14/] Fencing and stocking charges have been made

---

14. This development was carried out on a small farmlet close to Wairoa Borough. It was run in conjunction with a larger farm twenty miles away. The complete unit was not included in the farm survey.

in a similar fashion to those in the last section.

Development operations included:

(i) Approximately 25% of the area accessible to machinery, was bladed in early summer to uproot blackberry clumps.

(ii) Three double cuts with giant discs were then given, with up to two further double cuts over the areas that had been worst infested by blackberry.

(iii) The whole block was then harrowed twice.

(iv) The pasture was sown in the autumn with a roller drill which also spread 3 cwt. of superphosphate per acre. This fertiliser was supplemented by a topdressing of 3 cwt. soon after sowing.

Costs per Acre:	£
Machinery Work	17.16.0
Seed	5.10.0
Superphosphate (6 cwt.)	4.10.0
Fencing	7.14.0
Stock	9.15.0
Total costs per acre	45. 5.0

5.633 Development from blackberry

Historically, development from blackberry in the County has taken one of two general forms; by means of blading and cultivation (in which case the procedure corresponds closely to the one described in section 5.632), and by means of combinations of all or some of spraying, burning, oversowing and topdressing, and stocking heavily with goats and/or sheep.

The survey suggested that the first method was more popular with farmers mainly because it resulted in a pasture of better appearance. Of course, where blackberry forms large contiguous areas, cultivation using crawler tractors is the only means of development, but when the blackberry is present in clumps separated by areas of pasture, the second group of methods is applicable. In more detail, a procedure which had been used successfully, was:

(i) Spraying with hormone herbicides, in spring, as leaf area approached a maximum.

(ii) Burning canes in late spring or summer. In some cases, spraying had been omitted and a good burn still obtained, but success in this depended on choosing a very favourable time to burn. For consistent results, it appeared likely that a 'browning-off' by spraying would be justified.

(iii) After burning, the crucial requirement was for high stocking densities to prevent regrowth from ground level. Rates of at least 20 mature sheep per acre were required in late summer and autumn to achieve this. Alternatively, at least one farmer in the County had employed goats controlled by goat-proof fencing. This variation has obvious advantages when adequate numbers of 'punishable' mature sheep are not available.

(iv) Oversowing the burnt patches with clovers and superphosphate. Even though subsequent heavy stocking was not conducive to rapid pasture establishment, some healing of the patches still resulted.

(v) A further spraying-burning sequence was sometimes required in the following year although stocking rates were usually lower, allowing good establishment of pasture from a second oversowing.

No costs of this procedure were forthcoming from farmers, but the author has estimated them as follows:[15]

Costs per Acre	£
Assuming 30% infestation, spray and application charges in the first year	7.10.0
Spraying in the second year	3.10.0
Seed for spot oversowing in the first year and oversowing the whole area in the second year	2. 0.0
Fencing at 1 chain per acre (assuming that at least 1,000 mature sheep are available in the autumn to stock a 50 acre paddock)	8. 0.0
Additional stock, assessed as 3 EE per acre on 0.3 acres, and 1 EE per acre on 0.7 acres, and valued at £3.5.0 per EE	5. 4.0
Fertiliser, assessed as 3 cwt. per acre on 0.3 acres and two dressings of 3 cwt. per acre over the whole area, priced at 15/- per cwt.	5. 5.0
Total costs per acre	31. 9.0

The relative unpopularity of this method was probably due to some farmers experiencing poor results from it, possibly because they,

(i) Failed to spray correctly (usually as a result of using unsuitable equipment), and/or

15. The costs of application are based on the experience of Mr G.J.King, Masterton, on Wairarapa hill country.

(ii) Failed to provide sufficient grazing pressure after burning, this being caused by attempts to develop areas that were too large in relation to the stock available.

The availability of cheap, relatively foolproof, and manoevrable motorised blowers could well encourage more farmers to attempt blackberry eradication by this method, which appears to be considerably cheaper than cultivation, especially where the blackberry occurs in clumps.

An important point, often ignored by farmers, was that hormone sprays become increasingly effective as the area of foliage on each plant increases. Thus poor results can be expected from spraying mature blackberry that has been consistently eaten back by goats. Thus goats should be kept off intended development areas for at least one year prior to development starting.

5.64 Changes in stocking policies during farm development

In other North Island hill country districts, farmers have successfully modified their original Romney breeding policies, to policies that were more appropriate to farm development.[16] These modifications have included the establishment of large flocks of mature wethers, which are useful in pasture development as well as requiring little labour, and the introduction of Perendale breeding ewes at times when labour shortages prevent any increase in the Romney ewe flock.

No policies of these types were observed in Wairoa County. All farmers in the survey who were increasing production, had maintained their original

16. Two notable examples of modified stocking policies are described in Section 5.72.

Romney breeding ewe/ewe hogget sheep policies, although in some cases cattle numbers had not been increased as rapidly as the sheep.

5.65 Finance used for farm development

On the Purposive Farms, finance for development had been obtained from three sources. Seven of the sixteen farmers had State Advances Corporation development loans and one (who also had State Advances finance) had a mortgage for development from a stock firm. All farmers had some overdraft facility (with either or both of stock firms and trading banks), which could be claimed to assist in a minor way with financing development, but only one farmer had a substantial overdraft (of the order of £3,000) which had been allowed specifically for expenditure on development.

It was therefore evident that the State Advances Corporation had been easily the most popular source of capital for conscious efforts to increase production.

The seven State Advances loans referred to above were secured by either first or second mortages, which were bearing interest at 5% and 5½% respectively. When the borrower could offer only poor security loans were administered in conjunction with budgetary control over all farm and personal expenditure, but there was no clear distinction between situations warranting this control, and the more affluent positions of farmers who were allowed to uplift loan monies at will. On completion of advances, which were made on a current account basis, loans were converted to table mortgages repayable biannually for (most popularly) twenty-five or thirty years. Advisory work and investigations by Corporation appraisers centred about ensuring that borrowers would be able to service loan repayments and interest while enjoying a 'reasonable' standard of living.

While the amounts advanced were usually sufficient to increase production substantially, the experience gained by several farmers was encouraging them to consider development to much higher levels of production. These farmers felt, however, that the Corporation's general policy of spreading funds over as many loans as possible, might prevent them from obtaining further substantial loans.

5.7 High Production on Hill Country Outside the County

This section contains a review of farmers' experience with high production on hill country outside Wairoa County. It is thought that much of this experience has direct relevance to increasing production in the County.

Reference is made to the results from three experimental farms operated by the State, and to the management practices of two innovating farmers. Since these farms have all received considerable publicity, the following discussion takes the form of a brief summary.

Results from the experimental farms at Waerenga-o-kuri and Tangoio have been reported by Collin [27], while findings from the Te Awa experimental area have been presented by Suckling [28] and [29]. Innovating farmers' comments have been published by Tripe [30] and Inglis [31]. A concise summary of the production attained on all five farms has been prepared by Burgess [32].

At the outset, it must be emphasised that the published material on these farms deals almost exclusively with the technical procedures used to achieve and maintain high production. The experimental farm results pay no attention to the financial implications of increasing production to high levels, while Tripe and Inglis have made only brief comments on the economics of their management.

Thus the chief value of the currently available experience is that it should help to make other farmers confident that high production is technically feasible.

5.71 State experimental farms

Waerenga-o-kuri and Tangoio are situated near the northern and southern extremities of Wairoa County and can therefore be said to have greater in common with County farms than has Te Awa, which is situated in the Manawatu hill country. However, much of the information from Te Awa is also relevant to Wairoa. These farms are now discussed separately. In each case, attention is first directed at production. Subsequent discussion deals with some important aspects of management.

5.711 Tangoio and Waerenga-o-kuri

These experimental farms are described together because their aims and experimental methods have been essentially similar.

Tangoio has a grazeable area of 450 acres. The average rainfall of 60 inches and the light, sandy loan soil of moderate fertility, means that natural conditions are very similar to much of Wairoa County.

Two hundred of the 450 acres are devoted to a grazing trial, but the overall performance of the farm merits mention. Stock were wintered in 1965 at the rate of 5.0 EE per acre, this rate having increased from 2.7 EE per acre in 1959. Wool production reached 40 lbs. per acre in 1962/63.

Natural conditions at Waerenga-o-Kuri are generally similar although average rainfall is slightly lower (51 inches), and some soils are based on volcanic ash. Some 630 acres are farmed and in 1965 the overall stocking rate was also 5.0 EE per acre.

Both farms have particular areas set aside as grazing trials in which set stocking is compared with mob stocking on self-contained farmlets. Cattle are used only to control surplus feed.

Details of year-round management have been described by Collin [21] and no reference to it is made here.

The following tables indicate stocking rates and production on the two farms in the 1963/64 season.

Table 5.3 Production on Tangoio Grazing Trial

Treatment	Stocking Rate (EE per acre)	Lambing (% Docked)	Ewe Deaths (%)	Weaning Wts. per acre	Wool per Acre (lbs.)
Low Set Stocked	3.5	102.4	2.5	181	35.4
High Set Stocked	6.0	81.1	4.3	191	51.3
Mob Stocked	6.0	87.8	3.3	187	51.0

Table 5.4 Production on Waerenga-o-Kuri Grazing Trial

Treatment	Stocking Rate (EE per acre)	Cattle Grazing Days	Lambing (% Docked)	Ewe Deaths (%)	Weaning Wts. per Acre (lbs)	Wool per Acre (lbs)
Set Stocking	7.0	19	77.8	7.1	297	90.5
Mob Stocking	7.0	48	110.4	4.4	384	77.5

The most noticeable feature of these trials is that the stocking rates and production attained, under all of the treatments, are considerably higher than the levels reached on farms that were in the survey of Wairoa County.

Unfortunately, the stocking trials provide little information on how to increase production rapidly, and thus their chief value lies in demonstrating the practicability of high stocking rate management systems to farmers. It is also important to note that these trials do not indicate that high levels of production are profitable, or that high levels are more profitable than lower levels. It is therefore unreasonable to expect farmers to adopt high stocking rate systems on the basis of these technical trials alone.

The relative merits of set-stocking and mob-stocking in a high stocking rate management system, are discussed in Chapter 8.

5.712 Te Awa

Te Awa, situated in the Manawatu hill country, is considered to have less favourable natural conditions than much of Wairoa County. Rainfall averages 40 inches, winters are severe, and the soil type has low natural fertility.

As on the other experimental farms, the emphasis has been placed on investigating the practicability of stocking hill country to high levels, and not on demonstrating a method of increasing production. However, the trial work, together with observation on other farms, has allowed Suckling [28] to suggest techniques for achieving high production from hill country.

The trial work, which involved only set-stocking ewes with and without cattle, has been fully reported.[17]

Table 5.5 shows the results that are most important to the Wairoa study. Stocking rates indicate only the number of ewes that were set-stocked. In the trials, cattle were used as required to control rank pasture and coarse weeds, but no details of the numbers used have been published.

Table 5.5 Production on Te Awa (Average 1959/63)

Stocking Rates (Ewes per Acre)	Lambing (%) (a)	Ewe Deaths (%)	Wool per Acre (lbs)
3	115.2	3	47.4
4	108.4	7	62.4
5	102.2	4	74.5
6.5	99.6	3	84.5
7	92.9	4	81.2

Note: (a) Lambing percentage relates lambs weaned to ewes put to the ram.

17. See Suckling [29].

Suckling [28, p.53], has stated:

'To achieve high production from hill country, it is necessary to subdivide adequately, segregating sunny from shady faces wherever practicable; to topdress and oversow with legumes; to control grassgrub and subterranean caterpillar and to utilise fully the resulting grass growth'.

When full utilisation of pasture grown is the objective, adequate subdivision is related more to stock numbers than to paddock size. Suckling suggests, however, that 16 to 20 paddocks are required on each farm to ensure adequate flexibility in pasture management. Other important recommendations that he has made are:

(i) In the development of low producing pastures, oversowing, topdressing, and stocking are likely to give better results than discing and resowing, unless the cultivated areas can be fenced off from uncultivated areas.

(ii) Oversowing with innoculated clover seed should be done in late March on pastures that have been close-grazed. Close grazing should be maintained for some time after sowing. Topdressing with the seed is preferable, but not essential.

(iii) Anticipate increased pasture production when topdressing and oversowing, and stock up to the expected improvement.

5.72 Experience of innovating farmers

The two cases considered offer different lessons to farmers who are contemplating substantial production increases on hill country; one shows that very rapid increases are possible, while the other indicates that very high stocking rates are possible under commercial farming conditions.

5.721 'Wairere'[18]

This Wanganui hill country property is remarkable for two reasons; because very rapid production increases have been achieved on it, and because one and a half effective labour units comfortably handle 1,500 ewes, 1,000 hoggets, 3,400 mature wethers, and 55 cattle.

Development of the farm, which has a potentially grazeable area of 1,300 acres, commenced in 1960. At that time 2,050 EE were wintered. By the winter of 1965 stock had increased to 5,550 EE (that is, nearly 5.0 EE per acre); an average increase in stock of 37% per year. Wool production increased from 19,100 lbs. in 1960/61 to 65,000 lbs. in 1956/66; an average increase of 48% per year. In 1965/66, wool production had reached 50 lbs. per acre.

This production increase was attained by cutting and burning manuka scrub, oversowing the burns, and stocking so as to approach full utilisation of the new pasture.

The areas developed at any one time ranged up to 270 acres, and very little subdivision of these initially large areas was attempted. The key thought was that pasture management should be centrally dependent on the available concentration of grazing animals. Provided that sufficient extra animals were available to stock newly established pasture, subdivision was therefore superfluous.

---

18. See Tripe [30].

Development of a 'typical' paddock proceeded as follows:

(i) The original native-grass pasture was so infested with manuka that less than 2 mature wethers per acre could be run. All manuka was cut during summer by Indian labourers, and burned almost immediately.[19]

(ii) The whole paddock was then aerially oversown with seed at 15 lbs. per acre (including 5 lbs. per acre of cover seed). At the same time the paddock was topdressed with superphosphate at 3 cwt. per acre.

(iii) From the time of the burn, mature wethers were drifted onto the paddock until in the first winter they were stocked at approximately 4 per acre.

(iv) In the following spring, a further topdressing of superphosphate at 3 cwt. per acre was applied. Topdressing then reverted to an autumn applied maintenance of 2 cwt. per acre.[20]

(v) New grass was never spelled, and after the first winter stocking rates seldom fell below 6 wethers per acre. Autumn growth was controlled by mob stocking the wethers at a minimum of 20 wethers per acre. The need for this concentration of stock, together with the number of wethers available, placed an upper limit on the size of paddocks.

(vi) Fencing was therefore confined to making existing fences reasonably stock proof, and a minimum of new subdivisional fencing was erected. No attempt was made to ensure completely stock-proof fences, because pasture

---

19. Mr Tripe believes that immediate burning results in a hotter fire and a cleaner job, than is obtained when the manuka is allowed to dry.

20. Post-sowing topdressing policies varied on different paddocks. The one referred to appeared to be most successful in terms of pasture growth.

management could be little affected by wandering stock when all pastures were heavily stocked all the time.

The basic investment policy was to borrow as heavily as possible, and to spend first on items promising immediate returns. Thus fencing, gates and tracking represented only a small part of the total investment.

On 'Wairere' the annual rainfall is 41 inches, the soil is light and sandy, and the contours are exceptionally steep. These natural conditions are certainly no more favourable than in much of Wairoa County. It is therefore reasonable to suggest that production increases of the order attained on 'Wairere' could be achieved on Wairoa hill country.

5.722 'Ratahiwi' [21]

Although the even spread of rainfall and the easy hill contours result in this Woodville property being not strictly comparable with Wairoa hill country, at least two aspects of its management have important implications for Wairoa.

The first concerns the pasture management techniques used to attain a well-nourished winter stocking level of 6.5 EE per acre[22]; the other relates to the fact that 6,500 ewes, 1,000 hoggets, 70 rams and 70 two-year steers are easily handled by three workers.

Very briefly, pasture management is based upon set-stocking all sheep on paddocks ranging in area from 25 acres to 60 acres. Each paddock has access by means of a drafting-pen to at least one other paddock, thus

21. See Inglis[31].

22. This rate includes 5.65 breeding ewes per acre.

facilitating minor day-to-day adjustments in stocking rates in response to variations in the growth of different pastures. This method can be regarded as a refinement of the grazing management on 'Wairere', and pasture utilisation can be expected to be superior under this closer supervision, although the investment in fencing and yards is obviously much higher than on 'Wairere'. The crucial point is that pasture must be well utilised both to realise some return from the expenditure on promoting growth, and to maintain or improve pasture quality.

The high productivity of labour on 'Ratahiwi' has been greatly assisted by excellent access to all parts of the farm. Good roads and tracks, and motorised transport have contributed to a saving in time when sheep are handled and moved. As a result of intensive subdivision, mobs are relatively small, and this also facilitates rapid movement of stock. The requirement for labour during the critical period in early spring, is reduced by running a flock of 'self-help' Perendale ewes. As with the dry sheep on 'Wairere', the Perendale flock has allowed stocking to increase beyond the point where it would otherwise have been limited by labour shortages.

Both policies have direct relevance to farming in Wairoa County, particularly in those isolated areas where reliable labour is in short supply.

5.8 Summary and Conclusions

The most important findings that emerged in this Chapter were:

(i) The farm survey indicated that there was little variability in stock management practices on Wairoa hill country farms. Most practices were generally similar to traditional management in other North Island hill country districts.

(ii) The generally low lambing percentages appeared to be traceable in part to the small size of two-tooth ewes. The author concluded that faulty hogget management was often responsible for poorly-grown ewes.

(iii) The typical reliance on breeding cows and other heavy cattle to control pastures, was a prominent feature of stock management. However, this policy appeared to actually contribute to pasture deterioration, because farmers tended to understock their farms in order to ensure the availability of cattle feed at all times.

(iv) The autumn-calving system developed by a farmer in the County showed great promise. The author believes that further testing and (possibly) demonstration of the system, is warranted.

(v) Many farmers were needlessly pre-occupied with the relative merits of various types of fertiliser. The experience of farmers in the survey indicated clearly that superphosphate was the most important fertiliser component, although there was some suggestion that reverted superphosphate gave superior responses in some districts. The crucial point was that few farmers topdressed more than half the area of their farms each year. Until farmers begin to topdress the whole of their farms with superphosphate, while increasing stocking rates to utilise the extra pasture grown, the author sees little point in protracted arguments concerning alternative fertiliser mixtures.

(vi) Many farms had insufficient subdivision to allow effective control of pastures. This feature was exemplified by the general inability of farmers to correctly prepare pastures for oversowing.

(vii) Cultivation with heavy machinery was found to be far more popular than cutting and burning as a technique for developing pasture from manunka. However, comparative budgets showed that cultivation often cost £10 per acre more than cutting and burning. Moreover, pasture establishment after cultivation was often lengthy on the steeper areas, where consolidation of the seed bed was impossible.

(viii) The majority of farmers still favoured the 'conventional' type of fence, although the cheaper (by approximately £300 per mile) 'steel' fence was finding some acceptance among farmers.

(ix) Trial work on hill country adjacent to Wairoa County has shown that stocking rates of up to 7 EE per acre are physically feasible. However, these trials have <u>not</u> demonstrated that it is profitable for farmers to <u>increase</u> their stocking rates to these levels.

(x) The experience of innovating farmers on hill country outside the County suggested that the traditonal stocking policies in Wairoa could well be modified during farm development. In particular, it is clear that mature wethers could be used in pasture development, and that wethers or Perendale ewes could be used to increase stocking rates when labour shortages prevented any increase in Romney ewe flocks.

CHAPTER 6

THE EVALUATION OF HILL COUNTRY DEVELOPMENT PROGRAMMES

6.1 Introduction

Although some techniques that had been used in farm development were described in Chapter 5, the concept of complete development programmes has not yet been introduced. The initial purpose of this Chapter is to define this concept. Attention is then focussed on the reasons for evaluating farm development programmes. Finally, the concepts involved in evaluating programmes are discussed, and the actual procedures used to evaluate the development programmes presented in Chapters 7 and 8, are explained by means of a worked example.

6.2 Definitions

A development programme can be defined as a time schedule of resource inputs and outputs, together with information on how the inputs are to be transformed into outputs. During a development programme, production is increased from a pre-development level to a second 'plateau' or level at which physical production tends to remain constant. The development is said to be 'successful' if this change is profitable.[1]

1. See Chapter 3, Section 3.532, for definitions of 'profit' and 'profitability'.

The investment required when a programme is carried out is the diversion of resources from consumption or off-farm saving to processes providing for increased future production. This increased production is, in turn, expected to provide future opportunities for either consumption or further investment.

6.3 The Need for Evaluation of Development Programmes

The evaluation of development programmes is a pre-requisite to rational decision-making by both farmers and agencies that are entrusted with encouraging increased production from farms. This statement is explained in the following two subsections.

6.31 Evaluation by farmers

The main financial concern of a farmer contemplating the adoption of a development programme is likely to be whether or not the programme can be expected to increase post-tax profits, where increased assets are treated, to some degree, as equivalent to increased cash income. Hence an evaluation of the profitability of a proposed development programme should be a fundamental step taken by most farmers who contemplate production increases. In fact, there are two different situations in which such an evaluation is necessary. They are:

(i) The determination of whether a proposed programme is likely to be profitable or unprofitable, and

(ii) When several profitable proposals are contemplated, the identification of the most profitable alternative. That is, it may be necessary to rank alternative programmes in order of profitability.

Nevertheless, it is doubtful that an evaluation of the profitability would provide any farmer with sufficient information to either adopt or reject a development programme. In particular, most farmers would require information about the indebtedness associated with a development programme. In general, farmers are averse to indebtedness, and may are able to quantify their dislike in terms of a maximum tolerable level of indebtedness. Associated with these attitudes are desires to pay off debts, or at least stabilise them (as by converting a current-account debt to a table mortgage) as soon as possible.

Thus a farmer who subjectively believes that 'debt is bad *per se*', or who has a genuine aversion to the additional risk of losing control of his farm (this is implicit in lowered equity), may reject a profitable development proposal because its expected levels of indebtedness are too great.[1/]

Clearly, an evaluation of a development programme should include estimates of the maximum level of indebtedness and the time required to repay this debt.

---

1. As an example, consider two alternative development programmes for a farm, Programme A specifies a maximum indebtedness of £10,000, while Programme B has a maximum indebtedness of £6,000. In addition, Programme A can be shown to be more profitable than Programme B. Notwithstanding the greater profitability of Programme A, a farmer unwilling to incur a debt greater than, say £7000 will have no alternative to choosing Programme B. A second farmer faced with the same decision, may well tolerate a debt of £10,000 and adopt Programme A.

Finally, it should be noted that while a management advisor can be employed to evaluate a farm development programme for a farmer, the ultimate decision of whether to adopt or reject the programme can be taken by only the farmer himself. This fundamental point has been explained by Heady, [33, p.3].

6.32 Evaluation by planning agencies

In the present context, a planning agency may be defined as an organisation that is responsible for the promotion of increased farm production in a specified region. Current examples of such planning agencies are the New Zealand Agricultural Production Council, and its subsidiary District Agricultural Development Committees.

Planning agencies have an obvious obligation to ensure that 'increases in farm production' are profitable to the Nation as a whole.[2/] Farm development programmes which are unprofitable before the payment of taxation must be detrimental to the Nation. In spite of the increase in farm production that may result from these programmes, they should not be undertaken, because the total value of the resources that they consume is greater than

2. The concept of 'profit to the Nation' is defined in Chapter 3, Section 3.532. There can be no sensible technical definition of desirable increases in farm production. As an illustration, consider an extreme case in which 1,000 extra ewes could be carried on a farm, but only at the cost of applying an extra 500 tons of superphosphate. Although increased farm production would be obtained, this would almost certainly be undesirable, because profits from the farm would be reduced. That is, increases in farm production, can be regarded as desirable to the Nation, only if they increase profits.

the value of their production. 3/

The profitability of programmes to the Nation, can be correctly estimated by using domestic prices for exported produce, provided that official exchange rates between £N.Z. and overseas currencies accurately reflect their relative values. However, the current practices of domestic import licensing and control of overseas exchange, suggest that official exchange rates overvalue the £N.Z. Under these circumstances, development programmes providing for additional exports are more profitable to the Nation than is indicated by evaluations using domestic prices. However, since it is difficult to state the 'correct' exchange rate, domestic prices have been used in all the evaluations in this study.

Moreover, these types of development which are shown by evaluation to be profitable to the Nation must be examined with respect to their profitability to farmers. 4/ There is little point in 'planning' to promote an increase in production by particular techniques unless the increase is profitable to individual farmers. It is not sufficient that the production

---

3. Conceptually, maximum profits (to the Nation) from farm development can occur only when the marginal revenue of each variable resource is the same in all programmes in which it is used. This situation implies a 'shadow marginal cost' for each resource. If a development programme is unprofitable when resources are valued at their shadow marginal costs, it should be rejected, even though it may be profitable when resources are assigned real or market costs. In practice, however, it is reasonable for the Nation to 'go ahead' with any farm development that increases profits in real terms.

4. The payment of tax on revenue resulting from development will, of course, render development programmes less profitable to farmers than to the Nation.

increase is profitable to the Nation.[5]

Alternative techniques for increasing farm production may be available and it is likely that some of these would be more profitable than others to the Nation. A planning agency should usually expend no more effort in promoting a highly profitable technique than in promoting a less profitable one. Hence the efficiency of extension (that is, promotion) effort depends largely on ensuring that the proposed change in management is likely to be the most profitable of the available alternatives.[6]

6.4 The Development Model

Before discussing the concepts involved in evaluating farm development programmes, it is necessary to define their important physical, financial, and temporal features. In this section, a model of hill country development is described. All actual development programmes that the author has studied, have conformed to this basic model.

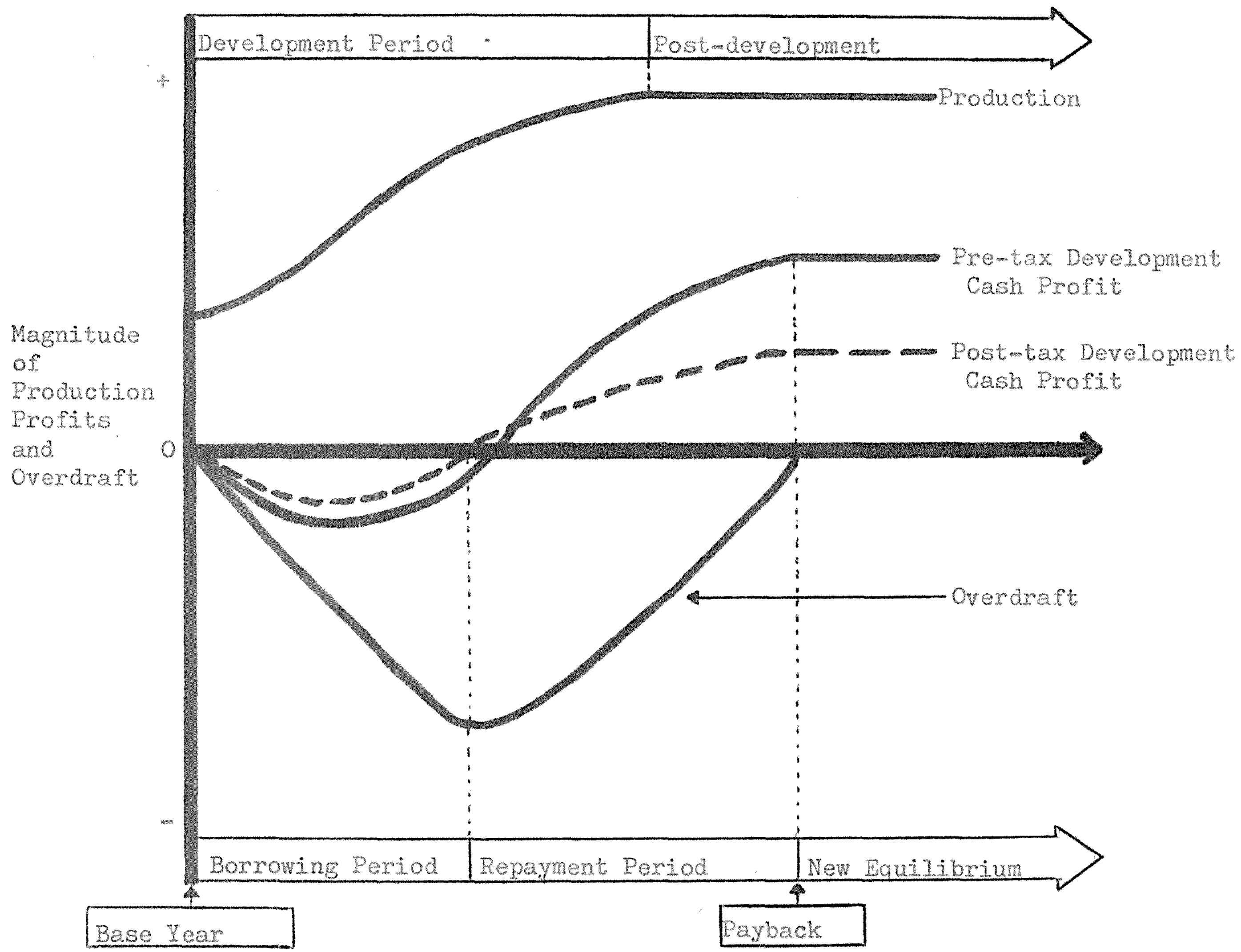
The model is described with the aid of Figure 6.1. To simplify the presentation, the diagram represents production, profits, and overdraft as being continuous. In practice they are accounted at specific points in time, usually at the end of each financial year.

---

5. Similarly, there is no point in 'planning' any increase in production on farms in a region unless the techniques that can be used to bring this about are known.

6. The planning agency should, of course, always promote the management change that is most profitable to farmers. Different taxation concessions may result in another management change being more profitable to the Nation.

Figure 6.1 Schematic Representation of a Development Programme



6.41 Temporal considerations

A hill country development programme almost invariably extends over several years. It can be regarded as commencing at the end of the Base Year, and continuing until the beginning of the year in which the farm may be said to be in New Equilibrium. The Base Year represents the management of the farm immediately prior to the commencement of development. It is supposed that Base Year management, production, and profits would be maintained indefinitely in the absence of development. New Equilibrium, on the other hand, is reached when the production and profits from the farm return to (higher) constant levels. It is also assumed that New Equilibrium profits are maintained indefinitely.

6.42 Production

Production, in terms of physical quantities of wool, fat lambs, and store stock, rises from the end of the Base Year for several years. This interval is known as the Development Period, and it ends when production again tends to a constant level. The Post-development period is assumed to extend indefinitely into the future.

6.43 Profits

In the early years of farm development, cash profits usually fall below Base Year cash profits.7/ The heaviest expenditure on development is

7. In this context 'cash profits' may be interpreted as either the pre-tax or post-tax cash profits from the operation of a farm. It is possible for the additional income from development to more than offset the additional expenditure on development. In this case, annual cash profits will always remain above Base Year cash profits.

is commonly made during this period. Additional income eventually exceeds additional expenditure, and cash profits rise above Base Year levels.

It is convenient to regard the cash profits from a development programme as 'the cash profits that would not have accrued if development had not taken place'. That is Pre-tax Development Cash Profits, and Post-tax Development Cash Profits, in the ith year of the development programme are defined as follows:

Additional Cash Income (V_i) in the ith year is given by,

$$V_i = A_i - A_o \tag{6.1}$$

Additional Pre-tax Cash Expenditure (C_i) in the ith year is given by,

$$C_i = E_i - E_o \tag{6.2}$$

Additional Post-tax Cash Expenditure (C_i*) in the ith year is given by,

$$C_i^* = E_i^* - E_o^* \tag{6.3}$$

where

A_i is the total cash income in the ith year,

A_o " " " " " " " Base Year,

E_i is the total cash expenditure (excluding tax) in the ith year,

E_o " " " " " (" ") " " Base Year,

E_i* is the total cash expenditure (including tax) in the ith year, and

E_o* is " " " " (" ") " " Base Year.

Then, in the ith year,

Pre-tax Development Cash Profits = $V_i - C_i$, and (6.4)

Post-tax Development Cash Profits = $V_i - C_i^*$. (6.5)

Figure 6.1 illustrates that if tax is paid in the Base Year, Post-tax Development Cash Profits are greater (often in the sense that they are less negative) than Pre-tax Development Cash Profits in years when the latter is negative. This feature is explained by tax payments being lower than Base Year tax in the years when development reduces farm profits.

6.44 Overdraft

In the years during the Development Period, when total cash income is insufficient to meet total cash expenditure and a farmer's personal drawings, finance must be borrowed.[8/] In most programmes, a Borrowing Period extends over early years. During this phase total revenue may increase, but in many programmes borrowing will still be required, at least in the first few years, thereby giving rise to increasing debt. A second phase, termed the

---

8. The level of personal drawings will affect the amount that has to be borrowed. The most meaningful measure of the profitability of a development programme will be obtained when personal drawings are never allowed to fall below the Base Year level. In this case, interest will be charged on all development expenditure that cannot be met by the income resulting from development. On the other hand, if personal drawings are allowed to fall below Base Year levels, the development programme receives the equivalent of an 'interest-free non-repayable' loan. This point is discussed in the context of actual programme evaluations, in Chapter 7.

Repayment Period, extends from the time of maximum indebtedness to the time when all debt associated with development has been repaid. The latter point in time is referred to as Payback. If the debt is regarded as an unlimited overdraft that is repaid as rapidly as possible from post-tax profits[9], then the Repayment Period is the minimum time in which the debt can be repaid.

As interest must be paid on outstanding debts, the profits from development cannot reach a maximum until after Payback. Thus, if the Repayment Period extends later than the Development Period, the New Equilibrium will be attained in the year after Payback. This situation is the one illustrated in Figure 6.1. It is also common for Payback to occur before the end of the Development Period. In this case, the New Equilibrium is attained in the first year of the Post-development period.

6.5 Expressing the Profitability of Development Programmes

The income and expenditure in any one year are usually accounted at the end of that year. If this is done, the Pre-tax and Post-tax Development Cash Profits that occur at the end of each year and the streams of annual profits (some of which may be negative) that are generated by a development programme may be calculated.[10] These streams contain all possible information about the profitability of the programme.

---

9. The rate of repayment is dependent upon the level of personal drawings. If they remain at Base Year level, then the whole of Post-tax Development Cash Profits are available to repay the overdraft.

10. It is important to notice that the Pre-tax and Post-tax Development Cash Profits that occur in the first year of the New Equilibrium situation, are assumed to recur indefinitely thereafter. Given a particular planning horizon, development profits could equally well be considered only as far as that horizon.

In practice, however, it is difficult to interpret the information in this form. A convenient way of summarising a stream of annual profits is to discount each annual profit to the beginning of the first year of development. The sum of these discounted profits is then termed the Present Value of the stream of profits. This procedure is explained more fully in the next section.

6.51 The present value of profits[11]

To facilitate exposition in this section, the effect of taxation on profits is disregarded. The procedure can, of course, be used to summarise any stream of profits, irrespective of whether or not tax is ignored.

Consider a hypothetical development programme which attains New Equilibrium in the year n. Then if V_i is the Development Cash Profit in the ith year if development, the stream of profits consists of the sequence $V_1, V_2, \ldots, V_{n-1}$, of (typically) unlike annual profits, and a sequence of like annual profits occurring in each year from n to infinity.

Now, persisting with the assumptions that profits occur at the ends of years, the present value of the first n-1 Development Cash Profits is given

---

11. Procedures generally similar to the one described in this section have been used by Ward and Parkes [34], MacArthur [35], and Holden [36] to evaluate farm development programmes. Other workers have used different procedures. The pitfalls inherent in two of them, the 'internal rate of return', and the 'return on capital', are the subject of Appendix E.

by,

$$PV_{(1 \text{ to } (n-1))} = \sum_{i=1}^{n-1} \frac{V_i}{(1+r)^i} \qquad (6.6)$$

where r is the annual market interest rate expressed as a decimal[12/].

Further it can be shown that the present value of a stream of like annual profits (V) occurring at the end of each year from n to infinity inclusive, is given by,

$$PV_{(n \text{ to } \infty)} = \frac{V}{r} \times \frac{1}{(1+r)^{n-1}} \qquad (6.7)$$

Hence the present value of the entire stream of Development Cash Profits is,

$$PV = \sum_{i=1}^{n-1} \frac{V_i}{(1+r)^i} + \frac{V}{r(1+r)^{n-1}} \qquad (6.8)$$

6.52 Estimating asset increments

It is conceptually possible to estimate from the cash flow information discussed above, the asset increment[13/] that is represented by a complete development programme.

---

12. On the assumption of a perfect capital market, the 'market interest rate' is equal to the price of capital; the interest rate payable on borrowed capital. Moreover, the market interest rate is equal to the 'opportunity cost of capital', the revenue that a farmer foregoes if he does not invest his capital outside his farm.

13. 'Asset increment', in this sense, is the increase in market value of the farm.

As an example, suppose that some development programme yields a New Equilibrium annual Pre-tax Development Cash Profit of £1,200. Consider also that the farm has a rational prospective purchaser who can obtain a maximum return of 6% on his capital if it is invested elsewhere. Now the investor must invest at least £20,000 elsewhere in order to obtain an annual return of £1,200[14]. It would be profitable for him to pay at most £20,000 more for the farm as a result of its being developed[15]. Thus the £20,000 may be termed the Maximum Asset Increment that the completed development programme represents.

In practice, the actual increase in market value would often be lower than Maximum Asset Increment because:

(i) The purchaser may be uncertain that the farm could earn an extra £1,200 under his management.

(ii) The purchaser may decide to run the farm along less profitable lines. He may well do this if he already owns another farm. (The converse of this situation could arise, in which case the purchaser could profitably pay more than an extra £20,000).

---

14. The annual return on a £20,000 investment, at 6% interest, is £1,200.

15. This statement ignores the effect that taxation may have on the relative profitability of investments. If on-farm and off-farm investments yield equal pre-tax returns, it is likely that the on-farm investment gives higher post-tax returns because more expenditure is deductible on the farm.

(iii) The additional £20,000 might make the total purchase price so high that very few prospective purchasers would be able to finance the transaction. This lack of demand would tend to reduce the market price.

6.53 Return on Investment

During the farm survey, the author noted that many farmers referred to profits derived from development as a 'return on extra expenditure' or a 'return on investment'. These were understood as ratio measures, with annual profits expressed as a percentage of investment.

While recognising the requirement for a form of expression of profits that should be intelligible to a wide audience, the author wished to select a ratio measure that avoided the difficulty of application associated with Return on Capital[16/]. Accordingly, an expression termed Return on Investment was developed[17/]. This is defined by equation (6.9).

Return on Investment

$$= \frac{r \times PV}{PV_{OD}} \times \frac{100}{1} \quad \% \qquad (6.9)$$

where r is the annual market interest rate,

PV is the Present Value of Pre-tax Development Cash Profits, and

PV_{OD} is the present value of the maximum overdraft (or indebtedness) associated with the programme.

---

16. See Appendix E.

17. The use of this expression to explain the profitability of farm development was originally suggested by Candler [37].

The term (r x PV) in equation (6.9) expresses the Present Value of Pre-tax Development Cash Profits as an annuity. An annuity is equivalent to the constant annual return from a sum equivalent to the present value, invested at the market interest rate.

The present value of the maximum overdraft is equivalent to a cash sum which, if available immediately prior to commencement of development, and if used in the programme as required, would just avoid indebtedness.

Thus, the present value of the maximum overdraft indicates the extra net expenditure incurred as a result of implementing the development programme. Since this sum must be obtained by either drawing from savings, borrowing, or diverting resources from current consumption, it represents the level of investment in the development programme. There is a conceptual similarity between Return on Investment and the yield on Government Stock.

6.54 Increase in Owner's Drawings[18/]

In addition to the foregoing expressions of profitability, most farmers contemplating development should be interested in the increase in Owner's Drawings that development will allow. As shown in Figure 6.1, the post-development increase in Owner's Drawings is equal to the New Equilibrium annual Post-tax Development Cash Profit.

---

18. This terminology, which refers to the maximum personal drawings that a farmer can make after he has paid tax, was introduced in Chapter 4, Section 4.8.

6.6 Objectives Other Than Profit

For most farmers, details of the likely profitability of a development programme are necessary, but not sufficient, information to allow its adoption or rejection. Farmers who are not motivated by profit will certainly require more information, because statements of profitability provide them with nothing relevant to their decision processes.

The author believes that two pieces of information are particularly important.

They are:

(i) Maximum Overdraft, which is the maximum indebtedness that a farmer could expect to face. This information is important to two groups of farmers; those who have an aversion to debt, and those who face a rigid restriction on borrowing facilities.

(ii) Repayment Period, which is the minimum possible period in which the entire debt can be repaid, after attainment of maximum overdraft. This will also interest farmers who are averse to debt, and it will concern those who can obtain loans only for some specified maximum period.

6.7 A Worked Example of Development Programme Evaluation

This section uses a hypothetical development programme to explain in detail the procedures which are used in evaluating programmes in later chapters. Raw financial data is introduced, but physical details of the programme are omitted as being irrelevant to this illustration. Even the financial data has no significance per se. Indeed, simplicity of interpretation was the main objective in developing the data.

The Development Period has a length of three years, but interest payments charged on the overdraft associated with the programme are made in two subsequent years. Attention must therefore be given to stock numbers and financial data in each of seven years; a Base Year, the three years of the Development Period, the two Post-development years over which the overdraft and associated interest payments are paid off, and a year representing the New Equilibrium situation.

6.71 The raw data

Table 6.1 sets out the items of expenditure usually found in a Profit and Loss Account. These items are tax-deductible.

It should be noted that development expenditure is included. For example, expenditure on fertiliser increases from £400 in the Base Year to £800 in Year 1. Table 6.1 does not include annual interest payments. Interest payments appearing in Farm Accounts are almost always misleading; most farmers who require finance to develop borrow from several sources, some of which may amortize loans and/or charge differing interest rates. In the present study, it was assumed that any borrowing required during development is met by an unlimited overdraft facility with a constant interest rate. This assumption was defensible on the ground that the main objective of the study was to evaluate the profitability of development per se. The study was not concerned with the various financial arrangements contracted by farmers. This treatment of overdraft and associated interest payments is delayed until the appropriate stage in the evaluation.

Table 6.1 Expenditure Items from a Hypothetical Profit and Loss Account

Farm Expenses	Base Year	Development Period			Post-development
		Year 1	Year 2	Year 3	
	(£)	(£)	(£)	(£)	(£)
(1) Wages	300	300	800	800	800
(2) Manure and Lime	400	800	700	600	600
(3) Seeds	-	200	-	-	-
(4) Scrubcutting	-	500	-	-	-
(5) New Fencing	-	400	-	-	-
(6) Bulldozing (tracks and dams)	-	50	50	-	-
(7) Shearing Expenses	300	350	400	450	450
(8) Stock Health Expenses	50	60	80	100	100
(9) Cartage	60	70	80	100	100
(10) Farm Stores	25	25	25	25	25
(11) Fuel and Oil	100	180	130	130	130
(12) Car Expenses (farm business)	80	80	80	80	80
(13) Repairs and Maintenance:					
Buildings and water supply	60	60	60	70	70
Vehicles and plant	100	130	100	100	100
Fences	100	100	100	120	120
Tracks, dams and culverts	25	25	30	30	30
(14) Electricity	40	45	50	60	60
(15) Telephone and Mail	20	20	20	20	20
(16) Insurance	20	20	30	30	30
(17) Rates	150	150	150	150	150
(18) Accounting Fees	50	50	50	50	50
(19) Statutory Depreciation	200	200	250	240	220

Items of cash expenditure that are not tax-deductible are usually found in a Balance Sheet. These items are represented by the hypothetical data in Table 6.2.

Table 6.2 Non-deductible Cash Expenditure Items from a Hypothetical Balance Sheet

	Base Year	Development Period			Post-development
		Year 1	Year 2	Year 3	
	(£)	(£)	(£)	(£)	(£)
(1) Additions to Buildings	-	-	50	-	-
(2) Additions to Plant	20	20	30	40	40
(3) Vehicles Purchased	-	-	-	400	-
(4) Table Mortgage Repayments (a)	200	200	200	200	200

Note: (a) For the purposes of this example the whole of mortgage repayments is treated as non-deductible.

The Stock and Wool Accounts of Farm Accounts provide three important items of data. They are:

(i) Income derived from stock and wool sales,

(ii) Expenditure on stock purchased, and

(iii) The total standard value of increased livestock numbers.

The actual Standard Values[19] used are not relevant to this exposition.

19. The question of Standard Values is discussed in the introduction to Chapter 7.

Table 6.3 Data Extracted from Hypothetical Stock & Wool Accounts

	Base Year (£)	Development Period Year 1 (£)	Year 2 (£)	Year 3 (£)	Post-development (£)
Income					
(1) Wool Sold	2,200	2,700	3,500	4,000	4,100
(2) Stock Sold	3,100	3,000	3,400	4,000	4,000
Expenditure					
(3) Stock Purchased	300	600	800	350	350
Inventory Change					
(4) Total Standard Value of Livestock Increases	-	200	300	200	-

6.72 Preliminary computations

Worked examples of the manipulation of the raw data relating to the Base Year and Development Year 1, now follow. The computational procedure for later years is identical to that for Year 1.

6.721 Base Year computations

The following steps are taken:

(i) Compute Gross Cash Income which is given by the sum of items (1) and

(2) in Table 6.3. In the example, Gross Cash Income equals the sum of revenue from wool sold, and revenue from stock sold.

That is, Gross Cash Income = £2,200 + £3,100

= £5,300

(ii) Compute Cash Expenditure which is the sum of

(a) The Tax-deductible Cash Expenses represented in Table 6.1 by the sum of items (1) to (18) inclusive, together with expenditure on Stock Purchase (item (3), Table 6.3),

(b) The Non-deductible Cash Expenditure represented in Table 6.2 by the sum of items (1) to (4) inclusive (Additions to Buildings and Plant, Vehicles Purchases, and Table Mortgage Repayments), and

(c) Interest Payments. In the example Base Year, this item is zero.

In the example,

Cash Expenditure equals Tax-deductible Cash Expenses,

plus Non-deductible Expenses

plus Interest Payments.

That is, Cash Expenditure = £2,180 + £220 + £0

= £2,400

(iii) Compute Taxation

Taxable Income is calculated by:

(a) Finding Gross Cash Income,

(b) Adding to this the Livestock Standard Value Increase (Item (4), Table 6.3),

(c) Subtracting all Tax-deductible Cash Expenditure and Statutory Depreciation.

In the example, Taxable Income for the Base Year is given by:

Taxable Income equals Gross Cash Income,
plus Livestock Standard Value Increase
less Tax-deductible Expenditure,
less Statutory Depreciation.

That is, Taxable Income = £5,300 + £0 - £2,180 - £200
= £2,920

Assuming personal and family exemptions of £780 for Income Tax and £104 for Social Security Tax, and allowing deductions for life insurance premiums totalling £150, Taxation is:

Income Tax	= £463
Social Security Tax	= £211
Total Tax	= £674

(iv) Compute Owner's Drawings from the expression:

Owner's Drawings equal Gross Cash Income,
less Cash Expenditure,
less Taxation.

In the example,

Owner's Drawings = £5,300 - £2,400 - £674
= £2,226

6.722 Development year 1 computations

These computations follow a basically similar pattern to those for the Base Year, with important additions which are described in detail.

The computational steps are:

(i) Compute Gross Cash Income as before.

In the example, Gross Cash Income = £2,700 + £3,000

= £5,700

(ii) Compute Additional Cash Income, (V) which is the difference between the Gross Cash Income occurring in Year 1, and in the Base Year.

In the example,

Additional Cash Income (Year 1) = £5,700 - £5,300

= £400

(iii) Compute Cash Expenditure as before.

In the example,

Cash Expenditure = £4,215 + £220 + £0

= £4,435

(iv) Compute Additional Cash Expenditure (C) which is the difference between the Cash Expenditure occurring in Year 1 and the Base Year.

In the example,

Additional Cash Income (Year 1) = £4,435 - £2,400

= £2,035

(v) Compute Taxation as before[20].

In the example,

Taxable Income = £5,700 + £200 - £4,215 - £200

= £1,485

then Total Taxation = £179

(vi) Compute Owner's Drawings as before.

In the example,

Owner's Drawings = £5,700 - £4,435 - £179

= £1,086

(vii) Compute Annual Overdraft.

The Owner's Drawings of £1,086 are less than the Owner's Drawings enjoyed in the Base Year by £1,140. If the farmer's standard of living is to be just maintained, £1,140 must be borrowed. This borrowed capital need not be regarded as contributing solely to living expenses; it is required to finance development while maintaining living standards.

6.723 Computations for later years

Computations for years subsequent to Year 1 follow an identical pattern to those for Year 1, with one exception. For the first time the advent of an overdraft in Year 1 gives rise to an interest payment. It is assumed that

---

20. In this example, no attempt has been made to minimise tax by claiming the exemptions allowable on some development expenditure, in later years.

the £1,140 overdraft is drawn for the whole of year 1. Thus, at a rate of 6%, a £68 interest charge falls due on the last day of Year 1. For the purposes of this evaluation, this interest payment is assumed to be made on the first day of Year 2, thereby becoming a tax-deductible expenses in that year. Interest is, of course, payable on the cumulative overdraft at the end of each year.

Table 6.4 summarises these computations.

Table 6.4 Preliminary Computations

	Base Year	Development Period			Post-development		
		Year 1	Year 2	Year 3	Year 4	Year 5	New Eqbm.
	(£)	(£)	(£)	(£)	(£)	(£)	(£)
Income							
Gross Cash Income	5,300	5,700	6,900	8,000	8,100	8,100	8,100
Additional Cash Income (V)	N.A.	400	1,600	2,700	2,800	2,800	2,800
Expenditure							
Cash Expenditure	2,400	4,435	4,083	4,354	3,947	3,910	3,875
Additional Pre-tax Cash Expenditure (C)	N.A.	2,035	1,683	1,954	1,547	1,510	1,475
Taxation							
Income Tax	463	76	545	1,000	1,003	1,024	1,044
Social Security Tax	211	103	228	304	305	307	310
Total Tax	674	179	773	1,304	1,308	1,331	1,354
Cash Statement							
Owner's Drawings	2,226	2,226	2,226	2,226	2,226	2,272	2,871
Annual Overdraft	Nil	1,140	182	Nil	Nil	Nil	Nil
Cumulative Overdraft	Nil	1,140	1,322	1,206	587	Nil	Nil

Note : 'N.A.' indicates 'not applicable'.

6.73 Computation of profitability

Computations of the profitability of the development programme follow directly from the data contained in Table 6.4. The streams of Pre-tax and Post-tax Development Cash Expenditure appear in Table 6.5. In the table, rows (1) and (2) are repeated from Table 6.4 in order to illustrate more clearly the derivation of rows (4) and (5).

Table 6.5 Pre-tax and Post-tax Development Cash Profits

	Development Period			Post-development		
	Year 1	Year 2	Year 3	Year 4	Year 5	New Eqbm.
	(£)	(£)	(£)	(£)	(£)	(£)
(1) Additional Cash Income (V)	400	1,600	2,700	2,800	2,800	2,800
(2) Additional Pre-tax Cash Expenditure (C)	2,035	1,683	1,954	1,547	1,510	1,475
(3) Additional Post-tax Cash Expenditure (C*)	1,540	1,782	2,584	2,181	2,167	2,155
(4) Pre-tax Development Cash Profit (V-C)	-1,635	-83	746	1,253	1,290	1,325
(5) Post-tax Development Cash Profit (V-C*)	-1,140	-182	116	619	633	645

Rows (4) and (5) of Table 6.5 show the streams of pre-tax and post-tax profits derived from the hypothetical development programme.

6.731 Present Value of Development Cash Profits

The Present Values of Pre-tax and Post-tax Development Cash Profits can be obtained by applying equation (6.8) to the profit streams in rows (4) and (5) of Table 6.5.

Thus, the Present Value of Pre-tax Development Cash Profits is given by[21/],

$$PV = -\frac{£1,635}{1.06} - \frac{£83}{(1.06)^2} + \frac{£746}{(1.06)^3} + \frac{£1,253}{(1.06)^4} + \frac{£1,290}{(1.06)^5} + \frac{£1,325}{0.06\,(1.06)^5}$$

$$= £17,468$$

A similar computation yields a Present Value of Post-tax Development Cash Profits of £7,856.

6.732 Return on Investment

From Table 6.4 it can be seen that the overdraft associated with the development programme reaches £1,322 at the end of year 2.

Hence,

Present value of maximum overdraft

$$= \frac{£1,322}{(1.06)^2}$$

$$= £1,177$$

21. It is assumed that the market interest rate remains constant at 6%.

Thus, from equation (6.9),

Return on Investment

$$= \frac{0.06 \times 17,468}{1,177} \times \frac{100}{1} \%$$

$$= 89.0\%$$

6.733 Asset Increment

The Maximum Asset Increment represented by the completed development programme is, according to the rationale described in Section 6.52, given by,

Maximum Asset Increment

$$= \frac{£1,325}{.06}$$

$$= £22,083$$

6.734 Additional information

Reference to Tables 6.4 and 6.5 will confirm that the computations already carried out permit statements of :

(i) Maximum Overdraft. This is £1,322 occurring at and the end of Year 2.

(ii) Repayment Period. The overdraft is repaid two years after the year of maximum overdraft, so that the interval between commencement of the programme and Payback is 4 years.

(iii) Owner's Drawings rise from £2,226 in the Base Year to £2,871 in the New Equilibrium situation, an increase of £645.

6.8 Conclusion

The purpose of this chapter has been to review the available procedures for evaluating hill country development programmes, and to describe the actual procedures used in Chapters 7 and 8. The methods of evaluation are not mentioned in these later chapters, therefore the reader should refer back to the present chapter for clarification of the procedures used to evaluate the actual development programmes.

CHAPTER 7

HILL COUNTRY DEVELOPMENT PROGRAMMES IN WAIROA COUNTY

7.1 Introduction

The last Chapter established a procedure for describing and evaluating development programmes. The main body of the present chapter is devoted to the application of this technique in the analysis of development programmes actually adopted by farmers interviewed in the survey.

A brief recapitulation of the reasons for investigating farmers' experience with development, first discussed in Chapter 3, is necessary:

(i) The development work already completed indicates at least some technically feasible methods of increasing production, and the extent and rate of production increases actually attained by leading farmers are indicated. The important features of development techniques in use in Wairoa County were described in Chapter 5, but that chapter paid no attention to the integration of these techniques into overall development programmes[1]. This Chapter records the important physical features of case development programmes. In addition to illuminating any technical 'bottlenecks' that may be retarding rates of increases in production or limiting production, the study of case development programmes may also indicate whether the application of new development methods may be needed.

1. A definition of a development programme appears in Section 6.2.

(ii) It is important to estimate the profitability of increasing production by methods already accepted by farmers. The degree of profitability indicates the likely attitude of profit-motivated farmers to increasing production by these methods. Moreover, the study may suggest that increased profits should result from modifications to the accepted forms of development.

In the particular evaluations present here,[2] the aims have been to first characterise each development programme, and then to seek an answer to the question 'if this programme was begun now, what would be its likely profitability?'.

Attention will now be turned to the assumptions used in the analysis of the case development programmes.

7.2 Assumptions in Programme Analysis

These assumptions fall into three categories; those concerning prices and costs, the assessment of taxation, and the treatment of living expenses.

7.21 Costs and prices

Costs and prices have been standardised[3] as follows:

(i) All stock purchased and sold, and wool sold, are valued according to

---

2. In this Chapter only case development programmes are considered. The author's recommendations concerning development techniques are discussed and evaluated in the form of a hypothetical development programme in Chapter 8.

3. Refer to Section 3.531 for a discussion of the need for standardising costs and prices.

the schedule appearing in Table 4.9. These are the author's estimates of the likely long term prices.

(ii) Costs (except for stock purchases) are standardised at 1964/65 levels. The costs obtained from farmers' accounts and records for years prior to 1964/65 have been converted to 1964/65 money values by the use of coefficients derived from Meat and Wool Boards' Economic Service data concerning costs on Class 2N (North Island hard hill country) farms. Further, it has been assumed that future costs will remain constant at levels ruling in 1964/65. The author could define no more likely set of future costs.

7.22 Taxation

Irrespective of the form of ownership actually found on the case farms, all calculations of tax have been made on the assumption that income accrues to an individual farm owner.

Taxation liabilities will depend, ceteris paribus, upon some or all of; the level of livestock standard value, the level of personal and family exemptions, the size of life insurance premiums, and the advantage taken of present legislation allowing the spreading-forward of the exemptions associated with certain categories of development expenditure.[4] The assumptions made with respect to each of these variables are discussed below.

---

4. The spreading of income among family members for the formation of partnerships, companies, or trusts, also affects taxation liabilities. In the present study, however, these arrangements have not been considered.

7.221 Standard values

In years when livestock numbers increase, taxable income is increased by a sum equal to the increase in stock numbers valued at their standard values.

Tax legislation introduced in 1966 allows the standard values of additional stock to be set at any level between zero and market value, although on sale of the farm, all stock are valued for tax purposes at market values[5].

The pros and cons of selecting high or low standard values require a fuller treatment than can be given here. In particular, it is tempting to claim that tax will be minimised if zero standard values are selected for increased stock. While this may be so, the need to pay tax on the stock at some time in the future suggests that an initial zero standard value will not necessarily minimise tax.

In spite of this, zero standard values have been assigned to stock increases in the development programmes analysed in this Chapter. This has been done because the sale of the farms is not considered in the analyses. Under these assumptions, any other set of standard values would have resulted in higher tax assessments.

7.222 Personal and family exemptions

Exemptions totalling £780 have been assumed. These exemptions correspond to those claimed by an owner-operator farmer supporting a wife and two

---

5. The details of the tax legislation concerning standard values are not discussed in this thesis. However, a detailed summary of the legislation has been prepared by Payne [38].

children. The assumption was quite arbitrary, but it is believed that exemptions of this order are claimed by a majority of farmers in Wairoa County.

7.223 Life insurance premiums

Present tax legislation allows deductions from taxable income of life insurance premiums provided that the exemption does not exceed £325. No farmers in the survey paid premiums totalling more than £150 and this figure has been arbitrarily fixed as a 'reasonable' deduction.

7.224 Spreading-forward exemptions

Current tax legislation permits certain items of expenditure[6] to be debited against income in any of the five financial years defined by the year in which the expenditure was incurred and the four subsequent years. Farmers wishing to take advantage of the legislation must nominate in advance their intended pattern of expenditure spread. It is clear that under a system of progressive taxation, expenditure transferred forward from a year of low taxable income (e.g., a year when expenditure on development is heavy) to years of higher taxable income, will result in a net reduction of taxation liabilities. Given a series of forecasted annual budgets, it is therefore theoretically possible to define a particular pattern of spread which will, in some sense, be optimum.

---

6. A list of the spreadable expenditure categories will be found in reference [39, p.20].

Appendix F discusses this problem in detail. An optimum spread is defined in the Appendix as one which minimises the discounted sum of taxation payments. The Appendix describes the method used to derive near-optimum exemption spreads in the programmes analysed in the present Chapter, and in Chapter 8. The evaluation of the development programme in this Chapter therefore assumes near optimum utilisation of the provisions for spreading forward the tax exemptions associated with some types of development expenditure.

7.23 Living expenses

Programmes are analysed under each of two assumptions concerning the funds required for personal and family living expenses.

Condition A holds that the standard of living or welfare of a farmer and his family should not fall below the level enjoyed prior to development (that is, in the Base Year). Thus Owner's Drawings, as defined in Chapter 6, are maintained throughout development at a level at least as high as in the Base Year. However, the standard of living is not raised until any overdraft associated with development is repaid.[7/]

---

7. The Condition A assumption insists that higher Owner's Drawings in one time period must not be obtained at the expense of a lowering of Owner's Drawings in another time period. Insofar as the level of Owner's Drawings is equivalent to the welfare of the farmer and his family, the Condition A assumption may therefore be regarded as a Paretian concept. Reder /40, p.21/, has explained Pareto's basic principle in terms of the exchange of goods (cf. Owner's Drawings) so as to maximise the satisfaction of two individuals (cf. the same farmer at different points in time).

Condition B holds that during development, a farmer is prepared to transfer some of his hitherto consumed cash income to investment in development. Except where otherwise stated, it has been arbitrarily assumed that Owner's Drawings can, if necessary, fall to £1,200.

Under Condition A a development programme is financially 'self-contained' in the sense that all capital that cannot be provided from revenue derived from the programme must be borrowed at market interest rates, and the debt can be repaid only from revenue generated by farm development.

Condition B, on the other hand, allows some degree of investment in development by diversion of resources from current consumption, without any charge being made for the use of these resources. This assumption closely approximates the situation in which a farmer will borrow only after his standard of living has fallen to a particular level. Evaluations of this type are likely to be of most use in explaining the implications of proposed programmes to particular farmers (who may, of course, substitute their own minimum figure for the £1,200 assumed here).

Where farmers are willing to reduce the level of personal drawings in order to develop their farms, analysis under Condition B may also provide better estimates of the overall credit requires for full development of Wairoa County, than could be obtained under Condition A.

7.3 The Case Development Programmes

Only five of the sixteen Purposive Farmers had both (i) increased production significantly in recent years, and (ii) achieved this increase by means of management steps which could be identified as a coherent programme.

Criterion (ii) is important because there is obviously little merit in proving that 'Farmer X increased production extremely profitably', if it is impossible to explain to other farmers the essential management steps that Farmer X took while increasing production.

The presentation of each development programme opens with a brief description of the farm itself. This is followed by details of the technical features of the programme. Reference is made to:

(i) The clearly identifiable land development operations,

(ii) Changes in stocking policies, stocking rates, and production, and

(iii) The requirements of the programme for extra labour, additional buildings, machinery and vehicles.

Wherever possible, this information appears in tabular form supplemented by explanatory notes. The account includes descriptions of the physical condition of the farm, stocking rates and production under the system of management used in the Base Year.

Finally, each programme is evaluated by the procedure outlined in Chapter 6.[8] Comments on the results of the individual evaluations appear in the final section of the Chapter.

---

8. The evaluations were computed on an IBM 1620 computer, using a programme written by the author.
Only the results of the evaluations appear in this Chapter. The budgets upon which the evaluations were based will be found in Appendix G. Appendix H contains tables showing the changes in taxable income resulting from the derivation of near-optimum patterns of exemption spreads.

7.4 Case Development Programme I - Farm 21

This farm, in the Morere district, has a total area of 350 acres, 340 acres of which are potentially grazeable. The soils, based on siltstone/sandstone and volcanic ash, are classified by the Soil Bureau as Hangaroa sandy loam and Matawai sandy loam.

Rainfall data for this particular farm was not available, but mean annual rainfall in the district is approximately 85 inches. This is usually spread evenly over the year, although short dry periods occasionally occur in summer and early autumn.

According to the author's classification[9], only 6% of the farm is flat or rolling, but 180 acres (51.4%) are steep ploughable land while 149 acres (42.6%) are unploughable.

The farm is freehold and owner-operated.

7.41 The development programme

At the time of the survey visit a proposed three year programme was in its second year. Consequently, details of development for only two years, and production for only the first year, were available. However, the intended development in the third year as well as the expected production in the second and third years, had been committed to paper jointly by the State Advances Corporation, which was financing the programme, and the Department of Agriculture, which had been called in to advised on pasture improvement techniques. In order to stabilise stock numbers, a fourth year of development had

---

9. This classification is described in detail in Chapter 4, Section 4.4.

to be budgetted by the author. Thus the programme presented here combines an ex poste analysis and an ex ante forecast.[10]

The essential features of the programme were :

(i) Heavy topdressing with superphosphate. This topdressing programme consisted of successive autumn applications of 4 cwt. per acre - 4 cwt. per acre - 3 cwt. per acre on 300 acres, and, on the remaining 40 acres, 4 cwt. per acre applied in the second year was followed by 3 cwt. per acre in the third year. From the fourth year onwards, a dressing of 2 cwt. per acre was applied to the whole farm. No topdressing was done before development began.

(ii) Oversowing 250 acres in the first two years. This total included 40 acres of burned hard fern/manuka which was oversown at 18 lbs. per acre in the first year, and 210 acres of poor native pasture which was oversown at 5 lbs. per acre in the second year.

(iii) Two miles of Ruakura-type electric fence was erected in the first year, the objective being to subdivide improved pastures into 30 acre paddocks.

(iv) Very rapid increases in stocking rates were achieved mainly by the purchase of 180, 130, and 120 two-tooth ewes in the first, second and third years respectively. Further increases were obtained by a general policy of retaining five-year ewes that could 'do for another year'. Apart from an increase in numbers, the stocking policy did not change substantially. Breeding ewes remained the most important stock class and most wether lambs continued to be sold as stores, but there was an increasing tendency for young

---

10. See Chapter 3, Section 3.533 for a discussion of ex poste, and ex ante, analyses of development programmes.

ewe stock to be culled as two-tooths rather than as lambs. A flexible cattle policy involving the purchase of weaners, which were sold in forward store condition during the following autumn, was maintained throughout the programme.

It will be noted that stock numbers did not stabilise until the second year after pasture improvement was completed.

Prior to development, the farm provided only part-time work for the owner, but development resulted in the farm providing fulltime employment for him. The only additional labour required has been casual labour for shearing and the erection of electric fences.

The programme is summarised in Tables 7.1, 7.2 and 7.3. In the tables the pre-development situation is clearly indicated along with the author's estimation of the post-development situation.

Table 7.1 Case Programme I - Land Development Programme

	Units	Base Year	Development Period				Post-dev.
			1	2	3	4	
Superphosphate Topdressed	tons	Nil	45	53	53	34	34
Scrub Burned	acres	Nil	40	Nil	Nil	Nil	Nil
Oversowing:							
(i) After burn (@ 18 lbs. per acre)	acres	Nil	40	Nil	Nil	Nil	Nil
(ii) On poor pasture (@ 5 lbs. per acre)	acres	Nil	110	100	Nil	Nil	Nil
New Fencing (electric)	chains	160 (cost £600)	Nil	Nil	Nil	Nil	Nil

Table 7.2 Case Programme I - Land Use

	Units	Base Year	Development Period 1	2	3	4	Post-dev.
Total Area	acres	350	350	350	350	350	350
Permanent Waste	acres	10	10	10	10	10	10
Potentially Grazeable Scrub-land	acres	40	Nil	Nil	Nil	Nil	Nil
Poor Pasture (including scattered scrub)	acres	300	190	90	Nil	Nil	Nil
Improved Pasture	acres	Nil	150	250	340	340	340

The data in Table 7.3 illustrates the following important features of the programme:

(i) The rate of increase in stock numbers was very substantial. Total EE increased by 334, or 63.1%, in the first year, and increases of 254 EE and 123 EE were expected in the second and third years. The overall increase in EE over a four year period was 138%, an average annual increase of 34.5%, or 24.5% per annum compounded.

(ii) Although an increase in the proportion of cattle to sheep was required in the early stages of the programme to control rough and unpalatable feed, the sheep to cattle ratio indicates that sheep became relatively more important as pastures improved and stocking rates increased.

(iii) The 237% increase in annual wool clip over the four years, is a reflection of the rapid increase in sheep numbers. While it might appear from the table that wool production per animal also increased during development, it must be recalled that the ratio of hoggets to breeding ewes wintered increased markedly, with the result that imputation of the total clip to breeding ewes is an unreliable indicator of production per animal.

(iv) The post-development levels of stocking and production were not high by comparison with well developed hill country outside the County. The author concluded that stocking rates and production could be increased by at least a further 50%.

Table 7.3 Case Programme I - Stocking and Production

	Base Year	Development Period				Post-dev.
		1	2	3	4	
Stock Wintered						
Breeding Ewes	400	630	800	900	900	900
Sheep EE	495	693	931	1,044	1.081	1,081
Cattle EE	40	176	192	192	192	192
Total EE	535	869	1,123	1,236	1,273	1,273
Ratio $\frac{\text{Sheep EE}}{\text{Cattle EE}}$	12.4	3.9	4.8	5.4	5.6	5.6
EE per acre pasture	1.78	2.56	3.30	3.64	3.74	3.74
EE per potentially productive acre	1.57	2.56	3.30	3.64	3.74	3.74
Annual EE increase	Nil	63.1%	28.9%	10.3%	2.7%	Nil
Production						
Wool: (i) Total clip (lbs)	4,710	7,090	9,480	11,070	11,180	11.180
(ii) lbs. per acre pasture	15.7	20.8	27.9	32.6	32.9	32.9
(iii) lbs. per potentially productive acre	13.9	20.8	27.9	32.6	32.9	32.9
(iv) lbs. per breeding ewe	11.8	11.3	11.8	11.8	12.4	12.4
Lambing %	90	90	90	90	90	90

Table 7.4 Case Programme I, Condition A, Preliminary Computations

	Base Year	Development Period				Post-development							
		1	2	3	4	5	6	7	8	9	10	11	New Eqbm.
Income													
Gross Cash Income	1,448	1,849	3,189	3,867	4,224	4,224	4,224	4,224	4,224	4,224	4,224	4,224	4,224
Additional Cash Income (V)	N.A.	401	1,741	2,419	2,776	2,776	2,776	2,776	2,776	2,776	2,776	2,776	2,776
Expenditure													
Cash Expenditure	996	3,285	3,086	3,138	2,839	2,785	2,729	2,720	2,720	2,720	2,720	2,720	2,720
Additional Pre-tax Cash Expenditure (C)	N.A.	2,289	2,090	2,137	1,843	1,789	1,733	1,724	1,724	1,724	1,724	1,724	1,724
Additional Post-tax Cash Expenditure (C*)	N.A.	2,276	2,098	2,162	1,891	1,838	1,782	1,773	1,773	1,773	1,775	1,827	1,857
Taxation													
Income Tax	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1	35	54
Social Security Tax	13	Nil	22	38	61	62	62	62	62	62	63	81	92
Total Tax	13	Nil	22	38	61	62	62	62	62	62	64	116	146
Cash Statement													
Owner's Drawings	439	439	439	439	439	439	1,281	1,442	1,442	1,442	1,440	1,388	1,358
Annual Overdraft	Nil	1,875	357	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	1,875	2,232	1,975	1,090	152	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Development Cash Profits													
Pre-tax (V-C)	N.A.	-1,888	-349	282	933	987	1,043	1,052	1,052	1,052	1,052	1,052	1,052
Post-tax (V-C*)	N.A.	-1,875	-357	257	885	938	994	1,003	1,003	1,003	1,001	949	919

Note: 'N.A.' indicates 'not applicable'

Table 7.5 Case Programme I, Condition B, Preliminary Computations

	Base Year	Development Period				Post-development						
		1	2	3	4	5	6	7	8	9	10	New Eqbm.
Income												
Gross Cash Income	1,448	1,849	3,189	3,867	4,224	4,224	4,224	4,224	4,224	4,224	4,224	4,224
Additional Cash Income (V)	N.A.	401	1,741	2,419	2,776	2,776	2,776	2,776	2,776	2,776	2,776	2,776
Expenditure												
Cash Expenditure	996	3,285	3,107	3,178	2,908	2,881	2,852	2,821	2,789	2,754	2,720	2,720
Additional Pre-tax Cash Expenditure (C)	N.A.	2,289	2,111	2,182	1,912	1,885	1,856	1,825	1,793	1,758	1,724	1,724
Additional Post-tax Cash Expenditure (C*)	N.A.	2,276	2,121	2,217	1,961	1,931	1,905	1,874	1,842	1,809	1,823	1,857
Taxation												
Income Tax	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1	32	54
Social Security Tax	13	Nil	23	48	62	59	62	62	62	62	80	92
Total Tax	13	Nil	23	48	62	59	62	62	62	63	112	146
Cash Statement												
Owner's Drawings	439	800	800	800	800	800	800	800	800	800	1,392	1,358
Annual Overdraft	Nil	2,236	741	159	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	2,236	2,977	3,136	2,682	2,198	1,688	1,147	574	Nil	Nil	Nil
Development Cash Profits												
Pre-tax (V-C)	N.A.	-1,888	-370	237	864	891	920	951	983	1,018	1,052	1,052
Post-tax (V-C*)	N.A.	-1,875	-380	202	815	845	871	902	934	967	953	919

Note: 'N.A.' indicates 'not applicable'

7.42 Evaluation of Programme I

The peculiar features of this farm necessitated some departure from the assumptions for programme analysis that are outlined in Section 7.23. Prior to development, the farm provided only part-time work for the owner. In fact, Owner's Drawings in the Base Year, amounted to only £439. Once development commenced, however, the owner was employed full time. In order to evaluate the programme under conditions of 'reasonable minimum' drawings for a fully-employed owner, Condition B analysis was modified to specify minimum Owner's Drawings of £800. The Condition A analysis was not modified; that is, Owner's Drawings were permitted to fall as low as £439.

7.421 Evaluation under Condition A

Preliminary computations are shown in Table 7.4. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £12,718

(ii) Present Value of Post-tax Development Cash Profits = £11,252

(iii) Return on Investment = 38.4%

(iv) (a) Maximum Overdraft: £2,232 in year 2

(b) Repayment Period: Payback occurs 4 years after the year of maximum overdraft, and 6 years from the start of development.

(c) Owner's Drawings rise from £439 to a New Equilibrium figures of £1,358, an increase of £919.

(v) Maximum Asset Increment = £17,533

7.422 Evaluation under Condition B

Preliminary computations for this evaluation are shown in Table 7.5. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £12,317

(ii) Present Value of Post-tax Development Cash Profits = £10,800

(iii) (a) Maximum Overdraft: £3,136 in year 3

(b) Repayment Period: Payback occurs 6 years after the year of maximum overdraft, and 9 years after the start of development.

(c) Owner's Drawings increased by £919.

7.5 Case Development Programme II - Farm 22

This farm, in the Ohuka district, has a total area of 946 acres, of which 920 acres are potentially grazeable. The soils, based on siltstone/ sandstone and pockets of volcanic ash, are classified as Taupo sandy loam and Mahoenui silt loam.

Rainfall is approximately 65 inches per year, typically well spread, although short dry period can occur at any time from mid-spring until late autumn.

The author's classification of topography shows that 150 acres (16%) of the farm are flat or rolling, while 190 acres (31%) are steep ploughable land, and 506 acres (53%) are unploughable.

The farm is freehold and owner-operated.

7.51 The Development Programme

This programme is instructive for several reasons:

(i) Although substantial production increases were achieved in the five years recorded, the final stocking rate attained is only slightly in excess of 50% of the estimated potential.[11] Since the programme analysis assumes production to 'level out' after the fifth year, this evaluation could shed light on the implications of 'stopping part way through' a development programme.

(ii) While the farmer acknowledged that further substantial production increases were possible, he was doubtful that the development loan required for further rapid progress could be obtained. A State Advances Corporation Loan was obtained for the programme described here.

(iii) Land development was largely based upon a discing/regrassing programme and complementary subdivision, although there was some scrubcutting and oversowing of poor pastures. Subdivision was aimed at obtaining paddocks of from 30 acres to 50 acres.

Table 7.6 summarises the land development programme, while Table 7.7 gives details of the expenditure on farm tracks, water supplies, new machinery and labour which was required during development.

---

11. The author estimated that this land was capable of carrying 5 EE per acre.

Table 7.6 Case Programme II - Land Development Programme

	Units	Base Year	Development Period 1	2	3	4	5	Post-dev.
Superphosphate Topdressed	tons	9	38	33	51	66	55	55
Discing:								
(i) grass to crop	acres	Nil	21	Nil	Nil	27	20	20
(ii) crop to crop	acres	Nil	Nil	21	Nil	Nil	7	Nil
(iii) crop to grass	acres	Nil	Nil	21	Nil	Nil	20	20
(iv) grass to grass	acres	Nil	Nil	54	62	Nil	Nil	Nil
Subdivision:								
(i) Electric fence	£	Nil	250	700	850	Nil	Nil	Nil
(ii) 'Conventional' fence	£	Nil	Nil	Nil	Nil	1,050	Nil	Nil
Scrub Cut	acres	Nil	Nil	Nil	Nil	40	Nil	Nil
Oversowing (clover @ 5 lbs. per acre)	acres	Nil	400	Nil	Nil	100	Nil	Nil

Table 7.7 Case Programme II - Other Resource Requirements

Item of Expenditure	Base Year	Development Period 1	2	3	4	5	Post-dev.
Casual Labour	Nil	Nil	Nil	£58	£370	£370	£370
Farm Tracks	Nil	Nil	£100	£58	Nil	Nil	Nil
Water Supplies (dams, tanks, pumps)	Nil	£52	Nil	£394	Nil	£100	Nil
New Machinery	£15	Nil	Nil	£12	£582	£20	£20

Increases in stock numbers were derived principally from stock bred on the farm. Two-tooth ewes bought in the first year (15) and the second year (105), were the only notable puchases. A 'conventional' stock policy was maintained throughout the programme. The sheep policy was based on Romney breeding ewes, with ewe hoggets wintered and wether lambs sold, while the cattle policy was based on breeding cows, with steers sold as weaner and cull heifers sold as two-year olds. Table 7.8 summarises stocking rates and production in the Base Year and in the Development and Post-development periods.

Table 7.8 Case Programme II - Stocking and Production

	Base Year	Development Period 1	2	3	4	5	Post-dev.
Stock Wintered:							
Breeding Ewes	870	847	1,010	1,120	1,160	1,250	1,250
Sheep EE	1,110	1,146	1,321	1,394	1,531	1,695	1,695
Cattle EE	645	767	838	761	763	781	781
Total EE	1,755	1,913	2,159	2,155	2,294	2,476	2,476
Ratio Sheep EE / Cattle EE	1.7	1.5	1.6	1.8	2.0	2.2	2.2
EE per acre pasture	2.19	2.39	2.70	2.69	2.73	2.95	2.95
EE per potentially productive acre	1.91	2.08	2.34	2,34	2.49	2.69	2.69
Annual EE increase %	Nil	9.0	12.9	Nil	6.5	12.3	Nil
Production							
Wool:							
(i) Total clip (lbs.)	11,820	11,620	13,290	14,050	15,710	17,400	17,400
(ii) lbs.per acre pasture	14.8	14.5	16.6	17.6	18.7	20.7	20.7
(iii) lbs.per potentially productive acre	12.8	12.6	14.4	15.3	17.1	18.9	18.9
(iv) lbs.per breeding ewe	13.6	13.7	13.2	12.5	13.5	13.9	13.9
Lambing %	84	84	91	91	100	100	100
Calving (%)	88	91	88	87	90	90	90

The data in Table 7.8 confirms that only modest production levels were achieved by development. It is interesting to note, however, that even at these relatively low stocking rates, the importance of sheep relative to cattle increased substantially as pastures improved. As the proportion of dry sheep to breeding ewes remained fairly constant, 'wool per breeding ewe' is a reasonable index of production per animal. Performance per animal therefore showed no sign of falling over the range of stocking rates encountered in this programme.

7.52 Evaluation of Programme II

The assumptions defined in section 7.23 were applied in the evaluation of this programme.

7.521 Evaluation under Condition A

Preliminary computations appear in Table 7.9. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £7,146

(ii) Present Value of Post-tax Development Cash Profits = £3,402

(iii) Return on Investment = 6.0%

(iv) (a) Maximum Overdraft : £8,984 in year 4.

(b) Repayment Period : Payback occurs 5 years after the year of maximum overdraft, and 9 years after the start of development.

(c) Owner's Drawings rise from £2,127 to a New Equilibrium figure of £2,903, an increase of £776.

(v) Maximum Asset Increment = £22,117.

Table 7.9 Case Programme II, Condition A, Preliminary Computations

	Base Year	Development Period					Post-development												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	New Eqbm.
Income																			
Gross Cash Income	4,080	4,433	4,449	5,735	5,607	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997
Additional Cash Income (V)	N.A.	353	369	1,655	1,527	2,917	2,917	2,917	2,917	2,917	2,917	2,917	2,917	2,917	2,197	2,917	2,917	2,917	2,917
Expenditure																			
Cash Expenditure	1,500	3,778	3,945	5,599	6,607	3,629	3,570	3,513	3,457	3,397	3,340	3,285	3,239	3,191	3,141	3,093	3,090	3,090	3,090
Additional Pre-tax Cash Expenditure (C)	N.A.	2,278	2,445	4,099	5,107	2,129	2,070	2,013	1,957	1,897	1,840	1,785	1,739	1,691	1,641	1,593	1,590	1,590	1,590
Additional Post-tax Cash Expenditure (C*)	N.A.	1,967	2,191	3,871	4,859	1,928	1,969	1,978	1,920	1,973	2,003	2,148	2,115	2,090	2,107	2,079	2,097	2,120	2,141
Taxation																			
Income Tax	284	52	90	108	94	128	205	256	255	345	415	581	592	611	668	685	703	722	740
Social Security Tax	169	91	109	117	111	124	148	162	162	185	201	235	237	241	251	255	258	261	264
Total Tax	453	143	199	225	205	252	353	418	417	530	616	816	829	852	919	940	961	983	1,004
Cash Statement																			
Owner's Drawings	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,920	2,946	2,924	2,903
Annual Overdraft	Nil	1,614	1,822	2,216	3,332	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	1,614	3,436	5,652	8,984	7,996	7,048	6,109	5,112	4,168	3,253	2,484	1,682	855	45	Nil	Nil	Nil	Nil
Development Cash Profits																			
Pre-tax (V-C)	N.A.	-1,925	-2,076	-2,444	-3,580	788	847	904	960	1,020	1,077	1,132	1,178	1,226	1,276	1,324	1,327	1,327	1,327
Post-tax (V-C*)	N.A.	-1,614	-1,822	-2,216	-3,332	989	948	939	997	944	914	769	802	827	810	838	820	797	776

Note: 'N.A.' indicates 'not applicable'.

Table 7.10 Case Programme II, Condition B, Preliminary Computations

	Base Year	Development Period					Post-development						
		1	2	3	4	5	6	7	8	9	10	11	New Eqbm.
Income													
Gross Cash Income	4,080	4,433	4,449	5,735	5,607	6,997	6,997	6,997	6,997	6,997	6,997	6,997	6,997
Additional Cash Income (V)	N.A.	353	369	1,655	1,527	2,917	2,917	2,917	2,917	2,917	2,917	2,917	2,917
Expenditure													
Cash Expenditure	1,500	3,778	3,889	5,487	6,434	3,392	3,266	3,139	3,090	3,090	3,090	3,090	3,090
Additional Pre-tax Cash Expenditure (C)	N.A.	2,278	2,389	3,987	4,934	1,892	1,766	1,639	1,590	1,590	1,590	1,590	1,590
Additional Post-tax Cash Expenditure (C*)	N.A.	1,967	2,169	3,787	4,717	1,745	1,729	1,736	1,690	1,844	1,966	1,994	2,141
Taxation													
Income Tax	284	52	114	129	116	169	254	361	364	490	592	615	740
Social Security Tax	169	91	119	124	120	137	162	189	189	217	237	242	264
Total Tax	453	143	233	253	236	306	416	550	553	707	829	857	1,004
Cash Statement													
Owner's Drawings	2,127	1,200	1,200	1,200	1,200	1,200	1,200	2,492	3,354	3,200	3,078	3,050	2,903
Annual Overdraft	Nil	688	873	1,205	2,263	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	688	1,561	2,766	5,029	2,931	816	Nil	Nil	Nil	Nil	Nil	Nil
Development Cash Profits													
Pre-tax (V-C)	N.A.	-1,925	-2,020	-2,332	-3,407	1,025	1,151	1,278	1,327	1,327	1,327	1,327	1,327
Post-tax (V-C*)	N.A.	-1,614	-1,800	-2,132	-3,190	1,172	1,188	1,181	1,227	1,073	951	923	776

Note: 'N.A.' indicates 'not applicable'

7.522 Evaluation under Condition B

Preliminary computations appear in Table 7.10. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £8,866

(ii) Present Value of Post-tax Development Cash Profits = £4,291

(iii) (a) Maximum overdraft: £5,030 in year 4.

(b) Repayment period: Payback occurs 3 years after the year of maximum overdraft, and 7 years after the start of development.

(c) Owner's Drawings increase by £776.

7.6 Case Development Programme III - Farm 24

This farm, in the Cricklewood district, has a total area of 1,235 acres, 1,210 acres of which are potentially grazeable. The soils, based on sandstone/siltstone and volcanic ash, are classified by the Soil Bureau as Hangaroa sandy loam.

Mean annual rainfall is approximately 50 inches, reasonably well spread, although short dry spells can occur during summer and autumn.

The author's classification of topography indicates that 150 acres (12%) of the farm are flat and rolling, 365 acres (30%) are steep ploughable land, and 720 acres (58%) are unploughable.

The farm is freehold and owner-operated.

7.61 The development programme

This programme, like Case Development Programme I, has a composite *ex poste* and *ex ante* specification. At the time of the survey visit, the fifth year of development had been completed, and the stocking rate had reached 3.12 EE per acre. The farmer had, however, tentatively planned a continuing land development programme that was expected to occupy a further five years. The farmer believed that a stocking rate approaching 5 EE per acre could be attained soon after the completion of this further development.

Using the farmer's tentative land development programme, the author subsequently developed a complementary stocking programme, and considered the expected changes in requirements for labour, buildings amd machinery. The resulting integrated development programme was then placed before the farmer, who agreed that it represented the probable plan for the future development of his farm.

Thus the programme presented here includes an *ex poste* description of the first five years, and a forecast of the likely course of development over the subsequent seven years.

The land development programme is based upon pasture establishment, pasture improvement and subdivision. Extensive use is made of cultivation for both pasture establishment and pasture improvement. In their pre-development state, several paddocks included areas of poor pasture (dominant in browntop and native grasses), thickly infested with clumps of blackberry, as well as other areas supporting only manuka. The farmer believed that development of these pastures could best be undertaken by cultivating the whole ploughable area. He felt that spraying and burning the blackberry, and cutting and burning the manuka, were likely to be prohibitively time-consuming and could result in slower establishment of the high-producing pasture species. Consequently, attempts were made to cultivate as much of each paddock was possible, with the result that cultivation of very steep slopes was undertaken[12/]. Pasture improvement by oversowing and topdressing alone was also undertaken in those paddocks where weed infestation was slight, and on the unploughable parts of cultivated paddocks.

The fertiliser used included superphosphate, DDT-superphosphate, sulphur-augmented superphosphate, and lime-reverted superphosphate.[13/] It is worth noting that pasture establishment problems associated with clover ill thrift[14/] were encountered in the first four years of development. These problems did not recur after the application of reverted superphosphate became standard practice.

Electric fencing was used with moderate success in the early stages of development, but 'Hurricane' and 'steel' fences were used with greater success in later years.[15/]

---

12. Refer to Chapter 5, Section 5.631 for the author's comments on the implications of very steep cultivation.

13. The use of various fertilisers in Wairoa County is discussed in detail in Chapter 5, Section 5.31.

14. The incidence and apparent importance of clover ill thrift are discussed in Chapter 5, Section 5.51.

15. Descriptions of these types of fences appear in Chapter 5, Section 5.61.

Year-by-year summaries of the land development programme and land use appear in Table 7.11.

Hired labour was required from the beginning of the development programme. A fencer/general hand was employed during the five completed years of development, but allowance is made in the forecasted programme for the replacement of this man by an experienced married shepherd in the seventh year. Provision is made for the expenditure of £800 on house renovations before the new labour unit is hired.

Provision is also made for the replacement of a Land Rover in the ninth year (at a net cost of £600), and for the replacement of a light crawler tractor in the eleventh year (at a net cost of £700).

Conventional breeding ewe and breeding cow policies are maintained throughout. All breeding stock, with the exception of 197 two-tooth ewes and 32 two-year steers purchased in the second year, is bred on the farm throughout the entire programme. While all wether lambs were fattened during the first five years, as the forecasted stocking rate rises above 3.5 EE per acre, it becomes necessary to allow for the sale of some wether lambs in store condition, until in the twelfth year 80% of all wether lambs docked are sold in this way. Throughout the programme, flock replacements are culled as two-tooths. The culling rate remained below 10% for the first four years, but the rate is forecasted to rise to 50% in the twelfth year. A policy of selling all steers as weaners is maintained throughout, but an early practice of culling some heifers as weaners was discontinued in the fifth year because the availability of winter feed had increased.

Table 7.11 Case Programme III - Land Development Programme and Land Use

	Units	Base Year	Development Period 1	2	3	4	5	6	7	8	9	10	11	12	Post-dev.
Land Development															
Pasture established by cultivation	acres	Nil	75	95	Nil	35	50	35	30	45	Nil	Nil	Nil	Nil	Nil
Scrub cut	acres	(a)	60	Nil	40	Nil	Nil	Nil	30	Nil	Nil	Nil	Nil	Nil	Nil
Area Oversown	acres	Nil	Nil	Nil	165	310	Nil	35	30	215	Nil	Nil	Nil	Nil	Nil
Topdressing:															
(i) Superphosphate	tons	37	Nil	30	42	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
(ii) DDT - superphosphate	tons	Nil	15	10	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
(iii) Reverted superphosphate	tons	Nil	Nil	Nil	Nil	57	79	81	121	121	114	114	114	114	114
Area topdressed		366	210	310	475	630	680	750	750	1,210	1,210	1,210	1,210	1,210	1,210
New fencing:															
(i) Electric	chains	Nil	40	30	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
(ii) 'Conventional'	chains	Nil	Nil	30	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
(iii) 'Hurricane'	chains	Nil	Nil	Nil	42	33	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
(iv) 'Steel'	chains	Nil	Nil	Nil	Nil	Nil	70	50	25	Nil	Nil	Nil	Nil	Nil	Nil
Land Use															
Total Area	acres	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235
Permanent Waste	acres	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Unimproved Pasture (including scrubland)	acres	1,150	1,000	900	735	580	530	460	460	Nil	Nil	Nil	Nil	Nil	Nil
Improved Pasture (newly established, oversown, or topdressed)	acres	60	210	310	495	630	680	750	750	1,210	1,210	1,210	1,210	1,210	1,210

Notes: (a) Continued reversion of low-fertility understocked pastures would necessitate 'maintenance' cutting to maintain the status quo. It has been assumed that permanent labour would undertake this work.

Table 7.12 summarises the stocking policy and traces production levels. The rapid increases in stocking rates and production actually achieved up to the sixth year, and projected thereafter, are apparent from the table. It is interesting to note that at least one farmer in the farm survey believed that current average stocking rates can be at least doubled, and wool production trebled.[16]

Referring again to Table 7.12, it will be noted that the ratio of sheep to cattle increases by some 66% during development, indicating once again the declining importance of cattle for controlling pastures as these are improved and as stocking rates are augmented. The increasing proportion of ewe hoggets wintered as development progresses, virtually invalidates 'wool per breeding ewe' as an indication of production per animal. In the first five years, however, wool per ewe increased from 10.3 lbs. to 10.8 lbs., and the author believes that the latter level can be maintained at 5 EE per acre.

7.62 Evaluation of Programme III

The assumptions defined in section 7.23 were applied in this evaluation.

---

16. See Section 4.7 for details of the average production levels suggested by the farm survey.

Table 7.12 Case Development Programme III - Stocking and Production

	Base Year	Development Period												Post-dev.
		1	2	3	4	5	6	7	8	9	10	11	12	
Stock Wintered														
Breeding Ewes	1,240	1,294	1,290	1,500	1,650	1,890	2,130	2,370	2,600	2,800	3,000	3,200	3,200	3,200
Sheep EE	1,519	1,753	1,705	1,975	2,189	2,515	2,858	3,196	3,534	3,811	4,069	4,372	4,426	4,426
Cattle EE	1,024	1,155	1,210	1,319	1,342	1,255	1,422	1,551	1,648	1,711	1,772	1,822	1,775	1,775
Total EE	2,543	2,908	2,915	3,294	3,531	3,770	4,280	4,747	5,182	5,522	5,841	6,194	6,201	6,201
Ratio Sheep EE / Cattle EE	1.5	1.5	1.4	1.5	1.6	2.0	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.5
EE per potentially productive acre	2.10	2.40	2.41	2.72	2.92	3.12	3.54	3.92	4.28	4.56	4.83	5.12	5.12	5.12
Annual EE increase	Nil	14.3%	Nil	13.0%	7.2%	6.8%	13.5%	10.8%	9.2%	6.6%	5.8%	6.0%	Nil	Nil
Production														
Wool:														
(i) Total clip (lbs.)	16,200	16,980	16,530	19,260	28,150	31,060	34,520	38,150	41,500	44,100	47,500	49,550	50,050	50,050
(ii) lbs. per potentially productive acre	13.4	14.0	13.7	15.9	23.3	25.7	28.5	31.5	34.3	36.5	39.3	41.0	42.0	42.0
(iii) lbs. per breeding ewe	13.1	13.1	12.8	12.8	17.0	16.4	16.2	16.1	16.0	15.8	15.8	15.5	15.6	15.6
lambing %	83.0	79.2	87.6	86.3	93.9	93.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
calving %	80.0	87.0	84.8	83.5	63.0	78.0	80.0	80.0	82.0	84.0	85.0	85.0	85.0	85.0

Table 7.13 Case Programme III, Condition A, Preliminary Computations

	Base Year	Development Period												Post-development	
		1	2	3	4	5	6	7	8	9	10	11	12	13	New Eqbm.
Income															
Gross Cash Income	6,512	6,434	6,341	7,169	8,869	9,426	10,804	12,376	14,111	15,123	16,086	17,409	17,683	17,683	17,683
Additional Cash Income (V)	N.A.	-78	-171	657	2,357	2,914	4,292	5,864	7,599	8,611	9,574	10,897	11,171	11,171	11,171
Expenditure															
Cash Expenditure	3,196	5,653	7,968	6,079	6,867	8,269	7,846	9,188	8,858	8,389	7,669	8,220	7,442	7,329	7,329
Additional Pre-tax Cash Expenditure (C)	N.A.	2,457	4,772	2,883	3,671	5,073	4,650	5,992	5,662	5,193	4,473	5,024	4,246	4,133	4,133
Additional Post-tax Cash Expenditure (C*)	N.A.	1,838	4,079	2,300	3,110	4,545	4,258	6,377	6,220	5,749	7,065	8,853	8,576	8,562	8,651
Taxation															
Income Tax	573	82	34	108	124	148	254	902	1,053	1,052	2,861	3,960	4,406	4,494	4,573
Social Security Tax	234	106	81	117	123	131	162	291	312	312	539	676	732	743	753
Total Tax	807	188	115	225	247	279	415	1,193	1,365	1,364	3,400	4,636	5,138	5,236	5,326
Cash Statement															
Owner's Drawings	2,508	2,508	2,508	2,508	2,508	2,508	2,508	2,508	2,508	2,508	2,508	2,508	3,225	5,118	5,028
Annual Overdraft	Nil	1,961	4,250	1,643	753	1,631	Nil	513	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	1,961	6,166	7,810	8,563	10,194	10,160	10,672	9,294	6,432	3,923	1,879	Nil	Nil	Nil
Development Cash Profits															
Pre-tax (V-C)	N.A.	-2,535	-4,943	-2,226	-1,314	-2,159	-358	-128	1,937	3,418	5,101	5,873	6,925	7,038	7,038
Post-tax (V-C*)	N.A.	-1,916	-4,250	-1,643	-753	-1,631	34	-513	1,379	2,862	2,509	2,044	2,595	2,609	2,520

Note: 'N.A.' indicates 'not applicable'

Table 7.14 Case Programme III, Condition B, Preliminary Computations

	Base Year	Development Period											Post-dev.
		1	2	3	4	5	6	7	8	9	10	11	New Eqbm.
Income													
Gross Cash Income	6,512	6,434	6,341	7,169	8,869	9,426	10,804	12,376	14,111	15,123	16,086	17,409	17,683
Additional Cash Income (V)	N.A.	-78	-171	657	2,357	2,914	4,292	5,864	7,599	8,611	9,574	10,897	11,171
Expenditure													
Cash Expenditure	3,196	5,653	7,896	5,925	6,636	7,957	7,453	8,706	8,279	7,831	7,283	7,985	7,329
Additional Pre-tax Cash Expenditure (C)	N.A.	2,457	4,700	2,729	3,440	4,761	4,257	5,510	5,083	4,635	4,087	4,789	4,133
Additional Post-tax Cash Expenditure (C*)	N.A.	1,939	4,024	2,338	3,073	4,499	4,078	6,068	5,641	5,193	6,846	8,882	8,651
Taxation													
Income Tax	573	157	45	255	273	357	425	1,054	1,054	1,054	3,009	4,195	4,573
Social Security Tax	234	133	87	162	167	188	203	312	312	312	557	705	753
Total Tax	807	290	132	416	440	545	628	1,366	1,366	1,366	3,566	4,900	5,326
Cash Statement													
Owner's Drawings	2,508	1,200	1,200	1,200	1,200	1,200	1,200	1,200	3,443	5,927	5,237	4,524	5,028
Annual Overdraft	Nil	709	2,886	372	Nil	276	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	709	3,595	3,967	3,374	3,651	2,128	1,023	Nil	Nil	Nil	Nil	Nil
Development Cash Profits													
Pre-tax (V-C)	N.A.	-2,535	-4,871	-2,072	-1,083	-1,847	35	354	2,516	3,976	5,487	6,108	7,038
Post-tax (V-C*)	N.A.	-2,017	-4,195	-1,681	-716	-1,585	214	-204	1,958	3,418	2,728	2,015	2,520

Note: 'N.A.' indicates 'not applicable'

7.621 Evaluation under Condition A

Preliminary computations appear in Table 7.13. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £59,166

(ii) Present Value of Post-tax Development Cash Profits = £18,138

(iii) Return on Investment = 50.1%

(iv) (a) Maximum Overdraft : £10,672 in year 7.

(b) Repayment Period : Payback occurs 5 years after the year of maximum overdraft and 12 years after the start of development.

(c) Owner's Drawings rise from £2,509 to a New Equilibrium figure of £5,028, an increase of £2,519.

(v) Maximum Asset Increment = £117,300.

7.622 Evaluation under Condition B

Preliminary computations appear in section 7.14. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £61,562

(ii) Present Value of Post-tax Development Cash Profits = £19,177

(iii) (a) Maximum Overdraft : £3,967 in year 3.

(b) Repayment Period : Payback occurs 5 years after the year of maximum overdraft and 8 years after the start of development.

(c) Owner's Drawings increase by £2,519.

7.7 Case Development Programme IV - Farm 25

This farm which is in the Ohuka district, has a total area of 2,854 acres, of which some 2,710 acres are potentially grazeable. In common with most other hill country farms in the County, this farm has soils based on siltstone and volcanic ash. The soils have Soil Bureau classifications of Hangaroa sandy loam and Matawai sandy loam.

While no accurate records of rainfall are available, a reasonable estimate of mean annual rainfall would be about 70 inches. Rainfall in each year is typically well spread.

The author's classification of topography indicates that 150 acres (5%) of the farm is flat and rolling, while 700 acres (25%) is steep ploughable land, and 2,104 acres (70%) is unploughable.

The farm is held under multiple-ownership. Management is supervised by an absentee part-owner, but day-to-day managerial responsibilty is taken by a hired manager. One other shepherd is employed.

7.71 The development programme

The programme analysed here obviously represents only the first stage of the possible development of this farm. No forecast budgets of further develop ment were prepared, because at the time of the survey visit the farmer had no definite plans for future land development and production increases. The analysis of this programme can provide no insight into the profitability of increasing production to high levels, but its relatively unambitious nature corresponds closely to the concept of 'normal' farm development commonly held by farmers in Wairoa County. This analysis therefore provides information on a programme of a type that is reasonably familiar to farmers.

The programme was relatively simple. It consisted of land development by cutting and burning scattered regrowth scrub, oversowing with clovers, and heavier-than-normal applications of superphosphate as well as a gradual but inconsistent increase in stock numbers over a six year period. These inconsistencies in stocking were, in general, not generally due to fluctuating feed supplies, but can be attributed to the 'stop-go' management which characterised the whole programme. This lack of continuity in development was an example of a common shortcoming of farm development work in the County. On this farm, difficulties had been encountered in securing permanent farm managers.

A considerable amount of new fencing was erected as part of development, but much of this replaced existing fences. As a result, the size of improved paddocks remained large; in the vicinity of 150 acres. In spite of this, large mobs of dry sheep were usually able to control pastures.

Development brought no changes in the requirements for labour, buildings or machinery, but additional water supplies were required.

The land development programme is summarised in Table 7.15.

Breeding policies for both sheep and cattle were used throughout the programme, with considerable emphasis being placed upon retaining dry stock. Virtually all steers were sold in store condition at $2\frac{1}{2}$ years or $3\frac{1}{2}$ years of age. A proportion of wethers was retained until the four-tooth stage, and this proportion retained tended to increase over the programme until, in the

Table 7.15 Case Programme IV - Land Development Programme

	Units	Base Year	Development Period 1	2	3	4	5	6	Post-dev.
Area Topdressed (Superphosphate)	acres	350	290	290	Nil	625	625	625	625
Rate of Application of Fertiliser	cwt.per acre	2	2	2	Nil	4	3	2	2
Scrub cut[a/]	acres	15	150	4	15	40	50	64	20
New Fencing[b/]	chains	Nil	60	65	87	107	154	Nil	Nil
Area Oversown (clover @ 5 lbs.per acre)	acres	Nil	290	Nil	Nil	Nil	625	Nil	Nil
Water Supplies	£	Nil	Nil	Nil	Nil	Nil	87	758	Nil

Notes:

(a) Scrub cut was scattered; thus the areas stated are rough estimates.

(b) Accurate details of the length of new fencing erected were not available. The figures quoted were derived from annual expenditures on new fencing.

sixth year, only 100 store wether lambs were sold. A summary of the changes in stocking patterns and production appears in Table 7.16. The table confirms that overall increases in stocking rates and production were slight, and the inconsistent increase in stock numbers is also clearly indicated.

Table 7.16 Case Programme IV - Stocking and Production

	Base Year	Development Period						Post-dev.
		1	2	3	4	5	6	
Stock Wintered								
Breeding Ewes	1,960	1,961	1,987	2,021	2,072	2,374	2,479	2,480
Sheep EE	3,279	3,280	3,556	3,340	3,357	3,905	4,909	4,973
Cattle EE	2,694	2,587	2,548	3,473	3,043	3,041	1,921	1,845
Total EE	5,973	5,867	6,104	6,813	6,400	6,936	6,830	6,818
Ratio $\frac{\text{Sheep EE}}{\text{Cattle EE}}$	1.2	1.3	1.4	1.0	1.1	1.3	2.5	2.7
EE. per potentially productive acre	2.20	2.16	2.25	2.51	2.36	2.56	2.52	2.52
Annual EE increase (%)	Nil	-1.8	4.0	11.6	-6.1	8.4	-1.5	Nil
Production								
Wool: (i) Total clip (lbs.)	30,600	30,680	32,723	37,150	36,456	38,498	44,045	44,100
(ii) lbs. per potentially productive acre	11.3	11.3	12.1	13.7	13.5	14.2	16.3	16.3
(iii) lbs. per breeding ewe	15.6	15.6	16.5	18.4	17.6	16.2	17.8	17.8
Lambing %	81.0	81.4	78.3	80.5	81.1	84.4	82.6	82.0
Calving %	76.0	76.0	97.0	98.6	82.5	85.4	81.7	82.0

Table 7.17 Case Programme IV, Condition A, Preliminary Computations

	Base Year	Development Period						Post-development														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	New Eqbm.
Income																						
Gross Cash Income	12,547	9,674	12,373	10,027	16,284	13,355	14,206	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844
Additional Cash Income (V)	N.A.	-2,873	-174	-2,520	3,737	808	1,629	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297	3,297
Expenditure																						
Cash Expenditure	6,095	8,598	6,860	6,189	9,580	11,543	9,367	8,244	8,131	8,102	8,073	8,043	8,012	7,980	7,947	7,914	7,879	7,843	7,838	7,838	7,838	7,838
Additional Pre-tax Cash Expenditure (C)	N.A.	2,503	765	94	3,485	5,448	3,272	2,149	2,036	2,007	1,978	1,948	1,917	1,885	1,852	1,819	1,784	1,748	1,743	1,743	1,743	1,743
Additional Post-tax Cash Expenditure (C*)	N.A.	1,044	-567	-1,239	2,234	3,985	1,939	1,420	2,822	2,809	2,795	2,781	2,766	2,750	2,735	2,718	2,701	2,683	2,696	2,715	2,734	2,792
Taxation																						
Income Tax	2,241	946	1,057	1,057	1,129	942	1,057	1,593	2,939	2,953	2,967	2,981	2,996	3,010	3,025	3,041	3,056	3,072	3,088	3,105	3,122	3,173
Social Security Tax	461	297	312	312	322	297	312	380	548	550	552	554	555	557	559	561	563	565	567	569	571	577
Total Tax	2,712	1,243	1,369	1,369	1,450	1,239	1,369	1,973	3,487	3,503	3,519	3,535	3,551	3,567	3,584	3,607	3,619	3,637	3,655	3,674	3,693	3,751
Cash Statement																						
Owner's Drawings	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	4,279	4,351	4,332	4,313	4,255
Annual Overdraft	Nil	3,917	Nil	1,281	Nil	3,177	280	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	3,917	3,523	4,805	3,302	6,479	6,759	4,882	4,407	3,918	3,416	2,900	2,369	1,822	1,260	681	86	Nil	Nil	Nil	Nil	Nil
Development Cash Profits																						
Pre-tax (V-C)	N.A.	-5,376	-939	-2,614	252	-4,640	-1,613	1,148	1,261	1,290	1,319	1,349	1,380	1,412	1,445	1,478	1,513	1,549	1,554	1,554	1,554	1,554
Post-tax (V-C*)	N.A.	-3,917	393	-1,281	1,503	-3,177	-280	1,877	475	488	502	516	513	547	562	579	596	614	601	582	563	505

Note: 'N.A.' indicates 'not applicable'.

Table 7.18 Case Programme IV, Condition B, Preliminary Computations

	Base Year	Development Period						Post-dev.	
		1	2	3	4	5	6	7	New Eqbm.
Income									
Gross Cash Income	12,547	9,674	12,373	10,027	16,284	13,355	14,206	15,844	15,844
Additional Cash Income (V)	N.A.	-2,873	-174	-2,520	3,737	808	1,659	3,297	3,297
Expenditure									
Cash Expenditure	6,095	8,598	6,707	5,978	9,292	11,345	9,003	7,838	7,838
Additional Pre-tax Cash Expenditure (C)	N.A.	2,503	612	-117	3,197	5,250	2,908	1,743	1,743
Additional Post-tax Cash Expenditure (C*)	N.A.	1,040	-693	-1,449	2,290	3,770	1,606	371	2,792
Taxation									
Income Tax	2,241	942	1,082	1,057	1,435	927	1,085	1,022	3,173
Social Security Tax	461	297	316	312	360	295	316	308	577
Total Tax	2,712	1,239	1,398	1,369	1,795	1,222	1,401	1,330	3,751
Cash Statement									
Owner's Drawings	3,750	1,200	2,906	2,680	5,197	1,200	3,391	6,677	4,255
Annual Overdraft	Nil	1,363	Nil	Nil	Nil	411	Nil	Nil	Nil
Accumulated Overdraft	Nil	1,363	Nil	Nil	Nil	411	Nil	Nil	Nil
Development Cash Profits									
Pre-tax (V-C)	N.A.	-5,376	-786	-2,403	540	-4,442	-1,249	1,554	1,554
Post-tax (V-C*)	N.A.	-3,913	519	-1,071	1,447	-2,962	53	2,926	505

Note: 'N.A.' indicates 'not applicable'

7.72 Evaluation of Programme IV

The assumptions defined in section 7.23 were applied in this evaluation.

7.721 Evaluation under Condition A

Preliminary computations appear in Table 7.17. Further computations on this data yeild:

(i) Present Value of Pre-tax Development Cash Profits = £4,651

(ii) Present Value of Post-tax Development Cash Profits = £1,279

(iii) Return on Investment = 5.9%

(iv) (a) Maximum Overdraft : £6,759 in year 6.

(b) Repayment Period : Payback occurs 11 years after the year of maximum overdraft and 17 years after the start of development.

(c) Owner's Drawings rise from £3,750 to a New Equilibrium figure of £4,255, an increase of £505.

(v) Maximum Asset Increment = £25,900

7.722 Evaluation under Condition B

Preliminary computations appear in Table 7.18. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £6,698

(ii) Present Value of Post-tax Development Cash Profits = £2,385

(iii) (a) Maximum Overdraft : £1,363 in year 1.

(b) Repayment Period : Although the £1,363 overdraft is repaid in the second year, a further overdraft of £411, occurs in the fifth year. This is repaid in the sixth year.

(c) Owner's Drawings increase by £505.

7.8 Case Development Programme V - Farm 26

This farm, in the Kotemaori district, has a total area of 560 acres, of which approximately 530 acres are potentially grazeable. The soils are based mainly on siltstone/mudstone with infrequent 'pockets' of volcanic ash, and are classified as Waitaha sandy loam.

Local farmers estimated that annual rainfall fluctuated from 30 inches to 60 inches, but the average is 50 inches.

The farm lies within the coastal rainfall region, and typically experiences dry periods during late summer and early autumn.

The author's classification of topography indicates that 30 acres (5%) of the farm are flat to rolling, while 70 acres (13%) are steep ploughable land, and 460 acres (82%) are unploughable.

The farm is freehold and owner-operated.

7.81 The development programme

A predominant feature of this programme is its simplicity. Although development of second-growth bush was carried out in the fourth year, the programme was based upon substantial applications of superphosphate and rapid increases in stock numbers together with the cutting of small areas of scattered scrub. Paddock sizes ranged from 60 acres to 100 acres before development, but the farmer believed that investment in fertiliser and stock was likely to be more profitable than further subdivision. This resulted in no new fencing being erected until the fourth year of development when the 100 acres of pasture established from bush required ring-fencing. Since the survey visit coincided with the fourth year of the programme, it was necessary to accept the farmer's expectations of stocking rates and production for the fifth year. The farmer felt that hired labour would be required if stock numbers were increased beyond these fifth-year levels. As he was uncertain that such labour would, in fact, be obtained, it has been assumed that the fifth year represents the post-development situation.

Throughout the programme, stock policies remained 'conventional'. A Romney breeding ewe flock provided flock replacements and cull two-tooth ewes. The initial policy of selling all wether lambs in fat or forward-store condition was modified in the third year to allow the wintering of small numbers of wether hoggets. By the fifth year, approximately 25% of the wether lambs were wintered, almost all of these being sold as fat two-tooths in the following spring. Steers were typically sold as weaners, while cull heifers were sold as rising two-year-olds.

No notable additions to farm tracks, water supplies, farm buildings, machinery or vehicles were made during development, but it should be noted that the farm had no shearing shed. All shearing was done on a neighbouring property.

Table 7.19 summarises the land development programme and traces changes in land utilisation, while Table 7.20 indicates year-by-year stocking rates and production.

Table 7.19 Case Programme V - Land Development Programme and Land Use

	Units	Base Year	Development Period					Post-dev.
			1	2	3	4	5	
Land Development Programme								
Area Topdressed (superphosphate)	acres	Nil	Nil	200	430	(a) 430 (b) 100	(a) 930 (b) 100	530
Rate of Application	cwt. per acre	Nil	Nil	1	3	(a) 3 (b) 4	(a) 3 (b) 4	3
Scrub Cut	acres	Nil	10	Nil	22	Nil	Nil	Nil
Pasture Established from Bush	acres	Nil	Nil	Nil	Nil	100	Nil	Nil
New Fencing ('conventional' type)	chains	Nil	Nil	Nil	Nil	50	Nil	Nil
Land Use								
Total Area	acres	560	560	560	560	560	560	560
Permanent Waste	acres	30	30	30	30	30	30	30
Potentially Grazeable Bushland	acres	100	100	100	100	Nil	Nil	Nil
Untopdressed Pasture	acres	430	430	230	Nil	Nil	Nil	Nil
Pasture annually topdressed	acres	Nil	Nil	200	430	530	530	530

Note: All scrub cut was in isolated patches. Thus the areas stated are rough estimates.

Table 7.20 Case Programme V - Stocking and Production

	Base Year	Development Period 1	2	3	4	5	Post-dev.
Stock Wintered							
Breeding Ewes	770	850	900	950	1,040	1,200	1,200
Sheep EE	1,042	1,116	1,164	1,300	1,463	1,717	1,717
Cattle EE	649	608	564	585	625	584	584
Total EE	1,691	1.724	1,728	1,885	2,088	2,301	2,301
Ratio $\frac{\text{Sheep EE}}{\text{Cattle EE}}$	1.6	1.8	2.1	2.2	2.3	2.9	2.9
EE per acre pasture	3.93	4.00	4.00	4.38	3.94	4.34	4.34
EE per potentially grazeable acre	3.19	3.25	32.5	3.56	3.94	4.34	4.34
Annual EE increase (%)	Nil	2.0	Nil	9.1	10.8	9.7	Nil
Production							
Wool: (i) Total clip (lbs.)	9,000	9,750	12,560	14,790	17,020	19,310	19,310
(ii) lbs. per acre pasture	20.0	22.7	29.2	34.4	32.1	36.4	36.4
(iii) lbs. per potentially productive acre	17.0	18.4	23.7	27.9	32.1	36.4	36.4
(iv) lbs. per breeding ewe	11.7	11.5	13.9	15.6	16.4	16.1	16.1
Lambing %	90.0	92.6	70.6	83.6	91.2	92.0	92.0
Calving %	75.0	68.3	95.2	75.3	78.0	80.0	80.0

Several points of interest arise from Table 7.20. These are discussed below:

(i) In the final three years of the programme, the stocking rate was increased very rapidly. It is significant that the farmer estimated correctly in advance that pasture improvement would result in substantial increases in feed available. He then increased stock numbers in order to utilise this extra pasture production as soon as it became available.[17/]

(ii) Once again, the ratio of sheep to cattle increased markedly with stocking rates.

(iii) The greater part of the increase in wool production came from improvement of existing pastures, and better utilisation, rather than from the development of hitherto unproductive land.

(iv) As with previously described programmes, the 'wool per breeding ewe' data is misleading due to changes in the composition of the flock. While records of production per animal were not available, the farmer was convinced that wool production per ewe had tended to increase slightly as pastures improved under increased stocking rates.

7.82 Evaluation of Programme V

The assumptions defined in section 7.23 were applied in this evaluation.

7.821 Evaluation under Condition A

Preliminary computations appear in Table 7.21. Further computations on

---

17. This crucial practice is not widely followed in Wairoa County. The importance of this practice has been stressed by Tripe /30/. See Section 5.721.

this data yield:

(i) Present value of Pre-tax Development Cash Profits = £10,847

(ii) Present Value of Post-tax Development Cash Profits = £ 5,506

(iii) Return on Investment = 23.5%

(iv) (a) Maximum Overdraft : £3,052 in year 4

(b) Repayment Period : Payback occurs 5 years after the year of maximum overdraft and 9 years after the start of development.

(c) Owner's Drawings rise from £2,361 to a New Equilibrium figure of £2,968, an increase of £607.

(v) Maximum Asset Increment = £18,867

7.822 Evaluation under Condition B

Preliminary computations appear in Table 7.22. Further computations on this data yield:

(i) Present Value of Pre-tax Development Cash Profits = £11,354

(ii) Present Value of Post-tax Development Cash Profits = £ 5,777

(iii) (a) Maximum overdraft : £1,182 in year 4

(b) Repayment Period : Payback occurs in the year after maximum overdraft; that is, 5 years after the start of development.

(c) Owner's Drawings increase by £607.

Table 7.21 Case Programme V, Condition A, Preliminary Computations

	Base Year	Development Period					Post-development					
		1	2	3	4	5	6	7	8	9	10	New Eqbm.
Income												
Gross Cash Income	3,950	4,352	4,200	4,624	5,170	6,613	6,613	6,613	6,613	6,613	6,613	6,613
Additional Cash Income (V)	N.A.	402	250	674	1,220	2,663	2,663	2,663	2,663	2,663	2,663	2,663
Expenditure												
Cash Expenditure	995	1,980	1,590	2,165	4,798	3,186	2,707	2,655	2,608	2,560	2,526	2,526
Additional Pre-tax Cash Expenditure (C)	N.A.	985	595	1,170	3,803	2,191	1,712	1,660	1,613	1,565	1,531	1,531
Additional Post-tax Cash Expenditure (C*)	N.A.	956	440	1,006	3,646	2,180	1,789	1,893	1,849	1,992	2,038	2,056
Taxation												
Income Tax	397	373	272	266	272	388	460	590	592	755	823	838
Social Security Tax	197	191	167	165	166	195	210	237	237	266	278	281
Total Tax	594	565	439	431	438	583	670	827	830	1,021	1,101	1,119
Cash Statement												
Owner's Drawings	2,361	2,361	2,361	2,361	2,361	2,361	2,361	2,361	2,361	2,471	2,483	2,968
Annual Overdraft	Nil	554	190	332	2,426	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	554	744	1,076	3,502	3,019	2,145	1,374	561	Nil	Nil	Nil
Development Cash Profits												
Pre-tax (V-C)	N.A.	-583	-345	-496	-2,583	472	951	1,003	1,050	1,098	1,132	1,132
Post-tax (V-C*)	N.A.	-554	-190	-332	-2,426	483	874	770	814	671	625	607

Note: 'N.A.' indicates 'not applicable'.

Table 7.22 Case Programme V, Condition B, Preliminary Computations

	Base Year	Development Period					Post-development				
		1	2	3	4	5	6	7	8	9	New Eqbm.
Income											
Gross Cash Income	3,950	4,352	4,200	4,624	5,170	6,613	6,613	6,613	6,613	6,613	6,613
Additional Cash Income (V)	N.A.	402	250	674	1,220	2,663	2,663	2,663	2,663	2,663	2,663
Expenditure											
Cash Expenditure	995	1,980	1,557	2,120	4,733	3,047	2,526	2,526	2,526	2,526	2,526
Additional Pre-tax Cash Expenditure (C)	N.A.	985	562	1,125	3,738	2,052	1,531	1,531	1,531	1,531	1,531
Additional Post-tax Cash Expenditure (C*)	N.A.	952	422	950	3,563	2,100	1,745	1,756	1,852	2,045	2,056
Taxation											
Income Tax	397	370	284	256	256	437	574	584	664	828	838
Social Security Tax	197	191	170	162	162	206	234	236	251	279	281
Total Tax	594	561	454	418	418	643	808	820	915	1,107	1,119
Cash Statement											
Owner's Drawings	2,361	1,811	2,189	2,085	1,200	1,742	3,279	3,267	3,172	2,979	2,968
Annual Overdraft	Nil	Nil	Nil	Nil	1,182	Nil	Nil	Nil	Nil	Nil	Nil
Accumulated Overdraft	Nil	Nil	Nil	Nil	1,182	Nil	Nil	Nil	Nil	Nil	Nil
Development Cash Profits											
Pre-tax (V-C)	N.A.	-583	-312	-451	-2,518	611	1,132	1,132	1,132	1,132	1,132
Post-tax (V-C*)	N.A.	-550	-172	-276	-2,343	563	918	907	811	618	607

Note: 'N.A.' indicates 'not applicable'

7.9 Summary and Conclusions

The important results from the evaluations of the case development programmes are summarised in Tables 7.23 and 7.24. Table 7.23 contains the results of Condition A evaluations, while Table 7.23 lists the additional results that were obtained by evaluating the programmes under Condition B.

Table 7.23 Evaluations of Case Development Programmes Under Condition A Summary

Programme Number T	Present Value of Development Cash Profits (£)		Return on Investment (%)	Maximum Overdraft (£)	Repayment Period (years)	Increase in Owner's Drawings (£)
	Pre-tax	Post-tax				
I-Farm 21	12,718	11,252	38.4	2,232	4	919
II-Farm 22	7,146	3,402	6.0	8,984	5	776
III-Farm 24	59,266	18,138	50.1	10,672	5	2,519
IV-Farm 25	4,651	1,279	5.9	6,759	11	505
V-Farm 26	10,847	5,506	23.5	3,502	5	607

Table 7.23 shows that farm development of the types illustrated by Case programmes I, III, and V, is likely to give extremely high pre-tax returns on investment. On the other hand, development along the lines of Case Programmes II and IV offer substantially lower returns. In fact, these programmes may not be as profitable as outside investments yielding 6% before

Table 7.24 Evaluations of Case Development Programmes Under Condition B - Summary

Programme Number	Present Value of Development Cash Profits (£)		Maximum Overdraft	Repayment Period
	Pre-tax	Post-tax	(£)	(years)
I - Farm 21	12,317	10,800	3,136	6
II - Farm 22	8,866	4,291	5,030	3
III - Farm 24	61,562	19,177	3,967	5
IV - Farm 25	6,698	2,385	1,363	1
V - Farm 26	11,354	5,777	1,182	1

Note: Minimum Owner's Drawings for Programmes II, III, IV and V were arbitrarily set at £1,200; this was lower than Owner's Drawings in the Base Year. Minimum Owner's Drawings for Programme I were set at £800. This was higher than Owner's Drawings in the Base Year.

tax.[18]

The disparity between the profitabilities of these two groups of Case Programmes suggests the presence of notable technical or managerial differences. This is indeed the case. Case Programmes I, III and V are all characterised by rapid increases in stock numbers to relatively high stocking

18. However, it must be remembered that due to the unique opportunities for farming to charge capital expenditure against income for taxation purposes, the post-tax profitability of Case Programmes II and IV could be slightly more profitable than outside investments yielding 6% before tax.

rates (of 3.74 EE per acre, 5.12 EE per acre, and 4.34 EE per acre, respectively). Moreover, these programmes all feature close reconciliations between extra feed grown and extra stock carried, with the result that pasture utilisation does not decline as feed availability increases.

In Case Programmes II and IV, on the other hand, stock increases halted while stocking rates were still at relatively low levels.[19] Case II in particular suggests that the failure to increase stock numbers as far as possible after heavy investment in pasture improvement is likely to reduce profitability considerably.[20] Case IV is a programme in which land development was carried out virtually independent of decisions to increase stock numbers. The need to 'redevelop' pastures oversown three years previously suggested that this initial work was faulty. It is likely that the rates of fertiliser applied when oversowing did not increase fertility sufficiently to support high-producing pasture species. It must be re-emphasised that development of this type is regarded by some farmers in Wairoa County as normal. This case example suggests that increasing production by these methods is likely to be unprofitable.

---

19. As stated in Section 7.51, the assumption that Case Programme II had halted completely at a stocking rate of 2.69 EE per acre may be somewhat artificial. As it is, this programme provides an indication of the financial outcome of programmes that are not completed.

20. Case Programme V provides a further example of this point. In spite of the high profitability of this programme, it is shown by Tables 7.19 and 7.20 that after 100 acres of new pasture were developed from bushland in the fourth year, stock was increased by only 213 EE before labour became the limiting resource. Thus, even by ignoring the fact that production from old pastures could be expected to increase in the fifth year as a result of the topdressing programme, this new pasture could be stocked at only 2.13 EE per acre if utilisation of existing pastures did not decline. Such a stocking rate is probably less than half the potential, and it is clear that the profitability of the programme could have been improved still further by increasing post-development stock to a quite feasible level of 2,600 EE.

The method by which pastures are established and improved would not appear to greatly influence the overall profitability of development in the County. Although Programmes I, III, and V all featured heavy application of fertiliser and extensive oversowing operations, only Case III involved the more expensive technique of improvement by cultivation, and only Case V had an important 'cutting and burning' operation. Thus different techniques of land development were employed, yet development as a whole was very profitable in each case. This result does not, however, imply that expensive land development techniques should be employed when cheaper alternatives are available. Only those techniques which offer highest profits should be employed.

Table 7.23 provides salutary information about the impact of taxation on the profitability of developing hill country farms. Except when Base Year and Post-development tax payments are both relatively small (as they are in Case Programme I), a considerable proportion of the profits from development accrues to the Inland Revenue Department. This very important observation is examined in some detail in Chapter 9.

An examination of Table 7.24 shows that the profitability of development is only slightly changed (as a result of lower interest payments) when Owner's Drawings are allowed to fall. On the other hand, the Maximum Overdraft and Repayment Period are substantially reduced when Owner's Drawings are reduced.

This chapter has described the important technical features of five development programmes adopted by farmers in Wairoa County. Evaluation of these programmes suggested that increasing production on Wairoa hill country can be extremely profitable before tax, the main criterion for success being a willingness to increase stock numbers at a rate sufficient to ensure good utilisation of feed grown. The evaluations also suggested that taxation substantially reduces the profitability of farm development to individual farmers.

CHAPTER 8

A MODEL DEVELOPMENT PROGRAMME FOR WAIROA HILL COUNTRY

8.1 Introduction

Construction of this model development programme for Wairoa Hill country was prompted by two types of inadequacy in the case studies presented in Chapter 7. First, none of the case programmes was representative in the sense that the farmer had faced all the important difficulties associated with hill country development in the County. Each case farm was in some way favourably disposed towards increasing production. Predisposing factors included; a house already suitable for an extra farm worker, use of a neighbour's woolshed, a State-maintained boundary fence, and the absence of some weeds (especially blackberry) that were prevalent on many other farms in the survey. Secondly, none of the case farmers had, in the author's opinion, taken sufficient cognizance of new management and development techniques shown to be successful outside the County.

Thus the model programme is a summary of the author's subjective assessment of the techniques which could profitably be used in developing Wairoa hill country. In this respect, this chapter complements Chapter 5, in which the development techniques actually observed in the survey are reported. It is not claimed that these are the 'best'[1] techniques, or that the order of their application and the rate of development adopted, are optimum. It is

1. Derivation of the 'best' development procedure would require a full and rigorous definition of the problems faced in developing Wairoa hill country. Insufficient information is available for such a rigorous definition to be possible.

submitted, however, that the model programme presented here would, with appropriate modification, result in development on a majority of farms being more profitable than it would be if attempted by methods currently used in the County. It will also be noted that the model programme has a target stocking rate of 5 EE per acre, the author's <u>conservative</u> estimate of potential average stocking levels in the County.

The financial analyses of the case programmes in Chapter 7 were based upon fixed assumptions for prices and costs, and it was therefore impossible to estimate the sensitivity of the financial outcome of development to variations in important costs and prices. The second part of this Chapter contains a modified analysis in which sensitivity is considered, but since the work involved is very time-consuming, the analysis has been restricted to one programme.

The model programme was considered to be more representative of likely future development projects than the case programmes. It was therefore chosen for analysis under variable costs and prices.

This Chapter represents a major budgetary exercise, aimed at presenting and examining the profitability of the development techniques likely to be used in the County over the next dacade.

The hypothetical farm to which the model development programme is applied is now described.

8.2 The Hypothetical Farm

The three considerations paramount in formulating this 'paper farm' were its size, its natural features, and its pre-development physical condition. These features are now discussed.

8.21 Size of the farm

If stocking rates were increased far beyond the present levels of 2 EE to 3 EE per potentially productive acre, many hill country farmers who currently operate their farms alone (possibly with the assistance of casual labour) would be obliged to hire permanent labour for the first time. The scheduling of farm development to accommodate this 'lumpy input' would be a significant management problem, which would be often compounded by the necessity to provide additional living quarters.

In general, farms in this category lie in the 800 acres to 1,200 acres range. Farms smaller than this can reach relatively high stocking levels without requiring extra permanent labour, while farms larger than 1,200 acres frequently already have two or more permanent labour units that are relatively under-employed. The problem of integrating a further labour unit into the management of these larger farms is seldom as severe as on farms of less than 1,200 acres, principally because the organisation of a two-man labour force is considerably more flexible than labour organisation on a one man farm. Further, on the larger farms, adequate housing is often already available for a third man.[2]

This problem is an important one, and any model development progamme ignoring it is likely to over-estimate the profitability of increasing production on farms in the 800 acres to 1,200 acre class. Consequently, the area of the hypothetical farm was set arbitrarily at 1,100 acres.[3]

8.22 Natural features of the farm

No particular assumptions for climate or soil type have been made. While slight modifications to the model programme may be required where mean annual rainfall is less than 45 inches, it is believed that the success of the programme would be insensitive to the variations in rainfall and soil types that are found in the County. Thus the farm may be regarded as lying virtually anywhere in the County, and the development programme is for the districts with higher fertility soils and more reliable rainfall.

'Typical' topography has been approximated by accepting the average classification for Random Farms[4] of 10% (110 acres) flat and rolling, 24% (265 acres) of steep ploughable contour, and 66% (725 acres) unploughable.

8.23 Pre-development physical condition

The average classification of the land use on Random Farms[5] has been

---

2. These problems are being considered in some detail in Milne's /41/ current study of labour problems on North Island hill country.

3. As indicated in Table 8.5, the single permanent labour unit is assumed to require assistance from casual labour costing £400 per year before development.

4. See Table 4.3.

5. See Table 4.5.

adopted as the pattern of pre-development land use on the hypothetical farm. It is assumed that 65% (725 acres) is grazeable pasture, 31% (330 acres) is unproductive but capable of development, and 4% (45 acres) is permanent waste.

Of the 725 acres of grazeable pasture, it is assumed that 110 acres (including all flat and rolling land) have received 2 cwt. of superphosphate per acre annually for several years, and that a further 260 acres have received 2 cwt. of superphosphate per acre every second year. Thus 110 acres can be regarded as supporting high-fertility pasture species, while a further 260 acres support recognisable amounts of ryegrass, cocksfoot, and white clover. The remaining 355 acres of pasture consist mainly of native grasses, low-fertility English grasses such as browntop and ratstail, and subterranean clover.

The unproductive land capable of development consists of 70 acres of 'solid' manuka, 25 acres of 'scattered' manuka, 195 acres of 'solid' manuka/blackberry, and 40 acres of scattered blackberry clumps. The author believes that this specification includes a higher proportion of blackberry infested land than is 'typical' for farms in the County, but this bias is intentional because it is intended that the hypothetical farm should represent a farm 'difficult' to develop. Further, by virtue of the emphasis on relatively expensive development techniques, analysis of the model programme will yield a conservative estimate of profitability.

8.3 Pre-development Situation

The description now turns to the pre-development state of improvements on the hypothetical farm, and the stocking policy immediately prior to the commencement of development.

8.31 Improvements

Fencing, buildings, water supplies and tracking are considered here.

8.311 Fencing

The farm is subdivided by 500 chains of internal fencing (in 'reasonable' stock-proof condition) and 435 chains of boundary fence, into ten paddocks with acreages of 200, 190, 160, 130, 125, 90, 85, 45, 35, and 30.

8.312 Buildings

The farm has a homestead and an adequate number of sundry sheds. The three-stand shearing shed and yards are adequate at pre-development stocking levels, and up to 2,000 bales of hay may be stored. There is no second house.

8.313 Water supplies

Apart from three open dams in the regularly-topdressed paddocks, all stock water is supplied by creeks. The large paddocks facilitate this system, and all paddocks have some permanent water available in them.

8.314 Tracking

Only the 'front' 350 acres have tracks negotiable by wheeled vehicles.

8.32 Stock policy

The average stocking rate per grazeable acre of Random Farms[6] of 2.98 EE has been assumed for the hypothetical farm. Hence, pre-development stock total 2,120 EE, comprising 1,330 sheep EE and 800 cattle EE which provides 1.86 sheep EE per grazeable acre, and a ratio of sheep EE to cattle EE of 1.66. These levels correspond closely to the average for Random Farms.

A class analysis of pre-development stock appears in Table 8.1, and a summary of pre-development production in Table 8.2.

8.4 The Development Programme

The basic objective of the programme is to increase the stocking rate as rapidly as possible without purchasing stock.[7] This restriction was imposed because the programme is a suggested method for increasing production thoughout Wairoa County. Such a programme should be self-supporting;[8] that is, it should require no resources that could be expected to be in short supply if a large number of farms was developed simultaneously. The stocking policy was adopted to meet the labour difficulty discussed in Section 8.21, and the land development programme was reconciled with the requirements for extra feed.

8.41 The stocking policy

The requirement that the programme must be self supporting in stock

6. See Table 4.7

7. This restriction does not, of course, include rams and bulls.

8. At present prices it might be profitable for farmers to increase stock numbers faster than in the programme by purchasing stock, but for Wairoa as a whole, it would not be possible to increase stock numbers by buying-in without forcing prices above present levels.

dictates that breeding policies for both sheep and cattle are maintained, but breeding cow numbers are increased only slightly above pre-development levels. Whenever possible, requirements for extra sheep are filled by breeding ewes and ewe hogget flock replacements, but in the first five years, wether hoggets or mature wethers are introduced. There are three reasons for this modification to the basic policy:

(i) By retaining all lambs produced (subject to minimum culling levels) and establishing a flock of mature wethers, maximum increases in aggregate numbers without buying-in can be obtained.

(ii) A policy of increasing sheep numbers by expanding the ewe flock alone would eventually be limited by the capacity of the single labour unit. It is unlikely that sufficient extra stock could be bred to justify, at least in the short term, the employment of a second permanent labour unit. This 'flat patch' in the farmer's ability to increase stock can be overcome to a degree by the employment of increasing amounts of casual labour, but the author favours a more formal approach to the problem. In this, expansion of the breeding flock is retarded as the maximum capacity of the single labour unit is approached. The labour capacity that remains is then utilised by a stock class possessing relatively low requirements for labour. When labour again limits further increases in stock numbers a permanent worker may be hired while concurrently boosting stock numbers substantially by both maintaining the increase in the low-labour stock class and retaining all breeding ewes that would previously have been culled. A wether policy is used to 'cushion' the lumpy labour input in the model programme. However, in the absence of the restriction on purchasing, the use of Perendale ewes would also be technically feasible.

(iii) Mature wethers have more flexible feed requirements than most other classes of stock, and they are able to withstand periods of low feed availability without suffering serious production losses. Wethers are therefore likely to be useful during the temporary over-stocking which may occur during development. Moreover, Tripe has demonstrated the use of wethers in establishing pasture after cutting and burning manuka.[9]

To summarise, it may be stated that a mature wether policy is particularly suited to the development of Wairoa hill country because; it allows maximum initial increases in sheep numbers; it overcomes the labour difficulty on farms in the 800 to 1,200 acre range; it affords some protection against the risks and uncertainties associated with feed availability during development (and this may be especially valuable in those districts of the County with unreliable rainfall); and large mobs of wethers can be an effective tool in pasture establishment.

Table 8.1 shows the class of analysis of stock carried in the Base Year, during the Development Period, and in the Post-development situation, while details of stock sales and purchases appear in Table 8.2. The important features of the stocking policy may be summarised as:

---

9. See Section 5.721.

Table 8.1 Model Development Programme - Stock Wintered

	Base Year	Development Period												Post-dev.
		1	2	3	4	5	6	7	8	9	10	11	12	
Sheep														
Ewe Hoggets	368	403	477	517	537	553	657	743	857	997	1,268	1,313	1,321	1,381
2th. Ewes	250	320	350	300	300	467	481	571	647	745	810	810	810	810
4th. Ewes	237	237	305	332	285	285	444	456	543	615	708	770	770	770
6th. Ewes	225	225	225	290	315	270	270	432	434	526	585	673	732	732
4yr. Ewes	214	214	214	214	275	300	257	257	410	412	500	558	639	695
5yr. Ewes	83	203	204	204	204	262	285	243	243	390	392	200	233	140
Total Ewes	1,009	1,199	1,298	1,340	1,379	1,584	1,792	1,959	2,277	2,688	2,995	3,011	3,184	3,147
Wether Hoggets	20	20	477	517	537	553	657	400	300	20	20	20	20	20
2th. Wethers	-	-	-	443	482	501	516	615	368	271	-	-	-	-
4th. Wethers	-	-	-	-	430	468	486	501	597	357	263	-	-	-
6th. Wethers	-	-	-	-	-	417	454	470	486	458	66	257	-	-
Total Wethers	-	-	-	443	912	1,386	1,456	1,586	1,451	1,086	329	257	-	-
Rams	30	30	30	30	30	32	36	40	46	54	60	60	60	60
Sheep EE	1,330	1,557	2,043	2,411	2,761	3,359	3,725	3,966	4,206	4,250	4,250	4,250	4,248	4,258
Cattle														
Breeding Cows	104	115	125	130	130	130	130	130	130	130	130	130	130	130
Rising 1yr.Hfrs.	39	39	44	48	50	50	50	50	50	50	50	50	50	50
Rising 2yr.Hfrs.	37	37	37	42	49	49	49	49	49	49	49	49	49	49
Bulls	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Cattle EE	800	855	925	982	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016
Total EE	2,130	2,412	2,968	3,393	3,777	4,375	4,741	4,982	5,222	5,266	5,266	5,266	5,264	5,274
Annual EE Increase	-	13.2%	23.1%	14.3%	11.3%	15.8%	8.4%	5.1%	4.8%	0.8%	-	-	-	-
Sheep EE / Cattle EE	1.7	1.8	2.2	2.5	2.7	3.3	3.7	3.9	4.1	4.2	4.2	4.2	4.2	4.2
EE per potentially productive acre	2.02	2.29	2.81	3.22	3.58	4.15	4.49	4.72	4.95	4.99	4.99	4.99	4.99	5.00

Table 8.2 Model Development Programme - Stock Sales and Purchases and Wool Production

	Base Year	Development Period												Post-dev.
		1	2	3	4	5	6	7	8	9	10	11	12	
Stock Sales														
Ewe Lambs	35	-	-	-	-	-	-	-	-	-	-	-	-	-
Cull 2th. Ewes	107	37	41	163	202	54	55	66	74	86	157	420	464	530
Cull M.A. Ewes	14	18	19	21	23	23	26	29	34	41	46	42	45	46
C.F.A. Ewes	203	79	193	194	194	194	249	271	231	231	370	657	498	659
Wether Lambs	391	391	-	-	-	-	-	343	566	997	1,275	1,321	1,328	1,390
4th. Wethers	-	-	-	-	-	-	-	-	-	113	280	-	-	-
6th. Wethers	-	-	-	-	-	-	404	440	456	471	444	64	249	-
Cull Brdg. Cows	17	17	17	17	17	20	20	20	20	20	20	20	20	20
Weaner Steers	41	41	45	46	50	50	50	50	50	50	50	50	50	50
Cull 2yr. Hfrs.	15	3	4	9	18	22	22	22	22	22	22	22	22	22
Potter Bulls (av.)	1	1	1	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$
Stock Purchases														
Rams (Romney)	8	8	8	8	8	10	12	13	16	19	20	15	15	15
Bulls (A.A.) (av.)	1	1	2	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$
Wool Production														
Total Clip (lbs.)	15,250	15,250	17,980	22,850	28,580	34,210	42,000	46,570	49,060	51,600	52,300	49,750	49,600	49,120
lbs. per potentially productive acre	14.5	14.5	17.0	21.7	27.1	32.4	39.8	44.1	46.5	48.9	49.6	47.2	47.0	46.6

(i) Breeding ewe numbers are increased as rapidly as possible during the first two years, but are held essentially constant in the third and fourth years. It has been assumed that 1,350 to 1,400 breeding ewes is the maximum number that many farmers in Wairoa County would be prepared to handle alone.

(ii) Insufficient extra feed is available to inaugurate a wether flock in the first year, but over the next five years all wether lambs are retained. The first sale of wethers occurs in the sixth year, when six-tooth wethers are sold.

(iii) It has been assumed that the capacity of the single labour unit is reached in the fourth year when 1,379 breeding ewes, 912 mature wethers, 130 breeding cows, and supporting stock are run.[10] The hiring of a permanent farm worker in time for the fifth year's lambing permits substantial increases in both breeding ewes and wethers in that year. In this, and subsequent years, breeding ewe numbers are increased as rapidly as possible by culling only 10% of two-tooth ewes and retaining sound ewes until six years old.

(iv) Wethers are gradually phased out after the seventh year by selling more wether progeny as lambs.

(v) Stock increases are virtually completed in the eighth year, but in the subsequent four years an all-breeding-ewe policy is reinstated. At the same time, the culling policy is changed so that one third of the five year old ewes are cast-for-age and all ewes are culled as six year olds.

---

10. The casual labour requirement over the first four years is shown in Table 8.5.

(vi) The pre-development proportion of rams to ewes, of 3%, is allowed to fall to 2% before the ram flock is enlarged.

(vii) The cattle policy is straightforward; the breeding cow herd is increased from 104 to 130 in the first three years, thereafter remaining at that level. Over the whole development period the ratio of sheep to cattle expressed as EE rises from 1.7 to 4.2. This massive change towards specialisation in sheep is based on the assumption that in the foreseeable future, sheep are likely to remain more profitable than cattle. Given this assumption, the argument in favour of specialisation is straightforward. At low stocking rates some complementary relationship between cattle and sheep is likely to exist. That is, cattle are necessary to maintain pastures in a condition suitable for grazing by sheep. However, as the overall stocking rate increases, pastures can generally be maintained satisfactorily by fewer cattle, and the ratio of sheep to cattle may be increased without pasture deterioration. On the other hand, cattle and sheep are likely to compete for pasture if the ratio of sheep to cattle is not increased as the overall stocking rate rises. This is clearly undesirable. Unfortunately, the author was unable to obtain any experimental evidence that suggested when cattle became competitive with sheep on hill country. Consequently, the stocking policy used in the model programme is not more than a guess at the upper limit of the complementary range under increases in overall stocking rates. Of course, as pointed out in Section 5.23, cattle are less flexible than sheep during droughts. This is a further argument in favour of specialising in sheep as stocking rates increase in Wairoa County.

Some explanation of the derivation of Tables 8.1 and 8.2 is required. In Table 8.1 the important assumptions concerning stock losses, culling rates, and lambing and calving percentatages, are:

(i) Stock losses

The losses assumed for all years are:

Lambs from docking to sale	3%
Lambs/hoggets from docking to 2-th (ewes and wethers)	5%
2 th., 4 th., 6 th., and 4 yr. ewes	3%
5 yr. ewes	5%
Rams (average over all ages)	25%
Breeding cows	4%
Rising 1 yr. and 2 yr. heifers	5%
Steer calves from making to weaning	2%.

(ii) Culling rates

Variable rates were assumed. The assumptions for the pre-development situation were:

Ewe lambs docked	10%
2 th. ewes	30%
4th. and 6th. ewes	2%

5 yr. ewes[11]	60%
6 yr. ewes	100%
Breeding cows	17%
Rising 2 yr. heifers	40%

During development the culling rates are modified by not culling ewe lambs at all, reducing the minimum rate for 2 th. ewes to 10%, and reducing the culling rate for 5 yr. ewes to 20%.

(iii) Lambing and calving percentages

These are assumed to remain constant throughout at:

Lambing: 2 th. ewes 75%; M.A. ewes 87%, and

Calving: 80%

The following comments concern the wether lamb selling policy and the basis of the wool weights shown in Table 8.2.

It is assumed that whenever wether lambs are sold, 20% are sold woolly (that is fat-off-mothers, or in fat condition soon after weaning), and the remainder are shorn and sold in store condition.[12]

The assumptions for wool production are:

(i) Production per animal per year

The author could not locate any published evidence concerning the variation

11. Ewes commonly referred to as 4 year olds actually have their fourth lamb when they are five years old. If they are culled after producing these lambs, they are variously referred to as '4½ year ewes' or '5 year ewes'.

12. It is likely that more than 20% of wether lambs could be fattened in favourable seasons. The assumption is therefore conservative.

in wool production from breeding ewes of various ages under increasing stocking rates on hill country. The figures actually assumed are likely to be reasonable estimates of actual production.

Breeding ewes:

(a) Up to and including the eighth year of development;

2 th., 4 th., 6 th., and 4 yr. ewes,	10.5 lbs.
5 yr. ewes	10.0 lbs.

(b) Subsequent to the eighth year of development;

2 th., 4 th., 6 th., and 4 yr. ewes	10.0 lbs.
5 yr. ewes	9.0 lbs.
Hoggets	7.0 lbs.
Mature wethers (2 th., 4 th., 6 th.),	10.5 lbs.
Lambs	2.5 lbs.

(ii) Deaths between winter and shearing

Ewes	2%
Wethers	1%
Hoggets	1%
Lambs	2%

8.42 The land development programme

Any land development programme consists of a series of projects, each of which is concerned with establishing or renovating pasture on a specific block of land. The actual pasture development projects are often complemented by fencing and the construction of tracks and water supply systems. In organising a programme, attention must be paid to the order in which the projects are undertaken, and the number of projects to be undertaken in each year.

In the model development programme, the order in which projects are undertaken is generally determined by their cost per unit of extra feed produced over the three years following initial development.[13] Thus, existing pastures are improved first because extra production can be obtained from them at relatively low cost by topdressing and oversowing. Similarly, projects involving pasture establishment by burning and cutting manuka take priority over those which require cultivation techniques. In some instances this general approach is modified. For example, when the clearing of manuka from one paddock greatly improves access to another paddock which is clear, the clearing project would be given precedence.

As it happens, the less expensive projects also tend to be the ones giving most rapid returns. For example, heavily topdressing an existing pasture is likely to give a substantial increment to feed supplies in the first

---

13. It is clearly necessary to define some specific production period when 'cost per unit of extra feed produced' is considered, yet no particular period is an obvious choice. For example, an acre of burned and oversown land may produce less than an acre of cultivated land in the first year after sowing, although the two-year aggregate production from each may be similar. In spite of this, it is reasonable to assume that pastures developed by any technique should reach similar levels of annual production by the end of the third year. On this assumption, the rule adopted above will correctly rank land development projects.

year, whereas some delay should be expected in obtaining substantial extra feed from an area of scrub that is being cut.

Hence the selection of projects which maximise extra feed per £ invested in development also results in a rapid accrual of revenue from the initial development expenditure. This feature is particularly desirable when the rate of increase in production is dependent, at least in part, on the amount of extra revenue available for re-investment in the programme.

The number of projects that are current at any point in time should depend upon the requirement for extra feed in the subsequent time periods. That is, it is essential to reconcile the extra feed produced with the extra stock available. In the model programme, the purchasing restriction implies that the rate at which extra stock can be bred is the major factor limiting the rate of land development.[14]

In Section 8.421 the land development techniques favoured by the author are discussed, and in Section 8.422 the land development programme is summarised and reconciled with the stocking policy.

8.421 Land development techniques

The techniques observed in the farm survey are discussed in Chapter 5. In the following subsections, some alternative techniques are considered, and the author's assessment of the alternatives is given.

8.4211 Fencing techniques

The 'steel' fence described in Section 5.61 is substantially cheaper than

14. In other circumstances the managerial ability of the farmer, or the availability of, say, scrubcutters, might limit the rate of land development.

the 'conventional' type. Moreover, it would seem to be practical and durable. On the premise that most farmers in Wairoa County could be easily persuaded to adopt the 'steel' fence, it is used in the model programme.

However, it is likely that at least two other fences could successfully be used for subdivision. These are the Ruakura electric fence, also described in Section 5.61, and the 'Soilcon' fence developed by Pearse and Humphries [49]. The electric fence is not used in the programme because it is not considered foolproof enough to be effective in the hands of all farmers in the County, and the 'Soilcon' fence, while showing great promise, is not yet sufficiently tested to warrant its unreserved recommendation.

8.4212 Pasture improvement

Separate techniques are specified for improvement of existing pasture. The 110 acres of regularly topdressed land merely receives an increased annual application of superphosphate, 3 cwt. per acre being applied as a maintenance dressing. A programme of oversowing with clovers and topdressing is applied to the remaining 615 acres of existing pasture. Superphosphate is applied in the autumn at 4 cwt. per acre with 4 lbs. of white clover and 2 lbs. of subterranean clover.[15] A further topdressing of 4 cwt. per acre is applied in the following spring, and thereafter a maintenance dressing of 2 cwt. per acre is applied each autumn.

---

15. This oversowing mixture has been suggested by Suckling [28].

8.4213 Pasture establishment

Separate techniques are favoured for the establishment of pasture from manuka, manuka in association with blackberry, and blackberry alone.

The cutting and burning technique for development from manuka is preferred to methods involving cultivation. The cutting and burning technique has been demonstrated very successfully outside the County, notably by Tripe [30], and it is considerably less expensive than cultivation.[16] In the model programme, all 'solid' manuka is cut and burned. The technique entails autumn sowing with simultaneous application of superphosphate at 4 cwt. per acre, followed by a further 4 cwt. in the following spring and 3 cwt. in the second autumn, providing a total application of 11 cwt. of superphosphate per acre in the first year. Following this, topdressing reverts to an autumn maintenance application of 2 cwt. per acre.

There is no alternative to cultivation for the development of manuka associated with blackberry and the method described in Section 5.632 is likely to be as successful as most others. In the model programme, however, topdressing has been modified to provide for application of 11 cwt. per acre in the first year - using a plan identical to that described in the last paragraph.

The method described in Section 5.633 for development from blackberry is used in the model programme.

8.4214 Installation of water supplies

Adequate clean water in every paddock is essential. Under high stocking

---

16. The two techniques are discussed and budgetted in Section 5.631.

rates the natural sources of water, which are often quite satisfactory when stocking rates are low, easily become fouled. Furthermore, intensive subdivision often isolates some paddocks from natural sources of water.

A relatively inexpensive way of obtaining clean water is by constructing in each paddock a fenced, tree-sheltered dam that supplies water by gravity to concrete troughs. In the programme seventeen such dams are constructed, at an estimated cost of £75 each.

8.422 A summary of the land development programme

This summary is based on Tables 8.3 and 8.4. These tables are largely self-explanatory and only brief interpretive comments are made here.

Table 8.3 contains a schedule of land development operations. The schedule indicates only the times at which the different projects are initiated. Oversowing and topdressing, together with the 'cleaning-up' of scattered manuka in the oversown paddocks, is undertaken in the early years. Questions of accessibility and convenience of subdivision largely determine the order in which the remaining pasture establishment projects are begun.

Table 8.4 has three sections. The topdressing section is self-explanatory and the land use section outlines the year-to-year changes in the pattern of land use on the farm. In this section, 'high producing pasture' is defined as that which annually receives at least 2 cwt. of superphosphate per acre.

In the feed reconciliation section, the estimation of extra feed available in terms of ewe equivalents requires some explanation. Quite simply, one EE of extra feed is sufficient to winter one breeding ewe. Thus, oversowing and topdressing one acre of low producing pasture is assumed to provide 1 EE of

Table 8.3 Model Development Programme - Iniation of Land Development

Development Operation	Units	Development Period								
		1	2	3	4	5	6	7	8	9
Topdressing rate increased (from 2 cwt. to 3 cwt. per acre)	acres	110	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Oversowing and topdressing	acres	205	305	Nil	55	50	Nil	Nil	Nil	Nil
Development from manuka (scrubcutting)	acres	10	5	Nil	35	15	Nil	15	15	Nil
Development from manuka/ blackberry (cultivation)	acres	Nil	Nil	35	Nil	100	60	Nil	Nil	Nil
Development from blackberry:										
First spraying	acres	Nil	25	Nil	Nil	5	Nil	5	5	Nil
Second spraying	acres	Nil	Nil	25	Nil	Nil	5	Nil	5	5
New fence erected	chains	61	153	19	42	80	22	Nil	Nil	Nil
New tracking constructed	chains	35	40	30	20	Nil	Nil	Nil	Nil	Nil
New dams constructed		4	6	1	1	3	2	Nil	Nil	Nil

Table 8.4 Model Development Programme - Topdressing, Land Use, and Feed Reconciliation

	Units	Base Year	Development Period									Post-dev.
			1	2	3	4	5	6	7	8	9	
Topdressing (Superphosphate)												
Area receiving 2 cwt/yr maintenance	acres	110	Nil	215	450	550	630	660	830	890	910	945
Area receiving 1 cwt/yr Av. maintenance	acres	260	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Area receiving 3 cwt/yr maintenance	acres	Nil	110	110	110	110	110	110	110	110	110	110
Total Fertiliser Applied	tons	37	103	172	93	113	156	133	118	118	112	111
Land Use												
Permanent waste	acres	45	45	45	45	45	45	45	45	45	45	45
Unproductive - capable of development	acres	330	320	290	255	220	100	40	20	Nil	Nil	Nil
Low producing pasture	acres	615	410	105	105	50	Nil	Nil	Nil	Nil	Nil	Nil
Pasture improved by oversowing	acres	Nil	205	510	510	565	615	615	615	615	615	615
Pasture developed from manuka	acres	Nil	10	15	15	50	65	65	80	95	95	95
Pasture developed from manuka/blackberry	acres	Nil	Nil	Nil	35	35	135	195	195	195	195	195
Pasture developed from blackberry	acres	Nil	Nil	25	25	25	30	30	35	40	40	40
Total High Producing Pasture	acres	110	325	660	695	785	955	1,015	1,035	1,055	1,055	1,055
Feed Reconciliation												
Annual feed increment	EE	Nil	300	547	460	395	616	382	247	245	50	Nil
Annual stock increment	EE	Nil	282	556	425	384	598	366	241	240	44	Nil
Surplus feed available	EE	Nil	18	-9	35	11	18	16	6	5	6	Nil

extra feed in the first year, a further 1½ EE in the second year, and a further ½ EE in the third year. An acre of pasture established after burning manuka is assumed to provide 2 EE of feed in the first winter, and further increments of 2 EE and 1 EE in the succeeding two years. Rather more rapid pasture establishment is expected from cultivation. This is reflected in the assumption of 3 EE of extra feed per acre in the first winter, a further 1½ EE per acre in the second year, and a further ½ EE per acre in the third year.

In all years except the second, the reconciliation shows a small amount of surplus feed. Given 'normal' conditions for pasture growth and no serious difficulties with pasture establishment, stock condition should not deteriorate, although adverse climatic conditions, or slower than expected pasture establishment may necessitate a reduction in the plane of nutrition of some classes of stock.[17]

8.43 Other resources for development

Table 8.5 summarises the requirement of the model programme for additional labour, plant, and machinery. Labour requirements, which have been discussed previously, are evident from the table, as are the requirements for a house for the hired permanent labour. The additions to the shearing shed would provide two more stands and cover for 800 more ewes.

The scheduled purchase of a motor cycle for each permanent labour unit requires comment. The author is convinced that the use of motor cycles would be feasible on most hill country farms in Wairoa County and the experience of

17. These comments ignore the fact that the farm tended to be understocked in its pre-development condition. Thus a 'hidden reserve' can be expected to exist throughout development. With the improved pasture utilisation resulting from higher stocking rates this pasture reserve is likely to be converted into improved stock condition.

Table 8.5 Model Development Programme - Miscellaneous Resources

	Base Year	Development Period									Post-dev.
		1	2	3	4	5	6	7	8	9	
Labour											
Permanent	Nil	Nil	Nil	Nil	Nil	£1,000	£1,100	£1,100	£1,100	£1,100	£1,100
Casual	£400	£400	£430	£460	£500	Nil	Nil	Nil	Nil	£30	£60
New Buildings	Nil	Nil	Nil	Nil	Additions to Shearing shed (£1,000)	Shepherd's house (£3,000)	Nil	Nil	Nil	Nil	Nil
New Plant and Machinery (Costs are expressed net of salvage value of traded-in machinery)	Sundry (£20)	Sundry (£20)	Sundry (£20) Motor cycle (£250)	Sundry (£20	Sundry (£20) Shearing plant (£100)	Sundry (£20)	Sundry (£20) Second motor cycle (£250)	Sundry (£20)	Sundry (£20) crawler tractor (£780)	Sundry (£20)	Sundry (£20)
New Drafting Yards	Nil	Nil	One set (£300)	One set (£300)	Nil	One set (£300)	Nil	Nil	Nil	Nil	Nil

farmers outside the County suggests that mechanised transportation results in a considerable increase in the productivity of labour. The replacement of a light crawler tractor is scheduled in the eighth year.

During development, three sets of drafting yards are built at strategic locations, where access to several paddocks is available. This innovation, which is becoming widespread outside the County, results in a considerable reduction in time spent on seasonal operations (such as drenching) as well as permitting easy control of grazing pressure in different paddocks.

8.5 Financial Analysis of the Model Development Programme

With the exception of different assumptions concerning prices, the technique used to evaluate the model development programme was similar to the procedure that was used in analysing the case development programmes.[18]

A notable shortcoming of this latter procedure was that it provided information which was valid only for the assumed set of prices.[19] Although this type of information is useful if the set of fixed prices are 'well selected', the procedure is clearly unable to either,

(i) directly estimate the financial implications of a development programme under any other set of prices, or

(ii) estimate the sensitivity of the financial outcome of development to changes in ruling prices.

---

18. The case development programmes are described and analysed in Chapter 7.
19. See Section 7.21.

In the analysis of the model development programme, an attempt was made to rectify this deficiency by relaxing the assumptions for fixed prices. The financial outcome of the model programme was examined over a specified range of prices. The assumptions concerning prices are described in detail in the next section.

It is obvious that a combinatorial approach could have been used in this analysis. That is, a separate analysis could have been completed for as many combinations of price levels as were wished. Such an approach would be extremely tedious and expensive, since if, for instance, all combinations of four prices, each set at three levels, were to be examined, a total of 81 separate programme evaluations would be required. A more efficient technique, used in this study for the first time, involves the derivation of a budgetary response surface. The rationale of this technique, which to the author's knowledge has not previously been used, is discussed in Appendix J, while the use of the technique in analysing the model development programme is fully described in Section 8.52.

8.51 The price assumptions

The computational burden involved in deriving a budgetary response function increases exponentially as the number of price variable resources and products increases, so that in practice it is unlikely to be desirable to consider the effect of varying all prices. Consequently, it is necessary to select a group of resources and products for analysis under variable prices, while other resources and products are assigned fixed prices. This selection should obviously be made so that as much information as possible is obtained for a given research effort.[20] That is, each resource or product selected for price variable analysis should be one that,

(i) accounts for a substantial proportion of expenditure or revenue, <u>and</u>

(ii) has a relatively uncertain future price level.

In the model development programme, wool sales and stock sales together contribute virtually the whole of each year's cash revenue. Moreover, the future price levels of both are subject to considerable uncertainty. For these reasons, information concerning the sensitivity of the financial outcome of development to changes in the assumed levels of wool and stock prices was thought to be important.[21]

Fertiliser is a major resource in the model programmes and changes in fertiliser prices were expected *a priori* to significantly influence the profitability of development. The analysis included fertiliser as a price-variable resource because,

(i) future fertiliser price levels were uncertain, and

(ii) the model development programme was considered suitable for adoption (with minor modifications) anywhere in Wairoa County. However, differing transportation charges to various districts

---

20. Strictly speaking, this criterion for the selection of variables is not sufficient. A research project should be expanded only while the marginal worth of additional research effort exceeds (or is equal to) the marginal cost of this effort. It is clearly unprofitable to apply more research effort when its marginal cost exceeds its marginal revenue, in spite of 'as much information as possible' being obtained.

21. There was no reason to expect the financial outcome to necessarily change at the same rate for changes in both wool prices and stock prices. Consequently, it was not possible to express these prices as a single variable.

in the County result in a variation in applied costs of at least £4 per ton.[22] Consequently, an analysis that considered a range of fertiliser prices was required to estimate the profitability of development in different parts of the County.

All prices except those for stock sold, wool, and fertiliser, were fixed at the levels defined in Section 7.21. The price ranges considered for stock, wool, and fertiliser were:

(i) Stock prices:[23] The model prices shown in Table 4.9[24] were taken as a 'benchmark', the price range considered being from 50% to 150% of benchmark prices. For example, the modal price for fat lambs was 40/-, and the range was from 20/- to 60/-, while the modal price for store breeding cows was £25, and the range was from £12/10/- to £37/10/-.

(ii) Wool prices: The range considered was from 27d. per lb. (net) to 51d. per lb.(net).

(iii) Fertiliser prices: Applied prices in the range of £13 per ton to £21 per ton were considered.

It was apparent from the analysis of the case development programmes that the level of minimum acceptable Owner's Drawings could have an appreciable effect on the financial outcome of a particular programme. The size of the maximum overdraft and the length of the repayment period have been shown

---

22 In the survey, applied costs were found to range from £14 to £18 per ton. (The prices were those ruling in 1965).

23. In the model development programme the only stock purchased are rams and bulls. Variation in the cost of these animals was not considered in the analysis.

24. See page 68.

to be particularly sensitive to the level of Owner's Drawings.

Since it was felt that many farmers in Wairoa County would, in fact, reduce personal drawings while developing their farms, it was considered relevant to examine the financial outcome of the model programme of setting Minimum Owner's Drawings at various levels. In the analysis, Minimum Owner's Drawings in the range £800 to £2,000 were considered.

8.52 Derivation of the budgetary response surface

The concept of 'fitting' a surface to a number of derived observations (each obtained by analysing the physical development programme for a particular set of costs and prices), and the relevance of some principles of experimental design in determining the price assumptions to be used for each observation, are explained in Appendix J.

Analysis of the model programme involved four variables; Stock Price, Wool Price, Fertiliser Price, and Minimum Owner's Drawings. The immediate objective was to obtain functions expressing each of Present Value of Pre-tax Development Cash Profits, Present Value of Post-tax Development Cash Profits, and Maximum Overdraft, in terms of the four variables. It was decided *a priori* to fit polynomial functions of the form,

$$R = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2 + b_{44}x_4^2$$

$$+ b_{12}x_1x_2 + b_{13}x_1x_3 + b_{14}x_1x_4 + b_{23}x_2x_3 + b_{24}x_2x_4 + b_{34}x_3x_4 \qquad (8.1)$$

where R is the appropriate dependent variable,

x_1 is the Stock Price,

x_2 is the Wool Price,

x_3 is the Fertiliser Price, and

x_4 is the level of Minimum Owner's Drawings.

A Central Composite[25] design was used to define the combination of levels of the independent variables for each observation. The appropriate second-order design for four independent variables is shown in coded form in Table 8.6.[26]

When the price ranges stated in Section 8.51 were applied to this design, the levels of the independent variables in each of the requisite twenty-five observations were obtained. These levels are also shown in Table 8.6.

The model development programme was then analysed under each of the twenty-five combinations of levels of the independent variables by using the procedure described in Chapter 6. The results of these computations appear in Table 8.7.

While the information contained in Table 8.7 is useful per se, it also provided the observations or 'experimental points' that were necessary for the derivation of the budgetary response surfaces.

---

25. Detailed descriptions of this design may be found in Heady and Dillon [42] and Cochran and Cox [43]. A less rigorous exposition appears in Dillon [7].

26. The design was obtained from Cochran and Cox [43, p.370]. The 'star' points or 'B values' (see equation (4) in Appendix J) in this design were set at the coded level of $\pm$ 2. Since it was not known a priori that any other level would give a more acceptable estimate of the response surface, the original level was retained.

Table 8.6 Design of Observations for the Budgetary Response Surface

Observation Number	Coded Design				Actual Variable Levels			
	Stock Price x_1	Wool Price x_2	Fert. Price x_3	Min. Owner's Drawings x_4	Stock Price (% of benchmark)	Wool Price (pence per lb.)	Fert. Price (£ per ton)	Min. Owner's Drawings (£)
1	-1	-1	-1	-1	75	33	15	1,100
2	1	-1	-1	-1	125	33	15	1,100
3	-1	1	-1	-1	75	45	15	1,100
4	1	1	-1	-1	125	45	15	1,100
5	-1	-1	1	-1	75	33	19	1,100
6	1	-1	1	-1	125	33	19	1,100
7	-1	1	1	-1	75	45	19	1,100
8	1	1	1	-1	125	45	19	1,100
9	-1	-1	-1	1	75	33	15	1,700
10	1	-1	-1	1	125	33	15	1,700
11	-1	1	-1	1	75	45	15	1,700
12	1	1	-1	1	125	45	15	1,700
13	-1	-1	1	1	75	33	19	1,700
14	1	-1	1	1	125	33	19	1,700
15	-1	1	1	1	75	45	19	1,700
16	1	1	1	1	125	45	19	1,700
17	-2	0	0	0	50	39	17	1,400
18	2	0	0	0	150	39	17	1,400
19	0	-2	0	0	100	27	17	1,400
20	0	2	0	0	100	51	17	1,400
21	0	0	-2	0	100	39	13	1,400
22	0	0	2	0	100	39	21	1,400
23	0	0	0	-2	100	39	17	800
24	0	0	0	2	100	39	17	2,000
25	0	0	0	0	100	39	17	1,400

Table 8.7 Evaluations of the Model Development Programme at Various Price Levels

Obs. Number	Present value of Development Cash Profits		Return on Investment (%)	Maximum Overdraft (£)	Repayment Period (years)	Increase in Owner's Drawings (£)
	Pre-tax (£)	Post-tax (£)				
1	13,617	684	4.7	27,518	13	2,298
2	40,319	8,931	17.4	19,680	6	2,436
3	41,749	13,401	18.8	18,914	6	2,503
4	65,166	16,586	38.0	13,778	5	2,778
5	4,045	-5,301	1.2	32,893	19	2,290
6	33,637	5,490	12.4	23,059	7	2,388
7	34,948	10,132	13.4	22,141	7	2,467
8	58,510	14,155	27.4	17,170	6	2,717
9	7,011	-4,172	2.0	33,631	25	2,298
10	38,548	8,107	13.8	23,803	8	2,436
11	40,061	12,449	14.8	22,970	8	2,503
12	64,054	16,326	30.2	17,025	8	2,778
13	-4,547	-10,467	-1.2	38,852	37	2,290
14	31,461	2,040	9.9	27,132	10	2,388
15	32,776	8,840	10.6	26,203	10	2,467
16	57,303	13,986	23.8	20,484	5	2,717
17	5,741	-1,635	1.7	32,465	23	2,399
18	60,450	13,775	27.8	17,442	5	2,754
19	5,698	-6,495	1.6	34,286	18	2,214
20	61,677	16,378	28.3	17,484	5	2,751
21	43,318	11,819	18.7	19,691	6	2,487
22	29,856	5,378	9.7	26,310	9	2,400
23	38,371	9,713	7.4	18,761	5	2,441
24	34,190	7,083	10.7	27,204	11	2,441
25	36,710	8,913	13.6	22,965	7	2,441

Table 8.8 Model Development Programme - Budgetary Response Functions

Regression Coefficient	Present Value of Pre-tax Development Cash Profits	Present Value of Post-tax Development Cash Profits	Maximum Overdraft
b_0	154,280.29000	76,243.16700	-35,702.35000
b_1	292.84060	327.23935	-227.36661
b_2	3,107.10900	883.97287	-880.03005
b_3	-20,178.39000	-10,567.80200	8124.19000
b_4	~~-11~~-118.73740	-45.77737	42.06840
b_{11}	4.77284	.43631	-.36150
b_{22}	-.61516	-.26265	.18215
b_{33}	568.58099	226.17605	-178.57379
b_{44}	.02448	.00951	-.00799
b_{12}	-21.13575	-11.65964	7.32207
b_{13}	-20.74922	6.08840	-4.36824
b_{14}	.31179	.06299	-.04526
b_{23}	40.83174	45.16394	-17.38524
b_{24}	.52686	.39259	-.19627
b_{34}	.37018	-.32665	-.01724
R^2	.967	.994	.997

The polynomial functions were obtained by least-squares curvilinear regression.[27] The regression coefficients are listed in Table 8.8, in which the coefficient symbols correspond with equation (8.1).

8.53 Acceptance of the budgetary response functions

The 'goodness of fit' of each regression function may be measured in a general sense by computation of R^2, the coefficient of multiple correlation.[28] Referring to Table 8.8, it will be noted that for the Maximum Overdraft Function, R^2 = .997. This states that 99.7% of the total sum of squares of observations of Maximum Overdraft, is attributable to the regression function. When R^2 = 1.000, the regression function fits the observed points perfectly, and in this sense it may be concluded that each of the derived functions is a 'good fit'. However, this does not imply that the fitted functions predict their dependent variables with sufficient reliability to be acceptable.

In most physical experiments, the experimental points are subject to stochastic error terms and in order to examine the characteristics of the regressions it is customary to compute significance levels for the regression coefficients, and confidence levels on the dependent variable and on independent observations.[29] By contrast, the observations for a budgetary response function are known with certainty, so that signifiance criteria based upon stochastic observations are irrelevant.

---

27. The regression computations were run on an IBM 1620 computer using IBM Library Program 06.0.003 SCRAP.

28. See Snedicor [44, p.420]

29. See Snedicor [44, p.442]

Thus, the derived regression coefficients can be interpreted only as the 'best attainable for the specified model' and the research worker must determine subjectively whether the regression provides a good enough fit. This decision may be facilitated by comparing the original observations with corresponding estimates obtained from the function.

Table 8.9 contains the results of testing the budgetary response functions in this way. Of the three columns for each dependent variable, the first repeats the budgetted outcomes shown in Table 8.7, the second column contains corresponding outcomes estimated by the derived response function, and the difference between elements in the first and second columns appears in the third column.

Inspection of the table reveals that the differences between true and estimated Present Values of Pre-tax Development Cash Profits are frequently large, and that serious distortions occur when the true outcome is low. This point is particularly obvious in Observations 5, 9, 13, 17 and 19. The author would conclude that the fitted polynomial does not satisfactorily approximate intermediate budgetary outcomes.[30]

On the other hand, the functions for both Present Value of Post-tax Development Cash Profits and Maximum Overdraft, predict outcomes with considerably more reliability, and the author would feel fairly safe in using the predicted outcomes to approximate the results which would be obtained by a full evaluation of the model programme.

30. It must be stressed that this result does not detract from the usefulness of the technique. A third-order polynomial could have been fitted in an effort to obtain better predictions and still higher-order polynomials could subsequently have been tried. To fit a third-order polynomial, it would have been necessary to compute approximately 25 further evaluations. This did not seem justified. Alternatively, the second-order polynomial could have been fitted with the independent variables altered over smaller ranges. This could have increased the accuracy of fit.

Table 8.9 Comparison of Budgetted Responses with Responses Estimated by the Derived Functions

Present Value of Pre-tax Development Cash Profits (£)			Present Value of Post-tax Development Cash Profits (£)			Maximum Overdraft (£)		
Budget-ted	Estim-ated	Differ-ence	Budget-ted	Estim-ated	Differ-ence	Budget-ted	Estim-ated	Differ-ence
13,617	12,514	-1,103	684	58	-626	27,518	28,109	+591
40,319	41,596	+1,277	8,931	9,575	+644	19,680	19,442	-238
41,749	44,505	+2,756	13,401	13,238	-163	18,914	18,589	-325
65,166	60,906	-4,260	16,586	15,759	-827	13,778	14,315	+537
4,045	6,663	+2,618	-5,301	-5,102	+199	32,893	32,638	-255
33,637	31,596	-2,041	5,490	5,633	+143	23,059	23,098	+ 37
34,948	40,615	+5,667	10,132	10,245	+113	22,141	22,284	+143
58,510	52,228	-6,282	14,155	13,985	-170	17,170	17,136	- 34
7,011	3,524	-3,487	-4,172	-3,760	+412	33,631	33,834	+203
38,548	41,960	+3,412	8,107	7,647	-460	23,803	23,809	+ 6
40,061	39,309	-752	12,449	12,246	-203	22,970	22,901	- 69
64,054	65,063	+1,009	16,326	16,657	+331	17,025	17,269	+244
-4,547	-3,215	+1,332	-10,467	-9,704	+763	38,852	38,322	-530
31,461	31,071	-390	2,040	2,920	+880	27,132	27,423	+291
32,776	34,529	+1,753	8,840	8,470	-370	26,203	26,554	+351
57,303	56,135	-1,168	13,986	14,099	+113	20,484	20,049	-435
5,741	14,127	+8,386	-1,635	-1,508	+127	32,465	32,447	- 18
60,450	64,815	+4,365	13,775	13,638	-137	17,442	17,274	-168
5,698	-1,077	-6,775	-6,495	-7,243	-748	34,286	34,238	- 48
61,677	55,978	-5,699	16,378	17,115	+737	17,484	17,343	-141
43,318	44,026	+708	11,819	12,452	+633	19,691	19,252	-439
29,856	29,247	-609	5,378	4,733	-645	26,310	26,562	+252
38,371	39,212	+841	9,713	10,250	+537	18,761	18,566	-195
34,190	33,490	-700	7,083	6,546	-537	27,204	27,204	0
36,710	35,852	-858	8,913	8,165	-748	22,965	23,203	+238

8.54 Interpretation of the budgetary response surface

An initial, slightly ironic, observation is that the derivation of acceptable budgetary response surfaces presents the analyst with an almost embarrassing amount of information.

More specifically, the response functions allow computation of,

(i) budgetary response at any point on the response surface,

(ii) estimation of the slope of the surface at any point, thus allowing measurement of the sensitivity of the response to marginal changes in the independent variables, and

(iii) location of break-even points; that is, combinations of independent variable levels that result in zero response.

The following sections are primarily intended to illustrate the computations suggested above. The examples discussed are not, of course, exhaustive, but they provide some useful information about the financial implications of the model development programme.

8.541 Point responses

Consider the question - 'What would be the estimated Present Value of Post-tax Development Cash Profits and Maximum Overdraft from the model development programme if future prices are assumed to include stock prices at 120% of benchmark prices, wool priced at 38.5d net, fertiliser costing £14/12/- per ton applied, and Minimum Owner's Drawings are assumed to be £1,040?'

The required information can be derived directly from the appropriate functions in Table 8.8. That is, Present Value of Post-tax Development Cash Profits

$= 76{,}243.16700 + (120)(327.23935) + (38.5)(883.97287)$

$- (14.6)(10{,}567.80200) - (1{,}050)(45.77737) + (120)^2(.43631)$

$- (38.5)^2(.26265) + (14.6)^2(226.17605) + (1{,}050)^2(.00951)$

$- (120)(38.5)(11.65964) + (120)(14.6)(6.08840) + (120)(1{,}050)(.06299)$

$+ (38.5)(14.6)(45.16394) + (38.5)(1{,}050)(.39259) - (14.6)(1{,}050)(.32665)$

$= £12{,}729.$

and,

Maximum Overdraft

$= -35{,}702.35000 - (120(227.36661) - (38.5)(880.03005)$

$+ (14.6)(8{,}124{,}19000) + (1{,}050)(42.06840) - (120)^2(.36150)$

$+ (38.5)^2(.18215) - (14.6)^2(178.57379) - (1{,}050)^2(.00800)$

$+ (120)(38.5)(7.32207) - (120)(14.6)(4.36824) - (120)(1{,}050)(.04526)$

$- (38.5)(14.6)(17.38524) - (38.5)(1{,}050)(.19627) - (14.6)(1{,}050)(.01724)$

$= £16{,}668.$

Thus the derived functions may be used directly to estimate budgetary outcomes, but it is important to note that reliable estimates can be assured only if all variables are specified at levels within the ranges assumed in Section 8.51. The fitted functions are unlikely to be reliable for variable levels outside these ranges.

If two of the variables are set at constant levels it is a simple matter to plot the calculated point responses, obtained as the other two variables are varied, on a two-dimensional graph. Estimates of budgetary response anywhere on the graph can then be easily obtained by interpolation between the plotted points. It is clear that enough information is available to construct an infinite number of graphs, but only four are presented here. The graphs appearing in Figure 8.1 should, however, illustrate the ease with which budgetary response surfaces may be interpreted. In the figure, the point responses are clearly indicated, and the curved lines are iso-response curves. That is, the budgetary response is constant along any particular curve. The actual iso-response curves shown were arbitrarily selected; iso-response curves may be drawn for any response that falls between the two extreme calculated point responses.

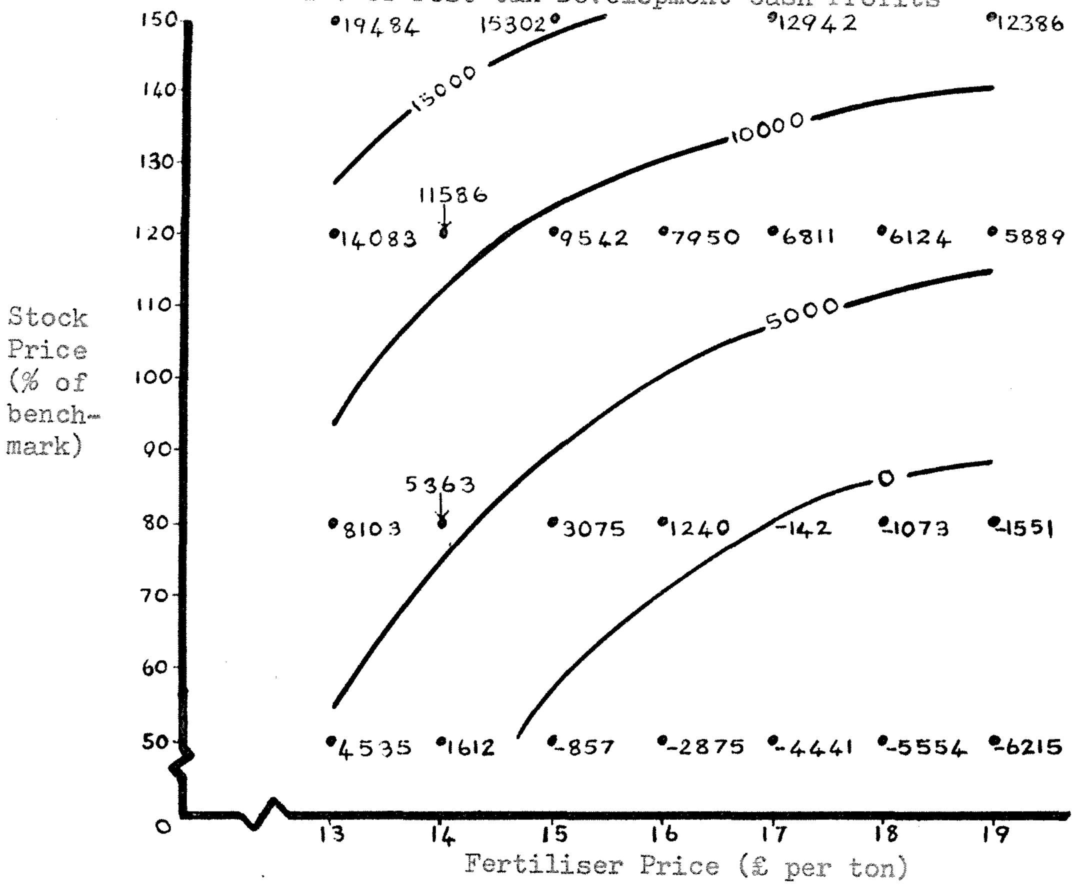
Graphs (a), (b), and (c) in Figure 8.1 show the effect on the estimated Present Value of Post-tax Development Profits of varying Stock Price and Fertiliser Price, Stock Price and Wool Price, and Fertiliser Price and Minimum Owner's Drawings, respectively. The constant levels of the other variables are clearly indicated in each graph. Graph (d) on the other hand, shows the effect on Minimum Owner's Drawings (treated as the dependent variable) of varying Wool Price and Fertiliser Price. Stock Price and the Present Value of Post-tax Development Cash Profits (treated as an independent variable), are held constant at the indicated levels.

8.542 The sensitivity of budgetary responses

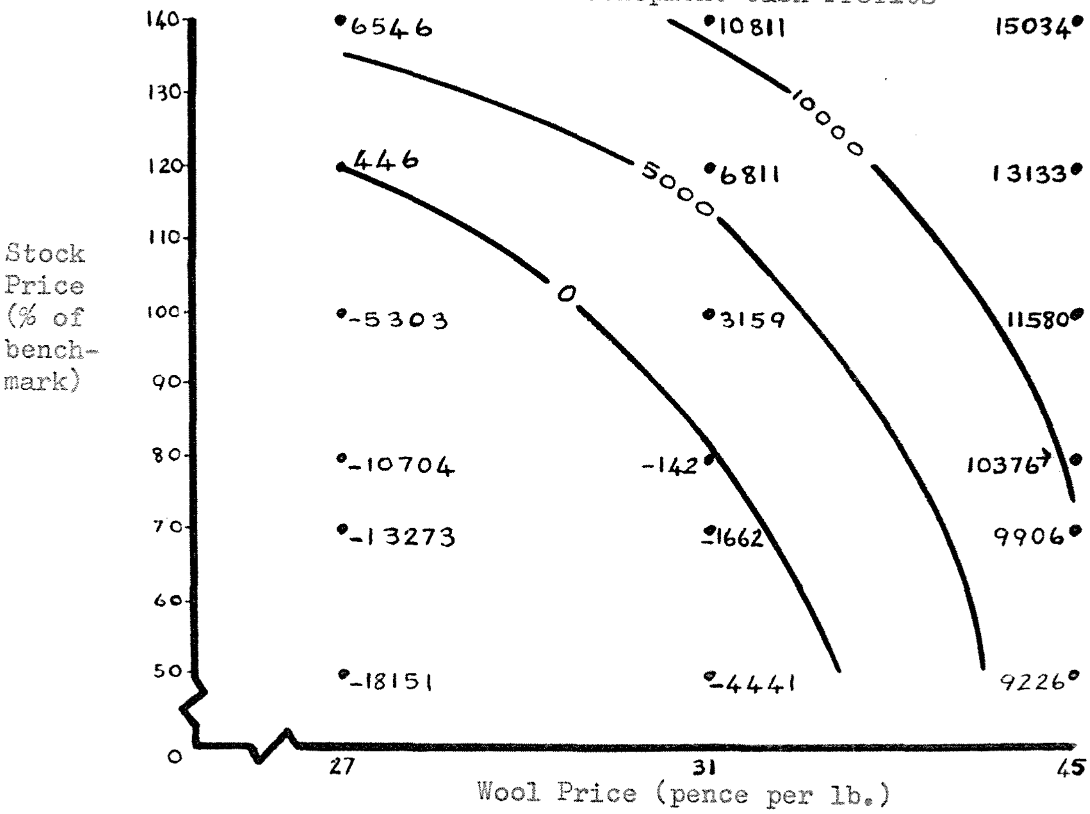
The slope of a response surface at any point clearly denotes the sensitivity of the dependent variable to marginal changes in the independent variables.

Figure 8.1 Budgetary Iso-response Curves

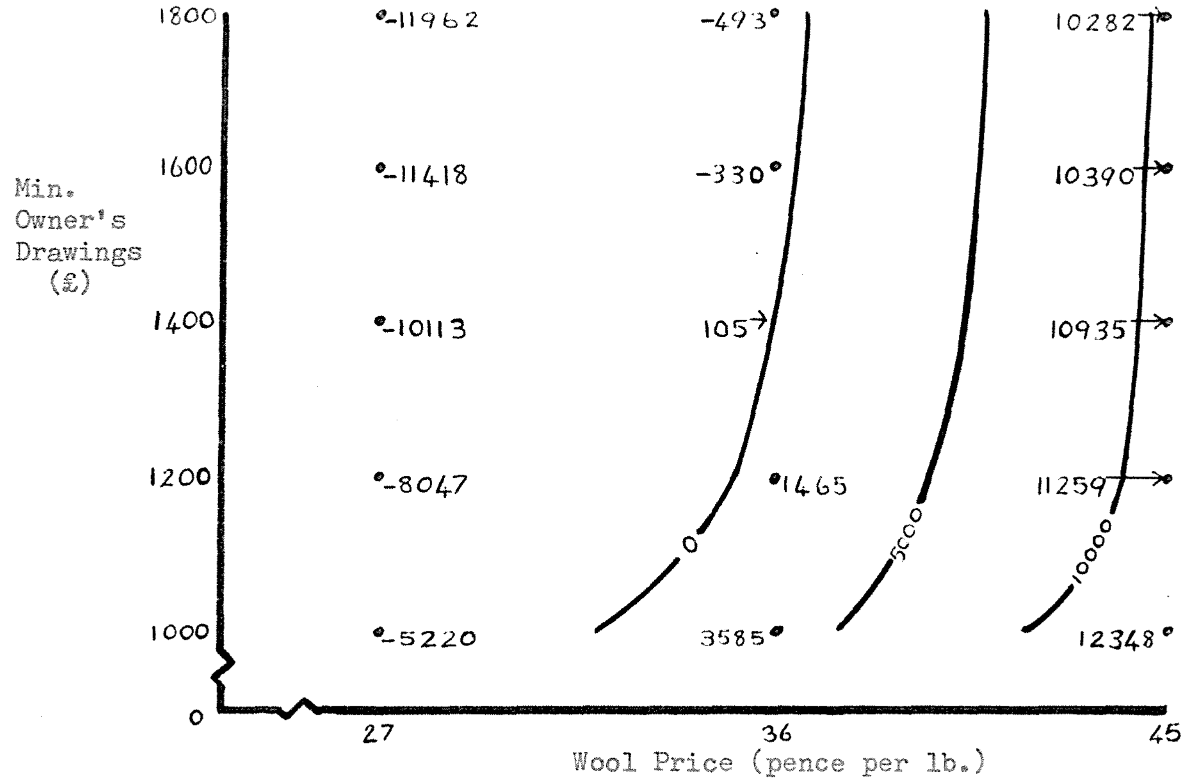
(a) Iso-Present Value of Post-tax Development Cash Profits



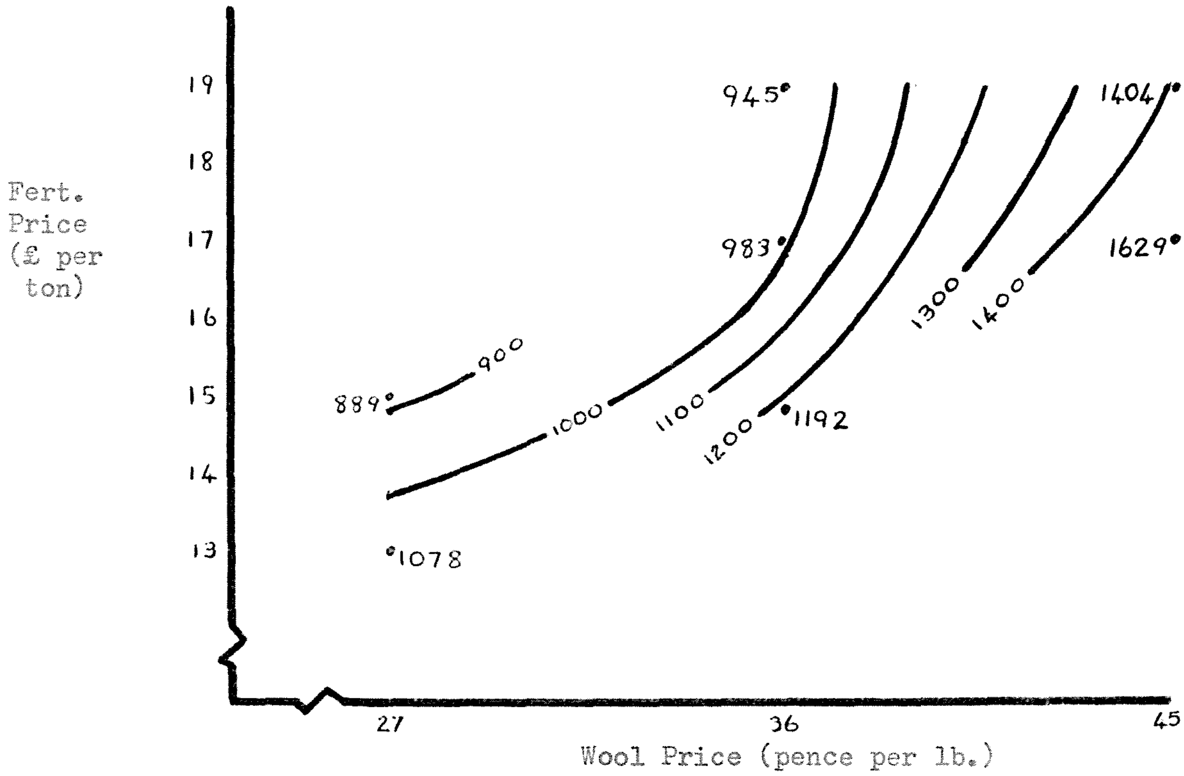
(b) Iso-Present Value of Post-tax Development Cash Profits



(c) Iso-Present Value of Post-tax Development Cash Profits



(d) Iso-Minimum Owner's Drawings



Since the response surfaces derived in this analysis are continuous, they are differentiable. Thus, in the notation of equation (8.1) the first derivative of R with respect to a particular variable x_i, provides the marginal change in R for unit change in x_i, with all other independent variables held constant. That is, the sensitivity of the budgetary reponse to changes in x_1, x_2, x_3 and x_4, respectively (with other variables held constant) are:

$$\frac{\partial R}{\partial x_1} = b_1 + 2b_{11}x_1 + b_{12}x_2 + b_{13}x_3 + b_{14}x_4 \qquad (8.2)$$

$$\frac{\partial R}{\partial x_2} = b_2 + 2b_{22}x_2 + b_{12}x_1 + b_{23}x_3 + b_{24}x_4 \qquad (8.3)$$

$$\frac{\partial R}{\partial x_3} = b_3 + 2b_{33}x_3 + b_{13}x_1 + b_{23}x_2 + b_{34}x_4 \qquad (8.4)$$

$$\frac{\partial R}{\partial x_4} = b_4 + 2b_{44}x_4 + b_{14}x_1 + b_{24}x_2 + b_{34}x_3 \qquad (8.5)$$

In the present analysis, the sensitivity of only the Presant Value of Post-tax Development Cash Profits[31], was examined. Even here, an infinite amount of information was available, but in practice, the exploration was restricted to those regions of the surface that were expected to yield important information. The first series of computations[32] investigated the sensitivity of P.V. to changes in Stock Price, Wool Price, Fertiliser Price and Minimum Owner's Drawings, at different points on the response surface.

Table 8.10 tabulates the sensitivity of P.V. to changes in Stock Price at

31. In subsequent discussion this is abbreviated to 'P.V.'.

32. Computations were carried out on an IBM 1620 computer using a programme written by the author.

Table 8.10 Sensitivity of Present Value of Post-tax Development Cash Profits (P.V.) to Changes in Stock Price

Stock Price x_1 (% of benchmark)	Wool Price x_2 (pence per lb.)	Fert. Price x_3 (£ per ton)	Min. Owner's Drawings x_4 (£)	$\frac{\partial P.V.}{\partial x_1}$	P.V. (£)
50	33	13	800	115.64	6,470
75	33	13	800	137.46	9,633
100	33	13	800	159.27	13,342
50	39	13	800	45.68	13,569
75	39	13	800	67.50	14,984
100	39	13	800	89.31	16,944
50	39	16	800	63.95	6,957
75	39	16	800	85.76	8,828
100	39	16	800	107.58	11,245
50	33	13	1,600	166.03	-2,402
75	33	13	1,600	187.85	2,021
100	33	13	1,600	209.66	6,990
50	39	16	1,600	114.34	-814
75	39	16	1,600	136.15	2,316
100	39	16	1,600	157.97	5,993

Note: $\frac{\partial P.V.}{\partial x_1}$ should be interpreted as 'the change in P.V. that would result from a 1% increase in Stock Price'.

Table 8.11 Sensitivity of Present Value of Post-tax Development Cash Profits (P.V.) to Changes in Wool Price

Stock Price x_1 (% of benchmark)	Wool Price x_2 (pence per lb.)	Fert. Price x_3 (£ per ton)	Min. Owner's Drawings x_4 (£)	$\frac{\partial P.V.}{\partial x_2}$	P.V. (£)
75	33	13	1,000	971.88	6,589
75	42	13	1,000	967.15	15,314
75	51	13	1,000	962.43	23,997
100	33	13	1,000	680.39	10,613
100	42	13	1,000	675.66	16,715
100	51	13	1,000	670.93	22,775
75	33	16	1,400	1,264.41	-4,773
75	42	16	1,400	1,259.68	6,584
75	51	16	1,400	1,254.95	17,900
150	33	16	1,400	389.93	12,193
150	42	16	1,400	385.21	15,682
150	51	16	1,400	380.48	19,127
100	33	13	1,800	994.46	7,304
100	42	13	1,800	989.73	16,233
100	51	13	1,800	985.00	25,119
150	33	19	1,800	682.46	10,421
150	42	19	1,800	677.73	16,542
150	51	19	1,800	673.00	22,620

Note: $\frac{\partial P.V.}{\partial x_2}$ Should be interpreted as 'the change in P.V. that would result from an increase in Wool Price of 1d. per lb.'

points on the response surface corresponding to 'low' stock prices and wool prices. It is clear that at all points examined, P.V. increases monotonically with increasing Stock Price.

The sensitivity of P.V. to changes in Wool Price at points scattered widely over the response surface, is shown in Table 8.11. At all points examined, the derivative is positive, but is magnitude declines with increasing Wool Price. However, it is reasonable to conclude that the derivative remains positive over the entire range of the surface; that is, P.V. continues to rise (albeit at a diminishing rate) as Wool Price increases.

The sensitivity of P.V. to changes in Fertiliser Price appears in Table 8.12. The response surface has a negative slope in the direction of the x_4 axis when Fertiliser Price is low. However, the surface 'curves up' as Fertiliser Price is increased; indeed, at a Fertiliser Price of £21 per ton, the derivative is positive at all points examined. This feature is superficially anomalous. A guide to the 'correctness' of this estimate can be obtained from the budgetted observations shown in Table 8.7. Table 8.6 shows that observations 21, 22, and 25, are similar except for their Fertiliser Price levels, which are £13, £21, and £17 respectively, yet in Table 8.6 the P.V. for these observations are shown to be £11,819, £5,378, and £8,913 respectively. Inspection of these responses shows that the 'actual' response surface 'curves down' as Fertiliser Price is increased. That is, the first derivative of P.V. with respect to Fertiliser Price 'should' become increasingly negative as Fertiliser Price is increased. The author has no intuitive

Table 8.12 Sensitivity of the Present Value of Post-tax Development Cash Profits (P.V.) to Changes in Fertiliser Price

Stock Price x_1 (% of benchmark)	Wool Price x_2 (pence per lb.)	Fert. Price x_3 (£ per ton)	Min. Owner's Drawings x_4 (£)	$\frac{\partial P.V.}{\partial x_3}$	P.V. (£)
100	33	13	800	-2,849.30	13,342
100	33	17	800	-1,039.89	5,564
100	33	21	800	769.52	5,023
50	42	13	800	-2,747.24	17,112
50	42	17	800	-937.83	9,742
50	42	21	800	871.58	9,609
150	33	13	1,400	-2,740.87	18,380
150	33	17	1,400	-931.46	11,036
150	33	21	1,400	877.95	10,929
50	42	13	1,400	-2,943.23	11,436
50	42	17	1,400	-1,133.82	3,282
50	42	21	1,400	675.58	2,366
100	42	13	2,000	-2,834.80	18,015
100	42	17	2,000	-1,025.40	10,294
100	42	21	2,000	784.01	9,811
50	51	13	2,000	-2,732.75	27,449
50	51	17	2,000	-923.34	20,137
50	51	21	2,000	886.07	20,062

Note: $\frac{\partial P.V.}{\partial x_3}$ should be interpreted as 'the change in P.V. that would result from an increase in Fertiliser Price of £1 per ton'.

explanation for this aberration, but its occurrence illustrates clearly that a 'well-fitted' function may still give (some) anomalous estimates. Note, however, that without using a response surface approach, the analyst could obtain no information at all about the sensitivity of responses to price changes.

The P.V. response surface was also examined at points determined by choosing levels of Stock Price, Wool Price, and Fertiliser Price, and deducing the Minimum Owner's Drawings by using these levels to calculate Base Year. This procedure corresponded to the 'Condition A' assumption under which the case development programmes were analysed. The assumption implies that Owner's Drawings are maintained (by borrowing if necessary) at a level greater than or equal to their level in the Base Year. The signifiaance of this assumption is discussed in Section 7.23. Table 8.13 illustrates the sort of information that can be obtained under the assumption.

8.543 'Break-even' points

This section describes the derivation of points on the Present Value of Post-tax Development Cash Profits (P.V.) surface at which response is zero.

If three dependent variables are set at particular levels, the P.V. response function becames a simple quadratic function in the fourth variable. For example, if thelevels of x_2, x_3, and x_4 can be regarded as constants, the response function may be written (in the notation of equation (8.1)), as

Table 8.13 The Sensitivity of Present Value of Post-tax Development Cash Profits (P.V.) to Changes in Stock Price, Wool Price, and Fertiliser Price Under Condition A Assumptions [a]

x_1 (%)	x_2 pence	x_3 (£)	x_4 (£)	$\frac{\partial P.V.}{\partial x_1}$	$\frac{\partial P.V.}{\partial x_2}$	$\frac{\partial P.V.}{\partial x_3}$	P.V. (£)
75	27	13	945	216.56	N.A.	N.A.	1,635
75	33	16	1,165	180.61	N.A.	N.A.	-3,004
100	39	16	2,013	184.02	N.A.	N.A.	8,051
100	39	19	1,937	197.49	N.A.	N.A.	4,685
75	42	13	1,736	N.A.	1,256.15	N.A.	13,264
150	51	13	3,248	N.A.	970.85	N.A.	66,633
100	42	16	2,141	N.A.	1,259.10	N.A.	13,121
100	33	19	1,660	N.A.	1,210.52	N.A.	-3,634
100	33	17	1,716	N.A.	N.A.	-1,339.29	-1,895
50	42	21	911	N.A.	N.A.	835.18	7,746
100	42	21	2,017	N.A.	N.A.	778.35	9,956
150	51	17	3,192	N.A.	N.A.	-704.11	57,910

Note: (a) Condition A assumptions are defined in Section 7.23

(b) 'N.A.' indicates 'not applicable'.

$$P.V. = b_{11}x_1^2 + (b_1 + b_{12}x_2 + b_{13}x_3 + b_{14}x_4)x_1 + (b_0 + b_2x_2 + b_3x_3 + b_4x_4 + b_{22}x_2^2 + b_{33}x_3^2 + b_{33}x_3^2 + b_{44}x_4^2 + b_{23}x_2x_3 + b_{24}x_2x_4 + b_{34}x_3x_4) \quad (8.6)$$

Equation (8.6) may then be solved for P.V. = 0. If real roots exist, and if at least one of these roots is within the specified range of x_1, then the 'break-even' level of x_1 (at the assumed combination of levels of x_2, x_3 and x_4) will be obtained. Otherwise no 'break-even' level exists within the range of the function.

An illustrative selection of break-even levels of Stock Price, Wool Price and Fertiliser Price appears in Table 8.14, 8.15 and 8.16 respectively.

Greater difficulty was encountered in obtaining break-even levels of Stock Price, Wool Price, and Fertiliser Price when it was desired that Minimum Owner's Drawings should be set at Base Year level.[33] Computational problems arose because the variable for which a solution was being sought, and Minimum Owner's Drawings, were interdependent. However, an algorithm providing a very close approximation to the solution was developed.[34] A selection of break-even solutions appears in Table 8.17.

---

33. This is the 'Condition A' assumption under which the case development programmes were evaluated. See Section 7.23.

34. A flow-diagram for this algorithm appears in Appendix K.

Table 8.14 Break-even Levels of Stock Price

Wool Price x_2 (pence per lb.)	Fert. Price x_3 (£ per ton)	Min. Owner's Drawings x_4 (£)	Break-even Level of Stock Price (x_1) (% of benchmark)
30	19	1,200	115.9
30	19	1,500	122.0
30	19	2,000	123.3
30	17	1,200	110.0
30	17	1,500	115.7
30	17	2,000	117.6
33	19	1,200	104.9
33	19	1,500	110.6
33	19	2,000	113.0
33	17	1,200	98.3
33	17	1,500	103.7
33	17	2,000	106.8

Table 8.15 Break-even Levels of Wool Price

Stock Price x_1 (% of benchmark)	Fert. Price x_3 (£ per ton)	Min. Owner's Drawings x_4 (£)	Break-even Level of Wool Price (x_2) (pence per lb.)
50	21	1,200	39.6
50	21	1,500	41.0
50	21	2,000	41.0
50	19	1,200	39.9
50	19	1,500	41.0
50	19	2,000	41.2
50	17	1,200	38.9
50	17	1,500	40.0
50	17	2,000	40.2
80	21	1,200	36.9
80	21	1,500	38.1
80	21	2,000	38.4
80	19	1,200	37.2
80	19	1,500	38.2
80	19	2,000	38.7
80	17	1,200	36.1
80	17	1,500	37.0
80	17	2,000	37.6

Table 8.16 Break-even Level of Fertiliser Price

Stock Price x_1 (% of benchmark)	Wool Price x_2 (pence per lb.)	Min. Owner's Drawings x_4 (£)	Break-even Level of Fert. Price(x_3) (£ per ton)
50	33	1,200	13.2
60	33	1,200	13.6
80	30	1,200	13.7
80	33	1,200	14.9
80	33	1,500	14.3
80	33	2,000	14.1
80	36	1,200	16.9
80	36	1,500	16.1
80	36	2,000	15.7
100	33	1,200	17.3
100	33	1,500	16.4
100	33	2,000	16.0

Table 8.17 Break-even Levels of Stock Price, Wool Price, and Fertiliser Price Under Condition A Assumptions

x_2 (pence)	x_3 (£)	x_4 (£)	Break-even Level of x_1 (% of benchmark)
27	17	1,953	125.6
27	19	2,003	130.9
30	17	1,973	117.0
30	19	1,920	122.5
33	17	1,909	106.5
33	19	1,849	112.3
x_1 (%)	**x_3 (£)**	**x_4 (£)**	**Break-even Level of x_2 (pence per lb.)**
60	17	935	35.7
60	19	920	36.6
80	17	1,515	37.7
80	19	1,509	38.7
x_1 (%)	**x_2 (pence)**	**x_4 (£)**	**Break-even Level of x_3 (£ per ton)**
60	30	617	16.2
60	33	803	16.5
80	27	1,064	13.3
80	30	1,229	13.6
80	33	1,358	14.4

8.55 A review of the response surface approach

Although the budgetary response surfaces derived in this Chapter have not been examined in great depth, the merit of the technique has been demonstrated. The chief advantages that this technique holds over conventional budgetting are:

(i) Given acceptable derived surface, budgetary responses for an infinite number of combinations of prices may be estimated without recourse to tedious budgetting. These estimates may be useful per se, or they may serve to suggest the price combinatons for which further budgets should be completed. It is a simple matter to construct graphs from which budgetary responses can be directly 'read off'.

(ii) The sensitivity of budgetary responses to price changes can be directly estimated from the derived surfaces. This facility is simply not available from conventional budgetting.

(iii) Price combinations which yield particular levels of profits (e.g.zero profits) can be readily computed. Conventional budgetting will provide this information only through arduous 'cut-and-try' procedures.

8.6 Conclusions

In this Chapter a hill country development programme for use on a 'typical' farm in Wairoa County has been proposed. The author believes that the programme is versatile in that its general principles could, with only minor modification, be applied on most farms in all districts of the County. An assumption prohibiting stock purchases (other than rams and bulls) was made to examine the pattern of development that would occur if the majority of farms were developed simultaneously. However, this assumption could easily be relaxed in situations where stock could be purchased at profitable prices. Purchases of stock would tend to accelerate the programme.

The financial implications of the programme were directly analysed for each of twenty-five combinations of costs and prices. These analyses suggested that changes in the assumed price levels of stock, wool, and fertiliser and changes in Minimum Owner's Drawings each had significant effects on all financial implications of the programme except the New Equilibrium Increase in Owner's Drawings. The latter were surprisingly uniform.[35]

It was apparent that development should remain profitable to the Nation over virtually all foreseeable price combinations. The analysis suggested that development should be profitable to farmers over most price combinations, although for wool prices lower than 33d. and stock prices lower than 75% of benchmark prices, development could be unprofitable, particularly at fertiliser prices higher than £15 per ton. The disparity between pre-tax and post-tax present values was remarkable. This important observation is the subject of Chapter 9.

Credit required for development varied markedly, but the lowest requirement was £13,778, while the average was £24,090.[36]

---

35. See the last column in Table 8.7.

36. It should be remembered that construction of a new house was included in the model programme. Even if this was not required, maximum indebtedness levels of the order of £20,000 can be expected during development of 1,100 acre farms. This is, after all, only about £20 of credit per acre.

Budgetary response surfaces were derived and while no attempt was made to extract a great deal of information from them, the sensitivity of profits to the farmer to changes in prices was explored and a number of price combinations yielding zero profits to the farmer were derived.

CHAPTER 9

THE IMPACT OF TAXATION ON THE PROFITABILITY OF FARM DEVELOPMENT

9.1 Introduction

The evaluation of the case development programmes [1] suggested that the impact of taxation on the profitability of farm development can be 'large', and that this is likely to be a significant disincentive to investment in increasing production. Analysis of the model development programme, in Chapter 8, reinforced this suggestion.

In all instances, the impact of taxation was indicated by a marked reduction in the present value of development profits when taxation was taken into account. [2]

In this chapter, the question is examined more rigorously. In particular, it is shown that:

(i) Taxation may withdraw more than two-thirds of the present value of development cash profits [3] in spite of a maximum current tax (income tax and social security tax) rate of 13/6 in the £, and

(ii) The post-development, debt-free, tax-paid annual additional cash surplus [4] may be substantial even though a negative present value of post-tax development cash profits indicates that the development programme is unprofitable to the farmer, or even to the Nation.

---

1. These evaluations appear in Chapter 7.
2. See Chapter 6, Section 6.51 for an explanation of the term 'present value'.
3. Indeed, taxation may withdraw more than 100% of the present value of development cash profits.
4. In the terminology used in Chapters 6, 7, and 8 this is the New Equilibrium increase in Owner's Drawings. See Section 6.54.

The author believes that these two results of current tax legislation are unlikely to be self-evident to many readers, yet both are central to an understanding of the effect that taxation can have on production decisions.

Indeed, it is intuitive to reject the notion that taxation can withdraw more than two-thirds (that is 13/6 in the £) from the profits of any enterprise. It will be demonstrated that such conclusions may be false if the period over which profitability is being measured includes at least one year of cash deficit. It is also difficult to accept the possibility of an unprofitable development programme affording a positive post-development additional cash surplus. To the contrary, it will be shown that this is likely to be the usual situation.

9.2 A Review of Empirical Results

Before proceeding to an examination of the points made in the last section, the results reported in Chapters 7 and 8 are reviewed in order to reiterate that these phenomena occur commonly in practice.[5]

The pre-tax and post-tax present values of development cash profits (computed under the assumptions stated in Chapters 6, 7, and 8) of the five case programmes recorded in the farm survey, and from selected analyses of the model development programme, will be found in Table 9.1. The fourth column of Table 9.1 records the proportion of (the present value of) cash profits claimed by taxation; that is, the proportion of profits not available to the farmer. The fifth column is self-explanatory.

There are two case programmes (numbers III and IV) in which taxation claims more than two thirds of the present value of development profits.

5. Results of this sort have not been confined to the author's work. Using a basically similar technique, Holden [36] analysed eight development programmes on North Island hill country farms. In six cases, taxation claimed more than two-thirds of the present value of extra profits resulting from development; in the most spectacular case, taxation claimed 189% of these profits.

Table 9.1 A Summary of the Impact of Taxation on the Profitability of Case Programmes and the Model Development Programme

Case Programme Number	Present Value of Development Cash Profits		Proportion of Profits claimed by Taxation $\frac{(a)-(b)}{(a)} \times \frac{100}{1}$	New Eqbm. Increase in Owner's Drawings 1/ (£)
	Pre-tax (a) (£)	Post-tax (b) (£)		
I	12,718	11,252	11.5%	919
II	7,146	3,402	52.4%	776
III	59,266	18,138	69.4%	2,519
IV	4,651	1,279	72.5%	505
V	10,847	5,506	49.2%	607
Model Development Programme, Observation Number				
1	13,617	684	95.0%	2,298
3	41,749	13,401	67.9%	2,503
4	65,166	16,586	74.5%	2,778
5	4,045	-5,301	231.1%	2,290
8	58,510	14,155	75.8%	2,717
13	-4,547	-10,467	-130.2% 2/	2,290
17	5,741	-1,635	128.5%	2,399
18	60,450	13,775	77.2%	2,754
22	29,856	5,378	82.0%	2,400
25	36,710	8,913	75.7%	2,441

Note: 1. See footnote (4) in the text for a clarification of the definition of items in this column.

2. The negative proportion of profits claimed by taxation in Observation 13 arises because taxation reduces 'profits' that were already in deficit. This case receives special attention in the text.

Perhaps more significantly, in four of the five programmes profits were reduced by more than 49% by taxation [6]. The reader is reminded that these programmes closely represented what many farmers regard as general practice, and their production goals were relatively unambitious compared to production potentials.

Turning now to the model development programme analyses summarised in Table 9.1, it should be noted at once that the analyses presented were selected because their underlying assumptions were particularly 'reasonable' or likely to occur [7]. The table indicates that in a programme of this nature, with the only 'atypical' feature being its ambitious scale, proportions of discounted profits claimed by taxation in the region of 70% to 80% can be regarded as commonplace [8]. Observations 5 and 17 suggest that, especially at the lower stock and wool prices, development programmes that are profitable before tax (that is, those which have positive pre-tax present values and are, therefore profitable to the Nation) may be unprofitable after tax (from the farmer's viewpoint, they have a negative present value). Under these circumstances, it is clear that taxation claims more than 100% of the present value of development profits. In terms of discounted cash flows, taxation absorbs more cash than is generated by development, leaving the farmer in circumstances worse than he was in before he started his programme. It is evident in this case, that the aims of the Nation contradict the aims of the farmer.

---

6. The remaining programme, number I, was peculiar in that it occurred on a very small farm where personal and family exemptions kept tax at relatively low levels even after high levels of production had been reached.

7. See Chapter 8, Table 8.6 for the assumptions underlying the analyses.

8. Indeed, in none of the twenty-five analyses of the model development programme was the proportion claimed by tax lower than 69%.

Note, however, that in Observations 5 and 17 the increase in annual Owner's Drawings is positive and substantially similar to that for other observations.

It is superficially surprising that the last point is also valid for Observation 13, where the programme is unprofitable before tax as well as after tax [9].

9.3 A Theoretical Explanation

Consider the development programme represented by Figure 9.1. No particular importance should be attached to its form or length, although in the author's experience, most actual programmes have followed the general pattern illustrated. One slightly atypical feature is that it has been assumed that no tax is paid prior to development commencing [10]. This assumption facilitates exposition, and as shown later in this section, it can easily be relaxed.

The figure may be explained as follows:[11]

(i) the symbols O, P_1, P_2, ..., P_{11} denote the magnitude of the pre-tax development cash profits occurring at the ends of the Base Year (year 0) and years 1,2,....., 11. An amount equal to P_{11} is assumed to be generated in each year after year 11.

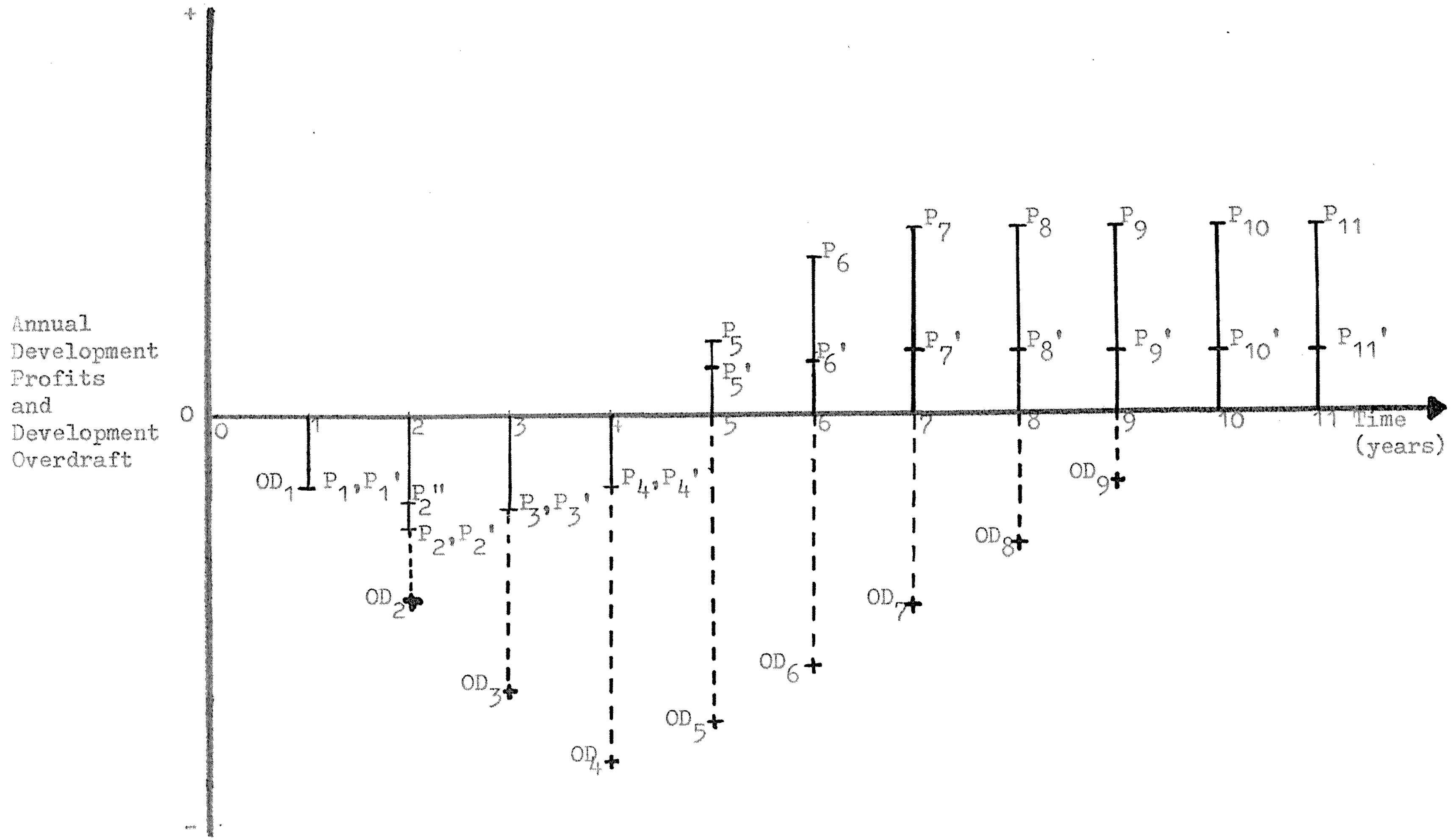
---

9. Adoption of the model programme would be profitable to the Nation under all assumptions analysed except the combination listed as Observation 13.

10. Real development programmes may have this feature. Obvious examples are the development of hitherto unproductive land (e.g. solid scrub) or development of a farm where pre-development taxable income did not exceed £104 (the personal exemption for social security tax).

11. See Chapter 6 for definitions of the terms used in Figure 9.1. It is important to understand that the annual profits and overdrafts indicated in the figure have no particular magnitude - but their signs are significant. There is no particular significance in the length of the period when annual development cash profits are negative. However, it is significant that negative profits exist, and that they usually occur in the early years of development.

Figure 9.1 A Farm Development Programme



(ii) Similarly, the symbols 0, P_1', P_2', ..., P_{11}' represent the post-tax development cash profits occurring at the ends of years 0, 1,2,...., 11, where an annual amount equal to P_{11}' recurs indefinitely. Further, $P_1' = P_1$, $P_2' = P_2$, $P_3' = P_3$ and $P_4' = P_4$, from the assumption of zero Base Year taxation.

(iii) The development overdraft (represented by the sumbols 0, OD_1, OD_2, ..., OD_{10}) is accounted at the end of each year. It accumulates when development cash deficits occur and is reduced as rapidly as possible (consistent with minimum Owner's Drawings requirements) whenever positive development cash profits occur.

Hence,[12]

$$OD_1 = P_1$$
$$OD_2 = OD_1 + P_2$$
$$OD_3 = OD_2 + P_3$$
$$OD_4 = OD_3 + P_4$$
$$OD_5 = OD_4 + P_5', \text{ etc., until finally}$$
$$OD_{10} = OD_9 + K(P_{10}') = 0$$

where the symbol K implies that only a proportion of P_{10}' may be required to pay off the overdraft. (That is, $0<K\leq 1$.)

(iv) The post-development, debt-free increase in Owner's Drawings is equal to P_{11}', which is obviously a <u>positive</u> amount.

---

12. Note that overdraft is treated as a negative quantity (that is, a deficit cash balance) and that because P_1', P_2', P_3', $P_4' < 0$, the overdraft becomes larger (that is, more negative) in years, 1,2,3 and 4.

Now the present value of pre-tax development cash profits is obtained by discounting and summing the annual pre-tax development cash profits. That is,[13]

$$PV = \frac{P_1}{1+r} + \frac{P_2}{(1+r)^2} + \frac{P_3}{(1+r)^3} + \frac{P_4}{(1+r)^4} + \frac{P_5}{(1+r)^5} + \frac{P_6}{(1+r)^6} + \frac{P_7}{r(1+r)^6} \qquad (9.1)$$

where r is the long-term market interest rate, expressed as a decimal, and PV is the present value of pre-tax development cash profits.

Equation (9.1) may be re-expressed as,

$$PV = A + B \qquad (9.2)$$

$$\text{where } A = \frac{P_1}{1+r} + \frac{P_2}{(1+r)^2} + \frac{P_3}{(1+r)^3} + \frac{P_4}{(1+r)^4} < 0$$

$$\text{and } B = \frac{P_5}{(1+r)^5} + \frac{rP_6 + P_7}{r(1+r)^6} > 0$$

Thus A is the negative component of the present value of pre-tax development cash profits (since $P_1, P_2, P_3, P_4 < 0$), and B is the positive component.

Similarly, the present value of post-tax development cash profits is obtained by equation 9.3 :

$$PV^* = \frac{P_1'}{1+r} + \frac{P_2'}{(1+r)^2} + \frac{P_3'}{(1+r)^3} + \frac{P_4'}{(1+r)^4} + \frac{P_5'}{(1+r)^5} + \frac{P_6'}{(1+r)^6} + \frac{P_7'}{(1+r)^7} \qquad (9.3)$$

$$= C + D \qquad (9.4)$$

$$\text{where } C = \frac{P_1'}{1+r} + \frac{P_2'}{(1+r)^2} + \frac{P_3'}{(1+r)^3} + \frac{P_4'}{(1+r)^4} < 0$$

$$\text{and } D = \frac{P_5'}{(1+r)^5} + \frac{rP_6' + P_7'}{r(1+r)^6} > 0$$

and PV* is the present value of post-tax development cash profits. Moreover, by assumption,

$$A = C$$

Then set $A = C = Q$, where $Q < 0$

13. See Section 6.51 for an explanation of the present value formula.

Now assume that in year 7, and subsequently, tax is paid at the maximum rate of 13/6 in the £, then for example, $P_7' \doteq \frac{P_7}{3}$ and it follows that D cannot be less than $\frac{B}{3}$ since tax is paid at less than the maximum rate in years 5 and 6. The analysis so far agrees with the intuitive feeling mentioned in Section 9.1, that post-tax profits cannot be less than one-third of pre-tax profits.

However, observe the the crucial point that

$$PV = B + Q \qquad (9.5)$$

and $$PV^* = D + Q \qquad (9.6)$$

It is now clear that PV* may quite feasibly be less than $\frac{PV}{3}$. [14]

This clarifies point (i) made in Section 9.1. Further, for $D < |Q| \leq B$, PV* will be negative while PV remains positive. [15] This explains the results obtained in Observations 5 and 17 of the model development programme. Finally, note that if $|Q| > D$ and $|Q| > B$, then PV* and PV will both be negative; the result for Observation 13 in Table 9.1.

In the foregoing, it was not necessary to relax the condition that the increase in Owner's Drawings remained positive. Thus, the increase in Owner's Drawings may be positive for programmes which are unprofitable (in the sense of having negative present value) after tax or before tax. The increase in Owner's Drawings can be non-positive only when post-tax annual development cash profits never reach a consistent positive level. Such programmes cannot be profitable, and hence the increase in Owner's Drawings must be positive for all programmes profitable to the farmer, and may be positive for programmes unprofitable to him.

---

14. For example, suppose that B = £10,000, D = £6,000, and A = C = Q = - £5,000. D is clearly greater than one-third of B, yet PV = B + Q
= £10,000 - £5,000
= £5,000,
and PV* = D + Q
= £6,000 - £5,000
= £1,000.

Obviously, in this case $\frac{PV^*}{PV} < \frac{1}{3}$.

15. $|Q|$ is the absolute value of Q which, by definition, is a negative number. For example, if Q = -£1,000, then $|Q|$ = £1,000.

If we now relax the original assumption for zero Base Year tax, we see that in years when annual pre-tax development cash profits are negative, annual post-tax development cash profits will be less negative. That is, for the year i for which $P_i < 0$, $P_i' = P_i + t_{BY}$, where t_{BY} is the tax paid in the Base Year, and P_i' is the annual post-tax development cash profits in the ith year, taxation being regarded as a cash expense.

The point P_2'' illustrates the effect of tax being paid in the Base Year. It is clear that

$$P_2'' - P_2 = t_{BY}$$

if there is no tax paid in year 2. If tax is paid in year 2,

$$P_2'' - P_2 = t_{BY} - t_2$$

where $t_2 > 0$ is the tax paid in year 2.

Our previous conclusions regarding the relation between PV and PV* are challenged when $t_{BY} > 0$. However, for t_{BY} small enough, our conclusions obviously remain valid, as indicated by the empirical evidence.

9.4 The Implications for Farm Development

The development of hill country farms is seriously affected by taxation in two separate ways. The first occurs when farmers motivated by profit do not proceed with farm development which, in the Nation's interest, should be undertaken. This leads to a misallocation of the Nation's scarce resources. The second way in which taxation affects farm development, is by placing a direct limit on the funds that some farmers have available to invest in farm development. This feature simply prevents investment in farm development.

These two implications of taxation are explained in the following sub-sections.

9.41 The misallocation of resources

The most obvious case of a misallocation of the Nation's resources occurs when farm development which is profitable to the Nation (that is, in the notation of equation (9.1), when PV is positive), is not undertaken by a farmer because it is not profitable to him (that is, PV* is zero or negative).[16] This case could commonly be extended to the situation where both PV and PV* are positive, but where PV* is so small that the farmer does not consider it worthwhile to proceed.

In both instances, the Nation loses all the profits that would have accrued to it from the development programme, and this loss is sustained solely as a result of progressive taxation.

Perhaps less obviously, the imposition of tax on any of the profit from increased production will amost invariably result in a misallocation of resources. This point is illustrated by Figure 9.2. The figure greatly simplifies the actual production situation, but this does not impair its expository usefulness. The resources used in farm development (X) and the increased production (Y) from development, are both assumed to be homogeneous[17]. It is thought that the line OP is a 'reasonable' representation of a farm development production function.[18]

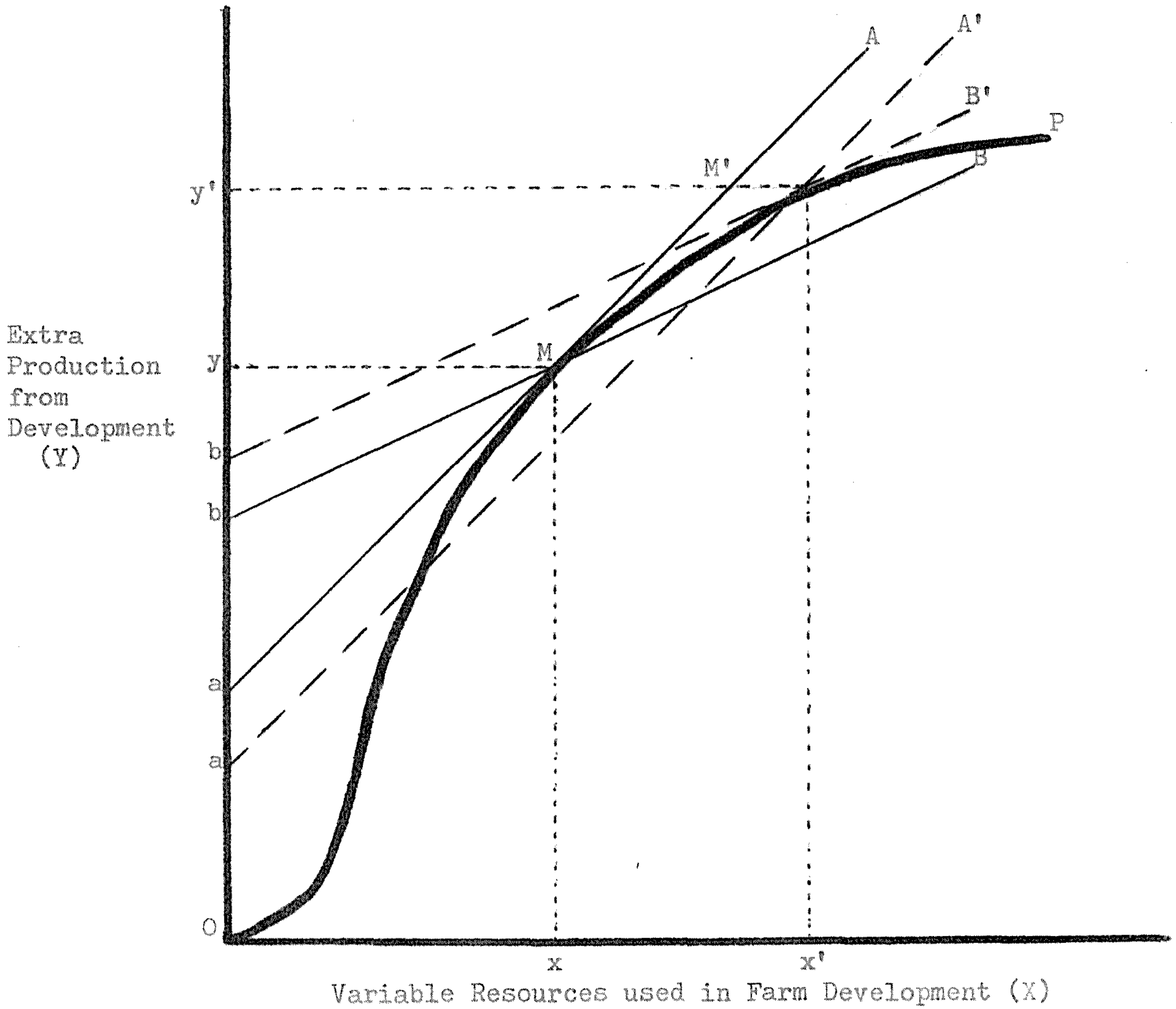
---

16. This statement is based on the assumption that the Nation should 'go ahead' with any farm development which generates a profit. See Chapter 6, footnote no. 3, for an explanation of the point that ideally the Nation should probably reject some profitable development programmes.

17. This assumption was made to allow representation of the production function in a two-dimensional diagram. Particular products and resources could be represented specifically, but each of them would add one dimension to the figure.

18. This is a 'Factor-Product' production function. A detailed discussion of the interpretation of factor-product production functions appears in Heady [33].

Figure 9.2 Misallocation of Resources Due to Taxation



Now suppose that the price received per unit of Y is P_y, and that the price paid per unit of X, is P_x. Moreover, let us regard tax as a cash expense (that is, equivalent to a resource which must be purchased). Hence, define the unit of expenditure, including tax, as P_x'. In other words, the price of a unit of resources 'to the Nation' is P_x, and the line B in the figure has a slope of $\frac{P_x}{P_y}$. On the other hand, the price of a unit of resources 'to the farmer' is P_x', and the line A has a slope of $\frac{P_x'}{P_y}$.

If we consider that the farmer will be 'optimally adjusted' when he has maximised his profits, we conclude that he will operate at point M on the production function [19]. That is, he will use x units of resource to increase production by y units. Total revenue will be $y.P_y$ and the farmer's profits will amount to $a.P_y$, with $(y-a)P_y$ being required to meet the cost of resources and taxation.

If the farmer produces at M, the profits accruing to the Nation amount to $b.P_y$.[20]

However, at M, the profits to the Nation are not maximised. The Nation's resources are not optimally allocated until production takes place at M', where x' units of resources would be used to increase production by y' units. In developing the farm further by moving from M to M', profits to the Nation are increased from $b.P_y$ to $b!P_y$. At the same time, however, profits to the farmer decline from $a.P_y$ to $a!P_y$.

It must be acknowledged that the marginal increases in resource use suggested by Figure 9.2 may not always be possible in actual farm development programmes; that is, large projects are undertaken, and completed, or they are not undertaken at all. However, to the extent that farm development does conform to the simple model in Figure 9.2, the taxation of income from development will always result in a misallocation of the Nation's resources.

19. At M, $\partial x.P_x' = \partial y.P_y$, the condition for maximisation of the farmer's profits.
20. It is obvious that $b.P_y > a.P_y$.

9.42 The restriction on funds

Farmers commonly face specific limits on the amount of capital that they are able to borrow for farm development. Other farmers, who are averse to indebtedness, place their own limits on the capital that they are prepared to borrow. In both cases, once borrowing limits have been reached, further farm development can be financed only out of 'revenue' (the funds remaining after non-development expenses, taxation, and personal drawings, have been met).

Under these circumstances, it is clear that taxation directly reduces the funds available for investment, and consequently curtails the rate of farm development.

9.5 Conclusion

This chapter has shown that taxation has a very substantial impact on the profitability of farm development. It has been demonstrated that taxation could claim more that 100% of the profits derived from farm development. This point was substantiated by empirical evidence. The misallocation of the Nation's resources was shown to be a near-inevitable consequence of taxing income from increased production, and it was pointed out that taxation commonly restricts the rate of farm development.

It is clear that these undesirable implications of income tax can be completely avoided only if tax is made wholly independent of production increases. The 'Factor Tax' suggested by Candler [37] is a potentially workable system which would meet this requirement.

CHAPTER 10

THE POTENTIAL FOR INCREASED PRODUCTION IN WAIROA COUNTY

10.1 Introduction

This Chapter has two parts. The first part states the author's estimates of potential production increases in Wairoa County. The author believes the estimate to be conservative, and that the production levels suggested can be achieved using present technical and managerial knowledge. The estimates are developed by first assessing increases in stock numbers, and subsequently interpreting these increases in terms of additional annual production. Finally, the contribution that the extra production could make to New Zealand's overseas exchange-earning capacity is estimated.

The second part of the Chapter contains an assessment of the total additional resources required to attain potential production levels.

10.2 Potential Increases in Stock Numbers

The estimates stated below do not include production increases on Maori-owned land in Wairoa County. [1] Increases are estimated in two stages; increases in Wairoa County itself, and increases on similar hill country outside the County.

In the absence of any more reliable data, information collected from the farm survey is used to determine present land use and stocking rates. That is, the land use pattern on the aggregate of Random Farms is assumed to apply to all farms in the County.

1. The author believes that technically, the production potential of Maori land is very similar to European-owned land. However, increasing production on Maori land could be hindered by difficulties, principally concerned with the form of land tenure, that would not be encountered on European-owned land and Crown land. Thus, in keeping with the conservative nature of the estimates, potential production increases on Maori land have been ignored.

From Table 4.5 it can be seen that this pattern is,

grazeable pasture	- 65%
unproductive land capable of development	- 31%
permanent waste	- 4%

Similarly, current average stocking rates in the County are assumed to correspond with the average stocking rates on Random Farms. The data from Table 4.7 which are relevant to the estimates are,

average stocking rate per acre of total area	- 2.14EE
average stocking rate per acre of grazeable pasture	- 2.98EE

The author believes that all farmable land in the County has a potential stocking rate of at least 5.0 EE per acre. Hence it is estimated that pasture being grazed at present has an average potential increase in stocking of 2.02 EE per acre.

10.21 Stock increases in Wairoa County

The total area of Crown and European-owned land held for pastoral farming purposes in Wairoa County is approximately 518,000 acres. [2]

By application of the land-use assumptions stated above, it may be concluded that grazeable pasture covers 336,700 acres, unproductive land capable of development covers 160,600 acres, and permanent waste accounts for 20,700 acres.

Hence,

total stock carried at present

= (518,000)(2.14)
= 1,108,000 EE.

2. An analysis of land tenure in the County appears in Tables 2.3 and 2.4. For use in the present chapter, the land areas quoted in the tables have been rounded to the nearest thousand acres below the quoted area. No allowance has been made for land devoted to dairying. The area of this land could not easily be estimated, but the author is satisfied that it comprises an insignificantly small proportion of the total area.

The development to its potential of all unproductive land capable of development would allow an extra (160,600)(5.0) = 803,000 EE to be carried.

Moreover, a further (336,700)(2.02) = 680,000 EE could be run on currently grazeable pasture.

That is,

potential stock increases

= 803,000 + 680,000

= 1,483,000 EE.

10.22 Stock increases on adjacent hill country

The author has estimated that there are 150,000 acres of hill country adjacent to Wairoa County that are basically similar to land in the County.[3]

It may be assumed that of this area, grazeable pasture covers 97,500 acres, unproductive land capable of development covers 46,500 acres, and permanent waste accounts for 6,000 acres.

Hence,

total stock carried at present	= (150,000)(2.14)
	= 321,000 EE,
and potential stock increases	= (46,500)(5.0) + (97,500)(2.02)
	= 232,000 + 197,000
	= 429,000 EE

Thus the potential increase in stock numbers in Wairoa County and adjacent districts is 1,912,000 EE - an increase of 134% over the present total. [4]

---

3. This land is indicated in Figure 2.1
4. That is, carrying capacity could be raised to 234% of the current level.

10.3 Potential Production Increases

This section estimates the increase in annual production which would result from the potential stocking levels.

For simplicity, it is assumed that all farms in the County will reach a post-development situation in line with the model development programme. [5] This post-development situation is used to estimate flock and herd composition, annual wool production, and the pattern of stock sales on all farms when fully developed.[6]

The post-development ratio of sheep EE to cattle EE in Table 8.1 is 4.2. Therefore, the extra 1,912,000 EE estimated above, can be considered to consist of 1,544,600 sheep EE and 367,800 cattle EE.

Further, by reference to Tables 8.1 and 8.2 it can be seen that:

(i) Increased annual wool production $= \frac{49,120}{4,258} \times \frac{1,544,600}{1}$

$= 17,818,400$ lbs.

(ii) Increase in annual total fat lambs slaughtered

$= \frac{1,390}{4,258} \times \frac{1,544,600}{}$

$= 504,200$

(iii) Increase in cull 2th. ewes $= \frac{530}{4,258} \times \frac{1,544,600}{1}$

$= 239,200$

(v) Increase in weaner steers sold

$= \frac{50}{1,016} \times \frac{367,800}{1}$

$= 18,100$

---

5. The model development programme is discussed in Chapter 8.
6. While this assumption may be considered sweeping, no more reasonable alternative suggested itself to the author.

10.4 A Comment on the Value of Production Increases

The objective in this section is to derive an estimate of the annual value of the potential increase in production from Wairoa County and adjacent districts, in terms of the net contribution to New Zealand's capacity to earn overseas exchange. No attempt is made to derive an accurate estimate, the aim is to express the 'amount of overseas exchange that New Zealand foregoes each year because Wairoa County is left producing only 43% of its potential.'

As a simplification, only those products which directly earn overseas exchange (that is, wool and fat lambs) are considered. The indirect contributions of cull 2th. ewes, c.f.a. ewes, and store cattle are ignored. On the debit side, only fertiliser is considered as a resource on which overseas exchange must be spent. Other resources requiring overseas exchange, such as farm machinery, building materials, and vehicles, are ignored. [7]

The prices assumed for wool and fat lambs are those which were used by the Targets Committee of the Agricultural Development Conference when that body established production targets for 1972/73.[8] That is, the prices assumed are,

(i) Wool : average price of 42 pence per lb. (greasy basis), and

(ii) Meat : £150 per ton.

It is further assumed that the fat lambs produced would have an average carcase weight equal to the New Zealand average. The weight actually used is 30.3 lb. per carcase, the New Zealand average weight for 1964/65. [9]

---

7. It is realised that this gives a very rough estimate. Even labour and and fence posts have some opportunity cost in terms of overseas exchange. The products and resources ignored would tend to 'cancel each other out'.

8. See reference [46, P.6].

9. See reference [47, p.66].

Under these assumptions, the overseas exchange earned by the estimated additional 17,818,400 lbs. of greasy wool would be £3,118,200. The 504,200 extra fat lambs slaughtered each year would earn £1,023,000 in overseas exchange.

On the other hand, the additional annual fertiliser required would be 112,000 tons. 10/ Since each ton of superphosphate has an imported content costing approximately £7 sterling 11/, the total annual expenditure of overseas exchange on fertiliser may be estimated at £784,000.

Hence, development of Wairoa hill country to its potential would increase New Zealand's capacity to earn overseas exchange by approximately £3,357,000 per year.

10.5 Additional Resource Requirements

In this section, the additional total resources required to achieve and maintain potential production levels are estimated.

Substantial extra supplies of fertiliser, skilled farm labour, and long-term credit would be necessary, and considerable expansion in management advice, transport, aerial topdressing capacity, and farm supply and trading services, would be required.

10.51 Fertiliser requirements

If farm development followed the pattern of the model development programme, an additional 714 tons of superphosphate per 1,000 acres would be required to develop a 'typical' hill country farm over a 9-year period. From Sections 10.21 and 10.22 it is clear that 641,300 acres would be involved in development. Hence, total fertiliser requirements for development may be

---

10. As explained in Section 10.51, annual post-development fertiliser requirements would be 128,500 tons; in 1964/65, 16,446 tons of fertiliser were used (See Section 2.45).
11. This figure was derived from data supplied by the East Coast Farmers' Fertiliser Company in November 1966.

estimated as 458,000 tons. [12]

With all farms fully developed, an annual 'maintenance' dressing at 2 cwt. per acre over the whole of each farm would demand 128,500 tons.

10.52 Farm labour requirements

The potential increase in sheep EE was calculated in Section 10.3 as 1,544,000, and it may be deduced from the model development programme that this total would include 1,142,000 extra breeding ewes. On the assumption that an additional skilled shepherd would be required for every 1,500 extra breeding ewes, an increase in labour requirements of 760 men could be expected. [13]

10.53 Requirements for long-term credit

It is clear that rapid development of Wairoa County would require very substantial injections of credit from outside the County.

Analysis of the model development programme suggested that development of a 'typical' 1,100 acre farm to potential production levels would involve a maximum indebtedness of at least £20,000. [14] Thus development of 497,300 acres could be expected to require total credit supplies of about £9,042,000. Of course, it is not suggested that the whole of this sum would have to be supplied from outside the County; repayments from early loans could obviously

12. This amount would not be required in any one 9-year period since all farms would not be developed simultaneously.

13. It is assumed that each skilled shepherd could be made responsible for 1,500 breeding ewes and their supporting stock. Reference to Section 4.31 will confirm that farm workers in Wairoa are currently handling, on average, only 800 breeding ewes and supporting stock. On the other hand, Milne's [41] study has revealed several North Island hill country farms on which farm workers successfully handle more than 2,000 ewes. In spite of this the present estimate of requirements for farm labour is likely to be conservative, although the productivity of labour should tend to increase as farm development proceeds. Land development itself should require no extra permanent labour, because heavy reliance would be placed on contractors for cultivation, scrubcutting, fencing, oversowing, and topdressing.

14. See Chapter 8, Section 8.6.

be re-lent to other farmers who had delayed the commencement of farm development. However, the point remains that farmers developing their farms along the lines of the model development programme would, in general, require long term credit to the extent of approximately £18,200 for every 1,000 acres ot total farm area.

A discussion of desirable changes in the institutional arrangements of farm credit appears in Chapter 11.

10.54 Advisory services

The author believes that greatly expanded management advisory services would be a pre-requisite for the rapid development of Wairoa hill country to its potential. A minimum of four, and preferabley six, well-trained advisors would be required to provide intensive farm management advice. A discussion of the nature of this advice appears in Chapter 11.

Sufficient extra veterinarians to service the additional stock would also be required.

10.55 Transport services

If Wairoa County was developed to potential levels, the 134% increase in stock numbers and five-fold increase in maintenance fertiliser would imply a need for at least three times the present number of road trucks. It is conceivable that even more trucks would be required during the development period when fertiliser deliveries could be greater (although stock movement could be expected to be reduced).

Such a substantial increase in road transport would place severe stress on the already poor roading system in the County. It is likely that development of the County would necessitate considerable road reconstruction.

10.56 Aerial topdressing services

The estimated requirement for 'maintenance' fertiliser in the fully developed County is 128,500 tons, and it is reasonable to expect the bulk of this to be aerially applied.

Since virtually all the 16,446 tons delivered to the County in 1964/65 were applied by aircraft, the 'fully-developed' requirement for aerial top-dressing services could be expected to be six times greater than in 1964/65. That is, while six small aircraft satisfied demand in 1964/65, the equivalent of thirty-six small aircraft would be needed in the fully-developed County.

10.57 Farm supply and trading services

A substantial expansion in stock firms' facilities for providing farm supplies and conducting stock sales would become necessary as production in the County increased.

10.6 Summary

The previous sections have suggested that on approximately 520,000 acres in Wairoa County and 150,000 acres of similar country outside the County, production could be increased by about 130%, to 230% of present levels. This would result in about 18 million lbs. of extra wool, .5 million extra fat lambs, .24 million extra c.f.a. ewes, and .02 million extra weaner steers, each year.

The extra inputs required to sustain this level of production would include an extra 760 skilled permanent farm workers, 128,500 tons of superphosphate (possibly reverted) per year, six times the present aerial topdressing capability, and a trebling of the present fleet of road trucks.

Development itself would require more than £9 million aggregate credit to farmers, and the provision of intensive management advice.

An extremely rough estimate places the potential extra direct overseas exchange earnings at more than £4 million per year, and extra direct claims on overseas exchange at £.8 million per year. On this basis, the extra net overseas earnings of £3.3 million per year, would provide a return to the Nation of 36.7% on the £9 million invested. 15/

---

15. The total capital inflow from outside Wairoa would be less than £9 million due to re-investment from loan repayments. However, in an opportunity cost sense, re-invested capital should be regarded as 'new' capital, so that the 'Nation's investment' is the aggregate £9 million.

CHAPTER 11

CONCLUSIONS AND SUGGESTIONS FOR INCREASING PRODUCTION

11.1 Introduction

In this Chapter, the important findings of the study are summarised, and the problem of obtaining potential production from Wairoa hill country, is discussed.

11.2 The Feasibility of Increasing Production

The author believes that a substantial increase in production from Wairoa hill country is physically feasible. Budgetting studies suggested that the average stocking rate in the County could be increased to 5 EE per potentially productive acre within nine years, given present technology.

No serious technological obstacles to increasing production were revealed by the farm survey. It should be noted, however, that the pasture establishment problem known as 'clover ill-thrift' [1] which is at present confined to a few localised manifestations, could become more significant over wider ares, as production increases.

11.3 Changes in Farm Management

In earlier chapters, several major changes to the farm management system used at present on Wairoa hill country were suggested. The new management system envisaged would replace the present low stocking rates with a high stocking rate/high production/high profitability system. The principal

1. Clover ill-thrift is described in Section 5.51. Should this disorder become more widespread as development of the County proceeds, technical experimentation to establish its cause and to suggest remedies should be justified.

features of this system would be:

(i) A stocking rate of at least 5 EE per acre,

(ii) Annual topdressing with superphosphate [2] (or reverted superphosphate at a rate of 2 cwt. per acre,

(iii) Further subdivision until most paddocks cover no more than 50 acres. This subdivision should be carried out using 'cheap' fences - either the 'steel' type (possibly using driven light wooden posts), or permanent electric fences.

(iv) Provision of clean water in every paddock would be essential.

(v) An increase in the number of ewes per man to at least 1,500. Even higher numbers may well be profitable when skilled labour expensive, in spite of the possibility of higher ewe and lamb deaths.

The emphasis in this system would be on achieving a much better utilisation of pasture than is at present customary in Wairoa. Higher Stocking rates and closer subdivision would ensure this, in spite of a substantial increase in the proportion of sheep to cattle (from 1.7 sheep EE per cattle EE to about 4.0). The consequently more flexible stocking policy would reduce the present need to ensure against drought-induced summer cattle-feed shortages by maintaining under-stocking during spring and early summer. At the stocking rates envisaged, the author sees no merit in continuous mob-stocking, but favours rotational grazing of ewes from weaning to crutching, with set stocking

---

2. Both superphosphate and reverted superphosphate have been used very successfully in Wairoa County. Although several farmers expressed a need for more information about the relative merits of these fertilisers, the author feels that this is unimportant compared with the problem of encouraging more widespread use of <u>any</u> fertiliser containing superphosphate in a high stocking rate/high profitability management system. Farmers' observations and plot trials have suggested, however, that reverted superphosphate can be expected to give superior responses on the lighter pumice soils in the County.

in the interim.

The farm survey indicates that, on average, farms in the County had 31% of their total area unproductive. The techniques favoured by the author for establishment of pasture on this land are:

(i) Development from manuka by cutting, burning, and aerial sowing of pasture mixtures and fertiliser,

(ii) Development of mixed manuka/blackberry which cannot be cut, by cultivation and sowing using heavy machinery, and

(iii) Eradication of blackberry clumps by spraying with hormone weedicides, burning, oversowing, and very heavy stocking (possibly obtained by the use of temporary subdivision).

At the time of the farm survey, the practice of using sheep classes requiring little labour was untried in Wairoa. The author believes that mature wethers and Perendale ewes are potentially very useful in the County, especially,

(i) When stock with a low requirement for labour are needed at the stage in a development programme when permanent labour cannot handle more breeding ewes, and

(ii) When a farmer is unable to (or does not with to) obtain more labour, although his farm is understocked.

Of course, provided that Romney ewes are more profitable than either Perendale ewes or mature wethers, the latter stock classes should not be used.

In the common situation where extra Perendales or wethers could be run without additional labour, but more Romney ewes would necessitate more labour (perhaps as an extra full-time permanent worker), extra Romneys should be run unless the real price of labour exceeds the farmer's shadow price for labour.[3]

---

3. The real price of labour is the actual cash that the farmer would pay to hire extra labour, but the shadow price of labour is the maximum price that the farmer could pay for labour without Perendale ewes or wethers becoming more profitable than Romney ewes.

11.4 Production Potentials

The production potentials estimated in Chapter 10 are summarised in this section. The major findings were that,

(i) An additional 1,108,000 EE could be carried in Wairoa County,

(ii) An additional 1,912,000 EE, an increase of 134% over the present total, could be carried in Wairoa County and adjacent hill country.

(iii) This stock would net an additional £3,357,000 of overseas exchange per year. 4/

11.5 The Profitability of Increasing Production

Analysis of farm development programmes being used by Wairoa farmers suggested strongly that increasing production would be profitable to the Nation, and to individual farmers, if sound techniques were employed. A model development programme budgetted by the author confirmed this conclusion and also indicated that development would be profitable over wide price ranges.

However, a finding of great importance was that increasing production would usually be considerably more profitable to the Nation than to individual farmers. Indeed it could be quite common for production increases that would be profitable to the Nation to remain unattained because they would not be profitable to farmers. 5/ The author believes that the taxation of revenue from production increases could be a fundamental obstacle to the attainment of

4. Once again, the reader is warned that this is only a rough estimate of the general order of magnitude of additional earnings. The author would welcome access to the information on the marginal value of additional exports, and the opportunity cost of New Zealand labour and other resources, which would permit a more refined estimate.

5. Of course, development which would be profitable to the Nation, may well result in a loss to farmers.

physically feasible production levels.

11.6 Resources Required to Attain Potential Production

Substantial increases in supplies of fertiliser and expansion of transport, aerial topdressing, and trading services were estimated in Chapter 10. No further comment on these estimates is offered here. In the following three sections, attention is turned to a discussion of desirable changes and additions to farm advisory services and facilities for long-term credit to farmers, and to some comments on the problem of obtaining and holding skilled farm labour.

11.61 Advisory services during development

The author believes that most farmers in Wairoa County would welcome expert advice on the planning, financing, and supervision of rapid farm development. Indeed, it is doubtful that many farmers would have the knowledge or confidence to proceed with development programmes involving indebtedness of the order of £20,000 without expert advice.

The 'expert advice' advocated above would represent a complete departure from traditional farm advisory services in Wairoa. To be effective in assisting the development of hill country, advice should concentrate on intensive assistance with farmers' management problems. The role of a management advisor in planning and implementing a 'typical' farm development programme, such as the model development programme, would consist of :

(i) A minimum of two weeks spent in assisting the farmer plan his programme. A complete familiarisation with the farm would be essential, and the advisor would require some knowledge of the farmer's goals and ambitions. At least one week of this time would be needed to budget alternative and development methods and stock policies. During this work the advisor would require close co-operation from the farmer's accountant. The specialist skills of the accountant would be necessary to take maximum advantage of the tax concessions available to the farmer, and in re-planning estate arrangements in the light of the development programme. The farmer's requirements for development credit would be estimated on completion of this initial planning, and the advisor could well assist the farmer in applying for long term loans.

(ii) Annual review of the development programme. This work would typically occupy about three days, and consist of an appraisal of the past year's progress and a revision of the next year's programme.

(iii) Ad hoc advice to the farmer on day-to-day management problems and advice concerning any unforseen results from the development programme.

An advisor working fulltime on this type of work would be hard-pressed to advise on more than 20 new development programmes each year, while servicing programmes already in progress. 6/

Hence, on the assumption that there are 500 farmers in Wairoa County and adjacent districts who would be potential recipients of this sort of advice, it is clear that even six fulltime advisors would require at least four years to satisfy all demands for assistance.

---

6. The increasing availability of electronic computers to perform repetitive clerical calculations means that substantial increases in the efficiency of farm advisors should be available in the next few years. This may mean that even with the intensive advice envisaged by this report, we may be able to look towards each advisor being able to handle sixty new farm development programmes each year.

Intensive management advice in Wairoa could be provided in any of the following ways:

(i) It could be offered by the State, free of charge to farmers. A suitable administrative framework already exists within the Department of Agriculture, but in the absence of a fundamental up-grading of salaries, it is doubtful if enough well trained management advisors could be attracted into the Department.

(ii) Employment of well-qualified advisors by a Farm Improvement Club established in the County. The established procedure in Farm Improvement Clubs of members contributing approximately equal fees, would be inequitable when only a small proportion of members would receive very intensive advice in any one year. Nevertheless, the formation of smaller active groups of about 20 farmers, paying higher fees, could be a practicable alternative.

(iii) The author believes that advice could best be offered by self-employed farm management consultants who would charge farmers only for advice actually given. Reasonable charges for the advice outlined above would be £200 for initial planning and subsequently about £50 per year for programme review and *ad hoc* advice. In order to encourage farm management consultants to establish practices in Wairoa, it would probably be necessary for local organisations to guarantee them a minimum income during the first year of establishment. This guarantee would need to be in the vicinity of £2,000 per annum.

11.62 Credit for development

It is certain that rapid farm development requires suitable credit in substantial quantities. The majority of Random Farmers in the farm survey saw little merit in borrowing for development. [7/] However, the author believes that

7. See Section 4.12.

many farmers would be prepared to borrow if the feasibility and profitability of development were demonstrated to them, and if the terms of borrowing were well suited to their needs.

For credit facilities to be 'well suited' to the needs of Wairoa hill country farmers undertaking development, they would require the following features: 8/

(i) Lending should be on the basis of productivity rather than security so that energetic and able managers should not be hindered by a lack of security.

(ii) No arbitrary upper limit should be placed on lending to an individual farmer. Analysis of the model development programme showed that credit requirements of approximately £18,000 per 1,000 acres should be expected. Loans in excess of £36,000 should not be uncommon.

(iii) Credit required for completion of a development project should not be withheld merely because a credit limit has been reached. Similarly, credit should be available to meet unforseen demands, such as might be caused by a failure in pasture establishment. That is, credit should allow for the uncertainty involved in development.

(iv) Repayments of both principal and interest should be delayed until they can be made without diverting funds required to complete development. 9/

---

8. Similar views have already been expressed by Wright [24]. The author's comments do little more than reiterate these earlier observations.

9. Alternatively, if the landing authority insisted upon payment of interest, further credit should be made available to meet these payments.

Institutions offering credit of this type would be facing higher risks than present lending institutions will accept. Higher interest rates would be charged to offset this risk, but more importantly, risk could be reduced by instituting supervised lending. That is, well-qualified advisors should be made available to assist farmers plan development, and in particular, to budget loan repayments. These advisors could either be employed by lending institutions or be farm management consultants whose hiring by farmers would be a pre-requisite to loans being granted.

11.63 Farm labour for development

In Chapter 10, it was estimated that an additional 760 skilled farm labourers would be necessary for the County to reach potential production. In view of the difficulty suggested by the farm survey, of maintaining supplies of skilled labour at present levels of production, severe shortages could occur if the County was developed rapidly.

Dissatisfaction with renting a house owned by employers would appear to be a major reason for experienced farm workers moving to urban occupations. This difficulty could possibly be overcome by inauguration of the Rural Settlement Plant - first suggested by J.C. Andrews [51] in 1962. This scheme envisaged small farm villages offering many 'suburban' facilities set up throughout country districts.

11.7 Stimulating Increased Production

Stimulating increased production in Wairoa would involve,

(i) Acquainting farmers with the essential features of the new management system, and

(ii) Demonstrating to farmers the profitability to them of increasing production, and

(iii) Ensuring that the extra resources required to increase production are available to farmers.

The problem of extending the methods and profitability of increasing production could be approached in one of three ways; by use of extension alone, extension based on co-operative demonstration farms, and extension based on a management demonstration farm.

The author favours the third approach for two reasons. First, the lack of experience of high-stocking rate management systems in the County would mean that efforts based on extension alone would suffer from advisors being uncertain exactly what they should extend. Moreover, farmers' confidence would not be encouraged by the absence of demonstrated success of the new management system in the County.

The second reason concerns the unsuitability of the co-operative demonstration farm approach. This form of extension relies on a co-operative farmer following a pre-determined management system while receiving some financial assistance from the planning authority. The objective is that this farmer, by his success, will recommend the management system to other farmers. It is imperative that the farmer implicitly follow the recommended management system. In the Wairoa case, the 'recommended management system' would be a development programme similar to the model programme. It would be asking a great deal of any farmer in Wairoa County to enthusiastically and implicitly follow a programme, relatively unproven in his district, which involved indebtedness in excess of £20,000.

11.71 The case for a management demonstration farm [10]

Management demonstration farms are a relatively new concept in New Zealand. To the author's knowledge, none has so far been established on hill

10. Small management farms have been described in some detail by Brougham, Candler and Wright. [9]

country.

They differ from co-operative demonstration farms in that the authority administering district development is directly responsible for their planning and control.

The objectives of a management demonstration farm are: [11]

(i) To demonstrate to farmers in a district the important technical features of a management system which is expected to be profitable,

(ii) To identify and remedy any (small) technical difficulties associated with the management system, and

(iii) To demonstrate the profitability of the new system. This requires two farms, one of which tests the new system, while the other serves as a 'control' by reflecting 'current district practice'.

The management system to be demonstrated should be defined and publicised from the outset, and any modifications to the system should be fully explained. The farm should become the focal point for the extension effort in the district and all relevant physical and financial information should be recorded and publicised.

The problem of increasing production in Wairoa County corresponds perfectly to these objectives.

The author doubts whether any substantial increase in the rate of development of the County will take place until a management farm has been set up to test and demonstrate a system of farm development similar to the one specified by the model development programme.[12]

---

11. Management demonstration farms should not be confused with management experiment farms, which are designed to test the technical feasibility and profitability of a new management system. No extension effort is necessarily associated with these farms, and since their profitability is not being compared with district practice, no 'control' farm is necessary.

12. In round figures, such a farm would cost in the region of £30,000 to set up, if land had to be purchased. If land could be leased (for example, from a Department of Lands and Survey development block), this cost could be halved. The salary of a management supervisor and expenditure on publicity would add some £3,000 per year to normal running expenses.

BIBLIOGRAPHY

1. Department of Scientific and Industrial Research, 'General Survey of the of the Soils of North Island, New Zealand'. Soil Bureau Bulletin No. 5, 1954.

2. Gibbs, H.S., 'Soils of the Gisborne-East Coast District and their Problems for Pastoral Use', Soil Bureau Publication 215, Department of Scientific and Industrial Research, 1960.

3. Gibbs, H.S., 'Yellow-Brown Pumice Soils in Wairoa, Hawkes Bay, and Rangitikei Districts', New Zealand Soil News, No. 1, February 1960.

4. Agricultural Economics and Farm Management Department, Massey University, 'Guide to 1965-66 Season's Costs and Prices for Budgeting'.

5. Frampton, A.R., 'The Economics of Growing Sugar Beet on Farms in South Otago', M. Agr. Sc. thesis, Massey University, available as Discussion Paper No. 35, Department of Agricultural Economics and Farm Management, Massey University, July,1965.

6. Townsley, R.J., ' A Whey : Meal Pig Production Function', unpublished M.Agr. Sc. theses, Massey University Library,1963.

7. Dillon, J.L.,'Economic Considerations in the Design and Analysis of Agricultural Experiments', Review of Marketing and Agricultural Economics, 34, 2, June,1966, p. 64.

8. Swanson, E.R., 'Problems of Applying Experimental Results to Commercial Practice', Journal of Farm Economics, 39, 2, May 1957, p.382.

9. Brougham, R., Candler, W. and Wright, A., 'Small Farm Experiments', Discussion Paper No. 11, Department of Agricultural Economics and Farm Management, Massey University, December,1963.

10. Saville, R.J., et al, 'Limitations and Contributions of Pilot Farms, Management Units, or Experimental Units in an Economic Research Programme', Southern Farm Management Research Committee, March 1954 (mimeo).

11. Arcus, P.L., 'An Introduction to the Use of Simulation in the Study of Grazing Management Problems', Proceedings of the New Zealand Society of Animal Production, 23, 1963, p.159.

12. Candler, W.V. and Townsley, R.J., 'The Maximisation of a Quadratic Function of Variables Subject to Linear Inequalities', Management Science, 10, 3, April 1964, p. 515.

13. Candler, W.V., 'Production Economics and Problems of Animal Production', Proceedings of the New Zealand Society of Animal Production, 22, p. 142, 1962.

14. Case, H.C.M., and Williams, D.B., 'Fifty Years of Farm Management', University of Illinois Press, Urbana, Illinois, 1957.

15. Wesney, D., 'A Study of the Financial Returns to Process Pea Growers in Hawkes Bay', Unpublished M.Agr. Sc. thesis, Massey University Library, 1964.

16. Warren, G.F., 'Agricultural Surveys', Cornell Agricultural Experiment Station Bulletin 344, April 1914.

17. Warren, G.F. and Livermore, K.C., 'An Agricultural Survey', Cornell University Bulletin 295, 1911.

18. Candler, W.V., 'The Role of Farm Management Surveys',paper presented to the Annual Meeting of the N.Z. Fertilizer Manufacturers' Association, 1965, and available as Discussion Paper No. 39, Department of Agricultural Economics and Farm Management, Massey University, October 1965.

19. Schapper, H.P., 'Uses and Limitations of Farm Surveys' Review of Marketing and Agricultural Economics, 25, 1-2, 1957, p.51.

20. H.M.S.O., 'The Farm as a Business', London.

21. Candler, W.V., and Sargent, D.S., 'Farm Standards and the Theory of Production', Journal of Agricultural Economics, 15, 2, December 1962, p. 282.

22. Graham, J.V., 'The Economics of High Rates of Fertiliser on South Taranaki Dairy Farms', Unpublished M.Agr. Sc. thesis, Massey University Library, 1964.

23. Cronin, M.B., 'A Study of Dairy Farming on the Rangitikei Plains', M.Agr. Sc. thesis, Massey University Library (forthcoming).

24. Wright, A., 'The Development of Unploughable Hill Country', Unpublished M.Agr. Sc. thesis, Massey University Library, 1963.

25. Candler, W.V., 'A New Look at Budgeting from the Standpoint of Linear Programming', Australian Journal of Agricultural Economics, 3,1, 1965, p. 46.

26. Coop, I.E., 'Live Weight, Flushing, and Ewe Fertility', Proceedings of the Ruakura Farmers' Conference Week, 1964, p.69.

27. Collin, F.H., 'Interim Report on Results from Tangoio and Waerenga-o-kuri Stocking Rate Trials', New Zealand Agricultural Science, 1, 5, March 1966, p.9.

28. Suckling, F.E.T., 'Hill Pasture Improvement', Newton King Group of Companies and the New Zealand D.S.I.R., 1965.

29. Suckling, F.E.T., 'Stock Rate Trials at Te Awa', Massey University Sheep Farming Annual, 1964.

30. Tripe, J.N., 'Rapid Production Increases Possible on Wanganui Hills', Proceedings of the New Zealand Grassland Association, 1965, p.38.

31. Inglis, J.A.H., 'Pathfinding in Hill Country Sheep and Wool Production', Massey University Sheep Farming Annual, 1965, p.7.

32. Burgess, A.C., 'Carrying More Ewes on Hill Country', Proceedings of the Ruakura Farmers' Conference Week, 1965, p.70.

33. Heady, E.O., 'Economics of Agricultural Production and Resource Use', Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1952.

34. Ward, J.T., and Parkes, E.D., 'An Economic Analysis of Large-Scale Land Development for Agriculture and Forestry', Agricultural Economics Research Unit, Lincoln College, Publication No. 27, 1966.

35. McArthur, A.T.G., 'Profitability of a Recommended Strategy for Development on Two Banks Peninsula Farms', Agricultural Economics Research Unit, Lincoln College, Publication No. 10, 1965.

36. Holden, J.S., 'The Economics of Hill Country Development', Proceedings of the New Zealand Grassland Association, 1965, p.64.

37. Candler, W.V., 'Incentives for Increased Output of Farm Products', Proceedings of the Lincoln College Farmers' Conference, 1964.

38. Payne, W.G., 'The Standard Value System of Livestock Costing in New Zealand', Discussion Paper No. 43, Department of Farm Management and Agricultural Economics, Massey University, April, 1966.

39. New Zealand Inland Revenue Department, 'Farmers' Tax Guide', Publication I.R. 292, Government Printer, Wellington, New Zealand, 1966 .

40. Reder, M.W., 'Studies in the Theory of Welfare Economics', Columbia University Press, New York, 1959.

41. Milne, A.C., 'A Study of Labour Productivity on North Island Sheep Farms', M.Agr. Sc. thesis, Massey University (forthcoming).

42. Heady, E.O, and Dillon, J.L., 'Agricultural Production Functions', Iowa State University Press, Ames, Iowa, 1961.

43. Cochran, W.G., and Cox, G.M., 'Experimental Designs', Second Edition, John Wiley and Sons, Inc., New York, 1957.

44. Snedecor, G.W., 'Statistical Methods', Fifth Edition, Iowa State University Press, Ames, Iowa, 1956.

45. Lloyd, A.G., 'Fodder Conservation in the Southern Tablelands Wool Industry', Review of Marketing and Agricultural Economics', 27, 1, March 1959, p.5.

46. Agricultural Development Conference, 'Report of the Targets Committee', Government Printer, Wellington, New Zealand, March 1964.

47. New Zealand Meat Producers Board, 'Forty-fourth Annual Report and Statement of Accounts', Wellington, New Zealand, August 1966.

48. Heady, E.O., and Candler, W., 'Linear Programming Methods', Iowa State University Press, Ames, Iowa, 1958.

49. Pearse, H.C.H., and Humphries, K.R., 'Reducing Fencing Costs on Hill Country', _Massey University Sheep Farming Annual_, 1966, p.225.

50. Gruen, F.H., and Pearse, R.A., 'Aerial Pasture Improvement', New South Wales Department of Agriculture, 1959.

51. Andrew, J.C., 'Some Thoughts on Farm Labour Problems in New Zealand', _Massey University Sheep Farming Annual_, 1962, p.57.

APPENDIX A

LETTER SENT TO SURVEY FARMERS

This appendix contains a facsimile of the letter that was sent to all farmers who were selected in the farm survey.

The Letter

Dear Sir,

You may have read or heard that I will be making a Survey of Farm Management in Wairoa County in the near future. The work is being sponsored by the Department of Agriculture with additional guidance from the Farm Management Department of Massey University.

In case you are unfamiliar with the aims of the survey, a brief summary follows:-

1. To provide information on the present systems of farming, levels of production, and incomes.

2. To provide information on farmers' views concerning management problems and land development, together with their thoughts on the possibilities of increasing production in the County.

3. To estimate the potential production levels in the County together with an assessment of the profitability of development and total resource requirements to achieve the potential.

The Survey technique will involve visits to a number of farmers, conversation with them, a look over their farms, and examination of stock records and financial accounts.

Your farm has been suggested to me as one well worth visiting. I hope that such a visit will meet with your approval because I am sure that a talk with you about farming in general, and development in particular, will be of considerable benefit to the Survey.

I would be very grateful if you would think the matter over. I will telephone you within the next two weeks to discover your reaction to my proposal. If your reaction is favourable we should be able to arrange a suitable date for my visit.

Yours faithfully,

R.W. Cartwright

APPENDIX B

THE DATA SHEET

This appendix contains a facsimile of the data sheet used to record information on farms during the Wairoa Management Survey. (The reader is reminded that this sheet was used only for recording, and was not regarded as a questionnaire)

WAIROA MANAGEMENT SURVEY

Category: Valn.Roll No:

Name: Valuation:

Tenure:

Date of Possession:

Total area: Altitude:

Grassed area: Rainfall:

Location & amenities:

Land Classification (as at ______________)

	Productive	Unproductive - Capable of Dev.	Waste	Total	Soil Type
Flat & Rolling					
Steep ploughable					
Unploughable					

Erosion:

Water Supply:

Internal Access:

External Access (special problems):

Labour:

Stock Management:

Pasture Management:

(a) Topdressing practices

(b) Subdivision

(c) Grazing policies

Cropping and Supplementary Feeding:

Details of Farm Development:

(a) Date started

(b) Plans and methods of development

(c) Financial arrangements

(d) Present stage of development

(e) Potential production level

(f) Alternative methods of development

(g) Factors limiting development

Livestock Data

Livestock Wintered

	Losses	
Ewe hgts		
2T ewes		
4T ewes		
6T ewes		
4Y ewes		
5Y ewes		
5Y+ ewes		
Wth hgts		
Other hgts		
Rams		
Brdg cows		
Hfr R1Y		
Hfr R2Y		
St R1Y		
St R2Y		
St R3Y		
Bulls		

Lambing %

Calving %

Breeds:

Stock Purchases

Ewes	
Rams	
Bulls	
Other	

Stock Sales

Fat lambs	
Store lambs	
Wths	
2T ewes	
CFA ewes	
Fat ewes	
Weaners	
Steers	
CFA cows	
Other	
Wool	

Financial Summary:

1. Current Working Accounts
   (a) Expenditure

Wages	Perm.	
	Casl.	
Stock Purch.		
Manure		
Lime		
Seeds		
Contract		
Fuel & Oil		
Cartage		
Car Exp.		
Shearing etc.		
Stock health		
Other Exp.		
R.& M.		
Electricity		
Tel & Mail		
Acctcy.		
Rates		
Insurance		
Interest		
Mortgage		

Taxation	
Other	

(b) Income

Wool	
Sheep	
Cattle	
Other	

2. Indebtedness

Bank O/D	
SAC	
ML	
Other	

Application for Access to Accounts:

____

____

____

Please make available to Mr. ____________________ any of my papers and accounts which apply to his Survey.

Signed: ____________________

APPENDIX C

ISO - STOCKING RATE CURVES

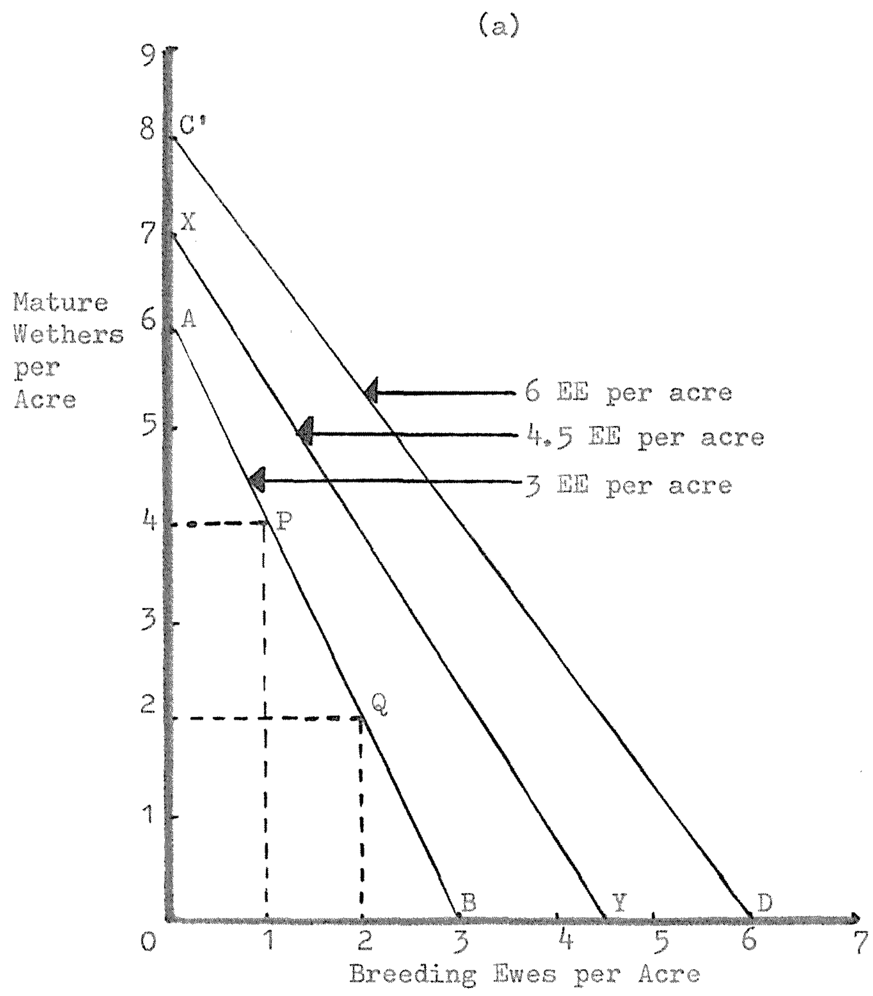
The ideas expressed in this Appendix were prompted by the need to explain the convention, that is used in the text, for the conversion of adult wethers to ewe equivalents (EE). In the following discussion, this convention, a description of which appears in Section 4.61, is used to illustrate the concept of iso-stocking rate curves.

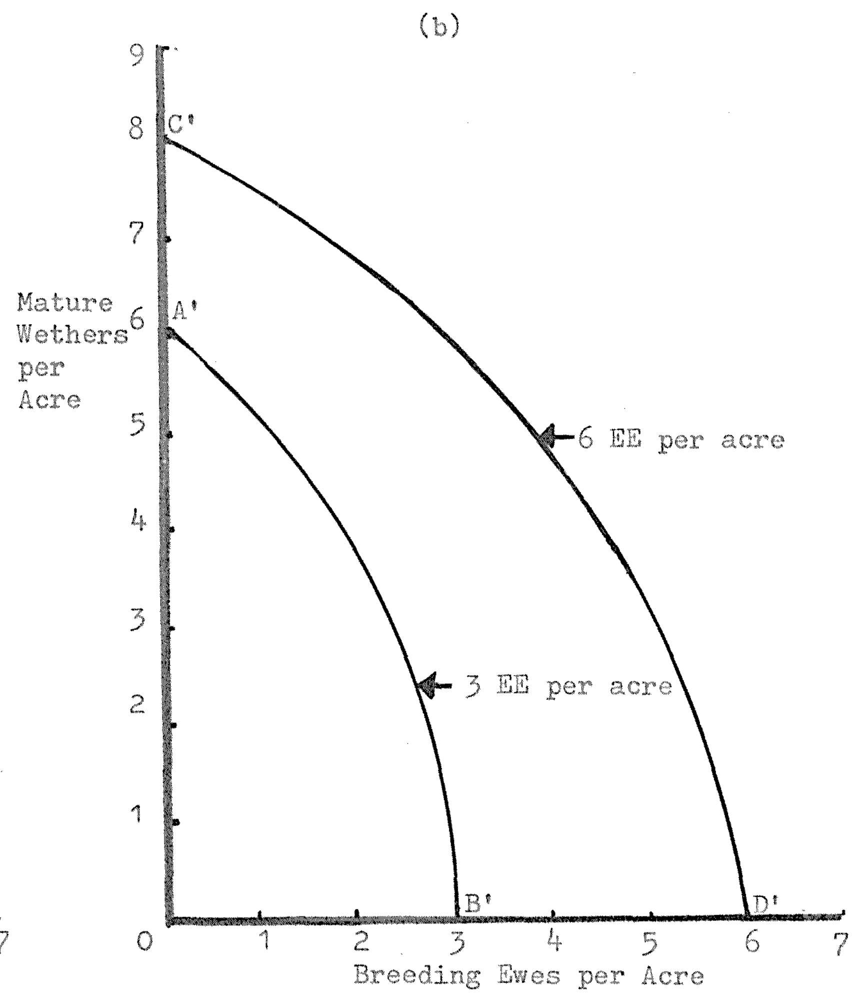
The convention states, *inter alia*, that a stocking rate of 6 adult wethers per acre is equivalent to 3 EE per acre. The stocking rate of 6 adult wethers per acre is represented by point A in Figure C.1 (a). Point B in the same figure represents a stocking rate of 3 breeding ewes per acre, or 3 EE per acre. Hence A and B may be regarded as two points on the '3 EE iso-stocking rate curve for adult wethers and breeding ewes.' In figure C.1 (a) this curve is linear between A and B; thus any point on the line AB represents a combination of adult wethers and breeding ewes which represent 3 EE.

The point P on AB implies that if a farmer runs adult wethers and breeding ewes in the ratio of four to one, while stocking them at an average of five animals per acre, the overall stocking rate will be 3 EE per acre. Similarly, at the point Q, an overall stocking rate of 3 EE per acre is obtained when adult wethers and breeding ewes are run in equal numbers at an average rate of four animals per acre.

Another rule stated by the convention is that a stocking rate of 8 adult wethers per acre is equivalent to 6 EE per acre. Therefore, points C and D in figure C.1 (a) are on the '6 EE iso-stocking rate curve', and, persisting with the assumption of linearity, this 'curve' is represented by the line CD.

Figure C.1 Breeding Ewe-Mature Wether Iso-stocking Curves





Let us accept a further assumption; that the rate of increase in the adult wether conversion coefficient is linear between 3 EE per acre and 6 EE per acre. Now place a point, say X, anywhere between A and C, and place another point, Y, between B and D, such that $\frac{AX}{XC} = \frac{BY}{YD}$. The line XY is then an iso-stocking rate 'curve'. In particular, the line XY in figure C.1 (a) is the 4.5 EE per acre iso-stocking rate 'curve'. By constructing similar 'curves', it is possible to find the overall stocking rate of any combinations of adult wethers and breeding ewes, subject to the conditions that the wethers are stocked at rates between six and eight per acre, and that the breeding ewes are stocked at rates between three and six per acre.

Up to this stage, the assumption that the iso-stocking rate 'curves' are, in fact, linear has been accepted. In other words, the marginal rate of substitution [1] of adult wethers for breeding ewes has been assumed to be constant for any one overall stocking rate. While there is no empirical evidence to indicate the contrary, it is intuitively more reasonable to expect non-linear relationships. In particular, the author would expect the curves to 'bow out' from the origin [2] in the general manner shown in figure C.1 (b). In this figure, the curves A'B' and C'D' are the non-linear counterparts of AB and CD in figure C.1 (a).

In spite of the suspected shortcomings of the linear analysis illustrated by figure C.1 (a), the author considers that it represents a considerable advance over previous fixed conversion coefficients for adult wethers.

---

1. The 'marginal rate of transformation' is a term used in production economics to explain the relationship between products on a 'production possibility curve'. The iso-stocking rate curves discussed in this Appendix are directly analagous to two-product production possibility curves.

2. This could be more rigorously explained as a 'diminishing marginal rate of substitution of breeding ewes for adult wethers.'

APPENDIX D

ANALYSIS OF FARM INCOMES

This Appendix illustrates, by means of a worked example, the procedure that was used to analyse the Random Farm Incomes in Section 4.8 of Chapter 4.

D.1 The Data

Hypothetical data is used in the worked example. Suppose that the data contained in Table D.1 was obtained from a farmer's accounts and other records during a farm survey interview.

Table D.1 Annual Financial Data from a Hypothetical Farm

Item	Amount	Item	Amount
Expenditure		Revenue	
(1) Wages	800	(19) Wool Sold	4,500
(2) Fertiliser	700	(20) Stock Sold	3,750
(3) New Fencing	300	(21) Skins Sold	50
(4) Bulldozing	150	Book (Statutory) Depreciation	220
(5) Shearing Expenses	400	Standard Value Change	
(6) Stock Health Expenses	80	Increase in aggregate livestock standard value	330
(7) Cartage	80	Taxation Exemptions	
(8) Fuel and Oil	160	(a) Income Tax Exemptions:	
(9) Car Exp. (farm business)	70	Personal (farmer, wife, two dependent children)	780
(10) Repairs and Maintenance	250	Life Insurance Premiums	110
(11) Electricity	50	(b) Social Security Tax	104
(12) Administration	100	Fixed Capital Repayments	525
(13) Insurance	30		
(14) Rates	100		
(15) Interest	250		
(16) Stock Purchases	350		
(17) New Plant	30		
(18) New Buildings	300		

D.2 The Computations

The first set of computations are made directly upon data of the type that appears in Table D.1. These computations analyse the actual income on the farm, and they were used to derive Section I of Table 4.10.

The computations are then repeated after excluding expenditure on farm development. This procedure, which was used to derive Section II of Table 4.10, provides an estimate of the income that the farmer would have received if he had not invested in farm development.

D.21 Section I

The computations are:

(i) Compute Gross Cash Income, the sum of items (19), (20), and (21) in Table D.1. That is,

Gross Cash Income = £4,500 + £3,750 + £50 = £8,300.

(ii) Compute Cash Expenditure, which includes all cash outgoings except tax and capital repayments. Hence Cash Expenditure is the sum of items (1) to (18) inclusive in Table D.1. That is,

Cash Expenditure = £4,200.

(iii) Compute Taxation. The following steps are involved in the computation of the tax paid by an individual farmer:

(a) Compute Gross Taxable Income which is the sum of Gross Cash Income and Standard Value Change. That is,

Gross Taxable Income = £8,300 + £330 = £8,630.

(b) Compute Tax-deductible Expenditure, which is the sum of all deductible expenditure items in Table D.1. In fact, all items except New Plant and New Buildings are deductible. Hence,

Tax-deductible Expenditure = £3,870.

(c) Compute Net Taxable Income by subtracting both Tax-deductible Expenditure and Book Depreciation from Gross Taxable Income. Hence,

Net Taxable Income = £8,630 - £3,870 - £220 = £4,540.

(d) Compute Income Tax. Assessable Taxable Income is found by subtracting both Personal Income Tax Exemptions and Life Insurance Premiums from Net Taxable Income. That is,

Assessable Taxable Income = £4,540 - £780 - £110 = £3,650.
(Income Tax)

Hence,

Income Tax = £1,238

(e) Compute Social Security Tax. The Assessable Taxable Income for this is found by subtracting the Social Security Tax exemption from Net Taxable Income. That is,

Assessable Taxable Income = £4,540 - £104 = £4,436
(Social Security Tax)

Hence, .

Social Security Tax = £333.

(f) Therefore,

Total Taxation = £1,238 + £333 = £1,571.

(iv) Compute <u>Owner's Drawings</u>, which, as explained in Section 4.8 of the text, is found by subtracting Cash Expenditure, Taxation, and Fixed Capital repayments, from Gross Cash Income. Therefore,

Owner's Drawings = £8,300 - £4,200 - £1,571 - £525 = £2,004.

(v) Estimate the <u>Capital Increment</u>, which is the sum of expenditure items that are considered to be associated with farm development. The items that were considered to be eligible are listed in Section 4.8 of the text. In the present example, the expenditure items comprising Capital Increment are:

(a) New Fencing,

(b) Bulldozing (which, it is assumed, represents dam and track construction),

(c) £200 of Fertiliser expenditure (The average expenditure on fertiliser in the previous two years is assumed to be £500),

(d) New Plant, and

(e) New Buildings.

That is,

Capital Increment = £300 + £150 + £200 + £30 + £300 = £980.

D.22 Section II

The computations in this section, which ignores farm development expenditure, are basically similar to the computations in Section I. Except where new procedures are used, the detailed descriptions in Section I is not repeated.

The computations are:

(i) Compute Gross Cash Income, as before. Hence,

Gross Cash Income = £8,300.

(ii) Compute Static Cash Expenditure, which is the sum of all expenditure items in Table D.1 except those items which represent farm development expenditure. These latter items are, of course, those which comprise Capital Increment. Hence Static Cash Expenditure is obtained by subtracting Capital Increment from Cash Expenditure.

That is,

Static Cash Expenditure = £4,200 - £980 = £3,220.

(iii) Compute Taxation. The computations are identical to those for taxation in Section I, except that Cash Expenditure is replaced by Static Cash Expenditure.

(That is, since farm development expenditure is ignored, it is not a tax-deductible item). Therefore:

(a) Gross Taxable Income = £8,300 + £330 = £8,630.

(b) Tax-deductible Expenditure is equal to Static Cash Expenditure because all non-deductible expenditure items have already been excluded as part of development expenditure.

Thus,

Tax-deductible Expenditure = £3,220.

(c) Net Taxable Income = £8,630 - £3,220 - £220 = £5,190.

(d) Assessable Taxable Income (Income Tax) = £5,190 - £780 - £110 = £4,300

Hence, Income Tax = £1,628.

(e) Assessable Taxable Income (Social Security Tax) = £5,190 - £104 = £5,086

Hence,

Social Security Tax = £381.

(f) Total Taxation = £1,628 + £381 = £2,009.

(iv) Compute Owner's Drawings, which is found by subtracting Static Cash Expenditure, Taxation, and Fixed Capital Repayments, from Gross Cash Income. That is,

Owner's Drawings = £8,300 - £3,220 - £2,009 - £525 = £2,546.

Under the assumption that there is no expenditure on farm development, Capital Increment must obviously be zero.

D.23 Section III

As explained in Section 4.8 of the text, Net Annual Investment is calculated by subtracting the Owner's Drawings in the 'real' situation (that is, from Section I) from the Owners drawings computed under the 'no-development' assumption (Section II). Hence, in the example,

Net Annual Investment = £2,546 - £2,004 = £542.

Our hypothetical farmer diverted this sum of £542 from consumption (that is, drawings) in order to invest in farm development. Actually, £980 was spent on farm development, but the tax saved as a result of this expenditure was £438.

APPENDIX E

COMMENTS ON TWO MEASURES OF PROFITABILITY

This Appendix briefly reviews the inherent shortcomings in the 'Internal Rate of Return' and the 'Return on Capital', two methods that have been used by other workers to evaluate the profitability of farm development programmes.

E.1 The Internal Rate of Return

This measure has been used by Gruen and Pearse [50]. Consider a farm development programme which generates a stream $c_1, c_2, \ldots, c_{n-1}$, of typically unlike annual development profits (which may be positive or negative - that is, deficits) occurring at the end of each year and a stream of like annual development profits occurring at the end of each year from n to infinity. Then the Internal Rate of Return of the programme is obtained by solving equation (E.1) for r, the interest rate (expressed as a decimal) used in discounting. [1]

$$\frac{c_1}{1+r} + \frac{c_2}{(1+r)^2} + \ldots + \frac{rc_{n-1} + c_n}{r(1+r)^{n-1}} = 0 \qquad (E.1)$$

Analytically, the Internal Rate of Return has three serious shortcomings.

(i) An nth-order polynomial may have up to n real roots, each one of which may be interpreted as the 'internal rate of return'. That is, solution of equation (E.1) may yield up to n interest rates which discount the stream of development profits to zero present value. Moreover, there is no *a priori* reason for choosing any patricular one of these roots. Of course, it is possible for an equation such as (E.1) to have only one real root, in which case this dilemma is somewhat fortuitously avoided.

---

1. The reader will notice that equation (E.1) is similar in form to equation (6.8) in Chapter 6, except that PV has been set equal to zero.

(ii) Solution of equation (E.1) for r implies that any cash inflow (that is, borrowing) is charged interest at a rate equal to the internal rate of return, and that cash surpluses are invested at the same rate. The actual investment situation is unlikely to coincide with these assumptions.

(iii) The derivation of an internal rate of return prompts statements such as: 'this farm development programme has a zero present value when the interest rate is x%'. The analyst (and the farmer) should obviously be concerned with the programme's present value when the market interest rate is used in discounting. Thus the internal rate of return is irrelevant unless it happens to be equal to the market interest rate.

E.2 Return on Capital

Both Wright [24] and Graham [22] have used a measure generally known as the 'Return on Capital'. The derivation of Return on Capital involves the following steps:

(i) Computation from budgets of a stream $p_1, p_2, \ldots, p_{n-1}$, of typically unlike annual development cash profits (that is, the added profits resulting from development, they may be positive or negative), and a stream of like annual development cash profits extending from the year n to infinity. If these profits are accounted at the ends of years, the present value of development profits, PV_p, is given by:

$$PV_p = \frac{p_1}{(1+r)} + \frac{p_2}{(1+r)^2} + \ldots + \frac{rp_{n-1} + p_n}{r(1+r)^{n-1}} \qquad \text{(E.2)}$$

where r is the market interest rate expressed as a decimal. Further, PV_p may be expressed as an annuity; $r.PV_p$,

(ii) Identification of the 'capital expenditure' in each year of development. This stream of n-1 sums (accounted at the ends of years) can be discounted and summed to give the present value of capital expenditure, PV_k :

$$PV_k = \frac{k_1}{1+r} + \frac{k_2}{(1+r)^2} + \ldots + \frac{k_{n-1}}{(1+r)^{n-1}} \qquad (E.3)$$

(iii) Then the Return on Capital is defined as:

$$\text{Return on Capital} = \frac{rPV_p}{PV_k} \times \frac{100}{1} \%$$

The foremost shortcoming of Return on Capital is that there is no clear distinction between maintenance expenditure and capital expenditure. While certain expenditure items such as new fencing, buildings and dam construction are obviously 'capital', there is no obviously 'correct' way of partitioning, for example, topdressing expenditure.

Clearly, Return on Capital is sensitive to the manner in which expenditure is partitioned. Indeed, it may range from a maximum of infinity if all expenditure is classified as 'maintenance' (in which case $k_1 = k_2 = \ldots = k_{n-1} = 0$), to a minimum when all expenditure is regarded as capital. Moreover this range can be traversed by computational manipulation, without any change in the basic data.

While experienced analysts can doubtless evolve rules for making these arbitrary decisions, the difficulty still exists in that different analysts can have different rules. This may result in appreciable variations in the evaluation of any particular development programme. In any case, no analyst can claim that his partition is 'correct'.

Another shortcoming of Return of Investment is that it cannot be used to rank alternative programmes according to their absolute profits. [2] Clearly, a high Return on Capital may indicate high absolute profits, but it may equally well result from low absolute profits if capital expenditure is also very low.

---

2. This feature is, of course, shared by the 'Return on Investment' defined in Chapter 6.

APPENDIX F

SPREADING TAX EXEMPTIONS

(Note: The footnotes in this Appendix will be found on pages F.16, F.17.)

1. Introduction

New Zealand income tax legislation allows some farm development expenditures [1/] to be claimed as exemptions from taxable income in the year they are incurred, or in any of the subsequent four years. That is, a claim for exemption can be made in any of five years, the first eligible year being the one in which the claimed expenditure is actually incurred.

New Zealand income tax is progressive, and hence if interest payments and discounting are ignored, the minimum aggregate tax paid by a farmer over a period will be obtained by minimising the maximum rate of tax liability in any year. In this simple case, the problem of optimising the claims for exemption would involve spreading tax exemptions from years when taxable income is low, to years when it is high.

This Appendix considers the problem of deriving optimum patterns of tax exemption spreads from forecasted budgets of future production. The 'Exact' algorithm, described in Section 2, was used in the Wairoa study to obtain near-optimum spreads. It will be noted that this algorithm cannot accommodate changes in interest payments. Such changes would, of course, occur whenever the tax changes implied by the exemption spreads, alter overdraft. That is, the algorithm assumes that the interest payments made in the 'before-spreading' situation are identical to the payments made after spreading. The author believes that this simplification did not seriously affect the solutions obtained in the study.

The problem will be considered first in its exact form, and later in the absence of interest.

Recognition of interest implies the introduction of the taxation function to the problem, and as will be seen in Section 2, the resulting computations can become burdensome and virtually necessitate the use of an electronic computer for their solution. If interest is ignored, the resulting 'Approximate Problem' avoids computation of taxation, and a relatively simple algorithm is available.

2. Exact Problem

This problem is ; find non-negative numbers $c_1, c_2, \ldots, c_n$, such that:

$$PV_t = \sum_{i=1}^{n} f(t_i - c_i)d^i \qquad \text{min} \tag{1}$$

subject to

$$c_i \leqslant \sum_{j=i-4}^{i} s_j \; ; \; i = 1,2,\ldots,n \; ; \; s_j = 0 \;\; \text{if } j \leqslant 0 \tag{2}$$

and
$$\sum_{i=1}^{k} c_i \leqslant \sum_{j=1}^{k} s_j \; ; \; k = 1,\ldots,n \tag{3}$$

and
$$s_j \geqslant 0 \tag{4}$$

and
$$d = \frac{1}{1+r} \tag{5}$$

where s_j ; $j = 1,2,\ldots,n - 4$, is the expenditure incurred in year j that is claimable as a tax exemption in any of the years j, j + 1, j + 2, j + 3, j + 4,

c_i ; $i = 1,2,\ldots, n$, is the amount of spreadable exemption that is claimed in the year i,

t_i ; $i = 1,2,\ldots,n$, is the taxable income in year i if $c_i = 0$,

$f(t_i - c_i)$ is the function [2] expressing tax liability in the year i in terms of taxable income $(t_i - c_i)$,

d is the discount rate,

r is the interest rate expressed as a decimal, and

PV_t is the present value of tax paid to the end of the nth year.

An algorithm for this problem is now discussed. Since the procedure is unsuitable for use on desk calculators, only the principles are presented.

The algorithm begins by setting

$$c_i = s_j \text{ ; } i = j = 1,2,\ldots, n - 4, \text{ and} \tag{6}$$

$$c_i = 0 \text{ ; } i = n - 3, n - 2, n - 1, n. \tag{7}$$

That is, none of the potentially spreadable tax exemptions are spread forward. A small unit, [3] Ω, of spreadable tax exemption is now defined, and an iterative procedure is initiated. In the first iteration, attention is focussed on identifying the pair of years between which a feasible transfer, Ω, of spreadable exemption, would reduce PV_t by the greatest amount. When this pair of years has been identified, the transfer between them is actually made. This completes the first iteration. In the second iteration, the transfer of a second unit, Ω, of spreadable exemption is considered. As in the first iteration, a transfer is made such that the maximum reduction in PV_t is obtained.

This procedure is continued until either,

(A) No further feasible transfer of spreadable exemption can be made, or

(B) Feasible transfers are possible, but none of them would result in a reduction in PV_t.

When either of the conditions (A) or (B) is satisfied, the required solution has been found. It may be noted that the algorithm is parametric. That is, the algorithm automatically provides optimum solutions for all values of total exemptions between zero and the value corresponding to (A) or (B) above.

The basic steps in the algorithm are now considered in greater detail.

Step I

Claim all spreadable exemptions in the earliest possible year, as illustrated by equations (6) and (7).

Step 2

Identify the pair of years between which a feasible transfer, Ω, of spreadable exemption will result in the maximum possible reduction in PV_t. That is, examine in turn the effect on PV_t of transferring Ω from each $s_j \geqslant \Omega$; $j = 1,2,\ldots,n-4$. The procedure for examining the effect of a transfer from the jth year is:

(i) Evaluate

$$PV_{t_j} = f(t_j - c_j)\, d^j \text{, and} \tag{8}$$

$$PV_{t_{j+k}} = f(t_{j+k} - c_{j+k})\, d^{j+k} \tag{9}$$

where PV_{t_j} and $PV_{t_{j+k}}$ are the present values of tax payable in the jth and $(j + k)$th years respectively.

(ii) Now make trial transfers of spreadable exemption such that

$$c'_j = c_j - \Omega \text{, and} \tag{10}$$

$$c'_{j+k} = c_{j+k} + \Omega. \tag{11}$$

Hence obtain $PV_{t'_j}$ and $PV_{t'_{j+k}}$

(iii) Since a transfer from s_j can be accepted by <u>any one</u> of c_{j+k} ; $k = 1,2,3,4$, it is clear that the four possible changes in PV_t are given by

$$b_{j+k} = (PV_{t_{j+k}} - PV_{t'_{j+k}}) - (PV_{t'_j} - PV_{t_j}) \; ; \; k = 1,2,3,4. \qquad (12)$$

where b_{j+k} is the change in PV_t that would result from a transfer of Ω from the jth year to the (j+k)th year. PV_t would be <u>reduced</u> when $b_{j+k} > 0$.

(iv) Thus the <u>maximum</u> reduction in PV_t provided by a transfer of Ω from the jth year is

$$B_j = \max_k (b_{j+k}) \; ; \; k = 1,2,3,4 \; ; \; b_{j+k} > 0 \qquad (13)$$

We may define $B_j = 0$ if $b_{j+k} \leqslant 0$; $k = 1,2,3,4$. If $B_j = 0$, proceed to (vi), otherwise denote the pair of years between which a transfer Ω yields the change, B_j, in PV_t by j and $(j + k^*)$.

(v) Record B_j, j, and $(j + k^*)$, reset all c_i ; $i = 1,2,\ldots,n$, and s_j ; $j = 1,2,\ldots,n - 4$, to their values prior to the trial transfer,

(vi) Make a trial transfer from some other year.

<u>Step 3</u>

When trial transfers have been made from <u>all</u> years satisfying $s_j \geqslant \Omega$, locate

$$M = \max_j B_j \; ; \; j = 1,2,\ldots,n - 4 \qquad (14)$$

(Note that we may regard $B_j = 0$ if $s_j < \Omega$). If $M = 0$, condition B is satisfied, and the required solution has been found, but if $M > 0$, denote the year associated with M by j^*. A transfer, Ω, of spreadable exemption, will give a <u>maximum</u> reduction in PV_t if the transfer is made from year j^* to year $(j^* + k^*)$. Hence, make the following <u>permanent</u> changes:

(i) Reduce s_{j^*} by Ω,

(ii) Reduce c_{j^*} by Ω, and

(iii) Increase $c_{j^*+k^*}$ by Ω.

Now return to Step 2. and iterate Steps 2 and 3 until either condition (A) or condition (B) above, is satisfied.[4]

3. Approximate Problem

This problem is specified by equations (1), (2), (3), (4), and

$$d = 1. \tag{15}$$

Equation (15) defines PV_t as the aggregate tax payment over the n - year period. In this problem, it is convenient to replace the symbol PV_t by T.

It is interesting to note that while the 'Approximate Problem' will yield only approximate solutions [5] when interest rates are positive, it will provide an exact solution if the rate of interest is zero.

The taxation function is progressive, hence aggregate taxation will be minimised if spreadable exemptions are allocated so that the maximum taxable income in any year is minimised. That is, a good start to the solution of the approximate problem could be obtained by replacing the objective (1), with a minimax objective:

$$T = \min_{c_i} \max_i f(t_i - c_i)$$

However this approach is not considered here. The following algorithm for the 'Approximate Problem' bears some resemblence to some algorithms for the Transportation Problem.

The algorithm described here starts from an initial solution in which $c_1, c_2, \ldots, c_n = 0$, thus maximising (1) subject to (2), (3) (4), and (15). It then proceeds by reducing the greatest taxable income to the level of the second highest taxable income by making appropriate claims on spreadable exemptions. This process is repeated until all spreadable exemptions have been allocated, at which point the required solution is obtained.

The algorithm is suitable for computation on a desk machine, and a convenient tableau for use when computing is shown in Table I.

In the tableau, the annual spreadable expenditures are entered in the s row, annual taxable incomes occupy the t-c column, and k_{ij} represents the claim made in the ith year from spreadable exemptions associated with expenditure incurred in the jth year. It is clear that, in the notation of Table I,

$$c_i = \sum_{j=1}^{n} k_{ij} \; ; \; i = 1,2,\ldots,n \tag{16}$$

and that

$$k_{ij} = 0 \tag{17}$$

when $\quad i - 4 > j > i$

Computation proceeds as follows:

<u>Step 1</u> Construct an initial tableau in which

$$c_i = k_{ij} = 0 \; ; \; i, \; j = 1,2,\ldots,n$$

<u>Step 2</u> Direct attention to the t-c column.

Find $M = \max_i (t_i - c_i)$; $i = 1,2,\ldots,n$, and identify all elements in t - c which are equal to M. Denote these p elements $(1 \leq p \leq n)$, by $(t-c)_m$; $m = 1,2,\ldots,p$. Identify the largest non-negative [6] element <u>not</u> equal to m, in t-c. Denoting this element by $(t-c)^*$, compute $D = M-(t-c)^*$. If D = 0 (that is, if p = n) proceeds to Step 3, otherwise go to Step 4.

<u>Step 3</u> If all non-negative elements in the t-c column are equal, arbitrarily assign to D a finite value equal to or greater than the largest element in the s row. Proceed to Step 4.

<u>Step 4</u> It is clear that we wish to make claims from the s_j that will reduce each of the $(t-c)_m$ by an amount equal to D. Moreover, if spreadable exemptions are insufficient to allow such a reduction, we wish to find the amount R^*_m $(0 \leq R^*_m \leq D)$ by which all the elements $(t-c)_m$ may feasibly be reduced. A <u>conservative estimate</u> of R^*_m, denoted r_m, may be established by computing the individually feasible reductions, R_m, as m is successively set equal to 1,2,...,p, and then computing

$$r_m = \min_m (R_m) \quad ; \; m = 1,2,\ldots,p. \qquad (18)$$

Computation of each R_m may be facilitated by use of a "trial claims tableau". This is initially identical to the tableau discussed in Step 2, except that it includes a summation row whose typical element S_j records the sum of claims made from s_j. Table III is an example of a trial claims tableau.

Computation of a representative R_m is now considered. For convenience, suppose that the element of interest in t-c is (t_i-c_i). The steps in computing R_m are:

(a) From the trial tableau, select the column q such that

$$q = i-4 \; ; \; i > 4$$

$$= 1 \quad ; \; i \leq 4$$, and increase k_{iq} in the trial tableau by an increment equal to D.

(b) Compute $S_q = \sum_{i=1}^{n} k_{iq}$. If $S_q \leq s_q$, it is clear that

$R_m = D$.

(c) If, however, $S_q > s_q$, two alternative procedures arise.

If $q = i$, set $R_m = D - (S_q - s_q)$, and reset $S_q = s_q$.

If, on the other hand, $q < i$, compute $U_q = S_q - s_q$, reset $S_q = s_q$, and reduce k_{iq} by U_q. Now transfer attention to the column immediately to the right (that is, increase q by 1) and increase the (new) element k_{iq} by an increment equal to U_q.

(d) Return to step (b) and continue until R_m is found.

Step 5 Find r_m from equation (18). While r_m is the maximum feasible reduction of a particular element, $(t-c)_m$, when all such elements are reduced by their feasible maximums, it could possibly take a higher value when all $(t-c)_m$; 1,2,...,p, are reduced by an amount equal to r_m. Thus r_m is a conservative, but 'safe' estimate of R_m^*.

Returning now to the original tableau, sequentially reduce the $(t-c)_m$; $m = 1,2,\ldots,p$, by r_m. This can be done by using a method essentially similar to that described in Step 3 (a), (b), (c), and (d). Finally reduce each of the elements s_m ; $j = 1,\ldots,n$, by the sum of the new claims made in the jth column.

Step 6 Inspect the s row. If $s_1, s_2, \ldots, s_n = 0$, the required solution has been found.

However, if $s_1, s_2, \ldots, s_n > 0$, examine the s row further and if:

(i) $s_1 = 0$, exclude $(t_1 - c_1)$ from further computations,

(ii) $s_1 = s_2 = 0$, exclude $(t_2 - c_2)$ from further computations,

(iii) $s_1 = s_2 = s_3 = 0$, exclude $(t_3 - c_3)$ from further computations,

(iv) $s_1 = s_2 = s_3 = s_4 = 0$, exclude $(t_4 - c_4)$ from further computations,

(v) $s_j = s_{j+1} = s_{j+2} = s_{j+3} = s_{j+4} = 0$; $j = 4,5,\ldots,n-4$, exclude $(t_i - c_i)$; $i = j + 4$, from further computations.

It is clear that any element of t-c conforming to these conditions is irreducible. A convenient way of excluding such elements from computations is to suppose that they take a temporary negative value. Since no bona fide element in t-c can be negative, this will effectively exclude irreducible elements from further computations.

4. Numerical Example of the Approximate Problem

A numerical example appears in Table II. The computations necessary to complete the first iteration are given in full. The 'trial claims' tableau appear in Table III and the outcome of the first iteration is summarised in Table IV. Finally, the solution to the problem, obtained after four iterations, is given in Table V.

First Iteration

Step 1 Table II summarises the situation where

$$c_i = k_{ij} = 0 \; ; \; i,j = 1,\ldots,7$$

Step 2 By inspection, M = 1,600, and p=3. That is, there are three elements in t-c of magnitude 1,600.

Then $(t-c)^* = 1,400$, from which D = 1,600-1,400 = 200.

Since D 0, we may proceeds to Step 4.

Step 4 Refer now to the trial claims tableau appearing as Table III. This is originally identical to Table II, and modifications are shown by crossing out superseded elements.

Let the p M-elements in t-c be designated by their row numbers; that is, $(t-c)_4$, $(t-c)_5$, and $(t-c)_7$. Dealing first with $(t-c)_4$, increase k_4 by D = 200. Then

$$S_1 = 0 + 0 + 0 + 200 + 0 + 0 + 0 = 200.$$

$S_1 < s_1$, and hence $R_4 = D = 200$

Proceed now to $(t-c)_5$, and increase k_{51} by D = 200. Now

$$S_1 = 0 + 0 + 0 + 200 + 200 + 0 + 0 + = 400$$

Thus $S_1 > s_1$, which is infeasible.

Hence compute

$$U_1 = S_1 - s_1$$

$$= 400 - 300$$

$$= 100$$

reset $S_1 = s_1 = 300$, and reset k_{51}.

That is,

$$k_{51} = 200 - U_1$$

$$= 200 - 100$$

$$= 100.$$

Continue by increasing k_{52} by U_1.

Hence,

$$S_2 = 0 + 0 + 0 + 0 + 100 + 0 + 0 + = 100.$$

Thus $S_2 > s_2$, and hence $R_5 = D = 200$.

Proceed now to $(t-c)_7$, increasing k_{73} by D = 200.

Now, $S_3 = 0 + 0 + 0 + 0 + 0 + 0 + 200 = 200.$

Thus $S_3 > s_3$, which is infeasible.

Hence compute

$$U_3 = s_3 - s_3$$

$$= 200-100$$

$$= 100$$

Reset $S_3 = s_3 = 100$

Now, inspection of the s row indicates that $s_4 = s_5 = s_6 = s_7 = 0$ and thus any further claims are infeasible. Therefore

$$R_7 = D-U_3$$

$$= 200-100$$

$$= 100$$

Step 5 $r_m = \min(R_4, R_5, R_7)$

$$= \min(200,200,100)$$

$$= 100$$

Thus a conservative estimate of the maximum feasible reduction of the three M elements in the t-c column of Table II is $r_m = 100$. By making these reductions the tableau for the second iteration is obtained. This appears as Table IV. It may be noted that, by comparison with the initial tableau (Table II), s_1 has been reduced by 200, which is the sum of new claims made in column 1, and s_3 has been reduced by 100, which is the sum of the new claims made in column 3.

Step 6 Inspection of the s row in Table IV indicates that further reductions to (t_i-c_i) ; $i = 1,\dots,6$, are possible.

Further computations are not given here, but Table V summarises the optimum solution to the problem.

Table I Computational Tableau for 'Approximate Problem'

$s \rightarrow$ / $t-c \downarrow$	s_1	s_2	s_3	s_4	s_5	s_6	...	s_j	...	s_n
t_1-c_1	k_{11}	0	0	0	0	0	...	0	...	0
t_2-c_2	k_{21}	k_{22}	0	0	0	0	...	0	...	0
t_3-c_3	k_{31}	k_{32}	k_{33}	0	0	0	...	0	...	0
t_4-c_4	k_{41}	k_{42}	k_{43}	k_{44}	0	0	...	0	...	0
t_5-c_5	k_{51}	k_{52}	k_{53}	k_{54}	k_{55}	0	...	0	...	0
t_6-c_6	0	k_{62}	k_{63}	k_{64}	k_{65}	k_{66}	...	0	...	0
.	.	.	.	.	.	.	...	0	...	0
.	.	.	.	.	.	.	...	0	...	0
t_i-c_i	0	0	0	0	0	0	...	k_{ij}	...	0
.	.	.	.	.	.	.	...	.	...	0
.	.	.	.	.	.	.	...	.	...	0
t_n-c_n	0	0	0	0	0	0	...	0	...	k_{nn}

Table II Initial Tableau for Numerical Example

		1	2	3	4	5	6	7
Row Number	s	300	800	100	0	0	0	0
	t-c							
1	800	0	0	0	0	0	0	0
2	900	0	0	0	0	0	0	0
3	1,200	0	0	0	0	0	0	0
4	1,600	0	0	0	0	0	0	0
5	1,600	0	0	0	0	0	0	0
6	1,400	0	0	0	0	0	0	0
7	1,600	0	0	0	0	0	0	0

Table III Trial Claims Tableau for First Iteration

		1	2	3	4	5	6	7
Row Number	s	300	800	100	0	0	0	0
	t-c							
1	800	0	0	0	0	0	0	0
2	900	0	0	0	0	0	0	0
3	1,200	0	0	0	0	0	0	0
4	1,600	θ 200	0	0	0	0	0	0
5	1,600	θ ~~200~~ 100	θ 100	0	0	0	0	0
6	1,400	0	0	0	0	0	0	0
7	1,600	0	0	θ ~~200~~ 100	0	0	0	0
	S	θ ~~200~~ ~~400~~ 300	θ 100	θ ~~200~~ 100	0	0	0	0

Table IV Tableau After Completion of First Iteration

		1	2	3	4	5	6	7
Row Number	s / t-c	100	800	0	0	0	0	0
1	800	0	0	0	0	0	0	0
2	900	0	0	0	0	0	0	0
3	1,200	0	0	0	0	0	0	0
4	1,500	100	0	0	0	0	0	0
5	1,500	100	0	0	0	0	0	0
6	1,400	0	0	0	0	0	0	0
7	1,500	0	0	100	0	0	0	0

Table V Solution Tableau for Numerical Example

		1	2	3	4	5	6	7
Row Number	s / t-c	0	0	0	0	0	0	0
1	800	0	0	0	0	0	0	0
2	900	0	0	0	0	0	0	0
3	1,175	0	25	0	0	0	0	0
4	1,175	200	225	0	0	0	0	0
5	1,175	100	325	0	0	0	0	0
6	1,175	0	225	0	0	0	0	0
7	1,500	0	0	100	0	0	0	0

Footnotes

1. See: "Farmers Tax Guide', New Zealand Inland Revenue Department Publication I.R.292, p.20, Government Printer, Wellington, New Zealand, 1966. Items which qualify for expenditure spreading include: clearing land, establishing and improving pastures,

   chemical fertiliser, drainage, soil-erosion control,
   weed and pest eradication, farm roading, farm water supplies,
   airstrip construction, and fencing.

2. In practice the taxation function is linear for taxable incomes less than £500 and greater than £3,600, but comprises thirty-one linear segments for taxable incomes between £500 and £3,600. If the last named part of the function is estimated as three quadratic functions, the tax liability T_i when taxable income in the ith year is $(t_i - \alpha c_i)$, is given by:

$$T_i = .210x_i - 15.600 \quad ; \quad 0 \leqslant x_i < £500$$

$$= 6.903141 + .108739x_i + .000112x_i^2 \quad ; \quad £500 \leqslant x_i < £900 \qquad (R^2 = 1.000000)$$

$$= 2.324120 + .204277x_i + .000056x_i^2 \quad ; \quad £900 \leqslant x_i < £3,050 \qquad (R_2^2 = 1.000000)$$

$$= 103.994030 + .218800x_i + .000062x_i^2 \quad ; \quad £3,050 \leqslant x_i < £3,600 \qquad (R^2 = 0.999780)$$

$$= 1036.900 + .675x_i \quad ; \quad x_i \geqslant £3,600.$$

3. An appropriate unit is £1.

4. It is interesting to note that another approach to the 'Exact Problem' would involve initially setting the interest rate, r, at a 'very high level', thus obtaining an optimum solution that is shown by (6) and (7) Parametric reduction of r would then generate successive optimum solutions with more spreading occurring in each one. This could continue until an optimum solution was found for the interest rate associated with a particular problem.

If we set r = 0, then 'Exact Problem' is, of course, identical to the 'Approximate Problem' that is described in Section 3.

5. When interest rates are recognised, it becomes relatively less profitable to spread expenditure forward. Thus when interest rates are positive, the 'Approximate Problem' will tend to give 'solutions' that overestimate the spreading required.

6. The condition of non-negativity is necessary because, as explained in Step 6, irreducible elements of t-c are excluded from consideration by temporarily assigning them negative values.

APPENDIX G

BUDGETS FOR CASE DEVELOPMENT PROGRAMMES

This Appendix contains the budgets upon which the case programme evaluations in Chapter 7 were based. Most of the budgets were developed from farmers' accounts and records, but in some instances forecast budgets were required. In the latter case, the budgets were drawn up by the author, often with the co-operation of the farmers concerned. The costs and prices used in the budgets conformed tc the assumptions stated in Section 7.21.

The budgets are self explanatory, although it should be noticed that interest is not included. This is because interest was actually calculated during the course of each evaluation. (See Chapter 6, Section 6.723 for an example calculation of interest).

Budgets for the Base Year, each year of the Development Period, and the New Equilibrium situation are included for each programme.

Table G.1 Budgets for Case Development Programme I

	Base Year	Development Period 1	2	3	4	New Eqbm.
Income						
Wool Sold	725	1,168	1,560	1,822	1,840	1,840
Stock Sold	723	681	1,629	2,045	2,384	2,384
Gross Cash Income	1,448	1,849	3,189	3,867	4,224	4,224
Cash Expenditure						
Stock Purchased	215	857	955	985	940	940
Fertiliser	-	675	758	765	510	510
New Fencing	-	600	-	-	-	-
Seed	-	169	110	-	-	-
Weedspray	25	25	25	25	25	25
Cartage	136	154	174	187	193	193
Shearing	116	151	195	230	227	227
Stock Health	54	77	103	115	120	120
Fuel and Oil	139	140	145	150	150	150
Fodder (hay)	20	80	80	80	80	80
Repairs and Maint.	135	192	258	287	300	300
Electricity	18	25	30	35	35	35
Rates	29	30	30	30	30	30
Insurance	27	30	30	30	30	30
Administration	62	60	60	60	60	60
New Machinery	20	20	20	20	20	20
Total Cash Expenditure (excl. Interest)	996	3,285	2,973	2,999	2,720	2,720
Book Depreciation	196	196	196	196	196	196

Table G.2 Budgets for Case Development Programme II

	Base Year	Development Period					New Eqbm.
		1	2	3	4	5	
Income							
Wool Sold	1,945	1,912	2,188	2,314	2,585	2,873	2,873
Stock Sold	2,135	2,531	2,261	3,421	3,022	4,124	4,124
Gross Cash Income	4,080	4,443	4,449	5,735	5,607	6,997	6,997
Cash Expenditure							
Wages	-	-	-	58	371	370	370
Stock Purchased	175	1,593	1,073	300	550	300	300
Fertiliser and Seed	105	574	501	760	981	830	830
Cultivation Contract	-	89	364	378	90	90	90
Scrub Cutting	50	-	-	-	399	-	-
New Fencing	-	250	700	850	1,050	-	-
Tracks and Dams	-	52	100	58	-	-	-
Water Supplies	-	-	-	394	-	-	-
Fuel and Oil	100	130	83	760	242	200	200
Cartage	225	229	237	536	355	370	370
Shearing	170	165	171	350	367	395	395
Repairs and Maint.	115	78	136	310	551	165	165
Electricity	60	62	71	78	80	85	85
Accountancy	60	60	60	60	65	65	65
Rates	65	65	63	68	65	65	65
Insurance	30	47	25	22	38	40	40
Working Expenses	330	384	264	399	482	485	485
New Plant and Machinery	15	-	-	12	582	20	20
Total Cash Expenditure (excl. Interest)	1,500	3,778	3,848	4,999	6,268	3,090	3,090
Book Depreciation	230	306	225	203	306	364	300

Table G.3 Budgets for Case Development Programme III

	Base Year	Development Period						
		1	2	3	4	5	6	7
Income								
Wool Sold	2,667	2,795	2,713	3,170	4,633	5,112	5,681	6,311
Stock Sold	3,845	3,639	3,628	3,999	4,236	4,314	5,123	6,065
Gross Cash Income	6,512	6,434	6,341	7,169	8,869	9,426	10,804	12,376
Cash Expenditure								
Stock Purchased	285	150	1,818	480	630	540	450	750
Wages	50	605	723	756	760	760	760	1,000
Fertiliser	555	248	615	623	855	1,185	1,215	1,185
Scrub Cutting	-	-	-	400	-	-	-	300
Cultivation Contract	-	1,875	1,920	-	840	1,250	875	750
New Fencing	-	310	360	465	330	840	600	300
Fuel and Oil	275	247	260	300	320	350	350	360
Cartage	50	60	60	65	70	73	84	93
Car Expenses (farm business)	110	114	125	138	150	150	150	150
Shearing	400	401	426	487	556	653	737	828
Working Expenses	275	412	299	464	413	455	494	518
Repairs and Maint.	205	308	220	465	280	295	310	330
Electricity	50	50	50	62	65	65	70	70
Accountancy	60	60	60	60	60	60	60	60
Rates	193	193	193	193	193	193	193	193
Rent	93	93	93	93	216	216	216	216
New Machinery and Plant	30	30	30	35	35	45	45	50
New Buildings	-	-	-	-	-	-	-	800
Table Mortgage Repayments	525	525	525	525	525	525	525	525
Total Cash Expenditure (excl Interest)	3,196	5,653	7,853	5,709	6,398	7,755	7,234	8,578
Book Depreciation	650	650	650	650	650	650	650	690

Table G.3 continued

	Development Period					New Eqbm.
	8	9	10	11	12	
Income						
Wool Sold	6,831	7,259	7,819	8,156	8,238	8,238
Stock Sold	7,280	7,864	8,267	9,253	9,445	9,445
Gross Cash Income	14,111	15,123	16,086	17,409	17,683	17,683
Cash Expenditure						
Stock Purchased	645	645	705	600	600	600
Wages	1,000	1,000	1,000	1,000	1,000	1,000
Fertiliser	1,815	1,815	1,710	1,710	1,710	1,710
Scrub Cutting	-	-	-	-	-	-
Cultivation Contract	1,125	-	-	-	-	-
New Fencing	-	-	-	-	-	-
Fuel and Oil	360	370	370	370	370	370
Cartage	103	109	115	122	122	122
Car Expenses (farm business)	150	150	150	150	150	150
Shearing	919	998	1,069	1,139	1,183	1,183
Working Expenses	542	566	585	615	615	615
Repairs and Maint.	340	350	350	350	350	350
Electricity	75	75	75	75	75	75
Accountancy	60	60	60	60	60	60
Rates	193	193	193	193	193	193
Rent	216	216	216	216	216	216
New Machinery and Plant	50	660	60	60	760	60
New Buildings	-	-	-	-	-	-
Table Mortgage Repayments	525	525	525	525	525	525
Total Cash Expenditure (excl. Interest)	8,218	7,831	7,283	7,985	7,329	7,329
Book Depreciation	690	910	865	1,200	800	800

Table G.4 Budgets for Case Development Programme IV

	Base Year	Development Period						New Eqbm.
		1	2	3	4	5	6	
Income								
Wool Sold	5,037	5,050	5,383	6,115	6,002	6,337	7,250	7,259
Stock Sold	7,510	4,624	6,990	3,912	10,282	7,018	6,956	8,585
Gross Cash Income	12,547	9,674	12,373	10,027	16,284	13,355	14,206	15,844
Cash Expenditure								
Stock Purchased	525	375	240	390	540	1,260	675	675
Wages	2,145	2,259	2,256	1,669	1,999	1,853	1,910	1,910
Fertiliser and Seed	525	1,159	813	-	1,632	2,017	1,267	1,235
Cultivation Contract	-	-	-	-	322	574	-	-
Water Supply	-	-	-	-	-	87	758	-
New Fencing	-	601	648	872	1,071	1,538	-	-
Scrub Cutting	150	1,479	37	147	405	487	636	200
Fuel and Oil	10	10	20	11	8	11	11	12
Cartage	430	522	266	432	539	525	407	500
Shearing	700	704	929	1,064	928	993	1,250	1,250
Stock Health	220	208	144	368	277	311	310	310
Repairs and Maint.	545	340	378	249	249	861	894	850
Electricity	140	138	216	141	119	123	153	150
Rates	250	265	277	255	180	217	215	220
Insurance	85	91	87	34	102	76	73	75
Fodder	50	112	-	48	49	76	43	75
Working Expenses	320	335	314	278	338	336	376	376
Total Cash Expenditure (excl. Interest)	6,095	8,598	6,625	5,478	8,778	11,345	8,978	7,838
Book Depreciation	200	226	215	200	176	174	289	200

Table G.5 Budgets for Case Development Programme V

	Base Year	Development Period 1	2	3	4	5	New Eqbm.
Income							
Wool Sold	1,481	1,605	2,067	2,435	2,802	3,179	3,179
Stock Sold	2,469	2,747	2,133	2,189	2,368	3,434	3,434
Gross Cash Income	3,950	4,352	4,200	4,624	5,170	6,613	6,613
Cash Expenditure							
Stock Purchased	175	60	150	50	100	190	190
Fertiliser	-	-	452	833	1,015	1,160	1,085
Seed	-	-	-	-	457	-	-
Cultivation Contract	-	-	-	-	32	-	-
Scrub Cutting	-	100	-	225	-	-	-
New Fencing	-	-	-	-	624	375	-
Bush Felling	-	-	-	-	1,313	-	-
Fuel and Oil	90	115	110	125	168	120	120
Cartage	95	108	120	115	117	130	130
Car Expenses (farm business)	51	288	157	97	100	100	100
Shearing	190	253	202	292	441	500	500
Repairs and Maint.	73	208	24	81	53	80	80
Electricity	52	59	61	65	68	75	75
Rates	86	86	86	86	86	86	86
Insurance	25	33	26	28	65	65	65
Working Expenses	158	115	169	123	94	95	95
New Machinery	-	555	-	-	-	-	-
Total Cash Expenditure (excl. Interest)	995	1,980	1,557	2,120	4,733	2,976	2,526
Book Depreciation	225	280	275	268	261	252	240

APPENDIX H

THE EFFECT ON TAX OF SPREADING EXEMPTIONS NEAR-OPTIMALLY

The current legislation that allows the spreading forward of tax exemptions associated with farm development expenditure, is explained in Section 7.224.

Appendix F contains an algorithm for obtaining near-optimum patterns of spread (that is, patterns which approach the minimum sum of discounted tax payments). This algorithm was used in the analysis of the Case Development Programmes, and the results of some of these computations are presented here. The results are noteworthy because they,

(i) emphasise that considerable overall tax savings can result from spreading exemptions, and

(ii) illustrate the effect that spreading exemptions has on individual tax payments.

Wherever negative taxable incomes occurred even after exemptions were spread, advantage was also taken of the legislation that allows annual losses (that is, negative taxable incomes) to be carried forward. This legislation insists that losses be written off as early as possible, and losses cannot be carried forward more than five years.

The following tables show the outcome of spreading exemptions near-optimally in the Condition B analyses of the Case Development Programmes. In the tables, 'Taxable Income' is simply Gross Cash Income less Tax-deductible Expenditure; 'Spreadable Exemption' is the sum of the exemptions which may be spread forward; 'Present Value of Tax', is the discounted sum of the tax paid in each of the indicated years of development. Each tax payment was discounted to the beginning of the first year of development.

Table H.1 Spreading Exemptions in Case Programme I

Year of Development	Before Spreading		After Spreading	
	Taxable Income (£)	Spreadable Exemption (£)	Taxable Income (£)	Spreadable Exemption (£)
1	-1,612	1,469	0	0
2	-72	893	407	3
3	559	790	749	0
4	1,211	535	930	515
5	1,260	535	895	0
6	1,312	535	930	115
7	1,328	535	928	0
8	1,328	535	928	0
9	1,328	535	935	0
10	1,328	535	1,168	0
Present Value of Tax (£)	678		394	

Table H.2 Spreading Exemptions in Case Programme II

Year of Development	Before Spreading		After Spreading	
	Taxable Income (£)	Spreadable Exemption (£)	Taxable Income (£)	Spreadable Exemption (£)
1	349	965	1,314	0
2	342	1,665	1,693	264
3	472	2,440	1,763	939
4	-515	2,520	1,705	0
5	3,313	830	1,937	0
6	3,473	830	2,263	830
7	3,571	830	2,620	170
8	3,627	830	2,627	0
9	3,627	830	2,997	0
10	3,627	830	3,267	0
11	3,627	830	3,327	0
Present Value of Tax (£)	4,305		3,298	

Table H.3 Spreading Exemptions in Case Programme III

Year of Development	Before Spreading		After Spreading	
	Taxable Income (£)	Spreadable Exemption (£)	Taxable Income (£)	Spreadable Exemption (£)
1	682	2,433	1,883	1,232
2	-1,634	2,895	1,261	0
3	1,177	1,488	2,263	388
4	2,185	2,025	2,329	681
5	1,437	3,275	2,607	404
6	3,344	2,690	2,813	0
7	4,419	2,535	4,263	2,535
8	5,778	2,940	4,263	2,940
9	7,567	1,815	4,263	1,815
10	8,523	1,710	7,533	1,710
11	9,509	1,710	9,509	1,710
12	10,139	1,710	10,139	1,710
13	10,139	1,710	10,139	1,710
14	10,139	1,710	10,139	1,710
15	10,139	1,710	10,139	1,710
16	10,139	1,710	10,139	1,710
Present Value of Tax (£)	21,706		19,236	

Table H..4 Spreading Exemptions in Case Programme IV

Year of Development	Before Spreading		After Spreading	
	Taxable Income (£)	Spreadable Exemption (£)	Taxable Income (£)	Spreadable Exemption (£)
1	850	3,239	4,060	29
2	5,522	1,498	4,313	1,497
3	3,849	920	4,269	500
4	7,330	3,430	4,909	3,430
5	1,721	4,703	4,031	2,393
6	5,028	2,661	4,318	2,661
7	7,806	1,435	6,206	1,435
8	7,806	1,435	7,806	1,435
9	7,806	1,435	7,806	1,435
10	7,806	1,435	7,806	1,435
11	7,806	1,435	7,806	1,435
Present Value of Tax (£)	17,780		14,260	

Table H.5 Spreading Exemptions in Case Programme V

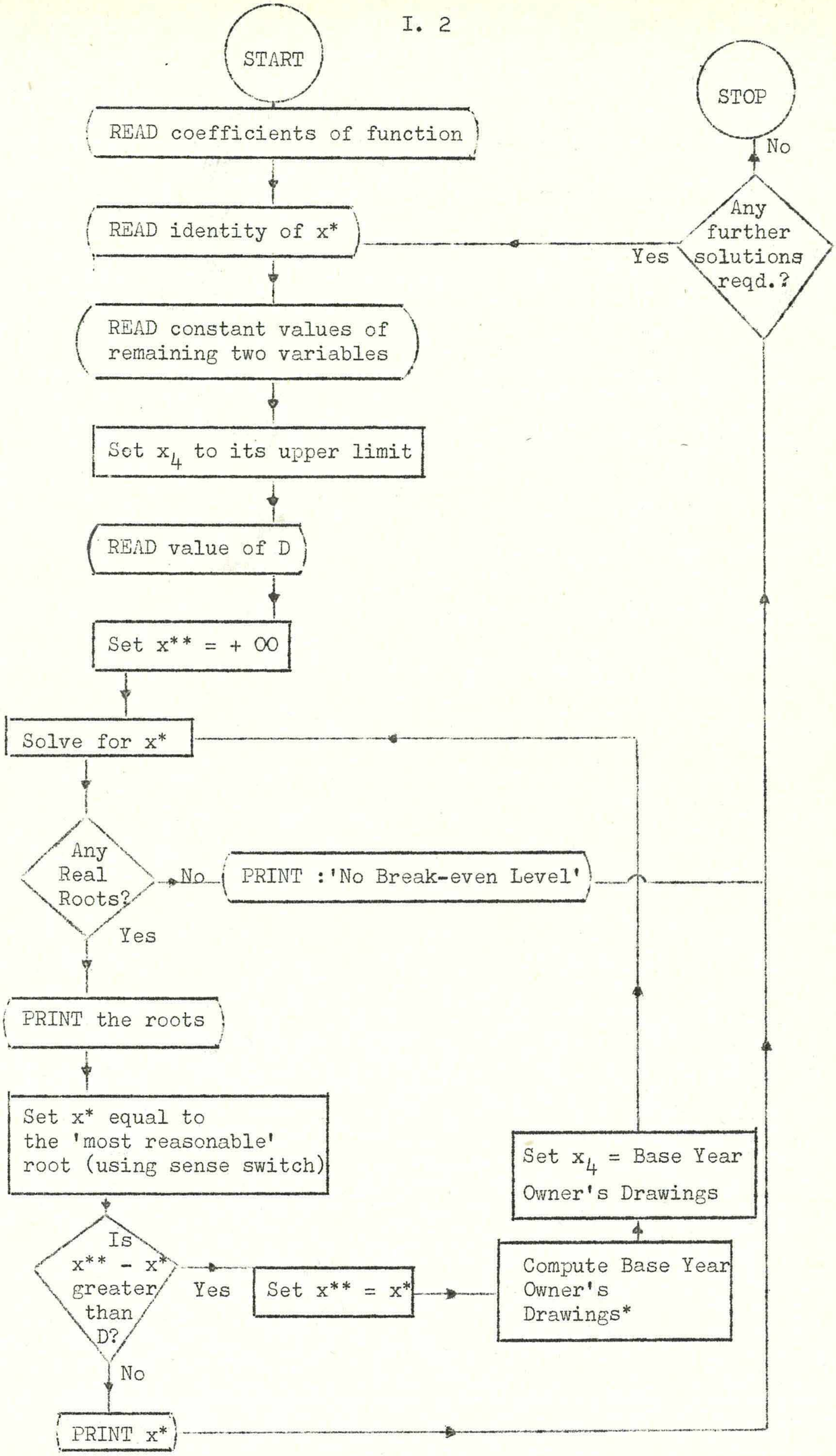
Year of Development	Before Spreading		After Spreading	
	Taxable Income (£)	Spreadable Exemption (£)	Taxable Income (£)	Spreadable Exemption (£)
1	2,647	100	2,647	100
2	2,368	452	2,368	452
3	2,236	1,058	2,269	1,025
4	176	3,441	2,269	1,338
5	3,338	1,535	2,847	1,514
6	3,847	1,535	3,233	1,535
7	3,847	1,535	3,247	1,535
8	3,847	1,535	3,447	1,535
9	3,847	1,535	3,826	1,535
Present Value of Tax (£)	4,816		4,427	

APPENDIX I

FLOW DIAGRAM OF AN ALGORITHM FOR OBTAINING BREAK-EVEN LEVELS OF INDEPENDENT VARIABLES IN A BUDGETARY RESPONSE FUNCTION

The problem in Section 8,543 of Chapter 8 requires the solution of a four-variable second-order polynomial for any one of x_1, x_2, or x_3 (in the flow diagram, the 'solution' variable is annotated x^*; the remaining two of these three variables are assigned temporary constant values), while x_4 (Minimum Owner's Drawings) is assigned a value which is itself dependent upon the value of x^*.

The algorithm initially sets x_4 at its maximum allowable value (in the problem considered in Chapter 8, this is £2,000). The polynomial is then solved for x^*. If real roots exist, the 'most reasonable' root is selected and x^* set equal to it. From a budget of the Base Year, Base Year Owner's Drawings are then computed, and x_4 is set equal to them. The procedure is then repeated, using the new value of x_4, thereby obtaining a new value for x^*, which in turn can be used in finding a further value for x_4. If this procedure is carried on for a sufficient number of iterations, successive estimations of x^* will become 'very similar'. That is, x^* will tend to assume a constant value - the required solution. In practice, the algorithm is terminated when the difference between successive values of x^* is less than an arbitrarily set 'allowable maximum' (annotated by D in the flow diagram).


START
READ coefficients of function
READ identity of x*
READ constant values of remaining two variables
Set x_4 to its upper limit
READ value of D
Set x** = + OO
Solve for x*
Any Real Roots?
No
PRINT :'No Break-even Level'
Yes
PRINT the roots
Set x* equal to the 'most reasonable' root (using sense switch)
Is x** - x* greater than D?
Yes
Set x** = x*
Compute Base Year Owner's Drawings*
Set x_4 = Base Year Owner's Drawings
No
PRINT x*
Any further solutions reqd.?
Yes
No
STOP

APPENDIX J

BUDGETARY FUNCTIONS AND RESPONSE SURFACES

This Appendix is intended to define the nature of budgetary functions and response surfaces, to discuss the methodology of their derivation,and to outline their more obvious applications in farm management research.

Budgetary functions fall into two broad categories ; those that may be written as explicit equations, and derived budgetary functions.
The former category is not new - as explained below, it is merely new terminology for an existing analytical technique. However, to the author's knowledge, no reference to derived budgetary functions appears in the literature. A particularly interesting feature of derived budgetary functions is their conceptual similarity to production functions. Many features of experimental designs are useful in the derivation of budgetary functions and response surfaces.

J.1 The Form of the Budgetary Function:

In general terms a budgetary function expresses a budgetary outcome, R (which may be, for example, annual post-tax income, the present value of a stream of annual pre-tax profits, or overdraft level), in terms of the levels of input factors and products, and their prices. That is:

$$R = f(x_1, x_2, \ldots, x_n, y_1, y_2, \ldots y_m, P_{x_1}, P_{x_2}, \ldots, P_{x_n}, P_{y_1}, P_{y_2}, \ldots, P_{y_m}) \qquad (1)$$

where x_i; i = 1,2,...,n is the level of the ith variable factor,

P_{x_i} ; 1,2, ...,n is the unit price of the ith variable factor,

y_j ; j = 1,2,..., m is the level of the jth product, and

P_{y_j} ; j = 1,2,..., m is the unit price of the jth product.

The function (1) represents a response surface in 2(n+m)+1 dimensions

J.2 Response Surfaces from Explicit Equations

It is clear that in many budgetting studies it may be possible to construct an equation such as (1) directly. In this form, a budgetary function is identical to a parametric budgetting equation. 1/

Of course, if all variables in (1) are assigned fixed values, the 'function' yields a 'point response' - the familiar outcome in conventional (that is non-parametric) budgetting.

It is worth noting in passing that yet another form of explicit budgetary function is the series of optimum plans generated in parametric linear programming. 2/ The optimality of this type of function should be contrasted with the typically sub-optimal production plan implied by parametric budgetting equations.

J.3 Derived Functions and Response Surfaces.

In some budgetting studies, it may not be possible to express the production situation in terms of one equation as in (1). This circumstance is likely to arise when the budgetary outcome, R, is associated with several years' production. Consideration of annual taxation payments, and the expression of R as a discounted sum of annual budgetary outcomes, futher complicates the problem.

In such cases, it is clearly impossible to obtain response surfaces directly from budgetary equations.

---

1. The term 'parametric budgetting' was coined by Candler [25]. An empirical example of the use of parametric budgetting has been reported by Lloyd [45].

2. See Heady and Candler [48], Chapters 7 and 8.

However, input and output coefficients, and prices may still be varied parametrically between successive computations of R. Thus, if n variables are varied parametrically, each computation will yield a point response for R in (n+1)-dimensional space. If a number of point responses are obtained, efforts may be made to fit a response surface to the points.

Thus, the derivation of a budgetary response function involves the following steps:

(i) Selection of the variables to be parametrically varied,

(ii) Determination of the ranges over which the parametric variables will be varied,

(iii) *A priori* specification a functional model,

(iv) Determination of the number and position of experimental points (that is, combinations of parametric variable levels),

(v) Computation of R at each experimental point,

(vi) Fitting the functional model to the observed values of R, and

(vii) Interpretation of the derived function. If this function is not acceptable, an alternative (possibly higher-order) model may be specified, and fitted after the requisite additional observations of R have been computed.

Some of these steps are now discussed further.

J.31 Specification of functional models

Unless *a priori* knowledge suggests otherwise, a second order polynomial function should be expected to provide an acceptable model of a budgetary response surface. If, for example, a problem has a budgetary response R and variables x_1, x_2, and x_3, the second-order polynomial model for the response surface is:

$$R = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{23}x_2x_3 \quad (2)$$

J.32 Determining the experimental points

A reasonable objective in determining the number and position of experimental points is to provide sufficient information for fitting the specified model, for a minimum of computational effort and expense.

Some aspects of experimental design theory are useful in determining the experimental points. In particular, Factorial and Central Composite Designs[3] are potentially useful.

Consider the determination of the number and position of experimental points to which a second-order two-variable polynomial is to be fitted. Then if both variables have coded ranges of -1 to +1 the following Complete Factorial will provide the required information:

(-1,1)	(0,1)	(1,1)
(-1,0)	(0,0)	(1,0)
(-1,-1)	(0,-1)	(1,-1)

Note that the minimum number of points (that is, three) is available for estimation of quadratic effects.

If, on the other hand, a Central Composite design is used, the coded points appear as :

		(0,B)		
	(-1,1)		(1,1)	
(-B,0)		(0,0)		(B,0)
	(-1,-1)		(1,-1)	
		(0,-B)		

in which both variables have a coded range of -B to +B where the value of B is at the discretion of the analyst.

---

3. These designs are described in detail in Heady and Dillon [42].

Comparing the two designs, it is clear that,

(i) both require nine experimental points,

(ii) they could be expected to estimate linear and interaction effects with a similar order of accuracy, but

(iii) the Central Composite design specifies five levels of each variable, and is therefore likely to estimate quadratic effects with more accuracy than the Complete Factorial, which has three levels of each variable.

When there are more than three variable factors, Central Composite designs specify fewer experimental points than Complete Factorial Designs. For example, if sufficient information is required to fit a second-order three-variable polynomial, a minimum of 27 experimental points is necessary if a Complete Factorial design is used. Equivalent information can be obtained from a Central Composite design containing 15 experimental points.[4]

Moreover, the discretionary allocation of a value to B (see (4) in Central Composite designs is potentially very useful when deriving budgetary response surfaces. As mentioned in the text (see Section 8.53), the research worker must determine subjectively whether the derived surface provides a sufficiently good approximation to the actual responses. In this sense, the choice of the value of B obviously influences the acceptability of the derived

---

4. In fact, the Central Composite design, with five levels of each variable would provide more information than the Complete Factorial.

surface. 5/

In short, it is apparent that Central Composite designs are likely to be of most use in determining the experimental points for budgetary response surfaces.

J.33 Fitting the functional model

Functional models may be readily fitted to the observation of R by the familiar least-square curvilinear regression.

J.34 Interpretation of the derived function

The concepts involved in determining the acceptability of a derived function, and the computational aspects of interpreting an acceptable function are described in some detail in the main text, 6/ and are not discussed further here.

---

5. It is clear that if, for instance, B is set equal to 1 (that is, the coded value 1 in (4) each variable will appear at only three levels, with a consequent loss of accuracy in the estimation of quadratic terms. If, on the other hand, B is very much larger than 1, the design will consist of a cluster of points close to the centre and a series of points distant from the centre. Unless the slope of the surface changes much more rapidly near the centre than elsewhere, this design will also provide poor estimates of quadratic terms. If it is known *a priori* that responses change most rapidly in particular regions of the surface, the value of B can be chosen to improve the accuracy of estimation of these regions. Otherwise, a trial value must be assigned to B, this gives an unsatisfactory level of approximation, B must then be assigned a new value in an effort to obtain an acceptable estimate.

6. See Chapter 8, Sections, 8.53, 8.54, 8.541, 8.542 and 8.543.