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THE RELATIVE PROFITABILITY OF
FORESTRY AND AGRICULTURE
ON THE MANAWATU-RANGITIKEI SAND COUNTRY

A Thesis Presented in Partial Fulfilment
of the Requirements for the Degree
of
Master of Agricultural Science
in the
Massey University of Manawatu

by

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P R E F A C E

This Discussion Paper is aimed at making Anthony Chisholm's Master's thesis more widely available than would otherwise be possible. The thesis is reproduced as originally presented, except for the transfer of a technical description of the sand country soils from the main text to Appendix XII.

The explicit findings of Chisholm's study (summarized in Chapter VII) are that approximately 39,000 acres of the poorest sand country soil types should be developed for forestry rather than sheep farming. At present only 15,000 acres of this land has been allocated to forestry. The author has calculated that the development of the remaining 24,000 acres into forests would yield revenue with a present value £400,000 greater than that to be attained by continuing its development for farming.

The land use recommendations made by Chisholm are tabulated in this preface. More important, in my view, than the explicit recommendations, is the example which this study provides of the objective evaluation of the profitability of alternative land uses. The expected yields, development costs, and returns from both forestry and farming have been carefully laid out, and the present value of land used for farming and forestry has then been calculated.

Three types of objection can be raised in connection with this study. These are:

(i) The Wrong Technical and Price Assumptions May Have Been Used

This is undoubtedly a valid objection, though as the reader will be able to see, Chisholm has been at great pains to collect as much pertinent information as possible before making his assumptions as to prices, yields and the like. The really important point, however, is that the study provides a framework into which other assumptions may readily be fitted. It is quite possible for the protagonists of agricultural development to claim that, say, fencing and

(iii)

initial cultivation costs have been over estimated. If they can show how land could be satisfactorily developed with a lower expenditure, then the increased present value of agricultural development can be easily calculated. From one point of view the study shows "what sheep farming has to be able to achieve to be able to compete with forestry," and from the other point of view, "how far the stumpage value could decline before forestry ceased to be the most profitable development."

The important point is that the study states explicitly what forestry and farming are expected to achieve in the way of costs and yields, and hence converts any "emotional" arguments about land use into technical arguments about what can and cannot be expected from different uses.

(ii) The Analysis Ignores Effects on the Balance of Payments

Some feel that account should have been taken of the effect on New Zealand's balance of payments. There are two difficulties here. Firstly, it would have been necessary to trace out, fairly exactly, the inputs and outputs from all enterprises to see whether they came from or were destined to go overseas. Worse still, the result of not growing trees, or the alternative use of labour and capital freed from the processing of forest products would have had to be considered. This would have been a vast task. Secondly, even if we knew that, say, farming would result in £1M more of exports each year, what allowance should have been made for this? So far as I am aware, there is no official estimate of the value of earning an extra £ of foreign exchange. Hence we would not know whether to allow 20/-, 25/- or 30/- for each extra pound sterling earned. It may be argued that it is not until the value of extra overseas exchange is decided that we can usefully replace the official exchange rate in the calculations illustrated in this Discussion Paper.

(iii) The Analysis Stops "at the Farm Gate"

Some believe that account should be taken of the use which is made of the agricultural or forest products before final sale. This argument really reduces to accepting the projected market prices assumed in the study but then arguing that, say, "forest products are really worth more than their market price, because of the value added in processing." Just as for the previous objection on the value of overseas exchange, this "processing" objection would require a separate study to see whether processing was exceptionally profitable, and an estimate of the "real value" of forest products would have to be provided before an allowance could have been made in this study. In economists' terms, this argument relies on farm or forest processing industries earning more than their transfer earnings, or on some element of monopoly profits in these activities. To establish this would be a major undertaking.

The original thesis explained Chisholm's reasons for tackling the study in the way he did. Despite the criticisms which have been made of certain aspects of the study, no attempt has been made to add to the original arguments in the thesis. This is because such arguments would further lengthen the discussion paper and, however convincing the arguments appeared to their author, they would undoubtedly be felt to be unsatisfactory by at least some readers.

I hope that most readers will agree that this thesis gives us a much better picture of the relative profitability of farming and forestry development of the poorer classes of sand country than was available previously. It illustrates a factual framework within which arguments about land use can be discussed objectively.

At the same time, it is certainly true that if Chisholm had had more than eighteen months to conduct the study, and if the terms of reference had been widened, still more useful and pertinent information could have been presented.

I would like to express my thanks to Mr J.D. Cowie of the Soil Bureau, D.S.I.R., members of the N.Z. Forest Service including the Forest Research Institute, the Valuation Department, the Lands and Survey Department, the Department of Agriculture and N.Z. Forest Products Ltd. for the very helpful way they assisted in providing the information required to carry out this analysis.

Wilfred Candler
Professor of Farm Management,
Massey University

11 January 1965

EXISTING AND RECOMMENDED LAND USE ON THE POORER SAND COUNTRY

Younger Dune Complex:								
Tenure	Protective Coastal Strip	Large Scale Forest	Preparation for Forestry	Dairy Farms	Sheep-Beef Farming	Run Off	Undeveloped and extensive grazing	Total Area
Crown	5,000	4,400	8,000	-	3,218	-	3,000	23,618
Private	1,500	1,000	800	2,661	512	-	13,909	20,382
Total (Actual)	6,500	5,400	8,800	2,661	3,730	-	16,909	44,000
Total (Recommended)	6,500	29,000	-	8,500	-	-	-	44,000
Himatangi - Foxton Land Class:								
Total (Actual)		700		4,500	15,000	9,800		30,000
Total (Recommended)		10,500	-	4,500	-	15,000		30,000

Source: Tables 4.1 and 4.2 and Chapter VII.

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INTRODUCTION

This study is an attempt to evaluate the relative profitability of agriculture, large scale forestry and farm forestry, on the lower producing soil classes of the Manawatu-Rangitikei sand country.

The study has been motivated by three related considerations:

(a) There has recently been a considerable intensification of competition for the use of the sand country as both forestry and agriculture attempt to expand.

(b) The competition for land between these uses is not, in general, resolved through a perfect pricing mechanism.

(c) The author was interested in economic models appropriate for the analysis of long term investment problems.

In the absence of an impartial economic analysis, the allocation of land between farming and forestry has necessarily been a matter of rule of thumb and common sense negotiations. It is hoped that this procedure can be improved upon.

In this study an endeavour is made to select and apply a suitable economic model to the above problem.

CHAPTER I

BACKGROUND

This chapter provides a background to the changing national and regional balance between forestry and agriculture. In particular, it outlines the present and estimated future balance in the southern portion of the North Island. This is followed by a guide to the contents and problems encountered in the study.

1.1 The National Balance Between Forestry and Agriculture

An abundant supply of high quality timber was available during New Zealand's early development. Exotic forests were established only on land which had been assessed as incapable of supporting agriculture.* This position is changing, and an increasing proportion of future timber supplies are likely to have to be met from exotic forests grown on land which is at least marginally suitable for agriculture. As a consequence the allocation of land has ceased to be the simple technical problem of allocating to forestry only the land unsuited to farming, and has become an economic problem of allocating land between competing uses. This change has been contributed to by two factors:

(a) The agricultural trend over the last decade has been one of falling prices, rising costs and increasing difficulty in finding profitable markets. This downward trend has recently levelled off. There is, however, no substantial evidence of a general long term upward price trend for agricultural products. In addition, future development of land for farms will tend to occur on less fertile land.

Despite the substantial increase in agricultural efficiency during the last decade, there is now an increasing public awareness that agriculture should not be regarded a priori as the

* For example, the establishment of extensive exotic forests on the Central North Island pumice country before the cause of "bush-sickness" was known.

most profitable land use.

(b) The decline in the "economic" value of land for agriculture has coincided with an increased imputed value to land from forestry.* This change has been caused by the continuous depletion of our capital reserve of indigenous timber, together with the utilization of extensive areas of exotic forest by pulp and paper mills.

Studies based on estimated population expansion and likely trends in per capita consumption of forest products, forecast the need to double the present area of exotic forest by the year 2000 A.D. (1,2,3,4,5).

It has been shown that there has been a change in the supply and demand for forestry and agricultural products. Following this change, a proposal has been made to expand the area of exotic forest by one million acres. This has the effect of extending the area within which farming and forestry compete for land. Land is not the only factor to be considered. Capital and labour have to be combined with the land to produce either product.

In short, the change in land allocation from a simple technical problem to an economic problem, indicates the need for an economic analysis to determine the relative profitability of forestry and agriculture.

1.2 The Domestic Forestry Policy

The broad domestic policy governing future forest establishment in New Zealand is one of regional self-sufficiency (6). This policy is, in part, due to the relatively high transport costs for a bulky, low unit value

* The present supply and demand situation for forest products is misleading with respect to probable future trends. This situation arises because of the temporary oversupply of timber in the Rotorua Conservancy, resulting from the peak maturation of the extensive 1925-35 plantings.

commodity such as timber. *

Because of economies of scale the present forest policy advocates the establishment of a small number of large pulp and paper mills. The proposed expansion in forestry is aimed to meet a relatively limited regional market, with the exception of areas where the establishment of pulp and paper mills or an export trade are envisaged. At present pulp and paper mills, or an export trade, are expected to be sited at Rotorua, South Otago and probably Nelson. A planting programme should incorporate a detailed assessment of the present and estimated future regional demand for timber. The intra-region market analysis for forest produce, which is sufficient in the light of the present policy of self-sufficiency is in contrast to a major exporting industry, such as the agricultural industry, where general world trends need to be borne in mind.

1.3 The Balance Between Forestry and Agriculture in the Southern Portion of the North Island

This study is concerned with the possibility of economically expanding exotic forestry on the Manawatu-Rangitikei sand country. This area is situated within the Manawatu-Wanganui region which is a part of the Wellington Forestry Conservancy. A projected timber supply-demand balance for the regions within this Conservancy is available (6). This forecast is based on estimates of population expansion and likely trends in per capita timber consumption. The additional area of exotic forest, needed to fulfil the predicted regional demand within the Conservancy, is shown in Table 1.1. Of the 25,000 acres deficiency anticipated in the Manawatu-Wanganui region, approximately 15,000 acres is at present held for future exotic plantings. This area, together

* In some instances the cost of transporting timber from a surplus region to a deficit region is equivalent to the stumpage value being received within the deficit region. For example, the present flow of timber from Rotorua to the Manawatu. The present transport cost is approximately £350 per acre of sawn timber. The reason for the present flow of timber between these regions is due to the temporary oversupply of timber in the Rotorua Conservancy, and the consequent nominal stumpage values prevailing.

TABLE 1.1

Projected Demand-Supply Balance for Timber in the Wellington Conservancy*

Region	Requirements for Year 2025 Forest Area Acres	Present Area Exotic Forest Acres	Equivalent Area Available in Local or Imported Indigenous Timber Acres	Estimated Net Exotic Forest Deficiency Acres
Taranaki	41,000	17,000	4,000	20,000
Manawatu- Wanganui	61,000	30,000	6,000	25,000
Wellington	102,000	1,000	11,000	90,000
Wairarapa	10,000	9,000	-	1,000
Hawkes Bay	54,000	20,000	5,000	29,000
Conservancy Total	268,000	77,000	26,000	165,000

* The source of Table 1.1 is Grainger (1960), (6).

More detailed data is at present being assembled in a New Zealand exotic forest survey, conducted by the New Zealand Forest Service but was not available at the time of this study. Indications are, however, that with the exception of some minor alterations, the broad trends will be as shown in the above table.

with the probable expansion in farm forestry as a result of recent incentives, should satisfy the Manawatu-Wanganui regional demand. Hawkes Bay and Wairarapa will also be self-sufficient. Taranaki on the other hand, has a negligible area of land on which it is likely that forestry could compete with agriculture. Taranaki will therefore be a timber importing region. The Wellington region with an estimated 90,000 acre forest deficit provides a substantial future timber market. To the author's knowledge the only feasible area for exotic forestry within the Wellington region, is a block of marginal undeveloped land in the Hutt district. Even with regard to this area there is controversy, since the very low soil fertility and high establishment and extraction costs would probably not be offset by the lower transport costs.*

The regions expected to supply the Wellington market are the Wairarapa and Manawatu-Wanganui. Allowing for a sector of the Wellington and Taranaki market, the Manawatu-Wanganui region could reasonably anticipate a future profitable market for 50,000 acres of exotic forest. This is in addition to the existing exotic forests, and the 15,000 acres at present allocated to future exotic afforestation.

1.4 Competition Between Forestry and Agriculture on the Sand Country

Following discussion with members of the Forest Service, the Manawatu-Rangitikei sand country was chosen for this study. The area appeared likely to be relatively profitable for forestry because:

- (a) Substantial areas are marginal agricultural land, whilst being capable of supporting reasonable tree growth.
- (b) The area is in a timber deficit region, well situated to supply the Wellington market.

* It is significant and characteristic of land use decisions that there should be "controversy" over such considerations. This controversy should be overcome by an analysis of the type used in the present study.

(c) Costs of establishment, logging and transport are relatively low.

(d) In many instances the range and combination of moist and dry soil types, characteristic of sand country, suggests a strong possibility of a complementary relationship between agriculture and farm forestry.

1.4.1 The Problem Defined in Detail

At this stage a detailed specification of the problem can be made. The overall problem of evaluating the relative profitability of agriculture and forestry on the Manawatu-Rangitikei sand country may be divided into the series of sub-problems specified below.

A. What is the relative profitability of developing the selected classes for:

- (a) Dairy farming.
- (b) Sheep farming.
- (c) Large scale forestry.
- (d) Dairy farming or sheep farming combined with farm forestry.
- (e) Run-off properties? *

B. Could developed or partially developed land at present in one of the above land uses be more profitably converted to an alternative land use? The potential alternative land uses being as outlined in section A.

In this study the above analysis is carried out for two major soil classes on the sand country.

1.4.2 Sources of Data

The following have provided the major sources of data used in this study:

* The information derived from the solution to the problems outlined in section A, is assumed to include whether the development of these soil classes for any of the specified land uses is economic.

A. Forestry

(a) A survey of 7 exotic sand country forests, 3 of which had an associated saw mill.

(b) The New Zealand Forest Service, Wellington Conservancy.

(c) New Zealand Forest Products Ltd.

(d) Sand country farm forests.

B. Agriculture

(a) The collection of physical and financial data from a survey of 16 sand country farms.

(b) The Valuation Department.

(c) The Lands and Survey Department.

(d) The Department of Agriculture and Farm Improvement Clubs.

1.4.3 The Place of Protective Forestry in this Study

In a study of forestry on the sand country it is necessary to distinguish between protective and commercial forestry. Because of the encroachment of wind-blown sand on to productive soils, it is necessary to establish a protective belt of sand-binding plants, shrubs and trees along the coast. This protective belt of forest, which it is anticipated will be one quarter of a mile wide, will ultimately border the 40 mile coast and comprise 6,500 acres of protective forest.

The function of the protective belt is to stabilize drifting sand and to provide a windbreak to assist production inland. No data are available which would permit the beneficial effect of the protective belt to be quantified. The protective belt is necessary, however, regardless of the land use inland. Hence for the purposes of this study there is assumed to be an equivalent beneficial effect from the protective belt for both forestry and agriculture. The cost of establishing and maintaining the protective belt is therefore excluded in this study. The implicit assumption of all sand country experts, that it is better to stabilize the sand than allow it to blow inland has been accepted.

1.5 Guide to the Thesis

This section presents a guide to the contents of the thesis and the problems encountered.

1.5.1 Development of the Thesis

The thesis may be broadly divided into 4 main sections:

(a) The formulation and discussion of a suitable economic model to determine the relative profitability of alternative long term investments.

(b) A description of the natural conditions and current land use of the Manawatu-Rangitiki sand country. In particular, reference is made to the formulation of a suitable soil classification. The sources of data and survey methods used for acquiring physical and financial input-output data for forestry and agriculture are discussed.

(c) The application of the selected economic model to determine the relative profitability of agriculture and forestry on two soil classes.

(d) A presentation of the results of this study. Finally the usefulness of the selected method, both in terms of absolute accuracy and in terms of present alternative methods of decision making for long term investments, is discussed.

1.5.2 Outline of Problems Encountered in the Study

To the author's knowledge, apart from a comprehensive soil survey (35) no survey results for agriculture or forestry, applicable to this study, were available. Hence a considerable portion of the author's time has been spent on field work and data collection. This has included a detailed land use study of the sand country, and the collection of sufficient data for an economic analysis of forestry and agriculture.

The main problems encountered in the collection and assembly of data were:

(a) Due to a very variable soil pattern the land use of the sand country is diverse and complex. This increases the quantity of data needed and also narrows the scope of application of any one set of results, as compared to an area of uniform soil.

(b) In many instances there were few records and often the usefulness of the records available was limited. There were two reasons for this:

(i) Records in the form of farm or forestry accounts are normally prepared for purposes of taxation or audit. For this reason there is usually a substantial difference between the "real" costs of farm and forestry production and the costs shown in accounts. For example, the division of capital and maintenance expenditure.

(ii) Even when data that accurately reflect past production patterns are available, these can often only be used as a guide to the future. This is because technological change has since taken place, but the long term effects of this new technique can only be subjectively predicted. For example, present forestry output data are based on untended forests. These data have to be substantially adjusted to be representative of the expected performance of forests receiving intensive silviculture.

Additional problems of speculation, price control, imperfect markets, sustained yield versus immediate planting and the effects of non-economic factors on decision making, are discussed as they arise.

CHAPTER II

AN ECONOMIC MODEL FOR LONG TERM

INVESTMENTS

In this chapter considerations influencing the selection of a model for long term investment decisions are discussed. Following this, two models are introduced. One model is then selected and described in detail. The shortcomings of the alternative model are discussed. In the main, this chapter is a discussion and summary of the ideas presented in references (7-24 inclusive) which should be consulted for further detail.

2.1 Necessary Considerations when Selecting an Economic Model

These are divided into the importance of non-economic factors in decision making and the importance of "time" in long term investments.

2.1.1 Importance of Non-Economic Factors in Decision Making

The extent to which economic factors should determine the allocation of resources is a contentious issue. There is a need, however, for an economic model, acceptable to policy makers, which could be used to determine the social benefit of alternative long term enterprises. The economic model could serve as an objective basis upon which the more subjective social and political considerations may be superimposed. For example, the aims of maintaining full employment, non-aggregation of land ownership, or alleviation of a small area of poverty, could then be assessed in terms of their economic cost. In the absence of such a model, national economic considerations are likely to be subordinated to local and political interests, and decisions will be made which do not rationally consider the claims of alternative projects. It is therefore important to know how resources would be allocated on economic grounds alone. This permits the cost and wisdom of supporting non-economic aims to be evaluated.

On the other hand, there may be a danger that a numerical but incomplete economic analysis suggests a misleadingly accurate

solution to the problem. It should always be remembered that the original problem will often have been simplified in order that a numerical economic analysis can be made. In these situations the economic or cash analysis represents the first approximation of the real profitability of alternative investments. In the final analysis, any less tangible benefits and costs not accounted for in the original numerical model must also be considered.

2.2 The Significance of "Time" in Long Term Investment Decisions

Land economics is concerned with the optimum allocation and use of scarce resources (7,17). Land cannot be valued in isolation, but only in the context of the value and productivity of the other scarce resources combined with land. Land economics is particularly concerned with problems in which land is regarded as a special factor of strategic or limiting importance. An important feature of most land use enterprises is a long production cycle.

2.2.1 Time Preference and Time Productivity of Capital

A model used for determining the present value of alternative investments should incorporate numerical estimates of all the benefits and costs, each evaluated with respect to the points in time at which they occur. The long time period required for forestry production and, to a lesser degree, the development of land for agriculture, provide examples of the importance of valuing inputs and outputs according to the points in time at which they occur. The importance of the timing of inputs and outputs arises from the opportunity cost of capital. This is normally expressed in terms of an annual interest rate. It is necessary to briefly consider the determinants of the interest rate. This enables the need for incorporating an interest charge for all capital investments in which there is a "waiting period" between inputs and outputs to be shown.

The determinants of the market interest rate may be broadly divided into two basic components:

- (a) The time-productivity of capital as a factor of

production; and

- (b) The time-preference for capital as a factor of consumption.

The time-productivity of capital investment is determined by its rate of growth. The greater the economy's anticipated marginal rate of capital growth, the higher will be the demand for investment capital. This demand is reflected in the market interest rate.

The time-preference component for consumption capital arises because individuals place different values on consumption at different points in time. Time preference for capital normally reflects a preference for present consumption over consumption at some future date (24). Hence a marginal quantity of present consumption will normally only be foregone for a greater resultant future consumption.

The rate of interest in the economy represents the interaction of time-productivity and time-preference for capital savings. In a perfectly competitive market these two factors are equated and jointly determine the interest rate. Thus a five per cent rate of interest not only implies a five per cent rate of marginal time-preference, but also a marginal productivity, or growth rate of capital investment, equal to five per cent. The fundamental relationship between time-preference and time-productivity of capital is well exemplified in Fisher's original theory of interest (14). In this theory he regards investment not as an end in itself, but rather as a process for distributing consumption over time. The importance of this underlying theory of interest has apparently been overlooked by proponents of the internal-rate-of-return rule, as a criterion for evaluating optimum long term investments. Shortcomings of this model are discussed in a later section.

In assessing the efficient allocation of scarce capital an important point emerges from the above discussion. This is, that the rate of growth of capital in any investment should be at least equivalent to:

- (a) The potential growth rate of capital in alternative investments.

(b) The satisfaction foregone in postponing additional present consumption.

That is, the foregone earnings from alternative investments, together with the time-preference for consumption, jointly determine the market interest rate. This has to be charged to the enterprise selected as the opportunity cost of capital.

The interest charge causes a sum of money received or paid at the present time to be worth more than the same sum at some time in the future. The more distant the time that the money is to be received the lower its present value. This relationship can usually be expressed in terms of a mathematical equation (17,8). One method, discounting, is the process by which revenues received or paid at some future date are converted to their present value. For example, the present value, PV, of a sum, V, received at the end of n years is given by the following equation:

$$PV = \frac{V}{(1 + r)^n} \quad (2.1)$$

Where r = the annual interest rate.

An alternative method of comparing net revenues received over different time periods is to compare the future value of present costs with future incomes. Converting present expenditures to future values is called compounding of costs. For example, the future value of a sum V, with present value, PV, is given by the following equation, where the symbols are as defined in equation (2.1).

$$V = PV (1 + r)^n \quad (2.2)$$

Relationships between a stream of net revenues (or net costs) and net revenues received (or costs paid) in a lump sum at different points in time are presented algebraically

and graphically in Fig. 1. * The use of mathematical equations for comparing investments through time is expanded in section 2.3.2, where economic models for determining the profitability of forestry and agriculture are discussed.

2.2.2 A Distinction Between External and Internal Interest Rates

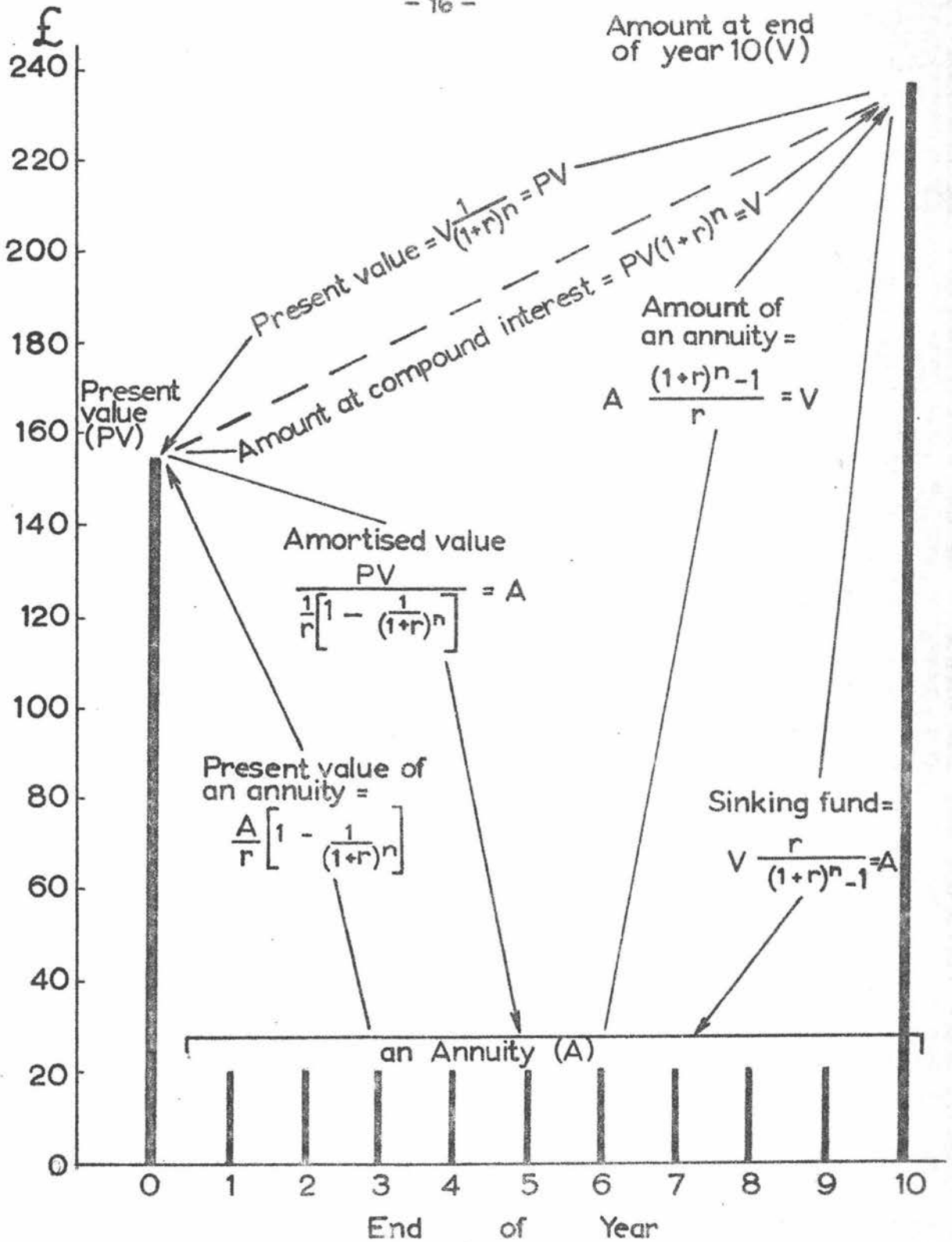
In considering economic models for long term investment decisions it is necessary to distinguish between the external, or market rate of interest, and the internal rate of interest. The external rate of interest represents the price at which marginal capital may be borrowed or invested within the economy as a whole. That is, it is indicative of the capital investment and borrowing opportunities outside the firm. On the other hand, the internal interest rate represents the "marginal" investment opportunities within the firm. It indicates the anticipated rate of growth of marginal capital investment within the firm. Divergence between external and internal interest rates are generally attributable to an imperfect capital market wherein, at a certain level of borrowing, capital is absolutely rationed to a firm. Or conversely, a borrower may not be prepared to accept the risk of additional borrowing if already heavily committed, even though the anticipated internal rate of return is higher than the external rate of return.

2.3 Selection of an Economic Model

This section outlines the assumptions on which the economic models are initially based. Following this two economic models are described and discussed. One is selected for use in this study.

* Fig.2.1 is a slightly modified version of a graph presented by Faris, J.E. (1960), J.F.E., 42, 759.

The pound values in Fig.2.1 assume an annual interest rate $r = 5$ per cent, compounded annually for $n = 10$ years. The amortized value, A , is that constant annual payment which is equivalent to the lump sum present value, or lump sum value at a specified future date. The remaining symbols used in Fig. 1 are defined in equations (2.1), (2.2).



Relationships Between Revenue Streams and their Values In a Lump Sum

Fig.2:1

2.3.1 Assumptions Made in the Basic Models

The models for long term economic analysis are initially outlined in the absence of complicating side issues. This enables the fundamental principles of long term investment decisions to be clearly shown. The restrictions imposed on the models presented in this chapter are relaxed in chapter three, and the problems which arise as a consequence are discussed, with particular reference to their relationship to forestry and agriculture.

The assumptions made in initially selecting an economic model are:

(a) The aim of the economic model is to rank alternative enterprises so that the "present value" of real national income is maximized.

(b) It is assumed that perfect knowledge enables the magnitude and timing of future yields, costs and prices to be specified without error, with the sole exception of the value of land.

(c) The market price of all factors of production, with the exception of land, reflect their true marginal value productivity.

(d) The scale of the enterprise under study does not affect the existing cost and price structure.

2.3.2 The Models

There are two commonly recommended methods of economic analysis (18) which may be used for appraising the value of alternative flows of inputs and outputs through time. Both of the proposed methods evaluate the net value of the income stream at a particular point in time. The net value is obtained by discounting inputs and outputs to obtain their present value, or compounding them to obtain their value at some future point in time. These two methods are:

(a) The present value method.

(b) The internal-rate-of-return method.

2.3.2.1 The Present Value Method

In this method an external interest rate is specified and all future costs and revenues are discounted to their present value via the external interest rate.

A general equation* for converting future income streams to their present value is: (2.3)

$$PV = \frac{V1}{1+r} + \frac{V2}{(1+r)^2} + \dots + \frac{Vi}{(1+r)^i} + \dots + \frac{Vn}{(1+r)^n}$$

Where PV = the present value of a future income stream
r = the external interest rate
Vi = the net cost or revenue in the i^{th} year
i = 1, 2, ..., n.

In applying the present value model to forestry and agriculture the procedure adopted is:

All inputs and outputs are valued at their estimated market value, with the sole exception of land. The income stream is then converted to a present value. The resultant residual or deficit thus imputed to land, is normally defined as the Land Expectation Value. The residual can then be conveniently expressed in terms of the estimated amount an enterprise can "afford" to pay for the land. At the same time, the enterprise pays the market price for all other inputs and achieves the external rate of interest on the total invested capital, including land.

In previous assumptions it was stated that the market price for all inputs reflects their true marginal value productivity. It is therefore clear that the price of these inputs reflects the "opportunity cost" of what they could have earned in other investments had they not been drawn into the selected enterprise. Hence the residual imputed to land reflects the marginal value productivity of land, or the amount added to the value of the outputs by land.

* The expanded equations for forestry and agriculture are given in their respective chapters. A full listing of discounting equations is given in Appendix I.

In practice the main limitation of this method is the need for policy makers to specify a long term external interest rate.

2.3.2.2 An Alternative Model and its Shortcomings

In practice, the difficulty of specifying a long term external interest rate leads to the initially plausible recommendation of ranking alternative enterprises according to their internal-rate-of-return (10,16). The internal-rate-of-return may be defined as the particular discounting rate p , which reduces the future stream of net returns to a present value of zero.

A general equation for finding the internal rate of interest for an investment is:

$$PV = \frac{V1}{1 + r} + \frac{V2}{(1 + p)^2} + \dots + \frac{Vi}{(1 = p)^i} + \dots + \frac{Vn}{(1 = p)^n} \quad (2.4)$$

Where the symbols are as defined in equation (2.3), with the exception that in equation (2.4), p represents the internal interest rate.

In this model p is unknown. The problem is to find a value, or values, of p which solve the equation giving a present value of zero. The particular value, or values, of p which provide a present value of zero, is defined as the internal rate of interest. The investment yielding the highest internal-rate-of-interest is selected as the most profitable. This method attempts to find a purely "internal" measure of the time-productivity of capital, for a particular investment, which is independent of the need to specify a market interest rate. It is considered basically useful in allowing decentralization of decision making, as it provides an easy and convenient criterion for determining the optimum allocation of capital within a firm.

For the following reasons, however, the internal-rate-of-return method has not been used in this study.

(a) There is not necessarily a unique value of p for a particular investment. Where an enterprise represents a series of outlays and revenues of varying magnitudes through a long time period, there are likely to be a number of break-even rates of p , which solve the equation. For example, an

nth polynomial may have up to n real roots, all of which provide a solution to the equation. Thus, because of the particular structure of the flow of outlays and revenues, a forestry enterprise may be shown to pay at a high and low rate of interest, but not necessarily at an intermediate interest rate.

(b) In calculating the break-even discount rate p , the method implicitly assumes that all intermediate revenues may be reinvested at an earning rate p , and intermediate outlays, if financed from borrowing, can only be borrowed at an interest charge equivalent to p . This is clearly not the normal situation. For instance, assume a unique break-even value of p has been found for two investments, for example forestry and agriculture. Furthermore, the present value of each enterprise is plotted over a range of interest rates from 0 to 15 per cent, as shown in Fig. 2.2.

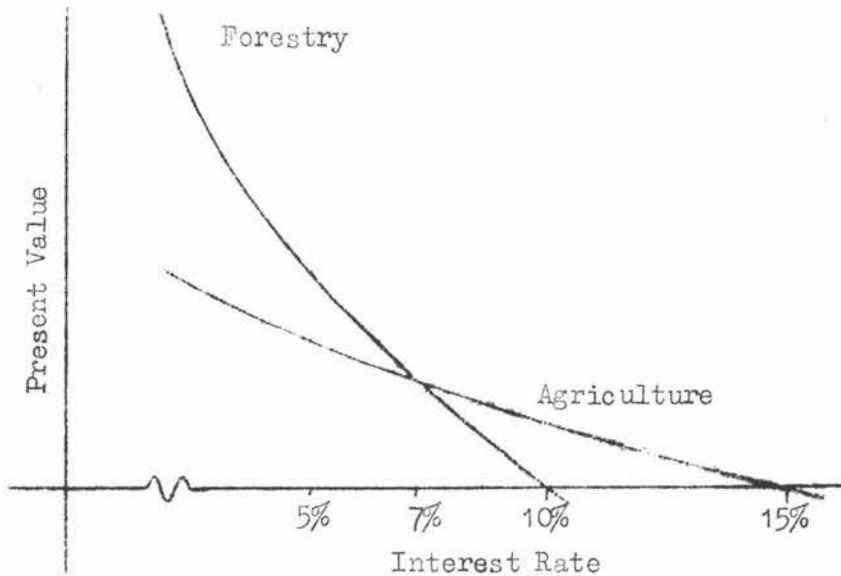


Fig. 2.2. Hypothetical Profit-Interest Rate Relationships

The example in Fig. 2.2 illustrates that a change in the interest rate has a differential effect on the profitability of the two enterprises, due to their differing outlay-revenue structure. Agriculture has the highest internal-rate-of-return, that is its present value falls to zero at a 15 per cent discounting rate, relative to a 10 per cent discounting rate for forestry. Hence the internal-rate-of-return rule would select agriculture as the most profitable investment, regardless of the ruling external interest rate. However, the present value rule clearly indicates that in a perfect capital market forestry is more profitable than agriculture when the external interest rate is below 7 per cent, and conversely for an external interest rate greater than 7 per cent. For this reason, even when there is a unique solution for p , the choice of the enterprise with the highest internal-rate-of-return is not necessarily the most profitable.

There are a number of less important limitations of the internal-rate-of-return method. These together with the above limitations are fully outlined and discussed by Hirshleifer (1958) (18). This discussion includes the limitation of the method to distinguish between multiple tangencies and the extreme breakdown of the method under conditions of non-constant market interest rates over time. Thus the method, in attempting to provide a purely internal measure of the time productivity of capital, completely overlooks Fisher's statement (14) that "investments cannot be considered in isolation, but only in the context of the other investment and consumption alternatives available". In so doing, the assumptions implied about the external opportunities for borrowing and investing capital are not generally correct or even generally reasonable.

For these reasons the internal-rate-of-return criterion has not been used in this study; the author is of the opinion that no method which attempts to avoid the difficulty of specifying an appropriate market interest rate for long term planning can be successful.

2.4 Problems in Estimating the Land Expectation Value

The land expectation value method of assessing the relative profitability of forestry and agriculture is selected for use in this study. Under the previously stated assumptions, this model provides a perfect criterion for determining the real profitability of forestry and agriculture. In practice, however, the main limitations of this method are:

(a) The difficulty of estimating a long term external interest rate and future produce prices.

(b) The frequent paucity and inadequacy of present data for predicting future physical inputs and outputs for forestry and agriculture on the sand country. This is largely a result of intensive farming on the area of sand country under study being a recent phenomena. The land has previously been used for extensive grazing. At present no farms are fully developed and many are only at early stages of development. Hence data are limited and, in some instances, data even when available are obsolescent as past technologies have been superseded by new technologies, the long term results of which can only be subjectively predicted.

The author considers that the difficulty of limited data and the need for subjective estimations will be encountered in most land use studies. The most important land use decisions have to be made at the pre-development stage when knowledge is normally incomplete. It is of limited value to make a sophisticated and accurate analysis of the problem in retrospect, when complete data are available, and on this basis make recommendations of what the land use should have been at the time when development was initiated 15 years previously.

As a consequence of the dynamic nature of agriculture on this class of sand country it was considered necessary to incorporate any imminent changes in technology which are not reflected in past methods of development and/or present production patterns.

Clearly, the above data problems will arise in the use of any model for determining the relative profitability of forestry and agriculture. The use of the internal-rate-of-return

method obviates the need to specify an external interest rate. In spite of this advantage, the method has not been used in this study. The reasons for not using this method are given in the preceding section.

(c) There was a problem of determining the relative standard of management at which the profitability of forestry and agriculture should be determined. In this study an attempt is made to compare the profitability of forestry and agriculture under high standards of management. The implications of a high standard of management are later outlined in the respective budgets for forestry and agriculture.

(d) Problems of applying the land expectation value method in an imperfect market are discussed in the following chapter.

CHAPTER III

PROBLEMS OF APPLYING AN ECONOMIC MODEL
TO AN IMPERFECT MARKET

The results of an economic analysis are, in general, dependant upon a number of restricting assumptions and considerations. The assumptions on which the basic economic models are based have been given in Chapter II. These assumptions are now relaxed and the important problems which arise are discussed. After a review of the literature (24-34) the author has selected for discussion what he believes to be the most important considerations. These considerations are initially outlined in a general context. Following this an endeavour is made to explain their relationship to forestry and agriculture. When interpreting the results of this study there should at least be an awareness of these problems, even though their numerical estimation is considered beyond the scope of the present study in many instances.

3.1 Differences Between Private and Social Net Product

The importance of problems arising from an imperfect market vary according to:

- (a) The type and size of the enterprise.
- (b) Whether value is expressed in terms of private or social net profit.

For this reason the importance of these considerations is discussed at two distinct levels of benefit:

- (a) The net value of each enterprise to the individual farmer or forest owner.
- (b) The net value of each enterprise to the nation as a whole.

The primary aim of the present study is to compare the value of forestry and agriculture at the level of individual farmer or forest owner benefit. However, there is clearly

a need to be aware of the additional problems involved in extending the results of the present study to give the respective social net profits from each enterprise.

3.2 Effects of Risk and Uncertainty

The original economic model implicitly assumed perfect forecasting of changes in technology, population trends and consumer preferences. This implies that the supply and demand curves for all resources and products associated with each enterprise can be projected into the future with complete accuracy. Risk and uncertainty, however, are important factors in long term planning, and it is clearly not possible to predict precisely all future outcomes of today's land use decisions. Generally in long range economic projections, all that can be hoped for is that all data are thoroughly analysed. Then in the context of a reasonable set of assumptions a "best guess" is made for the optimum allocation of land. In broad terms three possible knowledge situations of future trends can be identified:

- (a) Imperfect knowledge.
- (b) Partial knowledge.
- (c) Perfect knowledge.

(a) Imperfect knowledge is a situation typified by a complete absence of studies on the past or anticipated future supply and demand trends for resources and products. In this instance the only reasonable assumption that can be made is a continuation of present prices, as there is an equal probability of future prices rising or falling.

(b) Partial knowledge is the normal situation where some data and studies are available. This enables a more specific postulation of future trends to be made. For example, in the absence of unforeseen major technological changes, increased demand is expected to keep pace with increased supply of a product, and there is a high probability of present prices being maintained.

(c) The perfect knowledge situation. In this instance uncertainty is eliminated. "Pure risk" is quantitatively

incorporated in the results by expressing all possible outcomes in the form of a probability distribution. In biological production physical yields are sometimes expressed in terms of "pure risk". It is the author's belief, however, that long range price projections will always remain in the field of uncertainty. Under present knowledge profits from agriculture and forestry are evaluated in an environment of uncertainty. The investigator is well aware of the uncertainty of a particular outcome, but does not have sufficient data to express all possible outcomes in the form of a probability distribution.

In this study the method adopted for incorporating uncertainty is to express the result as a range of possible outcomes. The range of possible outcomes is derived by varying the vulnerable assumptions embodied in the basic model, within what is subjectively considered reasonable minimum and maximum limits. For example, particularly vulnerable assumptions in the present study are prices and the long term external interest rate. The method outlined is normally termed parametric budgetting (25).

Risk and uncertainty are considered equally important at both levels of private and social net profit.

The input-output structure of forestry and agriculture differ. The author considers that there is a higher risk for forestry production than agriculture because of the longer time period between inputs and outputs.

3.3 Effects of Political Decisions on Prices

The original model assumed that all prices were determined in a perfectly competitive market. In this case, the market price reflects the true marginal value productivity of resources. Hence the market price charged to an enterprise for the use of a resource reflects the real earnings foregone in an alternative investment also competing for the use of the scarce resource. In the existing economy, all prices that are determined under some form of protection, for example subsidization, special taxation, direct price control, import restrictions and tariff policies, may ideally need adjustment before representing their

true national value. For example, when a government advocates a policy of full employment with a compulsory minimum award rate, there are likely to be periods of under-utilization or unemployment of labour. In these instances the average wage will overvalue the true marginal value productivity of labour. When comparing alternative investments it may be very significant as to whether labour is valued at its marginal opportunity cost, or at the award wage. For example, in the situation where there is a large unemployed sector maintained by State unemployment benefits. It will clearly be of particular importance when the relative profitability of a labour-intensive and a labour-extensive enterprise are being compared. Similarly, an industry may have an annual return to capital of 10 per cent, but only because there is a restriction on cheap external supplies of the particular product, through import restriction and tariff control.

From the individual farmer's view point the prevailing resource and product prices are clear cut indicators of the net value of alternative investments. On the other hand, from the view point of social benefit, it is questionable whether price ratios established by politicians should be accepted, or whether an attempt should be made to derive "real" world prices. Ideally the prices of all resources should be expressed in terms of their true marginal opportunity cost.

It is conceivable that in evaluating the relative profitability of a labour-intensive and a labour-extensive enterprise, under conditions of disguised unemployment* that the labour-extensive enterprise is the most profitable to the individual farmer, but the labour-intensive enterprise is more profitable in terms of social benefit.

In this study no adjustments have been made to existing market costs and prices associated with agricultural and forestry enterprises. The most significant non-competitively determined price in this study is that for sawn timber. Price control was initially imposed on sawn timber in 1936 with the primary intention of maintaining low housing costs. Timber has

* For example, in the situation where the State pays unemployment benefits.

been under continuous price control since this date. A widespread view point has subsequently arisen that present levels of price control for timber are too low. If this assertion is true the author considers that one or both of the following situations must be prevailing:

(a) A system of rationing timber because, at the present level of price control, consumer demand exceeds supply.

(b) For certain types of processed timber there is no price control between merchant and consumer. Hence in the absence of rationing, supply and demand will only be equated by selling the limited supply of processed timber at a high price. In this instance the merchant will be obtaining a high "mark-up", but this is not reflected back to the mill and stumpage, because the merchant is unable to buy mill timber above the controlled price. In this case there would be a tendency for merchants to ensure their timber supplies by becoming integrated miller-merchants or grower-miller-merchants.

The present system of rationing, wherein a consumer can only buy a certain quantity of high grade timber providing he also buys a minimum amount of low grade timber, indicates that the present control price of high quality timber is probably too low. The author's impression, after discussion with timber merchants and foresters, was that merchants were obtaining relatively high "mark-ups" for some processed timber, not at present under price control. This, together with the tendency for merchants to obtain control of mills and forests, also indicates that the control price for some timber grades, particularly high quality timber, is too low.

The above situation does not necessarily indicate that present control prices for sawn timber, overall, are too low. Difficulty is at present being encountered in selling low grade box timber at the controlled price. For this reason, just as the control price for high grade timber is probably too low the control price for low grade timber is probably too high. It is the author's contention that the removal of price control on sawn timber would cause a larger differential between the price of high grade and low grade timber, rather than a

significant absolute rise in timber prices. This would be reflected back to stumpage values.

In brief, the author considers that price control on sawn timber could only effectively achieve lower housing costs if timber was rationed to the consumer.* If the control price of timber is too low demand will tend to exceed supply, and a rationing system would need to be adopted to distribute limited timber at that price. The author's impression is that at present sawn timber is not rationed in an absolute sense. Generally high grade timber is rationed, whilst low grade timber appears to be over supplied at present levels of price control.

It is contended that, unless price control is preventing monopolistic profits, it should be removed. This would enable consumer preferences for different grades of timber to be determined by a competitive market, and allow stumpage values to be related to the demand for sawn timber.

The price elasticity of demand for sawn timber in New Zealand is unknown. Hence, it is considered beyond the scope of this study to make any predictions of a likely long term supply and demand equilibrium for sawn timber in the absence of price control. In this study, where agriculture is more profitable than forestry, it will be shown to what level the control price would have to be raised for forestry to just "break-even" with agriculture. In this situation policy makers would then need to decide whether there would be a significant decrease in timber consumption at this higher price level.

The assumptions made in predicting future stumpage values are outlined in Chapter V.

3.4 Effect of Degree of Processing on Apparent Profitability of Agriculture and Forestry

It is important to clearly define the point in the processing chain at which the comparison of the relative profit-

* This is dependant upon the proviso that, in the absence of price control, there would be no elements of monopoly in the milling and selling of timber.

ability of each enterprise is made. For example, in this study a comparison is made at the farm gate and at the stump for agriculture and forestry respectively. In this instance the relative profitability ranking implicitly assumes that the subsidiary servicing and processing industries, for the additional amount of land converted to agriculture or forestry, are all earning the market rate of interest. Consequently in the pure economic sense, it is a matter of indifference whether capital and labour are employed in the servicing and processing industries of agriculture or forestry, or in some alternative enterprise equally capable of profitably absorbing additional capital and labour. On the other hand, if the market is functioning imperfectly and one of the subsequent industries has a "mark-up" greater than the average "mark-up", account must be taken of the additional profitability of this enterprise.

There may be a higher quantity of capital and labour employed in associated processing and servicing industries for one enterprise than another. If the less intensively processed and serviced enterprise is selected as the most profitable at the farm gate, it is important to know whether the additional capital and labour associated with the competing enterprise could be equally profitably employed in an outside investment. Such a study, however, would be difficult as account would need to be taken of the economies and diseconomies of scale, when existing servicing and processing industries marginally expand to meet the increased agricultural or forestry production. It would also be necessary to specify the point in time at which they would be required and to express their net profits in terms of a present value.

For the purposes of this study the point in the processing chain at which the comparison has been made is the farm gate and at the stump for agriculture and forestry respectively. A comparison at this point reflects the real value of the two enterprises under all conditions to the individual farmer. It also reflects the social benefit of each enterprise under the proviso that the servicing and processing industries associated

with agriculture and forestry are all earning the external interest rate.

3.5 Special Case of the Exchange Rate

Because of the present balance of payments deficiency facing New Zealand, it is extremely probable that the prevailing foreign exchange rate over-values New Zealand currency. Hence it is necessary to consider the net effect of an enterprise as an earner of overseas funds

It is considered reasonable to assume that agriculture and forestry are equivalent in this respect. Agriculture directly earns overseas exchange and forestry indirectly earns overseas exchange by saving the need to import timber for internal consumption. Imported raw material to provide inputs for agriculture and forestry are assumed to be approximately equivalent.

3.6 Effect of Output on Price

The original model assumed that the introduction or expansion of existing enterprises was on too small a scale to significantly affect the present cost-price structure for any resources or products associated with either enterprise. Clearly at the level individual farmer benefit, the prevailing market price is normally an accurate indicator of the value of marginal farm production. This is not necessarily the case, however, when the aggregate marginal production is being considered on a national scale and in terms of benefit to the nation as a whole. From a national view point, the following points should be considered when planning the expansion of agriculture for an export trade:

- (a) The size of the export market.
- (b) The proportion of the total export market supplied by New Zealand.
- (c) The price elasticity of demand for the particular export product.

New Zealand is in the awkward position of being an important supplier to some export markets. For example, butter, cheese and frozen lamb to the United Kingdom market. Coupled with her

importance as a supplier, is a probable unfavourable price elasticity of demand. Consequently it is conceivable that the reduction in average export price caused by an expansion in production may absorb a substantial portion or all of the profits accruing from the additional production.

In brief, this consideration is not important in assessing the profitability of agriculture and forestry at the farm gate. However, by carrying this view point over to the national level the marginal value of additional agricultural production is likely to be over-valued.

3.7 Credit Facilities and the "True" Interest Rate for Long Term Investments

Economic policy normally seeks to improve economic welfare in the face of constraints. Constraints may be physical, legal, administrative, or a predetermined level of risk. For example, there may be a limit on the rate of expansion of forestry caused by the need to expand personnel and diffuse administrative know-how. Apparent constraints, however, should be investigated closely before they are accepted as fixed.

In this study it is considered that the most important constraint arises because the capital market is not perfect. Credit institutions tend to lend on conditions of existing securities rather than on the potential of the particular investment. Capital rationing is particularly prevalent amongst small businesses, for example individual farms. Often rationing will take the form of a step ladder of definite interest rates as borrowing increases. There are, however, firms that are simply unable to borrow more credit at any interest rate.

Clearly even if, from a national view point, forestry appeared more profitable than agriculture, capital would still tend to flow into agriculture, because from the farmer's view point there is:

- (a) A higher risk associated with a long term investment such as forestry. There is also a common traditional view point that land should only be used for forestry as a last resort.

(b) With the capital market being imperfect, in many instances capital rather than land will become the most significant limiting resource. As a result a farmer may be forced to accept a lower return to his capital by investing in agriculture and so obtaining an annual return to provide for present consumption, even though forestry may be more profitable in the long run.

In long term investments such as forestry there are two complicating factors. Firstly, there is the high risk element which is simply a function of the long production cycle and the uncertainty of the distant future. Secondly, there is the question of how much capital a country, and more particularly an individual, can "afford" to invest for 30 to 40 years before obtaining revenues. Clearly most small firms cannot afford to invest substantially in forestry as the only forestry loan scheme known to the author is the recently introduced Government farm forestry scheme.

Hence at present there is an imperfect capital market facing most potential forest growers, although the Government farm forestry scheme has to some extent alleviated this position. To a lesser degree an imperfect capital market also faces agricultural producers. There is the important distinction, however, that whereas a farmer in the face of capital rationing can adopt a form of extensive agriculture on partially developed land, forestry is essential an "all or nothing enterprise".

3.8 Summary

There are a number of important considerations to be taken into account when interpreting the results of this study.

(1) There are two distinct levels of benefit:

- (a) Individual benefit.
- (b) Benefit to the nation as a whole.

The benefit assessed at one level does not necessarily reflect the benefit at the other level.

(2) The range of possible outcomes due to risk and uncertainty in long term investments is incorporated by varying the interest rate and product prices. These are considered the two most vulnerable assumptions, the variation of which tends to overshadow other variables, for example variation in physical yields.

- (3) The degree of imperfection of the capital market and the resultant consequences are more severe for forestry than agriculture.
- (4) It is likely that the ruling average price for some agricultural products tends to over-estimate the value of additional agricultural production, at the level of benefit to the nation as a whole.
- (5) The common argument that forestry provides profitable employment of labour and capital, additional to that in agriculture, because of the higher degree of processing of the raw product, is in the author's belief at least partly erroneous. Firstly, the point in the processing chain at which a comparison is made is only important when subsequent processing industries are obtaining a return to capital which is below or above the average market return. Secondly, agriculture has a higher quantity of servicing industries before the product leaves the farm gate and, thirdly, the returns from the subsequent wood processing industries will not be realized for 30 to 40 years and hence should be converted to a present value.
- (6) Forestry and agriculture were anticipated to have an approximate equivalent effect on the balance-of-payment problem.
- (7) The most important non-competitively determined price in this study is the control price of timber.

CHAPTER IV

THE NATURAL CONDITIONS AND CURRENT LAND

USE OF THE MANAWATU-RANGITIKEI SAND COUNTRY

This chapter provides a background of the natural conditions and current land use of the Manawatu-Rangitikei sand country.* This follows the selection of this area for study in Chapter I, and the subsequent selection and discussion of a suitable economic model for comparing the relative profitability of forestry and agriculture in Chapters II and III respectively.

The Manawatu-Rangitikei sand country represents a very variable soil complex, which in turn has determined a diversified land use pattern.** For this reason a detailed study of soil survey results is made in this chapter. A method of soil classification is adopted on which "productivity classes" for forestry and agriculture can be identified. Finally the sand country soils on which competition between forestry and agriculture is strongest are selected for an intensive study. A detailed land use classification of these soil classes is made.

4.1 Definition of the Area

The soil classes to be studied comprise a large area of the Manawatu-Rangitikei sand country. The following description of natural conditions and classification of soils is based largely on a comprehensive and detailed soil survey compiled by Cowie and Smith (1958), (35) and Cowie and Fitzgerald (1963), (36). The Manawatu-Rangitikei sand country, as defined in this soil survey, extends a distance

* See locality map, Fig. XII 1.

** For illustration, see land use and simplified soil maps, Figs. XIII.2, XIII.3 and XIII.4. Large scale, detailed soil maps of the sand country and additional raw data used in this study are lodged with the Department of Agriculture Economics and Farm Management, Massey University of Manawatu.

of 40 miles along the west coast. The area extends from the Hokio Beach in the south to the Wangaehu River in the north, and inland to a depth ranging from 2 to 12 miles. This area, covering approximately 170,000 acres, is composed of a large number of different soil types, the parent material of which is generally wind blown sand. Four rivers, the Manawatu, Rangitikei, Turakina and Wangaehu, flow through the sand country. Small areas of alluvial flats and terraces bordering the rivers' lower courses are included in the soil survey, but not in this study. There is approximately 100,000 acres of sand country south of the Hokio Beach and north of the Wangaehu River which has been excluded from the soil survey and this study. It is thought, however, that the results of this study could provide a guide on similar soil classes on this area.

4.2 Climate and Relief

The Manawatu-Rangitikei sand country lies within the Western Wellington climatic district, which is characterized by warm summers, mild winters and a reliable rainfall, evenly distributed throughout the year. Conditions on the sand country, however, are drier than further inland. The average rainfall is 33 to 35 inches per annum. Strong westerly and north westerly winds are a dominant feature of the sand country. These winds have controlled the orientation of the dunes. During spring, westerly winds increase in frequency, causing a loss of soil moisture, particularly on exposed sites. It is also a time when salts carried inland by wind can damage and retard the growth of pastures and crops. During summer, which is warm, rainfall is comparatively low and variable, inducing drought conditions on freely draining soils. Autumn is warm and, if the rainfall is adequate, this is a time of rapid growth.

The overall relief of the Manawatu-Rangitikei sand country is flattish with a gentle slope from sea level inland, up to a height of 300 feet above sea level. This low overall relief is obscured by the alternation of dunes and plains, which give the sand country a strong micro-relief. The

micro-relief, by affecting the level of the water-table and impeding natural drainage towards the coast, is an important determinant in the formation of different soil types.

The sand country may be divided into two broad classes:

(a) The Younger Dune Complex

This is a strip of relatively immature sand country bordering the coast to a depth ranging from one quarter to four miles. The Younger Dune Complex consists of relatively unconsolidated dunes and plains, large areas of which have insufficient plant cover to prevent wind erosion of sand. Approximately one-third of the area is raw unstabilized sand.* The erosion of sand on this area has in the past been initiated and aggravated by burning, ploughing and over-grazing of the natural plant cover.

The Younger Dune Complex comprises one quarter of the sand country.

(b) The Older Dune Complex

This is an area of relatively mature sand country situated inland from the Younger Dune Complex. The Older Dune Complex which extends from one quarter to 12 miles inland, consists in general of consolidated dunes and plains on which plant cover is good. There is little serious erosion, with the exception of some small localized dune areas.

Attention is now focussed on the two land classes selected for a detailed study.**

4.3 A Detailed Land Use Classification of the Selected Land Classes

This section provides a detailed description of the current land use of the Younger Dune Complex and the Himatangi-Foxton land class of the Older Dune Complex.

* For illustration see Fig XII.5.

** A detailed technical description of sand country soil types, originally part of the main text, has been transferred to Appendix XII.

4.3.1 The Younger Dune Complex

This area has been described in section XII.2.2. *
The current land use of the Younger Dune Complex is tabulated in Table 4.1.

The land use pattern shown in table 4.1 is:

Undeveloped Land

This consists of:

(a) 16,000 acres of completely undeveloped land, 6,500 acres of which are to be utilized for protective forestry. The remaining 9,500 acres may be developed alternatively for forestry or agriculture. Regardless of future land use, the initial development will be the planting of marram grass and tree lupin to fully stabilize the sand, and to build up the initial fertility to a level where it is possible to establish pasture or trees.

(b) 16,209 acres of relatively undeveloped but stabilized sand country which is used for extensive grazing or is being developed for forestry.

Within the Younger Dune Complex 26,709 acres are either in the undeveloped state or at a very early stage of development. This figure excludes the protective belt, but includes 1,000 acres of relatively undeveloped land classified under sheep and dairy farming in Table 4.1.

Developed Land

The total area of developed land within the Younger Dune Complex is 10,971 acres. This is subdivided into:

(a) Sheep-beef farming: Of the 3,730 acres devoted to sheep farming, 3,218 acres are in the process of development and subdivision. The tentative subdivision plan is for 5 sheep units and 1 dairy unit. The remaining 512 acres is a small developed block forming part of a large undeveloped property. The average carrying capacity at present is 2.0 ewe equivalents ** per acre.

* The need for and expected extent of a protective coastal belt of forest on the Younger Dune Complex has been outlined in Chapter I.

** For conversion of stock to ewe equivalents see Appendix VIII.

TABLE 4.1

The Current Land Use of the Younger Dune Complex

Tenure	Protective Coastal Strip	Existing Large Scale Forestry	Land in Process of being Developed for Forestry	Dairy Farming	Sheep-Beef Farming	Undeveloped and Extensive Grazing	Total Area
	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
Crown Ownership	5,000	4,400	8,000	-	3,218	3,000	23,618
Private Ownership	1,500	1,000	800	2,661	512	13,909	20,382
Total:	6,500	5,400	8,800	2,661	3,730	16,909	44,000

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(b) Dairy farming: The 2,661 acres devoted to dairying have been in the process of development since the 1920s. At present there are 7 dairy units, of which 240 acres are devoted to farm forestry. The average butterfat production is 75 pounds per acre

(c) Forestry: The two Crown forests have a combined planted area of 4,400 acres. There is a further 1,000 acres of private forestry giving 5,400 acres of established forest, excluding farm forests.

A broad classification of land classes within the Younger Dune Complex is:

- (a) A 6,500 acre protective belt.
- (b) 26,700 acres of land in an undeveloped state or at a very early stage of development.
- (c) 10,800 acres of relatively developed and farmed or forested **sand country**.

4.3.2 The Himatangi-Foxton Land Class

This land class comprises approximately 30,000 acres. The land class is scattered and dispersed amongst the other soil classes within the Older Dune Complex. However, four relatively large areas which are predominantly the Himatangi-Foxton soil class can be identified.*

These are:

(a) An area of approximately 7,000 acres situated to the south of the forest owned by the Marton Sash, Door and Timber Co. Ltd

(b) An area of approximately 7,000 acres in the Oroua Downs district.

(c) An area of approximately 8,000 acres which is bounded by the Sanson-Wellington highway, the Palmerston North-Himatangi highway and the Manawatu River.

(d) An area of approximately 2,500 acres directly east of Waitarere Forest.

* See soil maps, Figs. XIII.2, XIII.3, XIII.4.

TABLE 4.2

The Current Land Use of the Himatangi-Foxton
Land Class

Sheep-Beef Farms (acres)	Dairy Farms (acres)	Forestry (acres)	Run-offs (acres)
15,000	4,500	700	9,800

Table 4.2 indicates the current land use on the Himatangi-Foxton land class.

(a) Sheep-beef farming: Of the 15,000 acres devoted to sheep-beef farming, much is on large properties with considerable portions in an undeveloped or partially developed state.

The average rate of stocking is 1.6 ewe equivalents per acre.

(b) Dairy farming: Dairy farms are generally at a more advanced stage of development than sheep-beef farms. However, there are still areas of undeveloped land on most dairy farms.

The average production is 72 pounds of butterfat per acre.

(c) Forestry: There are only two forests exceeding 100 acres on this land class. There are a number of small plantations ranging in size from 5 - 50 acres. The aggregate 700 acres of forest is based on all plantations exceeding 25 acres.

(d) Run-offs: A full discussion of sand country run-offs is given in the following section.* This was considered necessary because of the present high price for run-offs.

4.3.2.1 The High Value of Run-offs

Table XII.4 indicates that approximately one third

* It is necessary to make a distinction between the use of land for run-offs and the use of land for extensive grazing. Undeveloped but stabilized sand country on the Younger Dune Complex can be used for extensive grazing, providing it is strictly controlled and very lightly stocked ($\frac{1}{4}$ - $\frac{1}{2}$ ewe equivalents per acre).

On the other hand, the Himatangi-Foxton soil class in its natural state is more mature, and can be relatively heavily stocked without serious wind erosion of sand. In addition, this area is better sited and roaded for run-off subdivision.

of the Himatangi-Foxton land class is at present used for run-offs. The dry, warm nature of these soils and their close proximity to the heavy, low-lying clay soils of the Kairanga plains, provide ideal conditions for wintering dairy and beef stock.

Sand country run-offs serve a number of areas and systems of farming, including the following:

- (a) Dairy farms within the sand country sited on poorly draining soils, for example those on the Pukepuke-Omanuka soil association.
- (b) Dairy farms and sheep-beef farms situated on the Kairanga plains and in the Feilding district.

It is considered beyond the scope of this study to determine whether the relatively high market price of run-offs is economically justified for the range of farming systems involving the use of a run-off. An assessment of the economic value of a run-off would be complicated by the following two factors:

- (a) The difficulty in many instances of accurately quantifying the proportion of the total farm production contributed by the run-off.
- (b) The diversification of farming systems which make use of a sand country run-off would necessitate a large survey sample.

Although a detailed economic survey of run-offs is beyond the scope of this study, it is important in the present study to have some knowledge of market prices and existing and likely future trends in the demand for run-offs.

The following is the author's general impression based on information assembled jointly from the Valuation Department and discussion with agricultural extension officers and farmers.

At present approximately one-third of the Himatangi-Foxton land class is used for run-offs. The market price for dairy farm run-offs in the past five years has ranged from £40 to £90 per acre. The average price being £60 to £70 per acre for undeveloped land devoid of buildings. The size of dairy farm run-offs ranges from 40 to 140 acres. In

contrast to dairy farm run-offs, sheep and beef cattle run-offs are generally leased at a rate of £3 to £7 per acre per year, and range in size from 150 to 400 acres. A rent of £4 per acre per year is approximately equivalent to a purchase price of £70 per acre, assuming a $5\frac{1}{2}$ per cent external interest rate is realistic. Hence some undeveloped and partially developed run-offs have a per acre market price which is higher than the government valuation for developed dairy farms, inclusive of buildings, situated on moister sandy soils. The author has no detailed numerical data but his impression is that the recent market price of run-offs is higher than their productive value. This impression is based on a high proportion of run-off owners being in a sound financial position and apparently prepared to pay for the easy and convenient method of overcoming wintering problems that a run-off provides. For example, excluding the effectiveness of each method, a run-off is normally a psychologically more acceptable method of overcoming wintering problems than providing a sacrifice paddock within the farm.*

In the present study it is assumed that the market price for run-offs reflects their true productive value. Further consideration is given to run-offs in Chapter VII, where the results and recommendations of this study are presented.

4.4 Summary

(a) The development and utilization of the sand country presents a number of problems. These arise from a complex soil pattern, varying and often unfavourable moisture conditions, and lack of consolidation of the soils.

(b) Following a general description of the natural conditions, methods and problems of soil classification on the sand country have been described and discussed.

* Clearly it may be argued that "psychic" factors, such as ease and convenience of a system combined with freedom from worry, constitute real productive value which a farmer is economically justified in paying for. The management award to a farmer with a run-off could well be lower than the cost of managing a farm without a run-off.

(c) A modified method of soil classification has been adopted for use in this study. This method classified sand country farms (or forests) into one of five "productivity classes", one within the Younger Dune Complex and four within the Older Dune Complex.

(d) Two "productivity classes", where competition between forestry and agriculture is most marked, have been selected for an intensive study. The present land use of these areas, namely the Younger Dune Complex and Himatangi-Foxton land class, has been described in detail.

CHAPTER V

FORESTRY LAND EXPECTATION VALUES

Amongst the most important information needed to evaluate the economics of forestry are: the growth rates and yields of timber, the predicted effects of silviculture on future stumpage values, the estimated costs, returns and timing of forest operations, and knowledge of the benefits and disadvantages of farm forestry relative to large scale forestry

This chapter provides a description and discussion of farm forestry, with particular reference to the recently introduced farm forestry scheme and the relative merits of farm forestry and large scale forestry. This is followed by a description of the surveyed forests and the interpretation of data obtained from this survey. The outlook for the round produce market is also discussed. Finally the forestry land expectation values are calculated.

5.1 Farm Forestry

In this study farm forestry is defined as:

A farm with Pinus radiata plantations ranging in size from 5 acres to 100 acres, which in aggregate do not exceed one half of the total farm area. The plantations are assumed to receive pruning to a minimum height of 18 feet and not less than two thinnings, with a final harvest between 30 and 40 years of age.

Until the last decade the purpose of farm forestry on the Younger Dune Complex and Himatangi-Foxton land class was mainly to provide shelter and protection against wind erosion of sand. The harvesting of timber has been a secondary consideration. More recent plantings, however, have been initiated because of a growing awareness of the direct value of well grown timber. On the Younger Dune Complex 240 acres of farm forests were established over the period 1926-58. The only silvicultural treatment has been low pruning. A

further 150 acres have been established within the last three years. On the Himatangi-Toxton land class approximately one-half of the surveyed properties had farm forests, ranging in size from 5 to 30 acres.

Yield and stumpage data from farm forests were very limited because few farm forests have been harvested. Those that have been harvested were generally scattered shelter belts which have had little or no tending. The limited data that were available have been used to substantiate yields and stumpage values given in Table 5.2 for existing large scale sand country forests.

5.2 The Farm Forestry Scheme

The Forest Service expects that private plantings, of which a substantial portion will be farm forests, will provide approximately one half of the additional one million acres of exotic forest envisaged by the year 2000 A D. The recently introduced (1963) Government farm forestry scheme is a reflection of the importance placed on the part farm forestry is to play in the envisaged future afforestation programme in New Zealand.

Briefly the essential points of the proposed farm forestry scheme are (37):

- (a) The establishment by the Government of a credit reserve of £700,000 for the purpose of providing finance for establishment and silviculture of farm forests.
- (b) The maximum loan is £25 per acre for establishment and £15 per acre for subsequent silviculture. The minimum area for which credit will be loaned is 5 acres and the maximum area 100 acres in any five-year period. This restriction is designed to ensure orderly planting and a planned age-class distribution to be achieved.
- (c) Conditional on the correct adoption of defined establishment and subsequent silvicultural procedures, up to £20 per acre will be written off as a suspensory loan.
- (d) Repayment of principal and interest at a rate of 5 per cent will be by table mortgage over a period of 20 years, commencing in the 20th year after establishment or in the year

of first realization.

The recent incentives for establishing farm forests given both in the form of availability of credit and giving confidence to potential growers, reflect some important advantages of farm forestry. These are now discussed.

- (a) Where farm forests are established in settled farming areas, there is a large saving of social overheads, for example roading, power reticulation and buildings. Where a large forest is established in a completely unsettled area, these social overheads have to be provided.
- (b) In many farming areas, particularly the sand country, there is a range from low-producing to high-producing soil types, within individual farms. Consequently, although there may not be large unbroken areas of soil types suitable for extensive forests, there are often many suitable small areas within farms which in aggregate would represent a substantial forest. Farm forestry also provides a diversification of farm production, and secondary benefits in the form of a cheap supply of farm posts, shade, shelter and protection against wind erosion of sand. When assessing the land expectation value for farm forests, no attempt has been made to place a numerical value on these secondary benefits. There will be a wide variation of these benefits between farms.

On some farms, farm labour may be utilized for tending plantations during a slack farming period. At this time the opportunity cost of the labour will be low. For example, using dairy farm labour for pruning after the milking herd has been dried off.

A further advantage of farm forestry is the absence of roading and tracking costs. However, this advantage is normally more than offset by the additional fencing costs required for farm forestry. The main disadvantage of farm forestry is the higher logging costs incurred in harvesting scattered farm forests. Further considerations for a

successful farm forestry scheme are the need for a system of co-operative marketing to ensure a steady supply of timber to the mill and to minimize transportation of heavy logging equipment between plantations. There would also be a need for an extension of service for extending correct silvicultural techniques to farmers.

5.3 Credit and Taxation Considerations with Respect to Farm Forestry

5.3.1 Credit

The Government farm forestry scheme is the only official source of credit available for establishing and tending farm forests at present known to the author. This raises an important problem when using the land expectation value criterion to determine the relative profitability of farm forests. The present value method implicitly assumes that the capital market is perfect. Therefore in choosing the optimum combination of farming land and farm forests, it is assumed that the farmer is in fact able to move to his optimum time preference pattern for consumption, by financing the investment in a perfect credit market. In addition to borrowing credit for the investment, a farmer who has a substantial proportion (20-40 per cent) of the farm in farm forests would probably need to borrow credit for present living expenses.*

Because of lending constraints and the forestry input-output structure,** many farmers may often be forced to accept a lower return to capital by devoting some land to agriculture which could have given higher long term profits as a farm forest. A possible method of overcoming this problem would be to institute a farm forestry scheme, whereby the Government paid an annual rental to farmers for land planted in trees.

* Quite apart from the likelihood of these credit sources never being available, the high risk of borrowing to this extent, for an investment not yielding returns until 30 years in the future, would be unacceptable to most farmers.

** For an example of the flow of income during the establishment phase of a forest see Appendix II.

5.3.2 Death Duties and Taxation

This section briefly summarizes pertinent features of taxation and death duties with respect to farm forests. For a detailed account reference should be made to Grainger (1950), (38) and Mitchell (1963), (39).

Death duties are no longer a disincentive to establishing farm forests, as trees were made completely exempt from death duties in 1960. With respect to taxation, Mitchell states:

"It seems fair to say that there is little in the taxation field for the farm forester to ask for, so long as his forestry activities are within the scope of the Farm Forestry Act 1962."

The present method of forest taxation is still claimed to be discouraging to forest companies. For example, the interest earned on capital invested as a provision for future forest maintenance expenditure is at present taxed. At the same time, the forest is not yielding any returns during this establishment phase.

5.4 Existing Sand Country Forests

A survey was made of 7 relatively large scale sand country forests to obtain the data necessary to determine the profitability of forestry.* A summary of the descriptive data collected during the survey is given in Table 5.1. These data are given in more detail in the following sections.

A number of experimental tree species were established in sand country forests. For example, Pinus pinaster, P. muricata and P. ponderosa. The results have shown that beyond the protective belt P. radiata is easily the most rapidly growing and most profitable species. This is the only species considered in this study.

5.5 Forest Productivity on Sand Country Soils

The stumpage yields and values given in Table 5.2 have been derived from harvested areas of sand country forests on the Younger Dune Complex and Himatangi-Foxton land classes.

* These forests are shown on the land use maps, Figs. XIII.2, XIII.3 and XIII.4 given in Appendix XIII. In these maps the first letter of a forests name indicates the forest. For example, Waitarere forest is shown as W.

TABLE 5.1
Existing Sand Country Forests

Forest	Ownership	Potential Area (acres)	Planted Area (acres)	Date of Planting Year	Total planted area. (acres)	Silvicultural Treatment	Soil Class	Harvested Area (acres)
Waitarere	Crown	3,000	2,555	1935 1945 1955 1961	9 876 1,909 2,555	All plantings have been pruned and thinned, although treatment of older stands was much delayed and not fully effective.	Hokio- Waitarere	None
Santoft	Crown	8,800	1,650	1925-35 1945-63	400 1,650	1925-35 plantings inadequate silvicultural treatment. All other plantings receiving intensive pruning and thinning. Proposed planting programme is 400-500 acres per year.	Hokio- Waitarere	None
Tangimoana	Crown	Unknown	800	1925-29	800	Mixed and generally inadequate silvicultural treatment. Planted in plantations ranging from 5 to 50 acres.	Hokio- Waitarere	42
Foxton-Railway	Crown	Unknown	35	1927-30	23	Receiving full silvicultural treatment.	Himatangi- Foxton	23
Marton, Sash, Door and Timber Co. Ltd.	Private	1,000	900	1948-62	900	Receiving full silvicultural treatment.	Hokio- Waitarere (inland area)	None
Kernohan) Gibbs)	Private	400	350	1925-35	400	Areas planted in last decade receive full silvicultural treatment.	Himatangi- Foxton	50

Table 5.2 gives the yields from harvested areas of 41.7 acres and 23 acres respectively. The age of the stands at harvesting has been approximately standardized to 33 years using generalized yield prediction tables (40,41). The forest "site index" based on Lewis's tables (40) ranges from 65 feet on poor areas of the Younger Dune Complex to 85 feet on the Himatangi-Foxton land class. These data are generally based on forests with

- (a) inferior seed sources,
- (b) unrecorded blanking, and
- (c) inadequate silvicultural treatment

producing a high proportion of low grade timber. The data in Table 5.2 can therefore only be used as an approximate guide, particularly for future stumpage values.

TABLE 5.2

Final Harvest Yields and Stumpage Values

Land Class	Yield/ft ³ /acre	Price ft ³	Stumpage Value per acre
<u>Younger Dune Complex</u>			£
Average	8,270	11.0d.	375
Minimum	7,200	10.0d.	327
Maximum	8,800	12.5d	422
<u>Himatangi-Foxton</u>			
Average	9,120	11.3d.	440
Minimum	8,400	9.2d.	350
Maximum	9,550	14.5d.	530

To the author's knowledge no sample plots have been established to obtain measurements for forests under intensive silvicultural management on these classes of sand country. Generalized yield tables for intensively managed P. radiata forests are in the process of being prepared at the Forest Research Institute, Rotorua.

The proportion of a large representative area of the Younger Dune Complex on which it is possible to obtain a productive P. radiata forest is not accurately known. The two largest established forests of 2,555 acres and 980 acres respectively, have a higher proportion of dunes than is characteristic of this land class as a whole, and are therefore not truly representative. Within these two forests there is a negligible area of soil types on which it has not been possible to establish P. radiata. These few small areas are too wet.

Difficulty in tree establishment has occurred in the Santoft Forest on the imperfectly draining Hokio sand and Hokio peaty soil types. However, it is possible that techniques of ridging and cheap drainage combined with the natural drying up of wet areas surrounded by forest will overcome this difficulty. Where these methods are not successful less productive species more adapted to moist conditions may be planted.

It is estimated that for a large scale forest sited on the Younger Dune Complex, 25 per cent* of the land would be classified as unproductive due to:

- (a) Access tracks for fire protection and tending operations.
- (b) Camp sites.
- (c) Excessively wet, swamp and lagoon areas.
- (d) Loss of forest due to fire, insect attack, disease and wind-throw.

The equivalent unproductive area for the Himatangi-Foxton land class is estimated to be 20 per cent. The lower unproductive area is due to there being negligible areas of exceedingly wet and swampy soils on this soil class. The estimated unproductive area for farm forestry is 10 per cent for both land classes.

The lower "unproductive" farm forest area is because

* The loss of production due to unproductive soil types is derived from existing unproductive areas on sand country forests, together with appraisal of detailed soil maps of the sand country.

normally the only loss of production will be from fire, insect attack, disease or windthrow. Moist areas will be farmed.

On the Younger Dune Complex, 5 per cent of the total area is estimated to be unproductive agricultural land, due to swamps, lagoons and lakes. Hence relative to agricultural **production** on this land class, the "productive" area for large scale forestry and farm forestry is estimated to be 20 per cent and 10 per cent lower, respectively.

The land expectation values for a large forest planted immediately and farm forestry are estimated to be equivalent. This is because the lower proportion of "unproductive" land in farm forests will tend to be offset by slightly lower stumpage values obtained from harvesting small scattered farm forests.

5.6 Round Produce Market

This is an important aspect of forestry as round produce from thinnings provide revenue at a relatively early point in time. The future outlet for round produce in the form of posts and poles is complicated amongst other factors by the likely substitution of wood for concrete, as an increasing quantity of good quality round produce is supplied. Consequently projected demand figures can only be used as an approximate guide for future demand trends. For the Manawatu-Wanganui region the estimated future demand for round produce, based on present sales, is 600,000 cubic feet per annum (6).

With production of 600 cubic feet of round produce from the first thinning and 300 cubic feet from the second thinning, 25.7 cubic feet of round produce per acre per year is produced from a 35-year rotation sustained yield forest. An area of approximately 23,500 acres of a 35-year rotation sustained yield forest would meet this annual 600,000 cubic feet demand. Considering the existing 30,000 acres of exotic forests, and the probable planting of an additional 30-80,000 acres in the Manawatu-Wanganui district, it is evident that the supply of round produce in its present form will tend to exceed demand. The sand country has a transport advantage over alternative supply areas hence the gross figure is not

directly applicable. However, this factor would tend to be offset by the fact that there would also be some roundwood from the final harvest, hence estimated gross acreage requirements may be slightly high.

To the author's knowledge, alternative outlets for round produce have not been formulated. It may be possible to convert the round produce to chips, by the use of portable chippers and to transport the raw chips to the nearest pulp mill for further processing. This method is adopted in the U.S.A. and, despite long transport distances, is evidently economic. At present, however, there is little indication of this practice evolving in New Zealand. In the event of an over-supply of round produce, there is the possibility of the establishment of a fibre or particle board plant. If such a plant were established, the source of round produce would have to be concentrated within a small distance of the processing plant, because of high internal transport costs in New Zealand.

If no alternative outlet for round produce can be found, the adoption of the resultant method of poison thinning to waste would represent a marked decline in the profitability of forestry, as estimated as stumpage.*

If there is a future over-supply of round produce, an important question arises as to whether a State forest should maximize its own profits or maximize national welfare.** A tree-growing company in a monopoly position will tend to

* In the absence of a full scale study on the future of the round produce market, the author was unable to obtain reliable estimates of future round produce prices. However, the data that are available (6), together with the general opinion of the Forest Service, suggests that round produce prices will tend to fall. In this study, forestry land expectation values have been calculated for a range of thinning prices. The maximum price in this range is taken to be present day prices and the minimum, the cost of poison thinning. When calculating the most likely land expectation value for forestry, round produce has been valued at one half its present price.

** This point is illustrated in Appendix III.

maximize its own profits by adjusting the supply of round produce entering the market so that net profits are a maximum. The level of supply will depend on the price elasticity of demand for round produce. If the latter is accurately predicted, the level of supply of round produce would be such that an increase in supply would give a greater quantity at a lower price per unit volume and a lower overall net profit.

From the national view point, however, thinnings represent a by-product which for a small additional cost may be harvested. There is a fixed minimum cost of thinning, regardless of whether the thinnings are utilized. This fixed cost is the cost of poison thinning. Consequently the national cost of supplying round produce to the market is given by the additional cost of harvesting thinnings above the alternative method of poison thinning to waste. Thus a State forest with the object of maximizing national welfare should increase the supply of round produce by supplying thinnings to a level where the average price received for thinnings just meets the additional cost of harvesting. That is until the marginal cost of harvesting thinnings equals the average per unit revenue obtained from the sale of thinnings. Only when the price has reached this level should surplus thinnings, if any, be poisoned. In the event of this policy being adopted, careful consideration would need to be given to maintaining an unfluctuating supply of round produce. And secondly to the tendency for wood round produce to absorb rapidly markets previously supplied by concrete products. Clearly in an economic sense, if a substitute product can be produced more cheaply in the form of wood, a large proportion of the labour and capital at present producing concrete products should be released and aided into alternative avenues of production.

5.7 Expected Effects of New Silvicultural Practices

A problem arises in determining expected timber quality, growth rates and timing of forest operations for future rotations. This is because the limited data from previous rotations, on which anticipated future yields are estimated, is based on comparatively untended forests.

Intensive silvicultural practices prescribed for future rotations, although reasonably clear in their general effect (42,43,44), are difficult to estimate numerically as no data are available from rotations which have been completely managed along these lines. The essential aspects of intensively managed future rotations appear to be:

(a) Low and high pruning, to a minimum height of 18 feet, to give a large proportion of high quality timber. The present control price differential between timber grades, makes this an economic practice. For example, box grade $3\frac{4}{9}$ to $4\frac{4}{9}$ per 100 ft. ft. compared with finishing grade $6\frac{1}{6}$ to $8\frac{4}{6}$ per 100 bd. ft.

(b) An intensive thinning programme, where, depending upon market outlet for round produce and small sawlogs, each rotation will have from two to five thinnings.

The thinnings have a threefold function:

(i) To ensure that the better pruned trees are not dominated by trees of inferior form, and also to allow the maintenance of a deep green crown on pruned trees.

(ii) To provide an early financial return which, because of its early timing, is important in effectively decreasing the rapidly increasing compounded stream of establishment and pruning costs.

(iii) To give a final harvest yield which has a lower final harvest volume than that for an equivalent unthinned forest. However, the yield is represented by fewer stems of greater volume, and greater value per unit volume, than from untended stands. The estimated effects of silviculture on future stumpage values is later discussed in section 5.9.

The following table indicates the estimated management schedules for a 30-year and a 40-year rotation on the Himatangi-Foxton land class.

TABLE 5.3

Estimated Forest Management Schedules for the
Himatangi-Foxton Land Class

<u>40-Year Rotation</u> Age (years)	10	18	28	40
Stocking before thinning (stems)	900	250	150	90
Volume before thinning (ft ³)	2,200	4,500	6,500	9,000
Thinning volume (ft ³)	800	1,800	2,000	
Volume after thinning (ft ³)	1,400	2,700	4,500	
Stocking after thinning (stems)	250	150	90	
Total yield (ft ³)				13,600
Mean annual increment (ft ³)				340
<u>30-Year Rotation</u> Age (years)	10	16	30	
Stocking before thinning (stems)	900	250	110	
Volume before thinning (ft ³)	2,200	3,600		
Thinning volume (ft ³)	800	1,600	8,000	
Volume after thinning (ft ³)	1,400	2,000		
Stocking after thinning (stems)	250	110		
Total yield				10,400
Mean annual increment (ft ³)				347

The above management schedules for the Himatangi-Foxton land class are based on assembled data from harvested sand country forests, as previously shown in Table 5.2. The data have been adjusted using generalized yield prediction tables (40,41,42) and yields from thinned and unthinned experimental plots established by the Forest Research Institute.* This has enabled the expected effects of thinning to be allowed for. The management schedules for the Younger Dune Complex are estimated to be the same as shown for the Himatangi-Foxton land class, with the exception that the final crop yield is 1,000 cubic feet lower.

* The yields given in Table 5.3 were finalized after discussion with members of the Forest Service.

5.8 Costs of Establishment and Routine Management

This section briefly outlines the pertinent establishment and management costs.*

5.8.1 Establishment Costs

	£ <u>Cost per Acre</u>
(a) Land preparation	5
(b) Roading and tracking	3
(c) Trees, planting and blanking	15
(d) Release cutting	7
	<u> </u>
Total establishment costs	<u>£30</u>

The above establishment costs represent averages for a large sand country forest. The range of establishment costs is estimated to be between £30 and £35 per acre.** The main reason for the variation in costs is due to the more than proportional rise in fencing costs as the size of the forest decreases. This is because fencing costs are approximately equal to the square root of the forest area enclosed. Small farm forests may have fencing costs up to £10 per acre but these are partially offset by the absence of roading and tracking costs.

5.8.2 Routine Management Costs

The annual forest maintenance costs will vary depending upon whether a new forest, with the overheads of buildings, is to be established, or whether an existing forest is to be expanded.*** Where a new forest including all overheads is to be established, the annual running costs are estimated to be £2.5 to £3 per acre. However, where overheads for a forest are already established, and the existing forest

* Full details of forest costs are given in Appendix IV.

** These establishment costs were derived from the survey of sand country forests and discussion with members of the Forest Service.

*** See Appendix IV for derivation of routine management costs.

is to be expanded, the additional annual running costs are of the order of £1.5 to £2 per acre. Farm forestry running costs are also estimated to be £1.5 to £2 per acre. For an expansion of forestry on the sand country, many of the overheads are already provided.

5.9 Timber Yields and Prices

This section gives forest budgets based on a 30-year and 40-year rotation.

Table 5.4 shows two rotation schedules for a sand country forest, sited on the Himatangi-Foxton land class. (A) indicates a 40-year rotation and (B) a 30-year rotation.

The forest returns shown in Table 5.4 are based on the following stumpage values for timber.

- | | | |
|-----|---|------------------------------------|
| (a) | Round produce and small sawlogs
from first and second thinning | 0 - 6d per cubic foot |
| (b) | Sawlogs from third thinning | 9d per cubic foot |
| (c) | Sawlogs from final harvest 30 years | 12d - 18d per cubic foot |
| | | 40 years 12.5-21.5d per cubic foot |

Returns from thinnings are based on present prices with a lower limit representing the situation where poison thinning is adopted, due to the possibility of a future over-supply of round produce.

Final harvest stumpage values are based firstly on a lower limit, where it is simply assumed that present stumpage values being received for untended plantations shown in Table 5.2 are projected into the future for fully tended forests. The evaluation of the increased stumpage attributable to intensive silviculture is based mainly on research work by Brown (1962), (42). Essentially the higher stumpage values from fully tended forests are attributed to a higher proportion of high quality timber grades, a higher conversion rate of large logs into sawn timber and, to a lesser extent, lower per cubic foot logging costs. The full increased value estimated by Brown has not been allowed for in this study for the following reasons:

TABLE 5.4

FOREST BUDGETS

For Two Rotation Schedules for a
Sand Country Forest

	£ Cost per Acre		£ Return per Acre	
	A	B	A	B
Cost of establishment	30-35	30-35		
Annual running costs	1.5-2.5	1.5-2.5		
First pruning at (6-8') 6 years	8	8		
Second pruning at (18') 9 years	9	9		
Third pruning at (35') 12 years	15			
First thinning at 10 years			-5 +20	-5 +20
Second thinning at 16 years				20-40
			25-45	
Third thinning at 28 years			75	
Final harvest at 30 years				400-600
			550-800	
				400-600

(a) The additional stumpage values are based on the Conical Hill sawmill which is fitted with band saws, and is therefore unlikely to be representative of future saw mills serving sand country forests.

(b) There would be a higher capital investment required in milling equipment if existing sand country sawmills were to produce high quality timbers. For this reason a part of the increased timber value would need to be attributed to the sawmill. Also, the loss of timber through removal of the knotty core is considered to be under-estimated.

(c) Finally, the calculations are based on production of board timber only, whereas a substantial portion of the timber supplying the Wellington market will be framing.

5.10 Forestry Land Expectation Values

Forestry land expectation values based on data given in Tables 5.3 and 5.4 are now presented in tabulated and graphical form.*

TABLE 5.5

Land Expectation Values Per Acre of Forest
Based on a 30-Year Rotation
"Immediate Planting"

	Annual Interest Rate (per cent)			
	4½	5	5½	6½
	£	£	£	£
(1) Maximum	138.14	104.50	85.68	52.43
(2) Average (H-F)	85.37	63.36	45.67	21.55
(3) (Y.D.C.)	67.13	48.40	33.46	12.68
(4) Minimum	31.34	17.04	5.83	-9.76

Table 5.5 expresses the forestry land expectation values for a range of external interest rates from 4½ to 6½ per cent. The land expectation values are based on an "immediate planted" forest. That is, the complete plantation or forest is assumed to be established in the first year. The effects of a longer planting period, aiming for a sustained yield forest, are discussed in section 5.11.

The average land expectation values shown in Table 5.5 are based on reasonably conservative estimates of the likely increased stumpage values for a fully tended forest. The actual costs and returns used are shown in the worked example.** The average land expectation values have been calculated for the Himatangi-Foxton (H-F) land class, and the Younger Dune Complex (Y.D.C.).

* The complete method of computation used for deriving forestry land expectation values is given in Appendix V. The method of specifying land expectation values in terms of an annual rental payment for land is also known.

** See Appendix V.

The minimum and maximum land expectation values have been derived from the two extremes of the values shown in Table 5.4. Finally, single variables have been varied, for example, the value of first thinnings, the results of which are discussed in the following section.

Land expectation values based on a 40-year rotation are not shown in Table 5.5, as a 30-year rotation imputes a higher land expectation value for all external interest rates exceeding $3\frac{1}{2}$ per cent.

In Fig. 5.1 the forestry land expectation values have been graphed over a range of external interest rates from $3\frac{1}{2}$ to $7\frac{1}{2}$ per cent. The graphs are numbered as given in Table 5.5.

5.11 Discussion of Results of Varying Assumptions with Respect to Forest Management and Yields

The following significant points arise from Table 5.5:

- (a) The extreme sensitivity of the imputed land expectation value for forestry to the selected external interest rate. For example, an increase in the external rate from $4\frac{1}{2}$ to $6\frac{1}{2}$ per cent reduces the forestry land expectation value by approximately £64 per acre. On the Himatangi-Foxton land class, forestry imputes a positive land expectation value up to a $7\frac{1}{2}$ per cent interest rate.
- (b) Although not shown in Table 5.5, the computations exemplified the important effect of the ruling interest rate on the optimum forest management schedule. An increase in the external interest rate will reduce the length of the optimum rotation and conversely for a reduction in the external interest rate. For example, at a $3\frac{1}{2}$ per cent external rate the value of the final harvest for a 40-year rotation would only have to rise by £90 to break-even with a 30-year rotation, whereas the corresponding rise at a $7\frac{1}{2}$ per cent interest rate would need to be £350.

Forestry Land Expectation Values

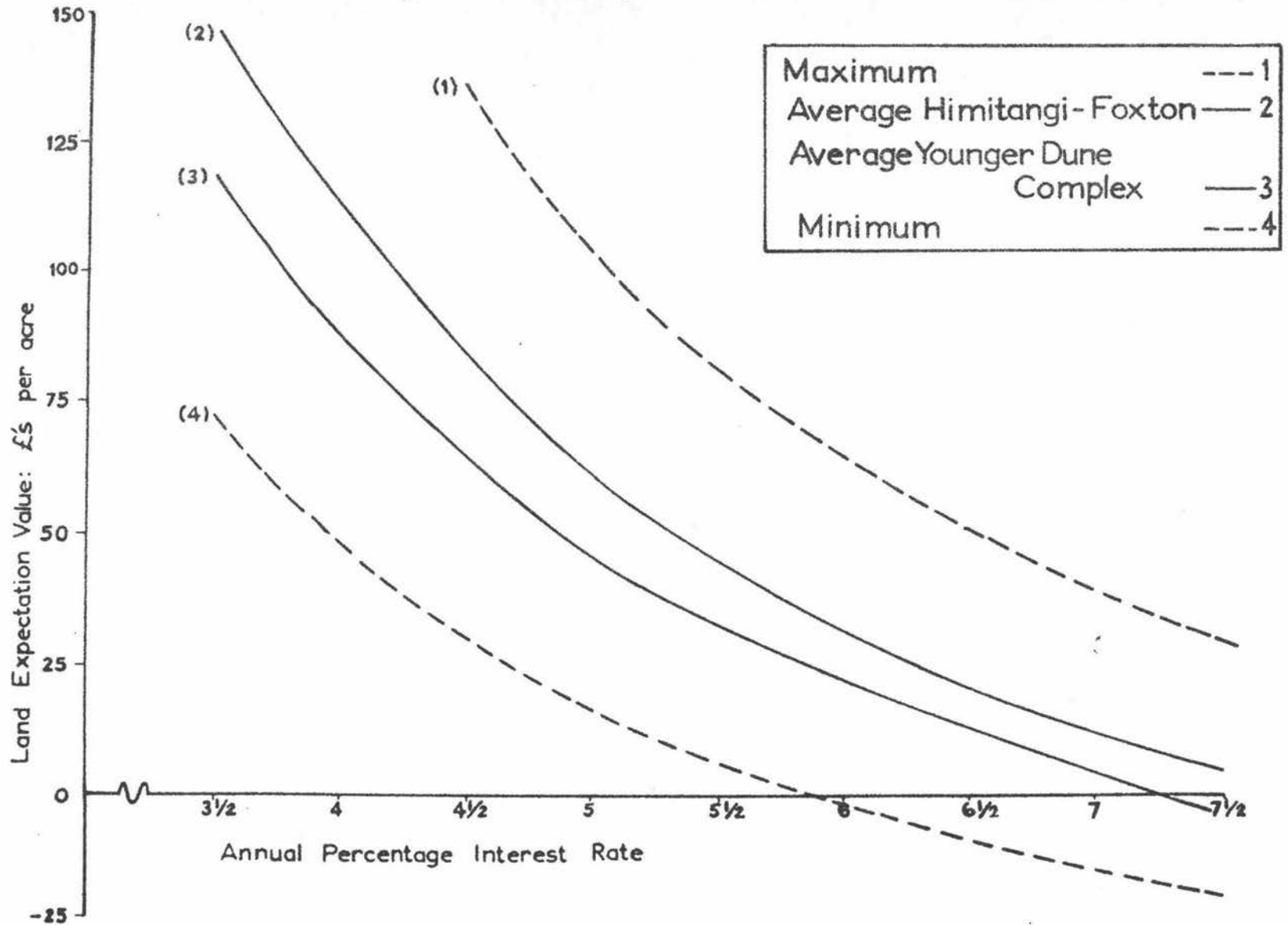


Fig. 5.1

(c) The magnitude of the effect of an increased annual running cost. For example, at a $5\frac{1}{2}$ per cent external interest rate an increase in annual running costs from £1.5 to £2.5 per acre decreases the land expectation value by approximately 30 per cent. A constant change in the annual running cost does not alter the optimum rotation. In the assessment of forest running costs a problem emerging from the study was the optimum level of fire protection for a forest. For a full analysis of this problem one would need to know the probability of a forest being destroyed by fire at different stages in its life. On economic grounds the maintenance of stringent fire protection measures in the early phases of establishment of a forest is questionable. Firstly, the value of the forest is much lower in early life than near maturity and, secondly, the effect of early maintenance costs are magnified as they are compounded to the end of the rotation. It is consequently quite clear that it is possible for a forest to be too well protected against fire. The author considers that present relatively high fire protection costs for some forests should be carefully reviewed in the light of the probable value of forest saved from fire, at varying levels of protection, and the cost of maintaining this level of fire protection.

(d) The importance of being able to find a profitable market outlet for first thinnings is exemplified when at a $5\frac{1}{2}$ per cent interest rate the adoption of poison thinning, reduces the land expectation value by approximately 25 per cent. An increase in the price received for thinnings will shorten the length of the optimum rotation and conversely for a decrease in the price of thinnings.

(e) It should be stressed that the forestry land expectation values given in Table 5.5 are based on the assumption that all forestry land is planted in the first year. In most instances this will be a realistic assumption for farm forests and small plantations. A large forest, however, is normally established over a period of years. The establishment period of a forest will vary with a number of factors, the primary

one being its size. Two conflicting aims arise when planning the establishment of a large forest. These aims are:

(i) An attempt to achieve an even distribution of age classes, by staggering planting dates, thus enabling the forest to be managed on an approximate sustained yield basis.* This will ensure a steady supply of timber and a steady demand for labour in the various forest operations. Clearly if the complete forest was established in one year there would be tremendous fluctuations in labour requirements as the major tending operations fell due, for example pruning.

(ii) Secondly, an attempt is made to establish the forest as rapidly as possible, partly because, during the establishment phase, many overhead facilities necessary from the beginning of the establishment phase are provided, but are not fully utilized until the complete forest is established, e.g. buildings.

When establishing a sustained yield forest, it is important to know whether land held for future planting is earning its opportunity cost during the waiting period. If for any reason the land is lying idle during the pre-planting period, the opportunity cost foregone by not utilizing it for extensive grazing or farming should be charged as a cost of establishing the forest. If unplanted forestry land is used for extensive grazing, but the alternative to forestry is to develop the land for farming, account would need to be taken of foregone earnings. The difference between the value of the land for extensive grazing and its value for farming (after development costs have been taken into account) constitutes the foregone earnings.

Land expectation values derived for a range of forest

* A "complete" sustained yield forest (for a 30-year rotation) is one in which the total forest is divided into 30 age classes of equivalent size. The age distribution of these classes ranges from new plantings to 30 years. In practice this is very seldom, if ever, achieved.

establishment periods are presented in Table 5.6.*

TABLE 5.6

Relationship Between Land Expectation Values
and Rate of Forest Establishment

Soil Class	Rate of Forest Establishment (years)						
	Immediate Planting	5	10	15	20	25	30
Himatangi-Foxton	45.67	39.10	34.56	30.61	27.32	24.55	22.14
Younger Dune Complex	33.46	28.64	25.30	22.41	19.85	17.96	16.21

Table 5.6 gives forestry land expectation values for seven possible forest establishment plans. These range from "immediate planting" to a completely sustained yield forest. The land expectation values are the amounts forestry can "afford" to pay for land and have unplanted part lying completely idle during the establishment phase, i.e. no allowance has been made for using land during the pre-planting period.

Present rates of planting for large scale sand country forests, for instance Santoft, indicate a 15 to 20-year establishment period.

In Chapter VII forestry and agricultural land expectation values are compared on the basis of a 15-20 year planting period for large scale forestry.

* The method of computation used for deriving these values is given in Appendix VI. A $5\frac{1}{2}$ per cent external interest rate is used in Table 5.6. In Appendix VI the land expectation values are given for a range of interest rates and planting periods.

CHAPTER VI

AGRICULTURAL LAND EXPECTATION VALUES

This chapter incorporates a description of data requirements, sources of data, survey methods, budgetting procedure and a description of the methods and costs of developing land for agriculture. Following this there is a section for both sheep and dairy farming, which gives a brief description of each system of farming, together with an example of the budgetting procedure used for deriving the net residual value to land. Finally the land expectation values are calculated for both sheep-beef farming and dairy farming over a range of external interest rates.

6.1 Sources of Information

A survey was made of 16 farms, 6 sheep-beef farms and 7 dairy farms on the selected land classes, and 3 farms on other soil classes. The aim of the survey was to obtain the following data for both sheep and dairy farms:

- (a) The period of development to the present level of production, and the approximate costs of development.
- (b) The present level and value of production, and the inputs necessary to "maintain" this level of production.
- (c) The anticipated future level and costs of production, and the period of time and capital inputs required to achieve this level of production.

In addition to the survey data, basic input-output data have been assembled for 145 properties on the sand country, including 40 properties sited on the Younger Dune Complex and Himatangi-Foxton land classes. The main source of these data has been the Valuation Department. Apart from the use of these data to compile land use maps, the data have been useful in providing a broad background to farming systems, inputs and levels of production, for a range of soil classes on the sand country. *

* See footnote ** p.34.

6.2 Budgetting Procedure Adopted

(a) The prices and costs for agricultural products and resources used in the following budgets are based on average prices within the Manawatu region during the three production seasons 1961, 1962 and 1963.

(b) The budgets incorporate the total value of gross farm outputs and the value of all inputs, regardless of their ownership, used in acquiring this production, with the sole exception of land.

(c) The farm inputs may be divided into two classes:

(i) Direct costs, which are normally completely utilized within a year's farm production, for example, shearing costs, wages and fertilizer. These costs can generally be readily assessed as they are recurring annual costs, and can normally be directly attributed to one year's production.

(ii) Indirect costs arising from inputs which give services over a long period of time, for example, buildings, plant and machinery. These overhead costs are not as easily evaluated as short term inputs.

Two distinct costs are recognised for long term inputs.

(i) Repairs and maintenance, incurred during the productive life of the input, necessary to maintain the factor of production in efficient working order.

(ii) The ultimate replacement cost of the input which is normally expressed in terms of a depreciation reserve.

In this study the above costs have been incorporated and expressed in terms of the following average annual costs:

(i) An annual charge of 3 per cent of the original capital value for buildings. This cost is divided into a $2\frac{1}{4}$ per cent repairs and maintenance charge and a $\frac{3}{4}$ per cent depreciation reserve.* The average life of farm buildings is assumed to be 40 years.

* The percentage depreciation reserve is that constant annual sum which, if compounded over the life of the asset, gives a total cash sum equivalent to the replacement cost of the asset See Appendix VII.

(ii) An annual charge of 10 per cent on the original capital value of plant and machinery. The average life of plant and machinery is assumed to be 15 years, with annual charges of 5 per cent for repairs, maintenance and depreciation respectively.

When isolating a residual payment to land it is necessary to make allowance, via the market interest rate, for the value of all capital inputs combined with land. The procedure adopted in this study is to allow an annual interest charge of $5\frac{1}{2}$ per cent on the capital value of stock, plant, machinery and buildings.*

Where farms are already partially developed, the past capital outlay for pasture establishment, fencing, drainage, water supply, etc. is regarded as an "historic cost". These improvements can only be used to service agriculture and hence have no opportunity cost for any other enterprise. In this instance the land expectation value is expressed in terms of how much agriculture can "afford" to pay for this land inclusive of these improvements. In the determination of the land expectation value of undeveloped land being considered for agricultural development, the total development costs are taken into account. This distinction is later outlined in section 6.5.

6.3 The Development of Sand Country for Farming

There is considerable variation in the methods and costs of developing sand country for farming. These costs depend upon the original cover of the land, the relative proportion of moist flats, dry flats and dune areas, whether the land is being developed for sheep or dairy farms, and finally the methods of development used.

This section outlines the methods and costs of developing sand country for farming. The important aspects of pasture establishment on the sand country are: drainage, preparation

* The interest rate charged for the capital value of stock, plant and machinery is varied over a range of external interest rates.

of the seed bed, sowing a suitable grass seed mixture and the application of an appropriate fertilizer mixture

6.3.1 Drainage

On the Younger Dune Complex peaty swamps often occupy what would otherwise be the most productive land. The formation of these swamps is largely a result of the natural drainage towards the coast being impeded by sand dunes. Because of the dependance of pasture growth on the height of the water table, however, care must be taken, when planning a drainage scheme, not to propose one which would cause over-draining of neighbouring soils. In many places it is not advisable to drain small low-lying patches of Hokio sand, peaty phase, because this will lower the water table in nearby soils which previously had a good moisture status. The small advantage gained from drainage on the peaty phase would often be more than offset by the loss of production from neighbouring soils. A possible alternative to drainage is the addition of sand from nearby dunes to peaty soils to build up the surface to a level where drainage is no longer necessary. To date, this method has not been adopted to any significant extent.

The method of draining is one of open vee drains. A drainage problem does not arise on the Himatangi-Foxton land class, as there are negligible areas of very moist soil types.

6.3.2 Preparation of the Seed Bed

The old method of deep ploughing of moist flats has, in most cases, been superseded by one of rotary hoeing. After rotary hoeing, the area is either directly sown to pasture in the autumn or sown to a winter crop, usually chou-moellier or swedes, followed by pasture establishment in the spring.

The above method may be used for development of dry flats, but this involves a risk of wind erosion. An alternative method at present being developed makes use of a flail harvester with rotary chain flails. The dry flats are chopped and levelled, leaving the area suitable for disc drilling of grass seed. This method allows the preparation of a seed bed with a minimum disturbance of the relatively light unconsolidated

sand. After a period of 5 to 10 years when the area has been consolidated and the fertility and organic content of the soil increased, the area will be rotary hoed and resown. This method is at present in the experimental stage, consequently its long term results are uncertain.

The development of dune areas also requires a method involving minimum disturbance of the relatively unconsolidated sand.

(a) Waitarere dunes: This series represents the raw unconsolidated dunes within the Younger Dune Complex which are now stabilized by vegetation. These normally provide rough grazing. They may, however, be partially developed by the surface sowing of grass and clover seed on shady faces under the cover of tree lupin, where sand is moist and temperatures lower. Grazing can only be light and strictly controlled, as the surface is easily broken by stock, and this results in serious wind erosion.

(b) Foxton dunes: These represent a more mature and consolidated phase than the Waitarere dunes and can be developed more fully. The present development method is to spray lupin, gorse and bracken fern, feed hay on the area and crush the growth with cattle. This is followed by the surface sowing of seed. The average cost of spraying tree lupins with 2-4-D is £1.15.0 per acre, and the cost of spraying gorse with 2-4-5-T, £7.0.0 per acre; sometimes two spray applications are necessary for a complete kill. Grazing must also be carefully controlled on these dune areas.

6.3.3 Seed Mixture

Pasture mixtures vary according to drainage conditions and the consequent moisture status of the soil. The usual seed application is a relatively heavy one of 30 to 40 pounds per acre. On sand dunes and dry flats the common seed mixture is ryegrass, cocksfoot, paspalum and subterranean clover (Talarook and Mt. Barker species). On flats with a good moisture status, the usual seed mixture is ryegrass, cocksfoot, and white and red clover, whilst on moist peaty flats straw-

berry clover replaces white clover; this latter clover thrives in wet saline conditions. On a number of occasions a poor strike on dunes and dry flats has necessitated resowing of pasture the following season. On these land classes pastures tend to "run out" to poor and low producing species from 8 to 10 years after establishment; this is largely the reason why a summer or winter crop is the usual practice on this class of sand country. The reason for pastures "running out" is because of the light, dry nature of these sandy soils.

6.3.4 Fertilizer Application

Soil moisture is the main factor determining production on the sand country. However, correction of nutrient deficiencies in plants and animals is a vital factor in attaining higher production. Sand country soils are deficient in a number of major and trace elements (36).

Liming: Most of sand country soils are moderately acid to slightly alkaline, and recognized responses to the application of lime have been few. Consequently liming is not a general practise except on some wetter areas and with the establishment of a lucerne stand.

Superphosphate: Levels of phosphorus obtained from soil tests range from medium to high. However, good responses are obtained from phosphate topdressing on nearly all of the sand country soils. This may be due to a high proportion of the phosphate ion being in a form not readily available to plants. As a result of this possible conversion and leaching of soluble ions, the usual application is $1\frac{1}{2}$ to $2\frac{1}{2}$ cwt. of $33\frac{1}{3}$ per cent potassic serpentine superphosphate per acre, in a split autumn and spring application.

Potash: The potassium content of sand country soils ranges from very low to very high, with most of soils being in the low range. Even in soils with medium or high levels of potassium, their potassium-supplying power is low and deficiencies are common under intensive farming. Sand country

soils cannot hold potassium and it is therefore taken up rapidly by plants in larger quantities than they need, or is leached from the soil. Thus, responses to potash are shortlived and consequently the normal topdressing procedure is a split autumn and spring application, in the form of $33\frac{1}{3}$ per cent potassic superphosphate.

Trace elements: Very few data are available on the trace element status of sand country soils. Trials conducted by the Department of Agriculture, on the Lands and Survey developmental properties, have given no significant pasture responses to trace elements, with the exception of molybdenum on some areas. In the past stock thrift problems have been very prevalent on the selected classes of sand country. For example, lambing percentages on sheep farms have been as low as 60 per cent and hogget mortality as high as 30 per cent. However, with the advent of selenium, copper and, to a lesser extent, cobalt, together with an intensive drenching programme, hogget deaths have been reduced to 3-5 per cent and lambing percentages increased to 85-110 per cent.

In summary, drainage is an important factor on the Younger Dune Complex, but is not normally necessary on the Himatangi-Foxton land class. Methods and the type of pasture mixture established vary according to the particular soil type. The capital and maintenance application of fertilizer on these classes of sand country is high relative to potential production. Capital applications are of the order of $2\frac{1}{2}$ - $3\frac{1}{2}$ cwt. of $33\frac{1}{3}$ per cent potassic superphosphate per acre, and maintenance applications $1\frac{1}{2}$ - $2\frac{1}{2}$ cwt. per acre. Generally one or a combination of the trace elements copper, cobalt or molybdenum is included in the fertilizer mixture.

6.4 The Cost of Developing Sand Country

The reasons for variation in the costs of developing sand country for farming have been given in Section 6.3.

In addition to the variation of development costs, problems were encountered in attempting to obtain costs which would be representative of future development on the sand country.

These problems arose from:

(a) Paucity of records and, in many instances, a reliance on a farmer's memory.

(b) Considerable changes in technology which often render past records, even when available, inadequate.

(c) Variation in the rate of development, depending upon size of property and financial position and objectives of farmer.

The development costs given below are based, in the main, on past development methods. Adjustments have been made to some development costs in an attempt to make them representative of anticipated future trends, for example, replacement of deep ploughing with rotary hoeing.

TABLE 6.1

Farm Development Costs

Item	Cost Per Acre
Rotary hoeing	£2. 15. 0
Rolling	15. 0
Grass seed	4. 10. 0
Fertilizer: 3 cwt of $33\frac{1}{3}$ per cent copper-ised potassic superphosphate	2. 10. 0
Fencing	3. 10. 0
Drainage and water supply	2. 10. 0
Spraying, tracking, culverts, regrassing and miscellaneous	3. 10. 0
Total development costs (excluding buildings)	£20. 0. 0

The above development costs are considered to be reasonably representative of an average sand country development plan.* It should be stressed, however, that the above develop-

* Table 6.1 is based on data from Lands and Survey budgets for two large sand country developmental properties, together with data from 4 properties being developed privately.

ment costs are average costs only, designed to show the individual items of development. There is considerable variation in individual costs between farms. Overall development costs are estimated to vary between £15 and £25 per acre. After discussion with managers of private and State development properties, a 10-year developmental period has been selected for this study.

6.5 Sheep-Beef Farming

This farming system is at present adopted on relatively light sand country, which has the associated problems of slow and difficult pasture establishment, weed control and stock thrift. The proportion of dry soil types is generally higher than encountered on dairy farms. This higher proportion of drier flats is considered as a physical constraint to dairy farming on these areas.

Data have been assembled from a survey of 6 sheep farms, including two large developmental properties. There were small variations in the systems of farming between farms, for example, the area of cropping. However, the basic farming pattern was essentially similar. Briefly the normal farming system was one in which a Romney breeding flock was maintained, surplus sheep being sold in forward store and fat condition. A beef breeding herd was also maintained, surplus cattle being sold as weaners and yearlings on the more developed properties, and as two-or three-year-old steers on the less developed properties. A summer or winter crop was the normal procedure, mainly due to pastures "running out" eight to ten years after establishment. A stand of lucerne was grown on one third of the properties.

The first step in this section is to exemplify the method of budgetting which has been used to impute a net return to land. Following the example, the net returns to land from the survey farms are expressed in tabulated form and the corresponding land expectation values for sheep-beef farming are derived.

The property which has been selected to exemplify the

method of calculating the land expectation value for sheep-beef farming was acquired by the Lands and Survey Department in 1956.

This experimental development block, which is now partially developed, consists of 2,865 acres which is divided into:

265	acres	high producing Pukepuke soils.
700	"	of Himatangi flats on which pasture is established.
200	"	of ungrassed Himatangi flats.
1,700	"	of sand dunes.

Total area: 2,865 acres

The tentative subdivision plan divides the property into 4 sheep-beef units with an average size of 708 acres. The estimated cost of additional development is approximately £10 per acre.

The property is at present managed as a single sheep and cattle breeding unit.

The present winter stock carrying capacity is:

Romney breeding ewes	1,856
Hogget replacements	850
Rams	50
2-tooth wethers	630
Breeding cows (Aberdeen Angus)	290
Dry cattle	240

This represents a carrying capacity of 2.1 ewe equivalents^{*} per acre, and an average development cost to date of £10 per acre.

The estimated future carrying capacity, at the time of settlement, based on a total subdivided area of 2,832 acres is:

4 sheep and cattle units, average size 708 acres.	
Romney breeding ewes	1,050
Hogget replacements	400
Rams	28
Breeding cows	75
Dry cattle	100

* See Appendix VIII for basis for converting all stock to ewe equivalents.

The above carrying capacity is 3.2 ewe equivalents and the additional development costs £10 per acre. This represents an increase in carrying capacity from the present 2.1 ewe equivalents per acre to 3.2 ewe equivalents per acre. This is a substantial rise in production, when it is realized that the additional land being brought into production is of a lower quality than the land already in production, and that breeding ewes are replacing 2-tooth wethers.

In exemplifying the application of the land expectation method for estimating the profitability of sheep farming, the following land expectation values are evaluated.

(a) The land expectation value for completely unimproved land which is being planned for development into sheep-beef farms. The average farm size is 708 acres. The period of development is estimated to be 10 years and the cost of all capital improvements to the land, excluding buildings, is £20 per acre.*

(b) The land expectation value for partially developed land. In this instance capital development to the existing level of production is regarded as an "historic cost". All inputs required to maintain this level of production are accounted for.

(c) The land expectation value where development to the present level of production is considered an "historic cost", but the land is further developed from its present carrying capacity of 2.1 to 3.2 ewe equivalents per acre. The estimated period required for additional development is 5 years, and the additional development costs £10 per acre. This is an average development cost per acre; individual areas on the property range from completely undeveloped to fully developed.

* A breakdown of development costs has been given in section 6.4. The development costs and estimated period of development have been derived from budgets held by the Lands and Survey Department and discussion with members of this institution.

The following budget* is an estimate of the value of the annual production, and the value of inputs required to maintain this level of production, for the fully developed sheep-beef farm. All inputs and outputs are expressed in £s per 100 acres. This enable trends in per unit area inputs and outputs between farms to be easily recognized.

The budget allows a labour and management award of £1,000.

The net profit equals gross profit less total expenditure. Total expenditure includes the labour and management award and interest on capital investment, with the exception of land.

Two distinct periods are recognized in the following calculation of the land expectation value for undeveloped land. The external interest rate in this instance is assumed to be five per cent.

A Annual Budget for Developed Sheep-Beef Farm

<u>Outputs</u>	<u>£'s per 100 acres</u>
Wool and skins	326
Sheep sales	231
Cattle sales	193
	<u> </u>
Total output	£ 750
	<u> </u>

* The following budget has been derived after discussion with members of the Lands and Survey Department and analysis of their current working budgets. The raw data on which the budgets for sheep-beef farming have been derived are given in Appendix IX. Budgets and calculations of land expectation values for (b) and (c) are also given in Appendix IX.

<u>Inputs</u>	<u>£'s per 100 acres</u>
Wages and management	144
Stock purchases	21
Fertilizer	122
Contract work (cultivation and hay)	39
Motor expenses and cartage	30
Shearing, dipping, veterinary and farm stores	52
Repairs, maintenance and depreciation	50
Miscellaneous	70
* Interest on capital investment	95
Total input	<u>£623</u>

Net profit = £127

£1.25 per acre per
year

(a) An initial 10-year developmental period. During this period the net profit is estimated to average one half of the profit at the fully developed stage.

The land expectation value imputed to land over the 10-year developmental period is given by the following equation:

* The interest charge is based on the following capital investment:

Stock	£6,900
Buildings	4,500
Plant and machinery	2,000
Total capital investment	<u>£13,400</u>
(excluding land)	

The reason for the relatively high plant and machinery investment is because cultivation is done with farm equipment, in contrast to contract cultivation for the partially developed property - see budget B, Appendix IX.

$$Ls1 - 10th\ year = \frac{V1}{r} \left[1 - \frac{1}{(1+r)^n} \right] \quad (6.1)$$

where $Ls1 - 10th\ year =$ Land expectation value for sheep farming over the 10-year developmental period.

$V1 =$ annual net profit, years 1 to 10.

$r =$ external rate of interest.

$n =$ length of developmental period.

$$\begin{aligned} Ls1 - 10th\ year &= \frac{0.625}{0.05} \left[1 - \frac{1}{(1.05)^{10}} \right] \\ &= £4.83\ per\ acre. \end{aligned}$$

(b) From the 10th year after the beginning of development an average annual net profit of £1.25 per acre in perpetuity is estimated.

The land expectation value from the 10th year, in perpetuity, is derived from equation (6.2), (Appendix I):

$$Ls10 - = \frac{\left(\frac{V2}{r} \right)}{(1+r)^n} \quad (6.2)$$

where symbols are as defined in equation (6.1)

$$\begin{aligned} Ls10 - &= \frac{\left(\frac{1.25}{0.05} \right)}{(1.05)^{10}} \\ &= £15.35\ per\ acre \end{aligned}$$

Therefore the total land expectation value, excluding development costs, is:

$$\begin{aligned} Ls1 - &= £4.83 + £15.35 \\ &= £20.18\ per\ acre \end{aligned}$$

(c) Development costs are estimated to be £20 per acre, and have been given in section 6.4.*

The present cost of development is derived from the following equation:

$$PCD = \frac{c}{r} \left[1 - \frac{1}{(1+r)^n} \right] \quad (6.3)$$

Where, in addition to symbols defined in equation (6.1), PCD = present cost of development
 c = annual per acre development expenditure

$$PCD = \frac{2.0}{0.05} \left[1 - \frac{1}{(1.05)^{10}} \right]$$

= £15.44 per acre

The land expectation value for undeveloped land planned for development for sheep-beef farming is:

$$L_s = L_{s1} \rightarrow 10 + L_{s10} \rightarrow 00 - PCD$$

$$= £20.18 - 15.44$$

$$= £4.74 \text{ per acre}$$

This represents the amount potential sheep-beef farms could "afford" to pay for undeveloped land, and achieve a return to the total capital invested in the farm, including land, equivalent to a 5 per cent external interest rate.

* In this instance it is estimated that approximately one-tenth of the property will be developed each year, and that development expenditure is evenly distributed over the 10-year developmental period. The fact that net profit will, on average, be slightly higher than one-half of the net profit obtained after development is offset by development costs also being generally slightly higher during the initial period of development. This is considered to be reasonably representative of a future development plan for the sand country. The author was not able to obtain a more specific and detailed development plan than has been given, as development was not planned in detail for more than two or three years in advance.

Budget B (Appendix IX) estimates the value of the present annual production and the corresponding value of inputs required to maintain this level of production for the partially developed property. The budget is based on an effective grazing area of 2,000 acres. The valuation of some inputs in this budget is particularly subjective because it is not possible, from the available data, to distinguish accurately between capital and maintenance expenditure. For example, the problem of defining a maintenance application of fertilizer

The land expectation value for partially developed land assumes all development costs to the existing level of production as "historic costs", and only includes the inputs necessary to maintain this level of production.

The land expectation value for the maintenance in perpetuity of partially developed land, assuming a five per cent rate of interest, is shown below:

$$L_s = \left(\frac{V}{r} \right) \quad (6.4)$$

where

L_s = land expectation value for partially developed land

V = per acre annual net profit

r = external interest rate

$$\begin{aligned} L_s &= \left(\frac{0.63}{0.05} \right) \\ &= \text{£}12.60 \text{ per acre} \end{aligned}$$

This represents the amount sheep-beef farms can "afford" to pay for partially developed land inclusive of improvements.

6.6 Presentation and Discussion of Sheep-Beef Farm Results

This section presents and discusses the range of production levels and land expectation values for sheep-beef farms.

TABLE 6.2

Per Acre Production and Net Profits for
Surveyed Sheep-Beef Farms

	Farm Area (acres)	Per Acre	
		Stocking Rate (ewe equivalents)	Net Profit (£)
Minimum	581	1.4	0.5
Average	1510	2.0	0.73
Maximum	2948	2.5	0.95

Table 6.2 shows the present minimum, average and maximum farm size, stocking rate and net profit per acre for the 6 surveyed sheep-beef farms. A significant factor arising from the study was the effect of economies of scale on the residual net profit imputed to land. Larger farms with an equivalent per acre stocking rate generally have a higher per acre net profit, due mainly to a lower overhead of buildings, plant, machinery and labour. For the purposes of this study sheep-beef farm land expectation values, for fully developed farms, are based on a minimum farm size of 600 acres with a potential carrying capacity (10 years after starting development) of 3.5 ewe equivalents per acre. On farms smaller than 600 acres, after allowing for all expenditure including the farmer's labour and management award, the net residual to land is normally below £1 per acre per year.

TABLE 6.3

Sheep-Beef Farming Land Expectation Values
(per acre)

Land Class	Interest Rate			
	4½%	5%	5½%	6½%
	£	£	£	£
Undeveloped Land	8.13	4.74	2.20	-2.02
Partially Developed Land	16.78	14.50	12.64	9.77

Table 6.3 expresses the land expectation values for sheep-beef farms, for both undeveloped and partially developed land, for a range of external interest rates from $4\frac{1}{2}$ to $6\frac{1}{2}$ per cent.* The land expectation values are also expressed in graphical form in Fig. 6.1 for a range of external interest rates from $2\frac{1}{2}$ to $7\frac{1}{2}$ per cent.

There is variation in sheep-beef farm land expectation values for partially developed farms, depending largely upon stage of development, farm size and the efficiency of the farm manager. The range in per acre stocking rate and net profits for the surveyed sheep-beef farms have been given in Table 6.2.

In Fig. 6.1 graphs 1, 2 and 3 show the relationships between the land expectation value for partially developed land and the external interest rate. Graphs 1 and 3 represent the present maximum and minimum annual net profits of £0.95 per acre and £0.50 per acre respectively, whilst graph 2 shows the average net profit of £0.73 per acre.

Graph 4 shows the relationship between the land expectation value for undeveloped land and the external interest rate, assuming an annual net profit, when developed, of £1.25 per acre per year. When assessing the annual net profit of £1.25 per acre per year, an attempt has been made to allow for a probable rise in the level of production following the initial 10-year developmental period. However, because of the possibility of underestimating this probable rise in production, the land expectation value has also been calculated for an annual net profit of £1.50 per acre for the 10th year onward. In the absence of major technological change or variation of present prices, the author estimates that at a $5\frac{1}{2}$ per cent interest rate, the maximum land expectation value for undeveloped land planned for sheep-

* It should be noted that part of the sensitivity of the land expectation value to the ruling rate of interest is due to the annual net profit, imputed to land in the underlying farm budgets, varying with the external interest rate. This is due to a varying external rate of interest being charged for the total capital investment in stock, buildings, plant and machinery.

See Appendix IX for data on which budgets have been based.

Sheep-Beef Farming Land Expectation Values

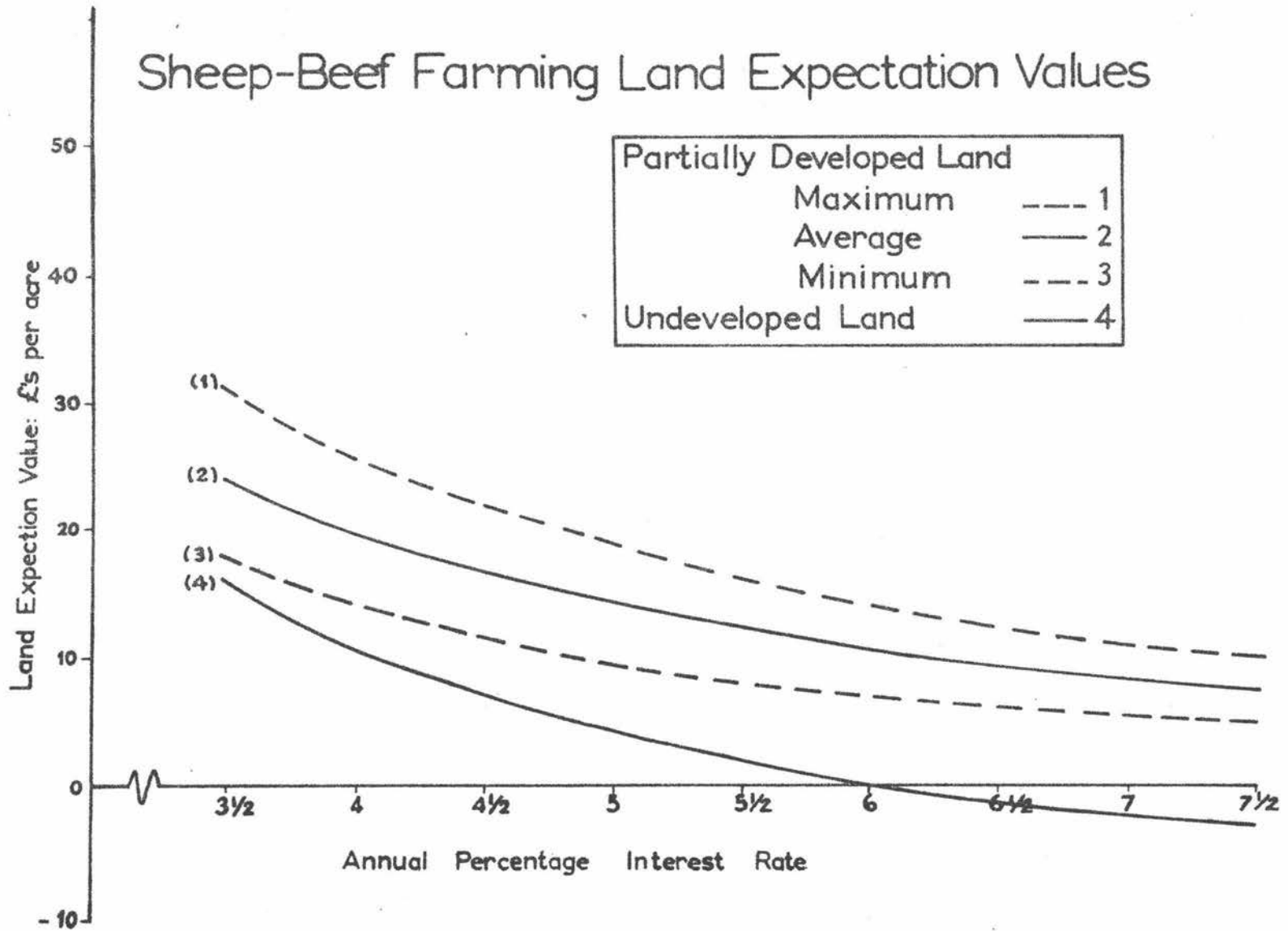


Fig. 6.1

beef farming on the selected land classes is £6.5 per acre.

In broad terms for a $5\frac{1}{2}$ per cent external interest rate, it is concluded that the amount sheep farming can "afford" to pay for land is within the range of £2.2 to £20 per acre, depending upon the existing level of development. Clearly, as no farms are fully developed, most will have substantial areas of land throughout the above range of land values, including some areas of fully developed land with a value up to £25 per acre.

6.7 Dairy Farming

Physical and financial input-output information, corresponding to the data collected for sheep-beef farms, has also been assembled for dairy farming, from a survey of 7 dairy farms on the Younger Dune Complex and Himatangi-Foxton land classes. A significant factor is that dairy farming is normally adopted only on areas which have a relatively high proportion of moist soil types. Hence the land expectation values derived for dairying cannot be applied to the whole of these land classes. The author estimates that approximately 20 per cent only of the land classes under study would have a sufficient area of moist flats to support the land expectation values to be derived for dairying.

As would be expected there were small variations in farming systems between dairy farms. Briefly, however, the dairy farms were carrying milking cows plus replacements, and supplying whole milk for casein production. Both a summer and winter crop were normal procedure, the former being mainly for combatting drought conditions. A lucerne stand was grown on 4 of the properties.

In order to exemplify the method of budgetting and deriving land expectation values for dairy farming, a 253-acre property has been selected. The property consists of 138 acres of established pasture, 85 acres of rough grazing and 30 acres of exotic plantations. Approximately 50 per cent of the total farm area is classified as moist flats.

The present carrying capacity is:

Milking cows	70
Heifer replacements	17
Production	19,000 lb butterfat.

Hence present production for an effective grazing area of 223 acres is 85 lb of butterfat per acre.

A summer crop of 7 acres of turnips and a winter crop of an equivalent area of chou-moellier is provided. A 10-acre lucerne stand has also been established and approximately 1,200 bales of hay are harvested annually. The farm at present is managed as a one-man unit.

Over a period of 5 years it is estimated that the carrying capacity will be increased to 90 cows and production to 24,500 lb of butterfat, or 110 lb per acre. At this carrying capacity the farm is expected to be managed by one man and a youth.

To exemplify the budgetting procedure and method of computation for dairy farming, budgets and land expectation values corresponding to those in sheep-beef farming are evaluated.*

The following budget is an estimate of the value of the annual production and the value of inputs required to maintain this level of production for the fully developed dairy farm.

Two distinct periods are recognized in the following calculation of the dairying land expectation value for undeveloped sand country. The external interest rate is assumed to be 5 per cent. In the final estimates a range of external interest rates between $4\frac{1}{2}$ and $6\frac{1}{2}$ per cent is given.

(a) An initial 10-year developmental period during which the net profit is estimated to average one-half that at the fully developed stage. The value imputed to land over the 10-year developmental period is derived from the

* The source of information for dairy farm budgets has been from farm accounts and discussion with farmers during the survey. Data used for compiling dairy farm budgets are given in Appendix X.

following equation:

$$\begin{aligned}
 L_{D1} - 10\text{th year} &= \frac{V_1}{r} \left[1 - \frac{1}{(1+r)^{10}} \right] * \\
 &= \frac{1.75}{0.05} \left[1 - \frac{1}{(1.05)^{10}} \right] \\
 &= \text{£}13.51 \text{ per acre}
 \end{aligned}$$

C Annual Budget for Developed Dairy Farm

<u>Outputs</u>	<u>£'s per 100 acres</u>
Butterfat	1,605
Stock sales	287
	<hr/>
Total output	1,892
	<hr/>

<u>Inputs</u>	
Wages and management	628
Fertilizer, seeds and spray	180
Contract work and cultivation	72
Motor expenses and cartage	99
Herd testing and veterinary	58
Stock purchases and stock foods	25
Repairs, maintenance and depreciation	133
Miscellaneous	140
** Interest on capital investment	205
	<hr/>
Total input	1,540
	<hr/>

Net profit = £3.52 per acre per year

* The following equations used for dairy farming have previously been defined for sheep-beef farms. (See also Appendix I.)

** Interest is based on the following capital investment:

Stock	£3,640
Buildings	4,000
Plant and machinery	1,500
	<hr/>
Total capital investment (excluding land)	£9,140
	<hr/>

(b) From the 10th year after the beginning of development, an average annual net profit of £3.5 per acre in perpetuity is estimated:

$$\begin{aligned}
 L_{D10} &= \left(\frac{V_2}{r} \right) \\
 &\quad \frac{1}{(1+r)^{10}} \\
 &= \left(\frac{3.5}{0.05} \right) \\
 &\quad \frac{1}{(1.05)^{10}} \\
 &= £42.97 \text{ per acre}
 \end{aligned}$$

(c) Development costs are estimated to be £25 per acre,* and evenly distributed over the 10-year developmental period. The following equation is used for estimating the present cost of development.

$$\begin{aligned}
 PCD &= \frac{c}{r} \left[1 - \frac{1}{(1+r)^{10}} \right] \\
 &= \frac{2.5}{0.05} \left[1 - \frac{1}{(1.05)^{10}} \right] \\
 &= £19.31 \text{ per acre}
 \end{aligned}$$

The land expectation value for undeveloped land planned for development for dairy farming is:

$$\begin{aligned}
 L_D &= L_{D1} \rightarrow 10 + L_{D10} \rightarrow \infty - PCD \\
 &= £13.51 + 42.97 - 19.31 \\
 &= £37.17 \text{ per acre}
 \end{aligned}$$

The calculation of land expectation values for partially developed dairy farms is given in Appendix X.

* Development costs for dairy farms are slightly higher than for sheep-beef farms because of greater sub-division, roading, and water facilities.

6.8 Presentation and Discussion of Dairy Farm Results

TABLE 6.4

Per Acre Production and Net Profits
for Surveyed Dairy Farms

	Farm Area (acres)	Per Acre	
		Butterfat (lb)	Net Profit (£)
Minimum	180	64	1.89
Average	325	79	2.18
Maximum	520	95	2.41

Table 6.4 shows the farm area, per-acre butterfat production and annual net profits for the 7 surveyed dairy farms. As with sheep-beef farming, economies of scale effects were apparent on the surveyed dairy farms. For example, the smallest dairy farm (180 acres) had the highest per-acre butterfat production, but at the same time had the lowest per-acre net profit. This was mainly attributable to the higher per-acre overheads of buildings, plant, machinery and labour.

In this study the minimum-sized dairy unit considered is a 150 acre one-man unit, potentially capable of producing 18,000 lb of butterfat, 10 years after beginning development.

Table 6.5 expresses the land expectation values for dairy farming for both undeveloped and partially developed land. The land expectation values are calculated over a range of external interest rates from $4\frac{1}{2}$ to $6\frac{1}{2}$ per cent. Land expectation values for undeveloped land have been calculated for an estimated minimum and maximum production potential at the stage of full development.

TABLE 6.5

Dairy Farming Land Expectation Values

Land Class	Interest Rate			
	4½%	5%	5½%	6½%
	£	£	£	£
(3) Undeveloped Land (min.)	32.0	22.4	15.3	4.3
(2) " " (max.)	48.1	37.2	28.8	14.9
(1) Partially Developed Land	57.8	50.0	42.0	28.0
Additional Development of Partially Developed Land	-	59.1	-	32.6

The land expectation values are also expressed in graphical form in Fig. 6 2 for a range of external interest rates from 2½ per cent to 7½ per cent. Graphs 2 and 3 show the relationship between the land expectation value for undeveloped land for an estimated maximum and minimum potential production. Graph 1 shows the relationship between the maximum land expectation value for partially developed land and the external interest rate.

In summary, for a 5½ per cent external interest rate, the land expectation values for dairy farming on moister soils are within the range £15 to £55 per acre, depending upon the present stage of development. As pointed out at the beginning of section 6.4 only 20 per cent of these land classes is estimated to have a sufficient area of moist flats to achieve these land expectation values.

Dairy Farming Land Expectation Values

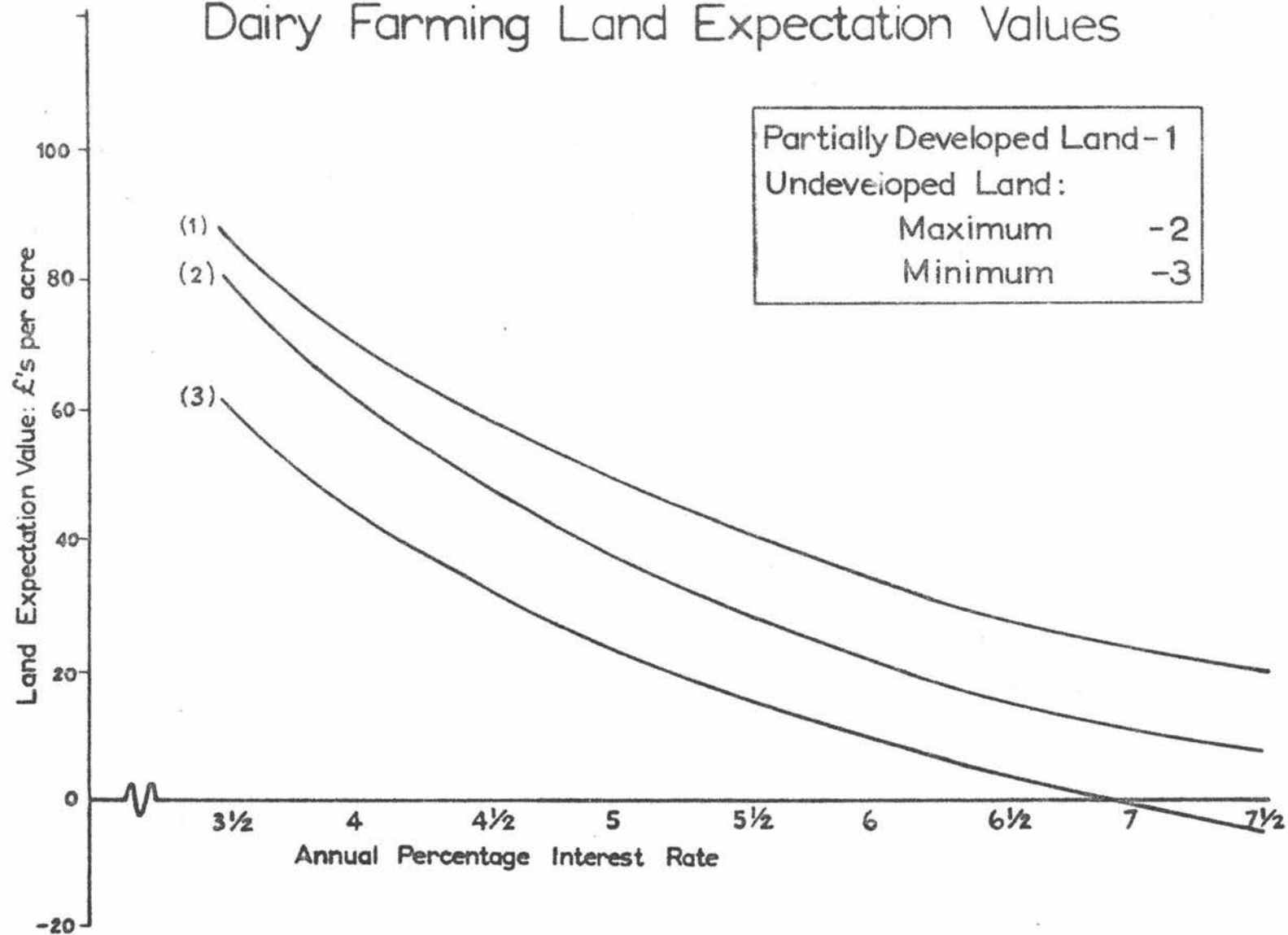


Fig 6.2

CHAPTER VII

SUMMARY OF RESULTS AND DISCUSSION

This chapter provides a summary of results and recommendations, together with a general discussion of what can be achieved by land use studies and their limitations.

7.1 Summary of Results and Recommendations

Table 7.1 shows the comparative land expectation values for sheep-beef farming, dairy farming and forestry over a range of interest rates from $4\frac{1}{2}$ to $6\frac{1}{2}$ per cent. These values are also summarised in Fig. 7.1. Dairy farming land expectation values (1) and (2) are based on a minimum and maximum expected production respectively, as the author was not able to specify the future production potential exactly. The land expectation values for dairying apply only to 20 per cent of the total area of the two land classes under study. The remaining area is considered to have an insufficient proportion (less than one-third) of moist soil types to be suitable for dairying.

For forestry, land expectation values are given for three rates of forest establishment on the Himatangi-Foxton land class (1), and the Younger Dune Complex (2).

Assuming a $5\frac{1}{2}$ per cent external interest rate,* Table 7.1 shows:

(a) On the Younger Dune Complex and Himatangi-Foxton land class, large scale forestry is more profitable than the maintenance, development or additional development of land for sheep-beef farms.** On the basis of this study, an increase in agricultural prices of 14 and 21 per cent would be needed to attain break-even land expectation values for

* The author considers this to be the best approximation of the external interest rate.

** This is based on partially developed farms with a present stocking capacity of 2.2 ewe equivalents per acre. The author was not aware of any farms with a higher stocking rate.

TABLE 7.1

Comparative Land Expectation Values (£s' per acre)

Land Use		Interest Rate (per cent)			
		4½	5	5½	6½
<u>Forestry</u>					
Immediate Planting (Himatangi-Foxton)	(1)	85.7	63.4	45.7	21.6
(Younger Dune Complex)	(2)	67.1	48.4	33.5	12.7
10-Year Planting Period	(1)	67.4	48.2	34.6	15.5
	(2)	53.1	36.9	25.3	9.1
20-Year Planting Period	(1)	55.5	39.5	27.3	11.9
	(2)	43.7	30.2	19.9	7.0
<u>Sheep-Beef Farming</u>					
Undeveloped Land		8.1	4.7	2.2	2.0
Partially Developed Land		16.8	14.5	12.6	9.8
<u>Dairy Farming</u>					
Undeveloped Land (min.)	(1)	32.0	22.4	15.3	4.3
(max.)	(2)	48.1	37.2	28.8	14.9
Partially Developed Land		57.8	50.0	42.0	28.0

Comparative Land Expectation Values

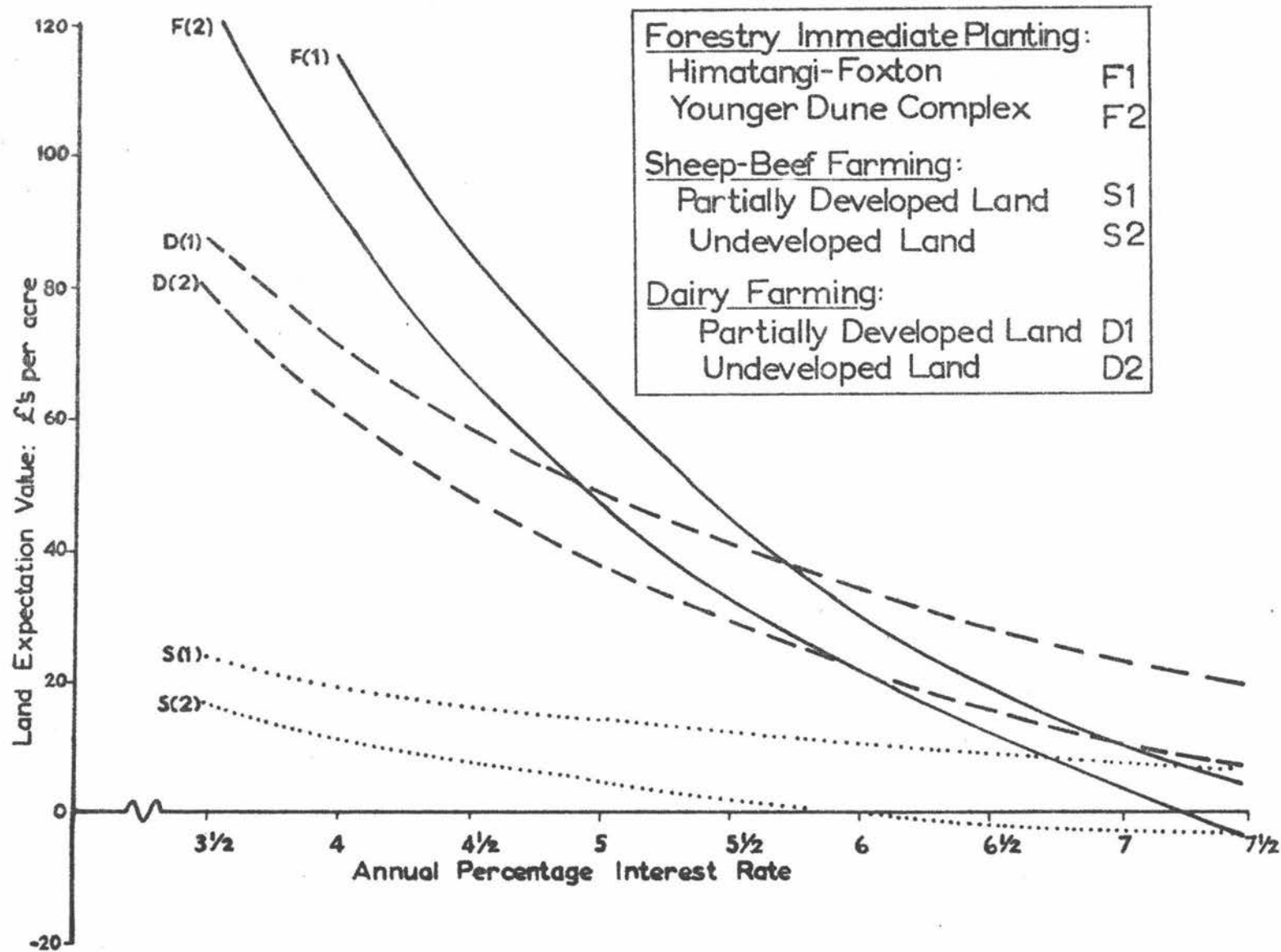


Fig. 7.1

partially developed sheep-beef farms* and large scale forestry, on the Younger Dune Complex and Himatangi-Foxton land class respectively.

The corresponding price increases needed to attain break-even land expectation values for undeveloped land are 31 and 41 per cent respectively.

With an increase in the external interest rate to $6\frac{1}{2}$ per cent, the relative profitability of maintaining partially developed sheep-beef farms or converting them to large scale forests is of the same order of magnitude.

It is estimated** that undeveloped land, planned for development into sheep-beef farms, should be potentially capable of supporting a stocking rate of the order of magnitude of $4\frac{1}{2}$ ewe equivalents per acre. At this stocking rate the profitability of developing land for sheep-beef farming or large scale forestry would be equivalent. Present estimates are that, in general, this stocking rate is unlikely to be achieved with less than 50 per cent of the farm area planted in farm forests.***

(b) The maintenance (or additional development) of dairy farms on the Younger Dune Complex is more profitable than their conversion to large scale forests. There is no significant difference between the relative profitability of maintaining dairy farms or converting them to

* In this study no differences between land expectation values of less than £10 per acre have been considered significant. The reason is given in the following discussion.

** See Appendix IX.

*** The author does not consider farming a property with more than 50 per cent of the area in farm forests to be feasible. The reason being due partly to credit restrictions, particularly providing for current living expenses, and partly to severe management problems imposed by a large number of scattered plantations sited on the low-producing farm soils - for example, the cost and inconvenience of providing stock access between paddocks.

large scale forests on the Himatangi-Foxton land class. There is also no significant difference between the profitability of developing land for dairy farming or large scale forestry, on both land classes. However, due to the range of soil types within a farm, dairy farms combined with farm forests are more profitable than the development of land for dairying without farm forests.

The following figures are given as a general guide. There will be wide variations between farms, depending on farm size, existing overheads and labour supply.

When planning the development of land for dairy farming, it should not be developed unless potentially capable of producing at least 110-120 lb of butterfat per acre 10 years after the initiation of development. Soil types within undeveloped farms not capable of this production should, in general, be planted in farm forests. Within partially developed dairy farms, undeveloped areas should only be developed providing they are capable of producing 90-110 lb of butterfat per acre.* If they are not considered capable of this production, these areas should be planted in farm forests.

The application of the above conclusions to the existing land use pattern of the Younger Dune Complex indicates:

(a) Approximately 29,000 acres of relatively undeveloped land should be developed into large scale forests.

(b) The 2,900 acres which is already partially developed for dairy farming should be maintained in dairying. In addition, approximately 5,600 acres should be developed for dairy farming combined with farm forestry.

(c) The development of land for sheep-beef farming is very much less profitable than forestry. No further land should be allocated to this use.

* The lower butterfat production requirement for the partially developed land is because, in most instances, overheads capable of servicing additional cows are already established.

The land use pattern of the Younger Dune Complex based on the above recommendations would be:

Protective forest belt	6,500
Large scale forestry	29,000
Dairy farming	8,500

The application of the results of this study on to the Himatangi-Foxton land class is more complex because of run-offs. The present market price for run-offs (£45-90) per acre indicates that the employment of a proportion of this land class for run-offs is the most profitable land use. At present approximately 40 per cent is being so used. The use of the remaining 60 per cent of this land class is a problem. At present there is approximately 15,000 acres of the Himatangi-Foxton land class which is being developed for sheep-beef farms and 4,500 acres for dairy farms. If in future the aggregate demand for run-offs does not exceed 50 per cent of the Himatangi-Foxton land class (at prices in excess of £40 per acre), the development of this land for forestry would be more profitable than its development for sheep-beef farms. The existing scattered pattern of run-offs, however, would greatly complicate the acquisition of land in large blocks and the systematic establishment of forests. An exception to this is the Whirokino developmental property situated directly east of the Waitarere Forest. This property is at present being developed for sheep-beef farms. In the author's opinion approximately 300 acres of high producing Pukepuke soils on it should be developed for dairying. The remaining 2,550 acres of poorer soil types (Himatangi-Foxton), at a relatively early stage of development, should be transferred to the Waitarere Forest. Many of the overheads of the existing forest would be capable of servicing the expanded area of forest without additional capital outlay.*

* See Appendix XI for a detailed tabulation of the estimated comparative returns from forestry and sheep-beef farming on the Whirokino property.

7.2 General Discussion

When evaluating the usefulness of the land expectation value method, it should be considered both in terms of absolute accuracy and in relation to existing methods of decision making. It is the author's contention that, of the errors which might arise in using this method, the inaccuracies of the data are likely to be the main contributing source. Two sources of possible error, arising from data limitations, can be identified:

(a) The difficulty of estimating physical input-output relationships for forestry and agriculture, which will be representative of the actual production achieved over the next 50 years. In the first group the following can be cited: the estimation of future timber grades and yields from forests under intensive silviculture, and the problem of assessing routine management costs for a large scale forest. In agriculture, there are problems of distinguishing between maintenance and capital expenditure (e.g. fertilizer), predicting the likely increases in per acre production, and obtaining realistic estimations for depreciation and repairs and maintenance costs.

(b) The second group of errors are those arising from inaccuracies in predicting resource costs and product prices 50 years into the future. Beyond this time period, prices and costs will still have some effects but, after discounting, these are relatively insignificant. The potential magnitude of errors arising from incorrectly specifying prices has been shown in Table 7.1. The table illustrates the extreme sensitivity of the profitability of forestry to the external interest rate.

In the light of the above data limitations, the author considers that no differences in land expectation values of less than £10 per acre should be treated as significant. On the other hand, differences of £40 per acre, as have been assessed in this study, are considered significant. The author contends that, in the absence of unforeseen major technological or price changes, differences of this

order of magnitude reflect the relative profitability of the two enterprises.

The usefulness of this method is illustrated by the magnitude of the differences in land expectation values between forestry and sheep-beef farming. In spite of this study concluding that forestry is significantly more profitable than sheep-beef farming, large areas are being allocated to sheep-beef farming, through the existing rule of thumb planning approach.

In conclusion, the author considers that the land expectation value method provides an objective framework upon which land use decisions can be made. It is considered that this approach is superior to existing rule of thumb methods. Because of the extreme sensitivity of results to long term product prices and the external interest rate (which are virtually impossible to accurately predict), the author would not advocate channelling of large amounts of research monies into sophistication of analytical techniques used in this study. In the author's opinion this would generally only lead to a spurious display of the accuracy of the underlying data. However, it is considered that macro-economic effects, discussed in Chapter III, could be more effectively incorporated in the final analysis than they have been in this study. The importance of these effects will increase with the magnitude of the area being considered, and will be particularly important when planning the balance of forestry and agriculture on a national scale. Even on the scale of this study important macro-economic considerations could arise. For example, if on some land classes it had been advocated that forestry should replace dairying, account would need to be taken of the repercussions of this decision on the whole milk or cream supply to existing dairy factories, the overheads of which are already provided.

Much additional research is needed to obtain numerical estimates of macro-economic effects, particularly at the level of benefit to the nation as a whole.

SUMMARY

A study has been conducted to evaluate the relative profitability of forestry and agriculture on the lower producing soil classes of the Manawatu-Rangitikei sand country. Two economic models for determining the profitability of long term investments have been considered. The economic model used in this study has been the land expectation value model. This expresses the net profits from each enterprise in terms of how much they can "afford" to pay for land, after meeting all other production costs, including interest payments on the total capital investment. Problems likely to be encountered in applying a model of this type to an imperfect market, with particular reference to forestry and agriculture, have been discussed.

Several classes of sand country have been considered. These involve a large number of soil types, exhibiting a considerable range in levels of forestry and agricultural production. Special soil productivity classes appropriate for this study were formulated. Two soil classes, where competition between forestry and agriculture is most marked, were selected for intensive study. These are the Younger Dune Complex and the Himatangi-Foxton land class. Physical and financial input-output data were collected for sheep-beef farming, dairy farming and forestry on these land classes. The relative profitability of these enterprises has been evaluated and expressed in terms of land expectation values. On the basis of these results, recommendations of the most profitable land use of the Younger Dune Complex and Himatangi-Foxton land classes have been made.

Briefly, the general trend of results was that large scale forestry was significantly more profitable than sheep-beef farming, the profitability of large scale forestry and dairy farming was of the same order of magnitude, dairy farming combined with farm forestry was more profitable than either enterprise on its own.

Finally, the usefulness of the land expectation value method, both in terms of absolute accuracy and in relation to existing methods of allocating land, has been discussed.

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APPENDIX I

Summary of Discounting Equations

The general discounting formula used in the preceding calculations for determining land expectation values is:

$$PV = \sum_{i=0}^n \frac{Vi}{(1+r)^i} \quad (1)$$

where PV = the present value of all revenues over a period of n years.

Vi = the actual revenue received (or cost paid) at the end of the *i*th year.

r = the external interest rate.

The present value of a constant annual revenue or cost over a period of n years may be expressed as:

$$PV = \frac{V}{r} \left[1 - \frac{1}{(1+r)^n} \right] \quad (2)$$

As n approaches infinity the above equation reduces to:

$$PV = \frac{V}{r} \quad (3)$$

The present value of a perpetual income stream beginning in year n is:

$$PV = \left(\frac{V}{r} \right) \frac{1}{(1+r)^n} \quad (4)$$

* The equations given in this study may be found in the following references:

Heady, E.O., 1952. Economics of Agricultural Production and Resource Use. Prentice Hall, Inc., p.382.

Duerr, W.A., 1960. Forestry Economics McGraw-Hill, New York, p.110.

Petrini, S., 1951. Elements of Forest Economics. Oliver & Boyd, Edinburgh, p.77.

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Given a present land expectation value, this may be converted to a constant annual rental payment for land, by modification of equation (2).

$$A = \frac{PV}{\frac{1}{r} \left[1 - \frac{1}{(1+r)^n} \right]} \quad (5)$$

where A = the annual rental payment for land

The forestry land expectation values have been checked using a modified Faustmann formula:

$$L_f = \frac{F_n + \frac{Ta(1+r)^{n-a} - Fb(1+r)^{n-b} - C(1+r)^n - \frac{e}{r}}{(1+r)^n - 1}}{\quad} \quad (6)$$

where L_f = land expectation value for forestry.

F_n = stumpage value of timber at year n.

n = length of rotation in years.

T_a = sum of value of thinnings during rotation.

F_b = sum of pruning costs during rotation.

e = annual forest maintenance cost.

r = external rate of interest.

APPENDIX II

Example of Revenue Flow During Forest Establishment

The following example illustrates the revenue flow from planting to the final harvest, for one acre of forest.

The per acre forest costs and returns are:

	<u>Year</u>	<u>Costs</u>	<u>Returns</u>
		£ per Acre	
Costs of establishment	1	32	
Annual maintenance costs	1-40	1.5	
First pruning	6	8	
Second pruning	9	9	
First thinning	10		20
Third pruning	12	15	
Second thinning	18		45
Third thinning	28		75
Final harvest	40		675

The external interest rate is assumed to be 5 per cent.

The present value of the income stream at different points in the rotation is derived from the following equation:

$$\begin{aligned}
 Lf^{1-40} = & -32 - \frac{1.5}{0.05} \left[1 - \frac{1}{(1.05)^5} \right] - \frac{9.5}{(1.05)^6} \\
 & - \frac{1.5}{0.05(1.05)^6} \left[1 - \frac{1}{(1.05)^2} \right] - \frac{10.5}{(1.05)^9} + \frac{18.5}{(1.05)^{10}} - \frac{1.5}{(1.05)^{11}} \\
 & - \frac{16.5}{(1.05)^{12}} - \frac{1.5}{.05(1.05)^{12}} \left[1 - \frac{1}{(1.05)^5} \right] + \frac{43.5}{(1.05)^{18}}
 \end{aligned}$$

$$- \frac{1.5}{0.05(1.05)^{18}} \left[1 - \frac{1}{(1.05)^9} \right] + \frac{73.5}{(1.05)^{28}}$$

$$- \frac{1.5}{0.05(1.05)^{28}} \left[1 - \frac{1}{(1.05)^{11}} \right] + \frac{673.5}{(1.05)^{40}}$$

$$\begin{aligned} Lf1-40 &= 32 - 30 (0.2163) - 7.084 - 22.37 (0.0934) \\ &- 6.77 + 11.36 - 0.877 - 9.18 - 16.69 (0.2163) \\ &+ 18.07 - 12.46 (0.3557) + 18.74 - 7.65 (0.4155) \\ &+ 95.57 \end{aligned}$$

This gives the following present value of the income stream through time:

- R0 = -32
- R5 = -38.49
- R6 = -45.57
- R8 = -47.66
- R9 = -54.43
- R10 = -43.07
- R11 = -43.95
- R12 = -53.12
- R17 = -56.73
- R18 = -38.66
- R27 = -43.09
- R28 = -24.35
- R39 = -27.53
- R40 = +68.04

R40 = £68.04 per acre

APPENDIX III

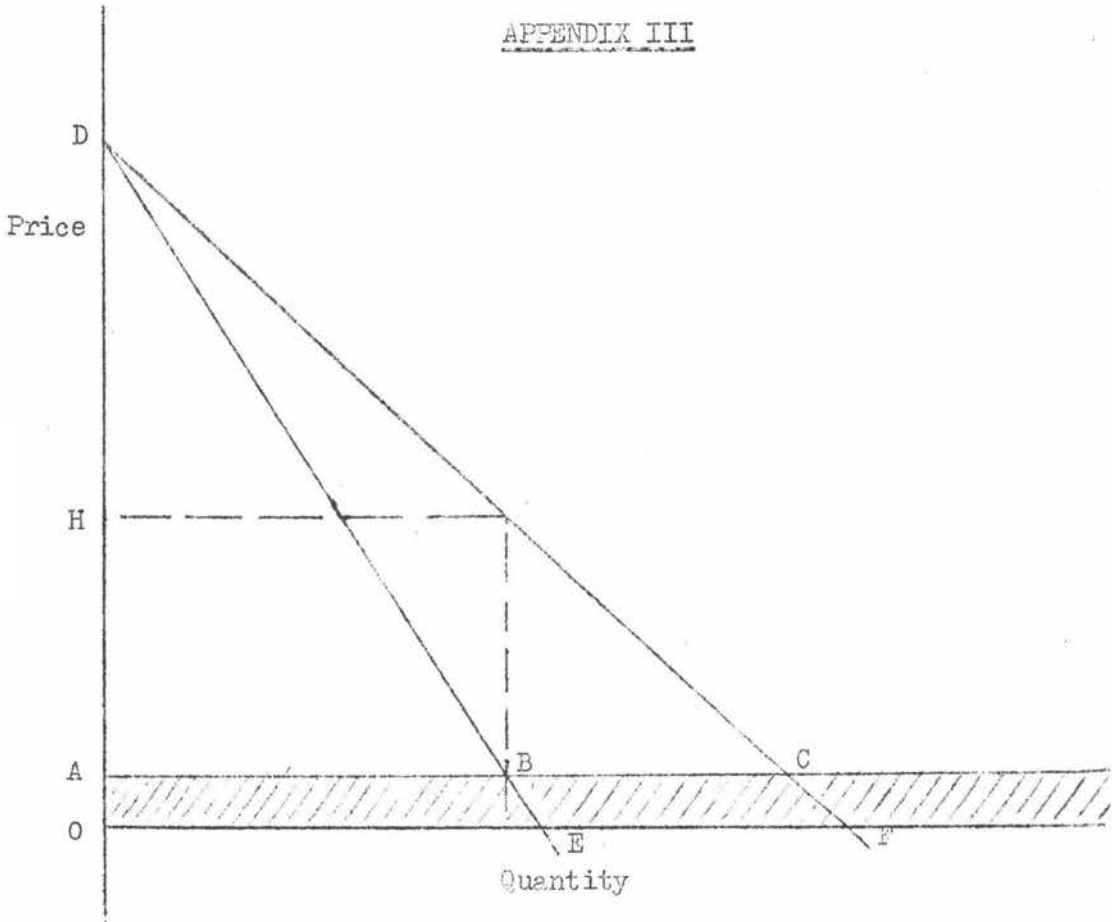


Fig. III.1

Hypothetical Price-Quantity Relationships for Round Produce

In Fig. III.1 line DBE shows the marginal revenue obtained per additional unit of round produce sold. Line DCF shows the average revenue obtained for a given quantity of round produce. OA indicates the additional cost of harvesting thinnings relative to the cost of poison thinning.

A monopolistic forest company will harvest AB units of round produce, and sell the round produce at an average price O.H. Surplus thinnings will be poisoned. On the other hand, Crown forests should aim to maximize social benefit. In this instance they will harvest AC units of round produce, and sell the round produce at an average price OA. Only when the average price begins to fall below the additional cost of harvesting should surplus thinnings, if any, be poisoned.

APPENDIX IV

Annual Routine Forest Costs

In this study routine forest costs are defined as all costs involved in maintaining a forest that are not costed directly to an individual forest operation.* Routine forest costs have a large effect on the profitability of forestry as they are recurring annual costs.

In deriving the routine forest costs used in this study, the accounts for the three financial years 1960, 1961 and 1962 for 7 major exotic forests within the Wellington Conservancy have been analysed, and the individual costs converted to a per acre basis.** Data have also been collected from sand country farm forests and three privately-owned large sand country forests.

For the following reasons financial accounts showing present routine forest costs must be treated with reserve when used as a guide to likely future costs:

(a) In most instances present running costs are based on forests which have been established with limited knowledge. As a consequence many of these forests have a poor design and layout, and have often had inadequate tending. The result is that in many instances present routine forest costs are inflated, due to the expense of correcting past mistakes and catching up on a backlog of work. For example, in the Waitarere Forest original fire access tracks were inadequate. To overcome this, immature trees have been felled to provide adequate access. A considerable portion of this cost has been charged to fire protection, thus inflating fire protection costs to 300 per cent above normal levels.

A number of these "latent capital" costs were found in

* Individual forest operations given in Chapter V include establishment, pruning and thinning.

** This appendix summarizes the derivation of routine forest costs; the raw data are held by the author.

maintenance expenditure accounts.

(b) The second limiting factor of present data is that routine costs for recently established forests are based on a small proportion of the potential forest area. For example, buildings, fire protection equipment etc. are normally established at the beginning of the planting period, but are not fully utilized until the complete forest is established. In many cases the ultimate forest size is not known. The following estimation of routine costs for a sand country forest have been derived after analysis of financial accounts and discussion with members of Forest Service.

The routine management costs accounted for in this study are:

- (a) Fire protection costs and noxious animal control
 - (i) Trespass and fire patrol
 - (ii) Maintenance of access tracks
 - (iii) Aerial patrol and standby
 - (iv) Fire prevention
 - (v) Fire suppression
 - (vi) Noxious animal control
- (b) Depreciation reserve, repairs and maintenance, interest charge on capital investment. *
 - (i) Roads, bridges, services and general
 - (ii) Plant and equipment
 - (iii) Buildings
- (c) Administration
 - (i) Camps and hostels
 - (ii) General administration (local office expenses, staff expenses and supervision)
- (d) Overheads

The cost of these items is listed in Table IV.1.

* The method of allowing for depreciation, repairs and maintenance, and interest on capital investment is the same as that used for agriculture and given in Chapter VI, Section 6.2 and Appendix VII.

TABLE IV.1

Routine Forest Management Costs

£'s per acre per year

Fire protection	0.25
Noxious animal control	0.10
Depreciation, interest, repairs and maintenance	
(a) General	0.30
(b) Plant and equipment	0.30
(c) Buildings	0.25
Administration	
(a) General	0.30
(b) Camp and hostels	0.10
Overheads *	0.25
Wet weather and holiday pay	0.22
Total routine management costs	<u>£2.07</u>

The above routine management costs are estimated average costs for a 6,000 - 12,000 acre sand country forest ^{**}.

Depending upon a number of factors including forest size and whether a new forest is being established or an old one (with existing overheads) is being expanded, routine management costs are estimated to vary between £1 and £3 per acre per year.

* These are Head Office and Conservancy overheads which are involved in planning and administering the management of forests. This makes allowance for all government institutions servicing forestry, with the exception of research institutions. The present basis for calculating overheads is to charge 23 per cent of the total wages paid by each forest as overheads. To put agriculture and forestry on the same basis, ideally some account would need to be taken of the government institutions servicing agriculture, for example, the Department of Agriculture. No account of these institutions has been taken in costing agriculture. To overcome this, only one half of the present forestry overheads has been allowed for in this study.

** This does not include protective forestry costs as these are necessary regardless of the future land use of the sand country.

APPENDIX V

The Method of Calculating Forestry Land
Expectation Values

The following forest budget, by way of example, is based on a 30-year rotation and a 5 per cent external interest rate. The initial step in calculating the forestry land expectation value has been to assess the present value of all forest costs and returns. The equations used for deriving the present value of forest costs and returns have been given in Appendix I. (Turn to budget on following page.)

When assessing the forestry land expectation value it is necessary to account for the net revenue from all future rotations, not just a single rotation. To achieve this, the first step is to convert the lump sum present value into an annuity payment.* This conversion is achieved by the following equation. (Equation (5), Appendix I)

$$A = \frac{PV}{\frac{1}{r} \left[1 - \frac{1}{(1+r)^n} \right]}$$

$$A = \frac{60.99}{\frac{1}{0.05} \left[1 - \frac{1}{(1.05)^{30}} \right]}$$

$$= \text{£}3.96 \text{ per acre per year}$$

The next step is to capitalize the annuity (or amortized value).

This is achieved by the normal capitalization equation (3), (Appendix I).

$$PV = \frac{A}{r}$$

$$= \frac{3.96}{0.05}$$

$$= \text{£}79.20 \text{ per acre}$$

* It should be noted that the particular forest rotation with the highest annuity payment is the optimum rotation, and not the single rotation with the highest present value.

TABLE V.1

Forest Budget

<u>Year</u>	<u>INPUTS</u>	<u>Present Value</u> <u>£ per acre</u>
1	Cost of establishment	= 32.00
1-30	Annual running costs = $\frac{2.0}{0.05} \left[1 - \frac{1}{(1.05)^{30}} \right]$	= 30.875
6	First pruning = $\frac{8}{(1.05)^6}$	= 5.95
9	Second pruning = $\frac{9}{(1.05)^9}$	= 5.80
	Total present value of costs	<u>£74.50</u>
	<u>OUTPUTS</u>	
10	First thinning = $\frac{10}{(1.05)^{10}}$	= 6.14
16	Second thinning = $\frac{30}{(1.05)^{16}}$	= 13.74
30	Final harvest = $\frac{500}{(1.05)^{30}}$	= 115.61
	Total present value of revenues	<u>£135.49</u>
	Present value of net revenue	<u>£60.99</u>

This is the net revenue (present value) obtained from a single 30-year rotation.

The forestry land expectation value is finally derived by deducting 20 per cent from the above figure for "unproductive" land.

Lf = £63.36 per acre

This may be expressed as an annual rental payment by the use of the following equation:

$$\begin{aligned} A &= PV \times r \\ &= 63.36 \times 0.055 \text{ per year} \\ &= \underline{\underline{\pounds 3.48 \text{ per acre per year}}} \end{aligned}$$

APPENDIX VI

Variation of Forestry Land Expectation
Values with Rate of Planting

The following example illustrates the method of computation used for deriving the forestry land expectation values given in Table VI.1.

Consider the forestry land expectation value for "immediate" planting is £45.67 per acre, and has been derived as in Appendix V.

The situation is now considered where a 9,000-acre sustained yield forest is planned to be established over a period of 30 years, at the rate of 300 acres per year. The forest rotation is 30 years. The average per acre land expectation value is given by the following equation:

$$L_{fs} = \frac{L_{fI}}{r} \left[1 - \frac{1}{(1+r)^n} \right]$$

Where L_{fs} = the land expectation value for a sustained yield forest.

L_{fI} = the land expectation value for "immediate" planting.

n = number of years in rotation.

$$L_{fs} = \frac{45.67}{0.055} \left[1 - \frac{1}{(1.055)^{30}} \right]$$

$$= £22.14 \text{ per acre}^*$$

Table VI.1 illustrates the comparative forestry land expectation values for seven planting rates and a range of external interest rates from $4\frac{1}{2}$ to $6\frac{1}{2}$ per cent.

* In this instance it is assumed that land waiting for planting is not used for grazing.

TABLE VI.1

Forestry Land Expectation Values for Seven Establishment Rates
(£s¹ per acre)

Interest Rate (Percent)		Immediate Planting	5	10	15	20	25	30
4½	(1)	85.4	74.9	67.4	61.1	55.5	50.6	46.3
	(2)	67.1	58.9	53.1	48.0	43.7	39.9	36.4
5	(1)	63.4	54.8	48.2	43.9	39.5	35.7	32.5
	(2)	48.4	41.9	36.9	33.5	30.2	27.3	24.9
5½	(1)	45.7	39.1	34.6	30.6	27.3	24.6	22.1
	(2)	33.5	28.6	25.3	22.4	19.9	18.0	16.2
6½	(1)	21.6	17.9	15.5	13.5	11.9	10.5	9.4
	(2)	12.7	10.6	9.1	8.0	7.0	6.2	5.5

- (1) Himatangi-Foxton land class
 (2) Younger Dune Complex

APPENDIX VII

Method of Computing Depreciation Reserve

The depreciation reserve for buildings, plant and machinery is expressed as a constant annual cost. It is defined as the particular constant annual cost which, if compounded over the life of the asset, has an end value equivalent to the replacement cost of the asset. The derivation of the annual depreciation charge for farm and forestry buildings is now illustrated. A 40-year life for farm and forest buildings has been assumed in this study.

In this study an annual depreciation reserve of 0.75 per cent of the original cost of buildings has been taken. That this reserve is equivalent to the replacement value of the building in 40 years' time is shown in the following equation* (Appendix I).

$$\begin{aligned} D_1 &= \frac{0.75}{0.055} \left[1 - \frac{1}{(1.055)^{40}} \right] \\ &= \text{£}11.98 \end{aligned}$$

This represents the lump sum value at the beginning of the period.

The value of this sum at year 40 is:

$$\begin{aligned} D_{40} &= 11.98 \times (1.055)^{40} \\ &= \underline{\underline{\text{£}116.13}} \end{aligned}$$

* The depreciation reserve is taken to the nearest quarter of a per cent, and is expressed per £100 of buildings.

APPENDIX VIII

TABLE VIII.1

Expressing all Stock in Terms of Ewe
Equivalentents

The following conversion table has been used for expressing all stock on sheep-beef farms in terms of **ewe** equivalentents.*

<u>Stock Type</u>	<u>Ewe Equivalentents</u>
Ewe hoggets	0.5
Two-tooth ewes	1.0
Other ewes	1.0
Wether hoggets	0.5
Other wethers	1.0
Rams	1.0
Heifers rising 1 year	4.0
Heifers rising 2 years	5.0
Breeding cows	7.0
Cows (dry)	6.0
Steers rising 1 year	4.0
Steers rising 2 years	5.0
Bullocks and bulls	6.0

The author realizes the limitations of a standard conversion table for stock. However, it is considered an adequate way of expressing relative stocking rates for the purposes of this study.

* The above table has been taken from the N.Z. J. Agric., March, 1962, p.203.

APPENDIX IX

Derivation of Budgets for Sheep-Beef Farms

This appendix gives a budget for an average partially developed sheep-beef farm. The situation is considered where the land is to be further developed. The two situations of developing completely undeveloped land and "maintaining" partially developed land have already been considered in Chapter VI.

A detailed breakdown of the inputs and outputs for sheep-beef farms, and the method of deriving the net profit attributable to land is given following the budget.

Budget B estimates the present farm outputs and the estimated inputs required to maintain this production.

B Annual Budget for Partially Developed Sheep Farm

<u>Outputs</u>	<u>£'s per 100</u> <u>acres</u>
Wool and skins	255
Sheep sales	162
Cattle sales	240
	<u>657</u>
 <u>Inputs</u>	
Wages and management	125
Stock purchases	78
Fertilizer	102
Contract work	72
Motor expenses and cartage	19
Shearing, dipping, veterinary and farm stores	42
Repairs, maintenance and depreciation	21
Miscellaneous	61
Interest on capital investment	72
	<u>592</u>
Net profit per acre	<u>£0.65</u>

The land expectation value is now calculated for partially developed land which is to be further developed. The present net profit is £0.65 per acre (Budget B) and this is anticipated to increase to £1.25 per acre over a 5-year period at an average capital development cost of £10 per acre.*

(a) The value of the land for the first 5 years is:**

$$\begin{aligned} Ls1 - 5 &= \frac{V}{r} \left[1 - \frac{1}{(1+r)^n} \right] \\ &= \frac{0.94}{0.05} \left[1 - \frac{1}{(1.05)^5} \right] \\ &= 18.80 \times (0.2163) \\ &= \underline{\underline{£4.07 \text{ per acre}}} \end{aligned}$$

(b) The value of the land from year 5 in perpetuity is:***

$$\begin{aligned} Ls5 \rightarrow \infty &= \frac{1.25}{0.05} \\ &= \frac{25}{(1.05)^5} \\ &= \underline{\underline{£19.59 \text{ per acre}}} \end{aligned}$$

(c) Development costs are:

$$\begin{aligned} PVC &= \frac{2}{0.05} \left[1 - \frac{1}{(1.05)^5} \right] \\ &= \underline{\underline{£8.65 \text{ per acre}}} \end{aligned}$$

The land expectation value is:

$$\begin{aligned} Ls &= Ls1 \rightarrow 5 + Ls5 \rightarrow \infty - PVC \\ &= 4.07 + 19.59 - 8.65 \\ &= \underline{\underline{£15.01 \text{ per acre}}} \end{aligned}$$

* The source of data is developmental budgets from the Lands and Survey Department.

** The net profit during this developmental period is estimated to be midway between the present net profit and the net profit after the completion of development.

*** The estimated net profit at the stage of full development has been given in Budget A, Chapter VI.

In this instance additional development is slightly more profitable than maintaining present production.

Budget B has been derived from the following data which are given in detail to exemplify the method of deriving the net profit (to land) for the surveyed sheep-beef farms. The property is representative of an average partially developed sheep-beef farm on the Himatangi-Foxton land class.*

		<u>Total Capital Investment (excluding land)</u>			
(a) Stock**					
Sheep					
503	2 ^{ths}	@	52/-	-	1,308
1,353	4 th , 6 th and 4 yrs	@	42/-	-	2,841
700	Ewe hoggets	@	38/-	-	1,330
150	Wether hoggets	@	38/-	-	285
630	2 th wethers	@	42/-	-	1,323
50	Romney rams	@	£12	-	500
Total sheep investment					£7,587
Cattle					
290	Breeding cows	@	£22	-	6,380
80	Rising 1 yr heifers	@	£13	-	1,040
60	" 2 yr "	@	£20	-	1,200
60	" 1 yr steers	@	£16	-	960
30	" 2 yr "	@	£25	-	750
10	Bulls	@	£50	-	500
Total cattle investment					£10,830
Total stock investment					£18,417

* The following data are based on an effective grazing area of 2,000 acres (that is, it does not include an area of approximately 800 acres of completely undeveloped land).

** Stock values are based on average values in the Manawatu for the three seasons 1960/61, 1961/62 and 1962/63. The values were obtained from "Farm Management - Guide to Rural Costs and Prices", Economics and Farm Management Department, Massey University of Manawatu.

(b) Buildings	-	8,870
(c) Plant and equipment*	-	1,500
Total capital investment (excluding land)	-	<u>£28,790</u>
Interest on capital investment** (5 per cent)	=	<u>£1,440</u>

Outputs

Wool	31,385 lb	@ 39d net	£5,100
Sheep - ewes:	100 works	@ 20/-	100
	244 e.f.a.5 year	@ 30/-	366
	145 2 ^{ths}	@ 50/-	<u>363</u>
			£ 829
	lambs: 100 mixed sex	@ 17/6	88
	620 fwd. store and fat	@ 36/-	<u>1116</u>
			£1,204
	wethers: 630 4 ^{ths}	@ 38/-	£1,197
Cattle - cull cows	45	@ £20	900
	weaner heifers	45	@ £12 - 540
	weaner steers	65	@ £14 - 910
	1½ yr heifers	30	@ £20 - 600
	1½ yr steers	30	@ £25 - 750
	2½ yr steers	30	@ £32 - 960
	bulls	3	@ £45 - <u>135</u>
			£4,795
		Total outputs	<u>£13,125</u>

* The investment in plant and equipment is relatively low as cultivation etc. is done by contract.

** In this study an interest charge on the total capital investment in buildings, plant and equipment for both forestry and agriculture has been made. The author considered that most of these assets had a high salvage value and could, if necessary, be adapted for use by the competing enterprise. Ideally no interest charge should be made on assets which have no salvage value (that is, these are regarded as an "historic cost"). The author was not able to specify salvage values exactly. However, the possible errors arising from the simplified approach used in this study are considered to be small.

Inputs

Labour and management (3 permanent men average)			
	(£750 plus £250 management reward)		£2,500
Stock purchases - 3 bulls	@ £85	- 255	
12 Romney rams	@ £20	- 240	
4.80 2 th wethers	@ 44/-	- <u>1,056</u>	£1,551
Fertilizer* - 120 tons potassic serpentine super-phosphate (Co,Cu, and $\frac{1}{3}$ mix D.D.T.)			
	@ £17 per ton (spread)		£2,040
Contract work - cultivation and seeds (80 acres old pasture - choulmollier and swedes - millet new grass)		- 1,165	
Hay baling (3,000 bales)		- <u>275</u>	£1,440
Motor expenses - car expenses (farm business) and cartage		- 100	
	fuel and oil	- <u>130</u>	£ 380
Shearing, crutching, woolpacks, dipping, etc.			£ 616
Farm stores and veterinary			£ 224
Repairs, maintenance and depreciation reserve - buildings (£3,870 @ 3 per cent)		- 266	
plant and equipment (£1,500 @ 10 per cent)		- <u>150</u>	£ 416
Miscellaneous - water supply		- 45	
roads and culverts		- 45	
drainage		- 50	
fencing		- 615	
scrub, weeds and pests (lupin, gorse)		- 265	
electric power, mail, telephone		- 60	
insurance		- 50	
accountancy		- 30	
unforeseen (horses, dogs, etc.)		- <u>60</u>	£1,220

* The present application is 180 tons; the author considers that two-thirds of this amount is sufficient to maintain present

Total inputs	<u>£10,387</u>
Net profit ¹	<u>£2,738</u>

This represents the net profit (after deducting a labour and management reward) attributable to the total capital investment in land, stock, buildings, plant and equipment. To obtain the net profit attributable to land alone, it is necessary to deduct an interest charge for capital investment in stock, buildings, plant and equipment

$$\begin{aligned}\text{Net Profit} &= \text{Net Profit}^1 - \text{interest} \\ &= 2,738 - 1,440 \\ &= \underline{\underline{£1,298}} \\ &= \underline{\underline{£0.65}} \quad \text{per acre}\end{aligned}$$

APPENDIX X

Derivation of Budgets for Dairy Farms

This appendix gives a budget for a representative partially developed dairy farm, and considers the situation where the farm is further developed. To exemplify the method of deriving the net profit to land for dairy farming, a detailed breakdown of the inputs and outputs is given.

Budget D gives the present production and the estimated inputs required to maintain this production for a representative 223-acre dairy farm on the Younger Dune Complex.

<u>D Annual Budget for Partially Developed Dairy Farm</u>	
<u>Outputs</u>	<u>£'s per 100 acres</u>
Butterfat	1,243
Stock sales	235
Total output	<u>1,478</u>
 <u>Inputs</u>	
Labour and management reward	448
Fertilizer, seeds and spray	161
Contract work and cultivation	67
Motor expenses and cartage	92
Herd testing and veterinary expenses	45
Stock purchases and stock foods	18
Repairs, maintenance and depreciation reserve	117
Miscellaneous	125
Interest on capital investment	181
Total inputs	<u>1,254</u>
Net profit	<u>£2.24 per acre</u>

The land expectation value is now calculated for a partially developed dairy farm which is to be further developed. The present annual net profit is £2.24 per acre (Budget D) and this is anticipated to increase to

£3.5 per acre (Budget C, Chapter VI) over a 5-year developmental period, at an average capital cost of £10 per acre.

(a) The value of the land over the 5-year developmental period is:

$$\begin{aligned} LD1 - 5 &= \frac{2.91}{0.05} \left[1 - \frac{1}{(1.05)^5} \right] \\ &= \underline{\underline{£12.59 \text{ per acre}}} \end{aligned}$$

(b) The value of the land from year 5 in perpetuity is:

$$\begin{aligned} LD5 - \infty &= \frac{3.5}{0.05} \\ &= \frac{\quad}{(1.05)^5} \\ &= \underline{\underline{£54.86}} \end{aligned}$$

(c) The present value of development costs is:

$$\begin{aligned} PVC &= \frac{2.0}{0.05} \left[1 - \frac{1}{(1.05)^5} \right] \\ &= \underline{\underline{£8.65}} \end{aligned}$$

The overall land expectation value is:

$$\begin{aligned} LD1 - \infty &= LD1 \rightarrow 5 + LD5 \rightarrow \infty - PVC \\ &= \underline{\underline{£12.59 + 54.86 - 8.65}} \\ &= \underline{\underline{£58.80 \text{ per acre}}} \end{aligned}$$

In this instance, at a 5 per cent interest rate, marginal development of land is more profitable than maintaining present production.

Total Capital Investment (excluding land)

(a)	Stock				
	70	Milking cows	@ £35	-	2,450
	16	Replacement heifers	@ £20	-	320
	2	Bulls	@ £50	-	100
		Total stock investment		-	<u>2,870</u>
(b)	Buildings (house, milking shed, hay barn)			-	3,700
(c)	Plant and equipment			-	<u>1,500</u>
		Total capital investment (excluding land)			<u>£8,070</u>
		Interest on capital investment (5 per cent)			<u>£404</u>

Outputs

Butterfat	19,000 lb	@ 35d.	-	2,771	
Stock					
14	Cull cows	@ £29	-	406	
47	Bobby calves	@ 50/-	-	118	
	Total outputs				<u>£3,295</u>

Inputs

Labour and management reward (£750 labour and £250 management reward)	-	1,000
Fertilizer, seeds and spray (20 tons $3\frac{1}{3}$ potassic serpentine superphosphate, Cu, $\frac{1}{3}$ mix D.D.T.)	-	360
Contract work and cultivation (15 acres old grass - choumoellier, turnips - new grass)	-	150
Motor expenses (farm business) and cartage (tanker supply)	-	205
Herd testing and veterinary expenses	-	100
Stock foods and stock purchases (Ppn. bull)	-	40

Depreciation reserve, repairs and maintenance

Buildings £3,700	@	3 per cent	- 111
Plant and equipment £1,500	@	10 per cent	- <u>150</u>
			261
Miscellaneous - Fencing	-		150
Roads and culverts	-		10
Drainage	-		15
Scrubs and weeds	-		25
Electric power	-		25
Insurance	-		34
Accountancy	-		20
			<u>279</u>

Total inputs £2,395

Net profit¹ £904

This represents the net profit attributable to the total capital investment (including a labour and management reward). To find the net profit attributable to land alone, it is necessary to deduct an interest charge for the capital value of stock, buildings, plant and equipment combined with the land.

$$\begin{aligned} \text{Net Profit} &= \text{Net Profit}^1 \quad - \quad \text{interest charge} \\ &= £904 \quad - \quad 404 \\ &= £500 \\ &= \underline{\underline{£2.24 \text{ per acre}}} \end{aligned}$$

APPENDIX XI

Comparative Returns from Forestry and
Sheep-Beef Farming on the Whirokino Property

This appendix illustrates the relative profitability of continuing development of the Whirokino property for sheep-beef farming, or converting the property to a large forest, by expanding the existing Waitarere Forest.* In Table XI.1 the comparative returns from these two competing enterprises are shown over a period of 75 years. When assessing returns from forestry and sheep-beef farming on this property it is assumed that approximately 250 acres of high producing Pukepuke soils will be transferred to dairy farming. The comparison is then based on the remaining area of 2,500 acres of the Himatangi-Foxton land class.

(a) Development of Land for Forestry:

The forest is estimated to be established over a period of 15 years at a planting rate of 170 acres per year. Land waiting for planting is assumed to be maintained in sheep-beef farming. The profits from this unplanted land are £0.65 per acre per year, as given in Budget B (Appendix IX). Routine maintenance costs, based on the full 2,550 acres, are £1 per acre per year during the 15-year planting period, and £1.5 per acre per year thereafter.**

(b) Development for Sheep-Beef Farming:

In this instance, over the period of the next 5 years, it is assumed that the property is further developed for sheep-beef farming at an average of £12 per acre. The

* Unless otherwise specified forestry costs and returns are based on Appendix V. Sheep-beef farming costs and returns are based on the budget given in Chapter VI.

** These are slightly lower routine forest costs than used in Appendix V. This is because many of the overheads (buildings, etc.) capable of servicing this additional area of forest are already established for the adjacent Waitarere Forest.

TABLE XI, 1

Comparative Returns from Forestry
on the Whirokino

Land Use	Years	5-Year					
		1-5	5-10	10-15	15-20	20-25	25-30
<u>Forestry Costs</u>							
Establishment	1-15	£25,500	25,500	25,500	-	-	-
Running costs	1-30	12,750	12,750	12,750	19,125	19,125	19,125
First pruning	6-21	-	5,440	6,800	6,800	1,360	-
Second pruning	9-24	-	1,530	7,650	7,650	6,120	-
Total costs		£38,250	45,220	52,700	33,575	26,605	19,125
<u>Returns</u>							
First thinning	10-25	-	-	8,500	8,500	8,500	-
Second thinning	16-31	-	-	-	20,400	25,500	25,500
Final harvest	30-45	-	-	-	-	-	-
Grazing	1-15	6,906	4,144	1,381	-	-	-
Total returns		£6,906	4,144	9,881	28,900	34,000	25,500
Forest net profit		-31,344	-41,076	-42,319	-4,675	7,395	6,375
Forest net profit (Productive land)		-25,075	-32,861	34,255	-3,740	5,916	5,100
Present values		-25,075	-25,123	-20,032	-1,672	2,023	1,334
Total present value		£102,656					
<u>Sheep-Beef Farming</u>							
Development costs	1-5	30,600	-	-	-	-	-
Returns	1-75	13,770	19,125	19,125	19,125	19,125	19,125
Net returns		£-16,830	19,125	19,125	19,125	19,125	19,125
Present values		-16,830	+ 51,925				
Total present value		£35,095					

average net profit (excluding capital development costs) over this period is estimated to be £1.08 per acre per year. From the 5th year onward the annual net profit is estimated to be £1.50 per acre. The author considers this is the maximum net profit likely to be attained for sheep-beef farming.

Table XI.1 shows the individual and total costs and returns (in 5 year periods), over a total term of 75 years, for both forestry and sheep-beef farming on the Whirokino property. The present value of these future incomes is also shown.* The table shows that the net returns from sheep-beef farming during the first 20 years are higher than the returns from forestry. From the 20th year onwards, however, the net returns from forestry are substantially higher than from sheep-beef farming. The present value of the future income from forestry is approximately three times as high as the present value of future returns from sheep-beef farming.

* The external interest rate used for computing present values is $5\frac{1}{2}$ per cent. For simplicity it has been assumed that all returns and costs occur at the beginning of each 5-year period.

APPENDIX XII

Sand Country Soil Types

XII.1 The Importance of a Soil Classification in this Study

The classification of sand country soils is important for two reasons:

(a) There is a wide variability of soil types on the sand country.*

(b) There is a strong connection between soil type, land use and level of production. In particular, soil type has a considerable influence on the relative forestry and agricultural production, and hence on competition between these two enterprises.

The wide variability of sand country soils is a result of a number of interacting factors. Firstly, the parent material of sand country soils is wind blown sand. Also, the area is subject to a low summer rainfall and frequent winds. These factors, combined with the coarse texture and low organic content of sandy soils, make their pasture and crop (including trees) productivity largely dependant upon the amount of soil moisture available. Soil moisture is determined jointly by the height of the water-table and drainage; and drainage is in turn determined by the very variable micro-relief characteristic of the sand country.

XII.2 Methods and Problems of Soil Classification on the Sand Country

This section describes two methods of soil classification at present used on the sand country. On the basis of these soil classifications a modified method, considered appropriate for land use studies, has been formulated.

XII.2.1 A Detailed Soil Classification

A detailed soil classification is available for

* For an illustration of three different soil associations on the sand country, see Figs. XIII.6, XIII.7, XIII.8.

part of the sand country (35). This covers 35,000 acres and is centred on the Himatangi district, which is representative of the major soil associations. This classification maps the individual soil types, sub-types and phases. Where data are available, this detailed classification is useful for predicting timber yields on different sites. Forestry production on a particular soil type can be assessed in isolation, since tree growth on one soil type is not significantly influenced by the nature of surrounding soil types. This method of classification, however, is not suitable for agricultural production, except on a within-farm basis. This is due to the fact that most farms on the sand country contain a number of soil types, sub-types and phases. Thus "interaction" occurs. The relative proportion of a farm's production which can be attributed to any one of the soil types is dependant upon the proportion and combination of other soil types associated with it. On most farms the manner and proportion in which soil types are associated determine not only the overall land use, but also the treatment and utilization of the individual soil types.

The detailed soil survey is useful as an aid to making farm management decisions. For example, fertilizer application and drainage plans. However, the method is not suitable for a broad land use study.

XII.2.2 Classification of Soil Associations

This section provides a brief description of the sand country soil associations, with particular reference to the competitive position between forestry and agriculture. The complete modified soil classification, used in this study, is given in section XII.2.3. A method of soil classification more suited for distinguishing agricultural productivity classes on a broader scale, known as "association" mapping has been developed by Cowie and Fitzgerald (1963), (36). This method has been used by Cowie to classify the soils on the remainder of the sand country. Soil associations are classified on the basis of defined and named soil types, sub-types and phases

which are geographically associated in a regular pattern and in similar proportions. In essence the soils of the dunes are grouped with those of the accompanying sand plains. Differences between the soil members within associations are primarily due to drainage, relief and aspect. The associations in general form a drainage sequence consisting of low lying plains, high lying plains and dunes. This basic unit is repeated in an approximate fashion moving inland from the coast.

Cowie has classified nine soil associations on the sand country, one within the Younger Dune Complex and eight within the Older Dune Complex. In Table XII.1 the respective areas and drainage characteristics of each soil association are listed. Also a guide is given to the relative forestry and agricultural production on the different soil classes.

A brief description of the soil associations listed in Table XII.1 is now given.*

The Younger Dune Complex

The 28,000 acre Hokio-Waitarere association together with 16,000 acres of relatively raw unstabilized sand comprise a combination of immature soil types, forming a drainage sequence from dry unconsolidated dunes to peaty swamps and lagoons. The latter are formed as a result of the natural drainage towards the coast being impeded by sand dune formation. The above 44,000 acres comprise the Younger Dune Complex, although some small scattered areas of the Hokio-Waitarere association also occur in the Older Dune Complex.

Agricultural production on this area is low, and on it forestry is expected to show to greatest advantage when compared with farming. A detailed description of the current land use and stage of development of this area is given in Section 4.3.

* To save unnecessary description, all soil associations with comparable levels of production have been amalgamated. The basis for this amalgamation and the completely modified soil classification is given in section XII.2.3. For a detailed and comprehensive description of sand country soil associations, see Cowie and Fitzgerald (1963), (36).

TABLE XII.1

Soil Associations of the Manawatu-Rangitikei Sand Country

Soil Association	Area (acres)	Drainage	Agricultural Production	Forestry Production
<u>Younger Dune Complex</u>				
Hokio-Waitarere	28,000	Imperfect to freely draining	Low	Medium
Unstabilized Sand	16,000	"		
<u>Older Dune Complex</u>				
Himatangi-Foxton	30,000	Freely draining	Low	High
Foxton-Himatangi	2,500	" "	Low	High
Awahou-Foxton	6,000	" "	Medium	High
Foxton-Omanuka	5,000	Imperfect "	Low	Medium
Pukepuke-Foxton	32,500	" "	High	Low-Medium
Pukepuke-Omanuka	13,500	" "	Medium-High	Low-Medium
Carnarvon-Black Foxton	18,500	" "	High	Low-Medium
Carnarvon-Brown Foxton	12,000	" "	High	Low-Medium
Soils of the river flats and terraces	6,000	-	-	
Total area	170,000			

The Older Dune Complex

Himatangi-Foxton Association: This, covering an area of 32,500 acres, occurs on the less consolidated parts of the Older Dune Complex on which freely and excessively draining soils predominate.* The association has the lowest per acre agricultural production within the Older Dune Complex, and competition between forestry and agriculture is strong. A detailed description of the current land use of the area is given in section 4.3.

Foxton-Omanuka Association: This is in a relatively undeveloped state and is mainly confined to the area south of the Waitarere Beach. It covers an area of 5,000 acres on which excessively draining sand dunes are dominant while the remaining areas are occupied by peaty swamps. Farming is almost exclusively sheep farming. In the main, the level of agricultural production on this association is comparable to production on the Himatangi-Foxton association. For the purposes of this study these two soil associations are combined into one soil class.

Awahou-Foxton: This association is formed on the more consolidated parts of the Older Dune Complex on which freely draining soils predominate. It covers an area of 6,000 acres representing a similar drainage sequence to the Himatangi-Foxton association, but a more mature phase. The current land use is mainly sheep farming. Production is approximately one ewe equivalent per acre higher than on the Himatangi-Foxton association. An intensive study of this association has not been made in the present study.

* For the purposes of this study the Himatangi-Foxton and Foxton-Himatangi associations have been combined into one soil class. These two associations may be used to illustrate the naming of the soil associations. Foxton refers to the sand dune areas and Himatangi to the plain areas. The Himatangi-Foxton association is plain-dominant and the Foxton-Himatangi association is dune-dominant.

Other Associations: The Pukepuke-Foxton, Pukepuke-Omanuka, Carnarvon-Black Foxton and Carnarvon-Brown Foxton soil associations comprise a combined area of 77,000 acres. For the purposes of the present study the level of agricultural production on these soil associations has been considered sufficiently comparable for their amalgamation into a single soil class. The above soil associations are all similar in that they have a high proportion of imperfectly draining soils. The proportion of moist soil types ranges from 50 to 80 per cent of the total area. The current land use of these areas is predominantly dairying with production ranging from 130 to 300 pounds of butterfat per acre between farms. In a number of instances the low proportion of freely draining soil types on these farms, necessitates wintering of stock on a run-off property situated on dry sand country.

Present knowledge indicates that due to the high proportion of imperfectly draining soil types within these associations, it would probably be possible to establish productive Pinus radiata forests only on 30 to 60 per cent of the area. Large scale afforestation may be technically possible, by intensive drainage and the planting of tree species adapted to moist conditions, for example Eucalyptus spp. In the author's opinion, however, farm forestry and a limited number of small plantations is the only form of forestry likely to compete economically with agriculture on these soil associations.

A land use study of these soil associations would involve:

(a) The determination of whether any farm land could be profitably used for farm forestry.

(b) The proportion of farm land that could profitably be planted in farm forestry. The optimum proportion of the farm area devoted to farm forestry would vary widely between farms, as it is dependant upon the relative proportion of dry and moist soil types.

The balance of the soils comprising the 170,000 acres of sand country are those of the river flats and terraces.

XII.2.3 The Modified Soil Classification Used in this Study

The method of classifying soils into associations (section XII.2.2) overcomes to a considerable extent the problem of "interaction", and is certainly a more applicable basis for land use studies than the detailed classification. The soil association classification is used for the Younger Dune Complex where there is only one soil association.

An unmodified method of classifying soils into associations on the Older Dune Complex is not suitable for this study. Associations on the Older Dune Complex do not occur as large unbroken blocks, but are scattered and irregularly dispersed amongst one another. Consequently, the soils of an individual farm may vary from a single association to a combination of three or four associations.

The formulation of a modified soil classification requires a considerable quantity of data, because of the diversity of soil types, farming systems and levels of development and production on the sand country. For this reason production and soil data from a small sample of farms are inadequate. To overcome this problem the following data have been assembled for 145 properties sited on the Older Dune Complex.*

- (a) The type and size of farm.
- (b) The current level of production, and
- (c) The corresponding soil associations within the farm.

It is hoped that these data will allow the order of magnitude of the difference, if any, between the level of production and the corresponding soil associations to be determined.

The modified method of soil classification based on the above data and adopted on the Older Dune Complex in this study is:

- (a) The amalgamation of the Himatangi-Foxton, Foxton-Himatangi

* The major source of these data has been the Valuation Department in Palmerston North and Wanganui. See footnote ** p.35. The data was also necessary for the formulation of the sand country land use maps; See Figs. XIII.2, XIII.3, and XIII.4.

and Foxton-Omanuka soil associations into one soil class. This group of associations is referred to as the Himatangi-Foxton soil class.

(b) The amalgamation of the Pukepuke-Foxton, Pukepuke-Omanuka, Carnarvon-Black Foxton and Carnarvon-Brown Foxton soil associations into one soil class, called in this study the Pukepuke-Foxton soil class.

The 145 farms are classified into one of four categories; A, B, C, or D. This classification is based on the relative proportion of the Himatangi-Foxton soil class combined with the Pukepuke-Foxton soil class. The classification is given in Table XII.2.

TABLE XII.2

Farm Classification on Older Dune Complex

Farms	Relative Proportion of the	
	Himatangi-Foxton soil class	Pukepuke-Foxton soil class
A	75 per cent	25 per cent
B	50 " "	50 " "
C	25 " "	75 " "
D	0 " "	100 " "

In Table XII.3, the minimum, average and maximum farm production figures for 100 farms is shown.* The table illustrates the connection between level of production and farm type (as classified in Table XII.2). There is an upward trend in production progressing from farms with a high to a low proportion of the Himatangi-Foxton soil class. For example, per acre production is two to three times higher on type D farms than on type A farms.** On the other hand,

* The remaining 45 properties were used as run-offs.

** It should be noted that a proportion of this higher production should be attributed to the generally higher levels of development of farms on better soil types, and not all to soil type alone.

TABLE XII.3

Levels of Farm Production on the Older Dune Complex

Farming System	FARMS			
	A	B	C	D
Dairy Farming		<u>Pounds Butterfat per Acre</u>		
Minimum	55	65	75	100
Average	72	105	125	165
Maximum	95	135	180	270
Sheep Farming		<u>Ewe Equivalentents per Acre</u>		
Minimum	1	2	2.5	3.0
Average	1.6	2.6	3.5	4.7
Maximum	2.5	4.7	4.5	6.5

overall forestry production on type D farms would generally be lower than on type A farms, due to a higher proportion of moist flats unsuited to Pinus radiata forests on type D farms.

Table XII.4 shows the trends in farm size and land use. The table also shows the relative proportion of each type (A, B, C or D) which is devoted to sheep-beef farming, dairy farming or run-offs. Progressing from farms in type A to those in type D, the table indicates a decrease in farm size and an increase in the proportion of land used for dairying. Run-offs occur almost exclusively on type A.

The land classes selected for an economic comparison of forestry and agriculture are the Younger Dune Complex and the Himatangi-Foxton land class (farm type A).^{*} Competition between forestry and agriculture is the most marked on these two soil classes. A description of the land use of these two land classes is given in section 4.3. It is hoped that the results for these areas may be used as a guide for planning land use on the remaining sand country soils.

* Type A farms are in this study classified as the Himatangi-Foxton land class.

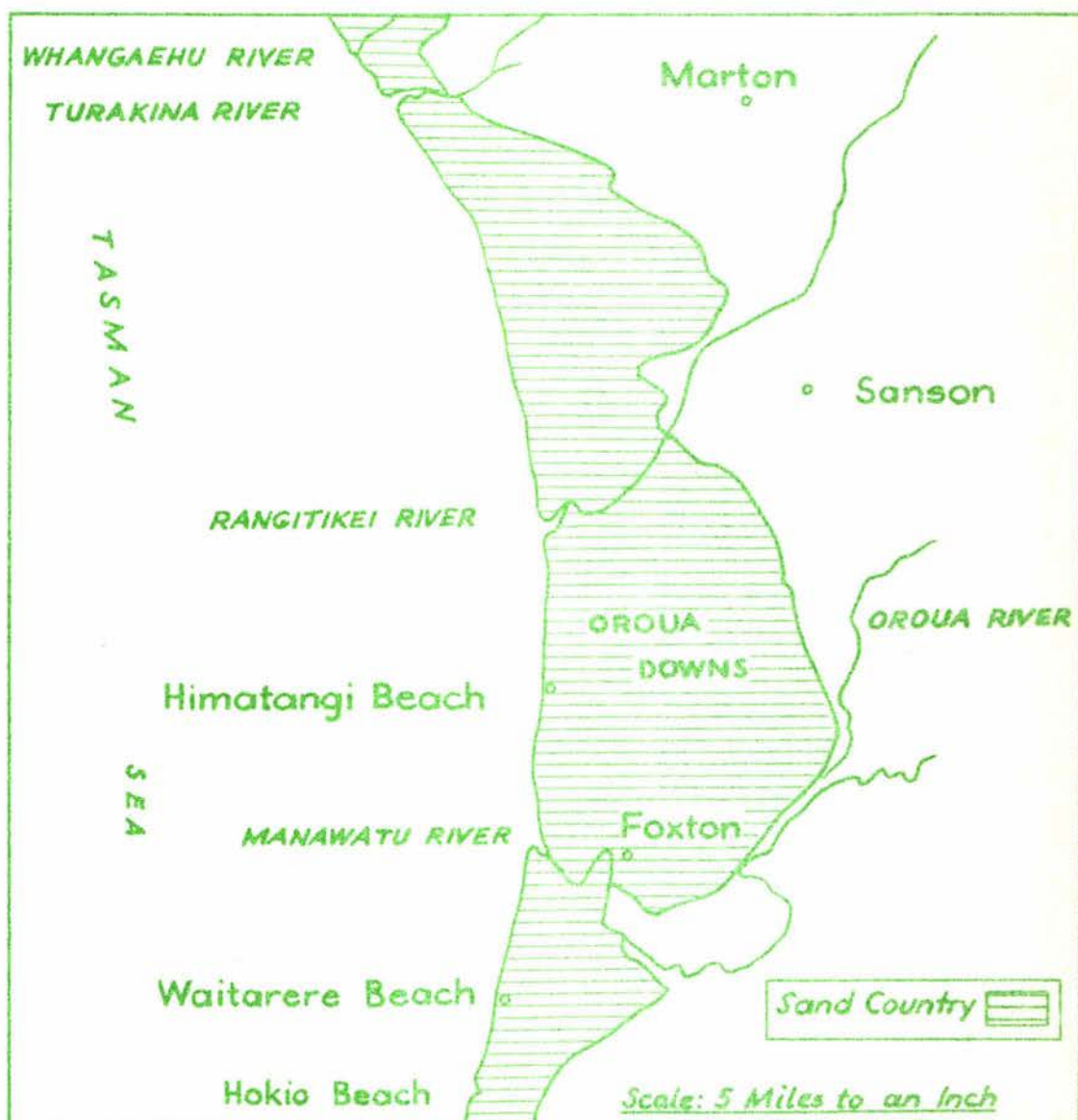
TABLE XII.4

Farm Size and Land Use Trends on the Older Dune Complex

Land Use	Land Type							
	Farm Size (acres)	A Proportion of the Total Area (per cent)	Farm Size (acres)	B Proportion of the Total Area (per cent)	Farm Size (acres)	C Proportion of the Total Area (per cent)	Farm Size (acres)	D Proportion of the Total Area (per cent)
<u>Sheep-beef farms</u>								
Minimum	459		197		202		188	
Average	1,600	50	1,150	75	600	60	390	40
Maximum	2,865		4,490		1,231		600	
<u>Dairy farms</u>								
Minimum	180		110		121		110	
Average	230	15	230	20	200	40	140	60
Maximum	405		522		270		240	
<u>Run-offs</u>								
Minimum	40							
Average	120	35		5	-	-	-	-
Maximum	400							

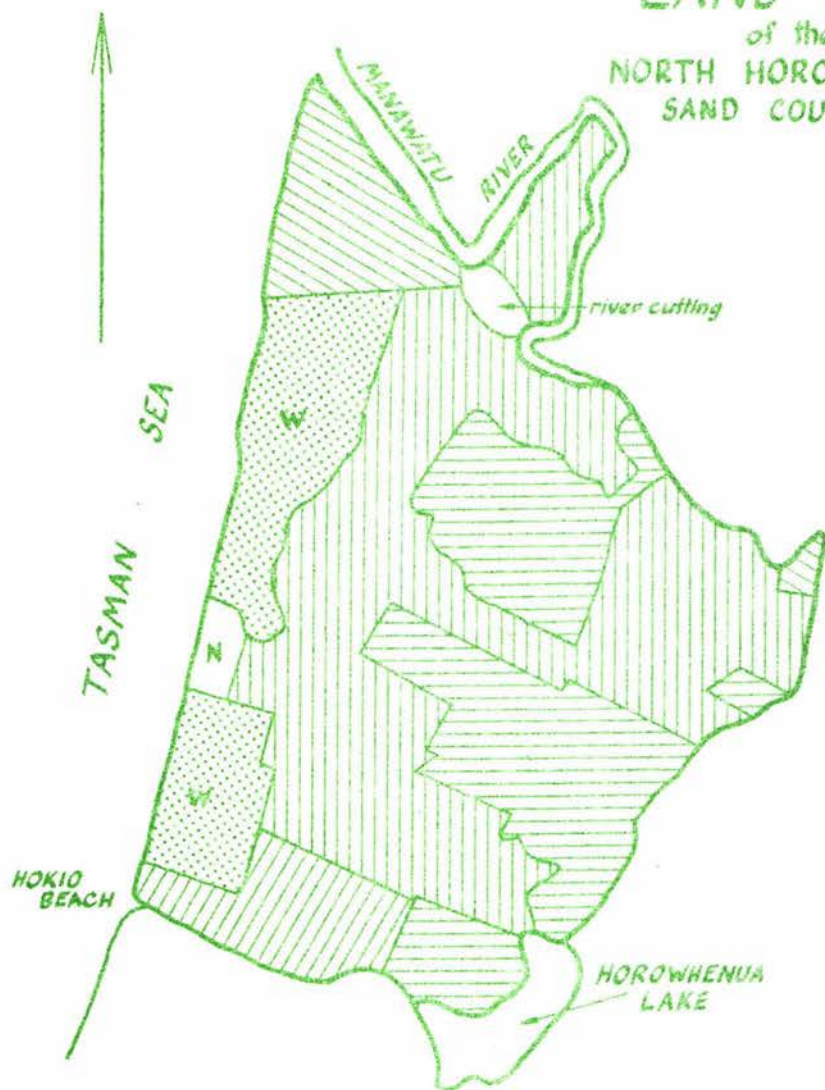
APPENDIX XIII

MAPS AND ILLUSTRATIONS



Locality Map of the Manawatu-Rangitikei Sand Country

LAND USE of the NORTH HOROWHENUA SAND COUNTRY



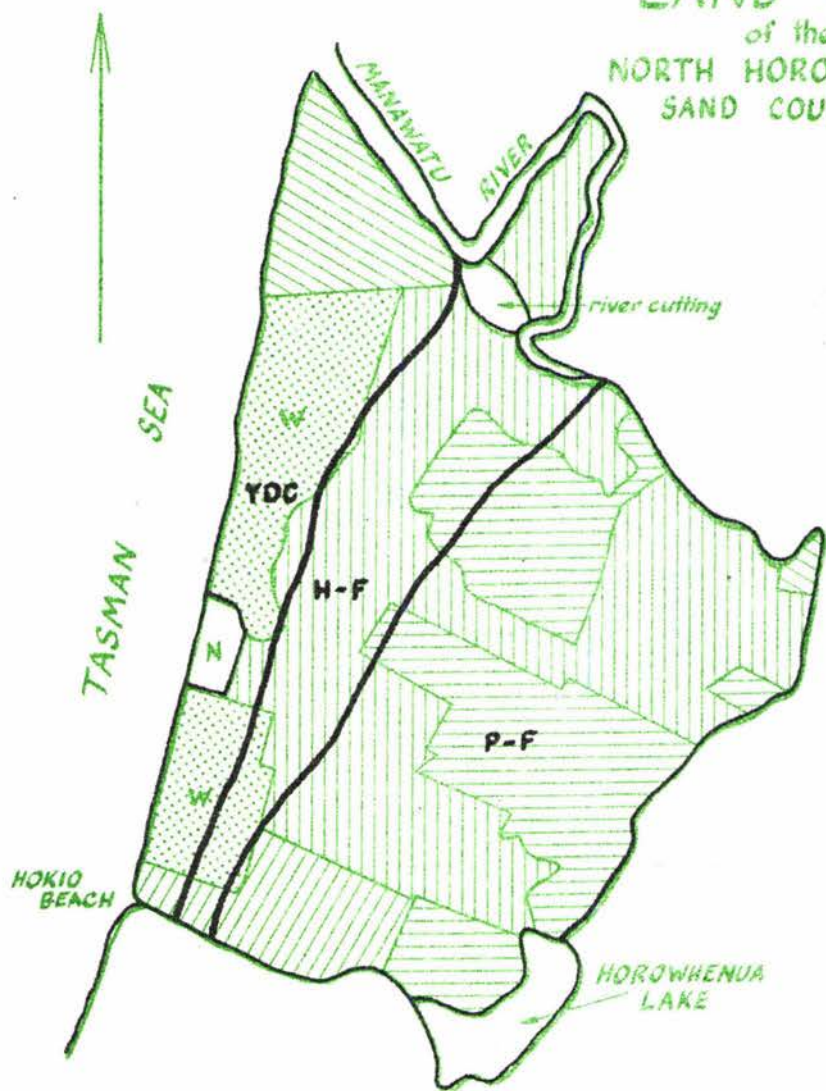
LEGEND

LAND USE	
SHEEP-BEEF FARMS	
DAIRY FARMS	
FORESTS	
GRAZING & RUN-OFFS	
UNUSED LAND	
NON-RURAL LAND	

Scale : 2 miles to an inch.

Fig XIII²

LAND USE of the NORTH HOROWHENUA SAND COUNTRY



LEGEND

LAND USE		SOIL	
SHEEP-BEEF FARMS		YOUNGER DUNE COMPLEX	YDC
DAIRY FARMS		HIMATANGI-FOXTON LAND CLASS	H-F
FORESTS		PUKEPUKE-FOXTON LAND CLASS	P-F
GRAZING & RUN-OFFS			
UNUSED LAND			
NON-RURAL LAND	N		

Scale : 2 miles to an inch.

Fig XIII²

LAND USE OF THE MANAWATU SAND COUNTRY

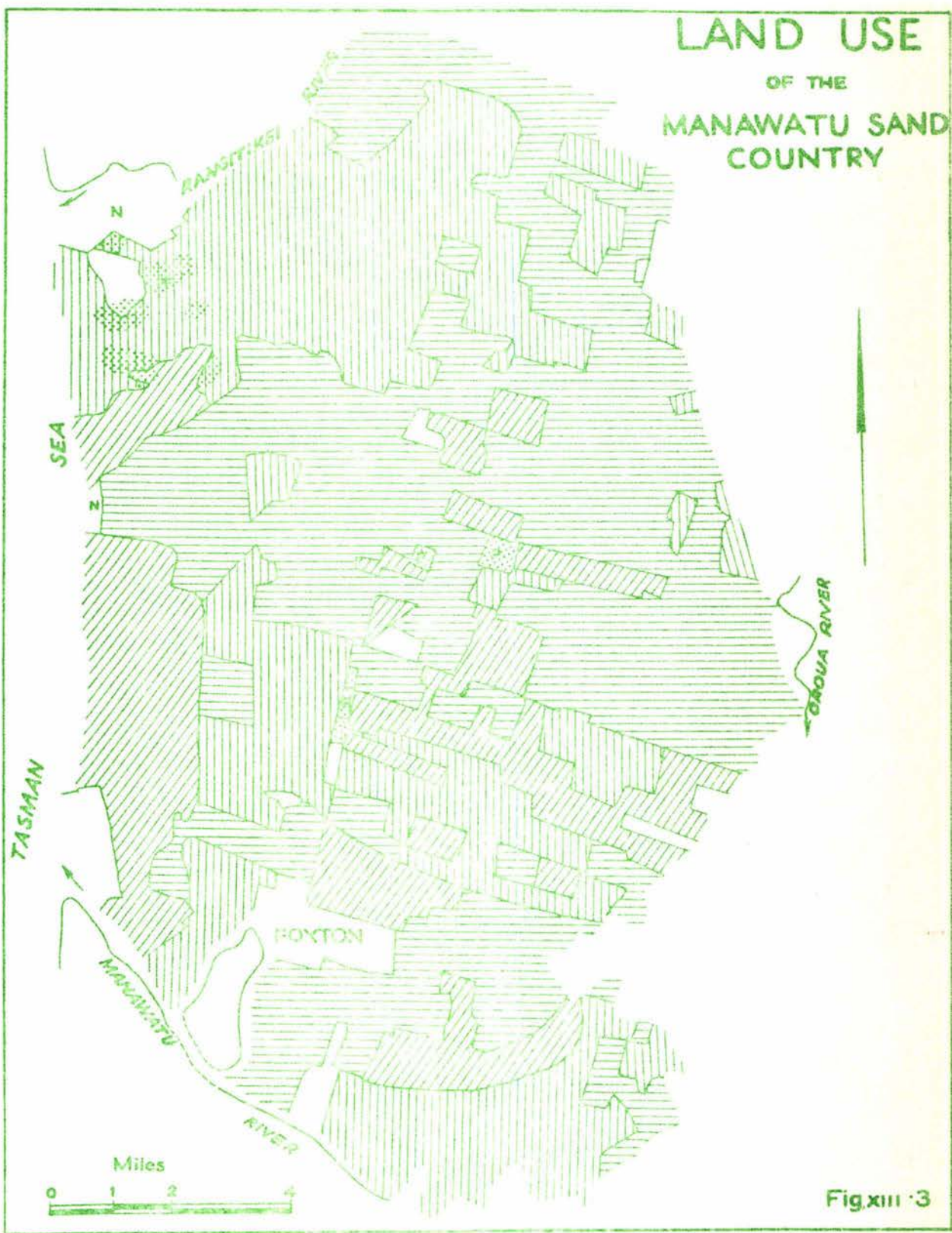
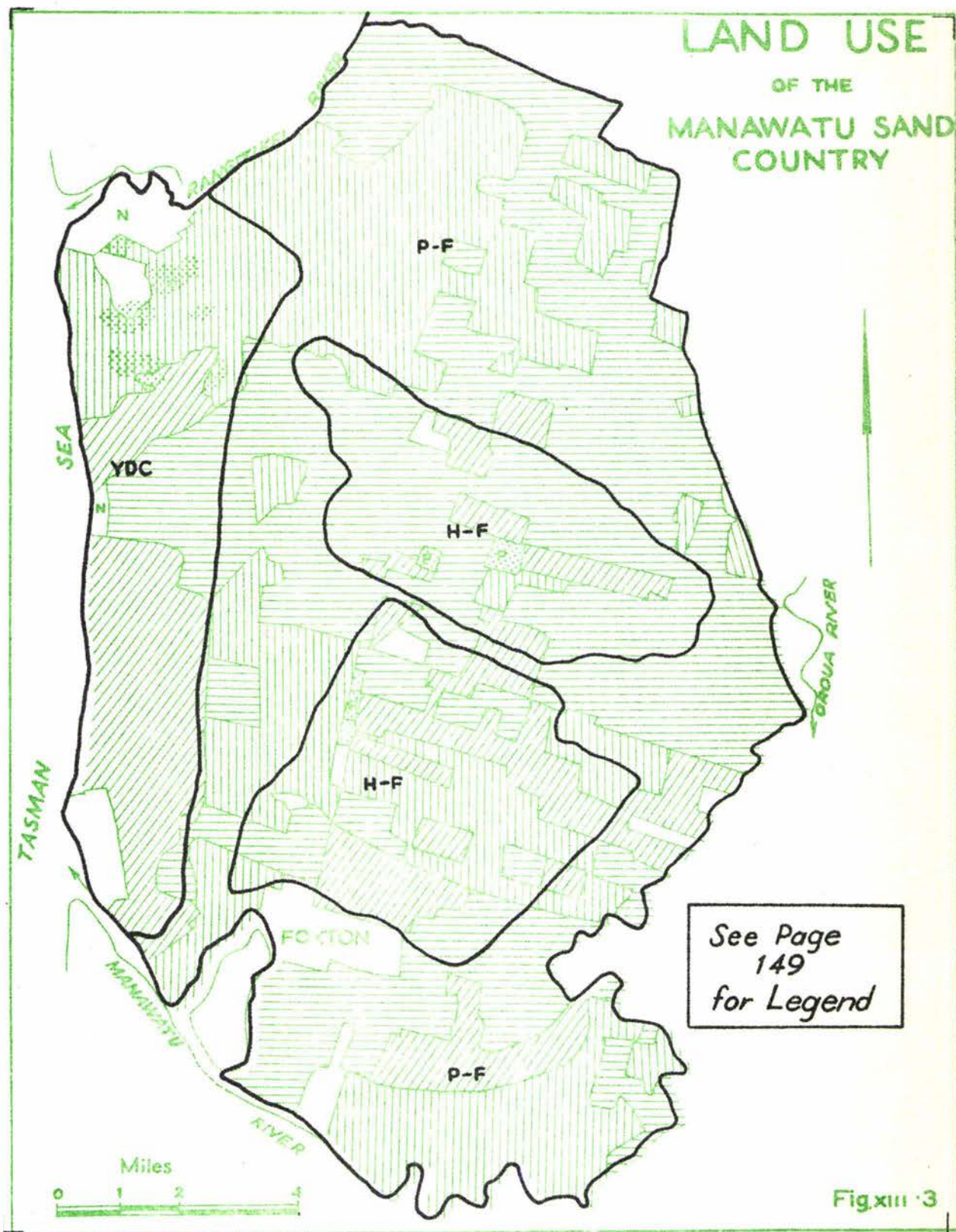


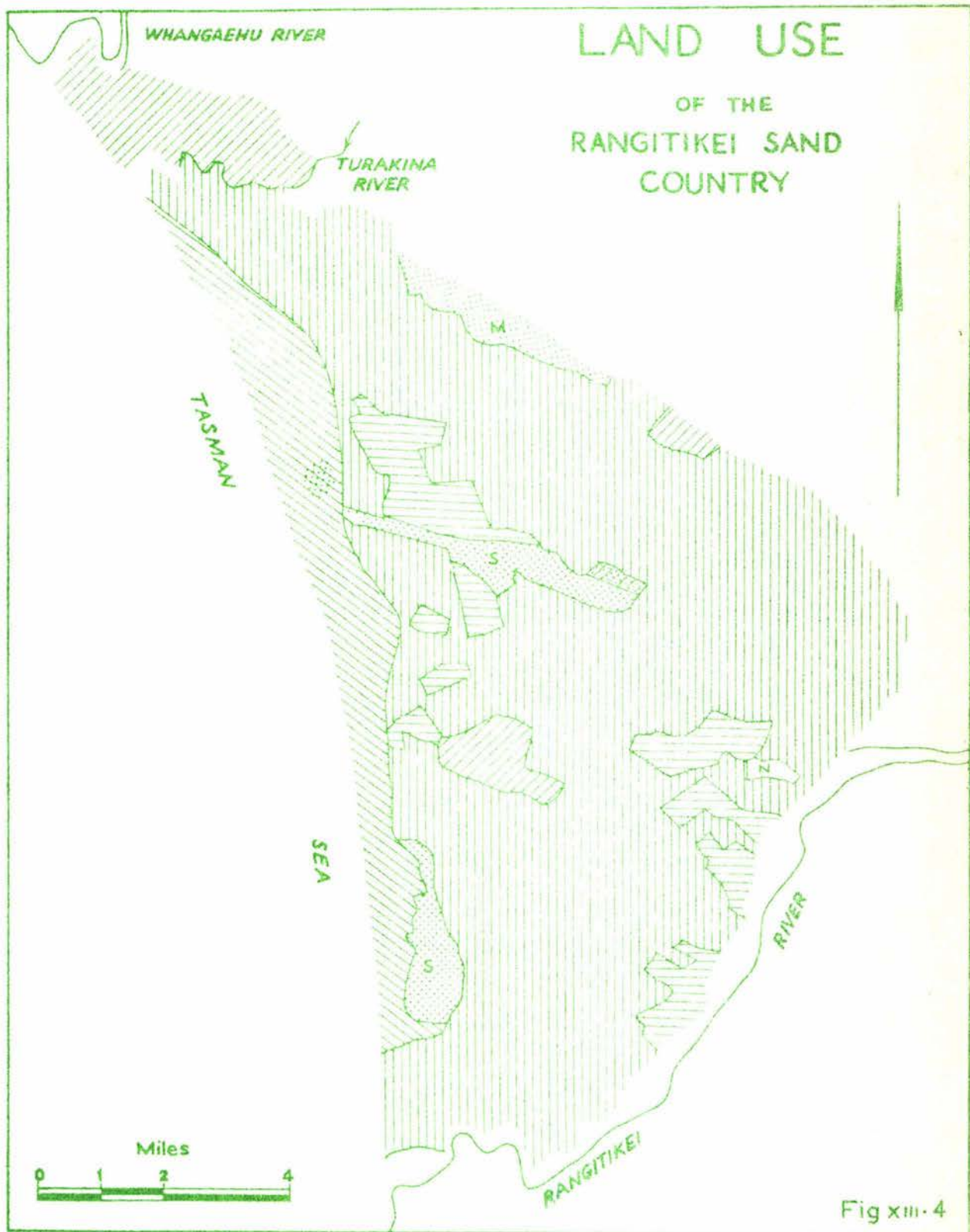
Fig. xiii 3

LAND USE OF THE MANAWATU SAND COUNTRY

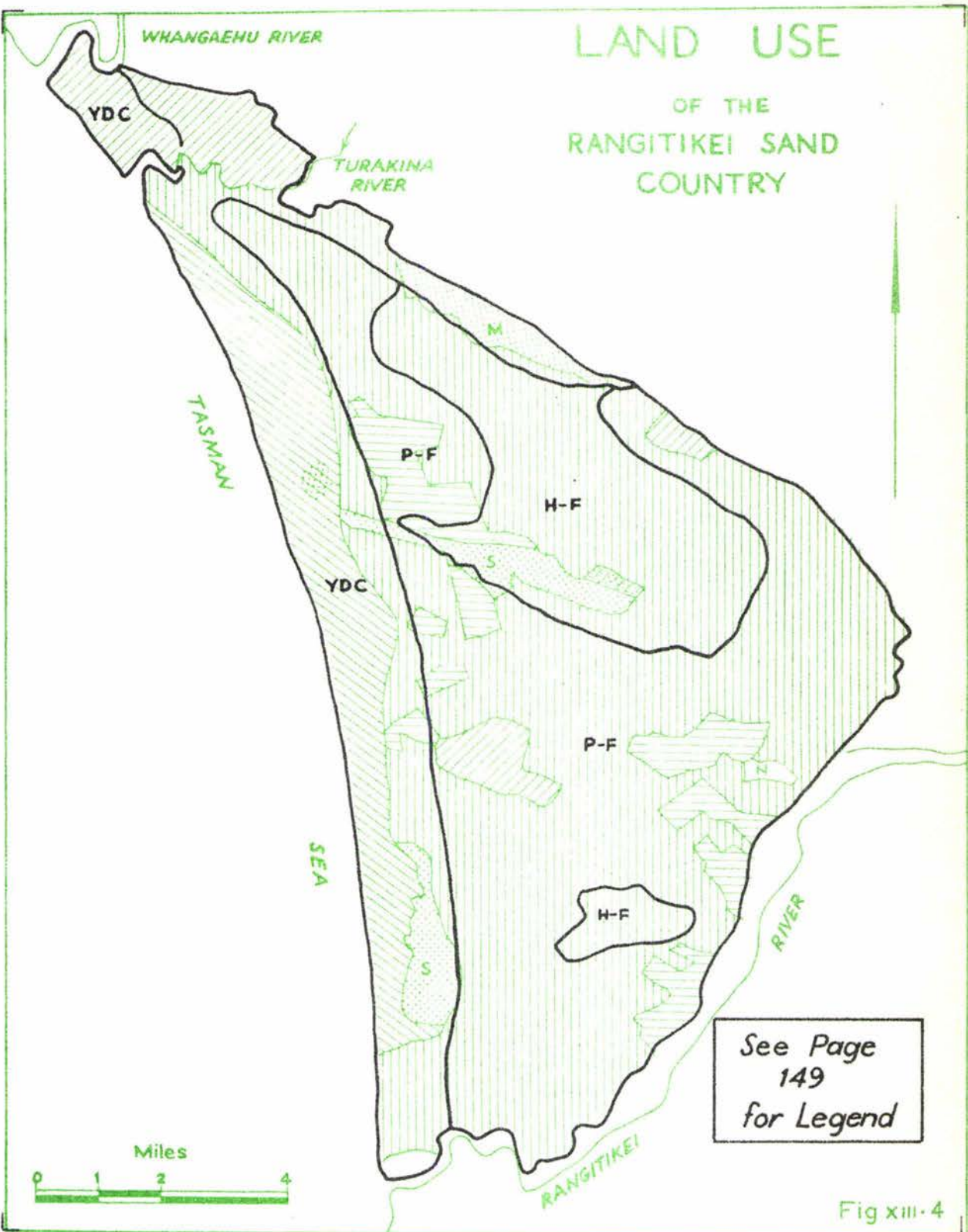


See Page
149
for Legend

Fig. XIII 3



LAND USE OF THE RANGITIKEI SAND COUNTRY



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Fig XIII-4



Fig. X111.5. The younger Dune Complex at an early stage of stabilization



Fig. X111.6. Typical partially developed phase of the Hokio-Waitarere Association (Younger Dune Complex)



Fig. X111.7. The Himatangi-Foxton land class



Fig. X111.8. The high producing
Pukepuke-Foxton soil association