AGRICULTURAL ECONOMICS
RESEARCH UNIT

Lincoln College
UNIVERSITY OF CANTERBURY
New Zealand

AN ECONOMIC ANALYSIS OF LARGE-SCALE LAND DEVELOPMENT FOR AGRICULTURE AND FORESTRY

by

J. T. WARD and E. D. PARKES

in association with

M. B. GRAINGER and R. T. FENTON

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PREFACE

THIS publication is the report of an economic analysis of large-scale land development for agriculture and forestry. It is based on a case study of the Maraetai block on the pumice country in the Taupo-Rotorua area. In addition to this, however, it is also the report of an exercise in co-operation between a number of organisations that have widely differing interests in land development. The Agricultural Economic Research Unit at Lincoln College is interested in the theoretical basis of assessing long term investment and in how analytical techniques may be applied in the field; the Department of Lands and Survey is concerned with developing land for settlement, while the responsibility for farmers after settlement rested until recently with the State Advances Corporation; the Forest Service is similarly concerned with developing land for exotic forests. Not infrequently, the land earmarked by the Forest Service for afforestation is also suitable for land settlement and a conflict of interest between the government departments occurs. The main aim of this study was to suggest a method of analysis for land development which was suitable for all departments and to seek their co-operation in applying it to case studies. It is hoped that we have gone some way to achieving the former, at least as far as 'engineering studies' go, while there has also been some success with the latter objective. Several departments have co-operated—to a greater or lesser extent—with the study.

The study was planned and directed by Dr J. T. Ward who devised the method of analysis and wrote the report. The agricultural projection which is analysed in Chapters 5 to 8 is largely the responsibility of Mr E. D. Parkes: in preparing the projection for primary development he was greatly assisted by Mr G. Palmer, formerly of the Rotorua office of the Department of Lands and Survey, while Mr D. M. Glenday and Mr J. C. Hepburn of the Hamilton office of the State Advances Corporation provided advice and information on farming the block after settlement. The forestry projection was carried out by Mr R. T. Fenton and Mr M. B. Grainger of the Forest Service.

B. P. PHILPOTT

Lincoln College
November 1965

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(NZ.F.S. photographs by T. Ransfield)

FOREWORD

THE fact that the agricultural and forestry projections included in this study, although within the same framework of analysis, were conducted by two different groups of people raised problems of presentation. The forestry projection involved a very detailed analysis which lent itself to the accumulation of technical appendices and did not merge well with the analysis of agricultural development based largely on the historical development that had taken place on the Maraetai block. A detailed account of the forestry projection is being published simultaneously with this report as a working paper from the Forest Research Institute (Silvicultural Branch Report, No. 31, 1965) and the advisability of publishing a separate account of the agricultural study was considered. This was, however, rejected as it would obviously weaken the comparative nature of the study and so defeat one of its major objectives. It was decided instead to include in this final report the full account of the agricultural projection together with a shortened version of the forestry projection giving a broad outline of the regime to be adopted and of its economic analysis. As a result the report may appear unbalanced in the much fuller treatment given to the agricultural aspect of the study. It may, however, be regarded as covering two aspects: firstly, an analytical account of large-scale land development of a block of pumice country for agricultural settlement and, secondly, a comparison of the results of this development with those for similar development for forestry.

The method of analysis employed is the same for both studies and it is hoped that the forward budgeting approach involving a cash flow analysis will be more widely used in project development. It is not only valuable for comparative studies but could obviously be employed for analysing either form of development in isolation. It is felt that the agricultural study by itself may be of interest in the context of the Agricultural Development Conference, in indicating the scale of inputs and outputs required for this form of agricultural expansion and in assessing its profitability. It could also serve as a basis for policy recommendations in considering the relative merits, from the national point of view, of bringing in further large blocks of land for settlement in comparison with the more intensive development of land which has been settled for some time.

J.T.W.

Chapter 1

THE ECONOMIC BACKGROUND TO LARGE-SCALE LAND DEVELOPMENT FOR AGRICULTURE AND FORESTRY

IN the last few years there has been a growing awareness in New Zealand that the rate of economic growth in this country during the post-war period has been far from satisfactory. A number of papers have drawn attention to our poor performance in comparison with other Western countries and these, together with the discussions they have generated, have been influential in promoting economic growth as a major economic objective.[1] Concurrently with this change in the climate of opinion there has been a cautious recognition that a system of indicative planning such as has been adopted successfully in many other countries may be necessary if a reasonable growth target is to be achieved, but New Zealand is still a long way from establishing the economic apparatus necessary for indicative planning. A tentative exercise of this nature, although restricted to a single sector of the economy, is being carried out by the Agricultural Development Conference. Export and production targets have been set for 1973 and specialised committees are now studying ways and means of achieving them.[2]

The key to New Zealand's future growth lies in her dependence upon overseas markets for earning foreign currency without which it will be impossible to support the level of imports essential for secondary industries. The Conference has predicted that in order to achieve a modest two per cent growth in real income per head per annum it will be necessary to expand total exports from the £300 million achieved in 1962/3 to £467 million in 1972/3, an increase of fifty-five per cent. It is estimated that only £24 million of this can be looked for outside the pastoral and dairy industries so that our traditional exports of wool, meat and dairy products will have to increase from £286 million to £422 million. These figures emphasise that New Zealand's prosperity must continue to remain predominantly dependent upon her farming industry; if this country is to maintain a high standard of living it is essential to develop those lines of production in which we have a comparative advantage in relation to other countries.

It has long been recognised that we have such an advantage in the pastoral and dairy industries due to a favourable grassland climate

[1]C. A. Blyth, 'Economic Growth 1950-1960', Research Paper No. 1, N.Z. Institute of Economic Research, 1961; Monetary and Economic Council, 'Economic Growth in New Zealand', Report No. 2, 1962; F. W. Holmes, 'Planning for Growth in a Freer Economy', Third Sir Sydney Holland Memorial Lecture, Wellington, 1962.

[2]Report of the Targets Committee of the Agricultural Development Conference, Wellington, 1964.

and to our traditional pattern of land settlement. Historically, land development has been fundamental to New Zealand's economy and at the present time further large-scale development is in hand or proposed. Since the Second World War much of the extensive land development has been carried out by the Department of Lands and Survey for settlement under the Returned Servicemen's Rehabilitation Scheme. In the early post-war years the majority of settlement farms came from Crown land already under development before the war or from grassed properties purchased for settlement, but after 1952 the emphasis changed and settlement was based increasingly on land developed from unimproved tussock, native grasses or scrub. This land had to be cleared and sown to English grasses and clover before subdivision and the later stages of development could follow. Over the past ten years the Department has brought into settlement between 40,000 and 50,000 acres a year, mostly in the North Island and especially in the districts of Rotorua, Auckland, Te Kuiti and Hawkes Bay. The only development of any significant size in the South Island has been in Southland. The Department has almost one million acres of unimproved or reverted land under various stages of development at the present time, while it has estimated that a further million acres could be developed immediately if facilities were available and that an additional one and three-quarter million acres, while of lower priority, could be developed in the future.[3]

It is only in recent years that it has been generally recognised that New Zealand has a comparative advantage over many other countries in forestry production as well as grassland products, as our climate is also suited to tree growth. This is particularly true of the species, *Pinus radiata,* which is not regarded as a merchantable tree in its native California but exhibits a remarkable rate of growth in New Zealand and is well suited for pulping and also, when properly managed, for timber production. A major problem which has still to be resolved, however, is whether this country can sell exotic forest products in the world markets on any large scale. The answer will depend upon the degree of competition from other countries whose production is still based on the exploitation of indigenous forests, and upon our comparative efficiency in processing the raw material into sawn timber, pulp and other products. There is little doubt that the markets will be there, if we can win them. Demand for forest products—timber, plywood, hardboard, pulp, newsprint and paper of various kind—is high and continues to rise rapidly. F.A.O. reports suggest that world consumption is increasing at around six per cent per annum and that the level of consumption and the rate of increase are both highest in the more developed countries, indicating a high income elasticity of demand for these products.

It has been estimated that total production from the exotic forests for the year ending 31 March 1965 was approximately £65 million valued at the mill. Of this total, domestic consumption accounted for £53 million and exports almost £12 million. Imports of all forestry products during the same year amounted to £9 million c.i.f. Given a continuing

[3]See Annual Reports of Director-General of Department of Lands and Survey.

development of the pulp and paper industry and more systematic management of exotic forests for higher quality saw logs, New Zealand should be capable of supplying almost all its own requirements for forest products and also expanding its export trade in the future. The New Zealand Forest Service has forecast that New Zealand could supply ninety per cent of its needs for pulp products and virtually all of its sawn wood by the year 2000, and that the timber industry could earn an additional £60 million in overseas funds (measured at today's prices).[4] On the basis of these projections it has been calculated that there is a need for an additional one million acres under exotic forests by the year 2000 with a further million acres by 2050. These figures have been adopted as the basis of the planting programme of the Forest Service.

This programme expresses the hope that as much as fifty per cent of the proposed expansion scheme should come from planting by private enterprise on forestry company holdings and on individual farms. A farm-forestry scheme was introduced in 1962 but it met with a very limited response and early in 1965 the Government announced sweeping changes to make the scheme more attractive to farmers. Without special inducements, trees remain unattractive as a major crop to the individual farmer and their planting tends to be directed more to the need for soil conservation, shelter belts and farm wood supplies than for commercial woodlots. It is not possible at this stage to assess the impetus which farm forestry may receive from the liberalised incentive scheme but farm woodlots should become much more important in the future as a source of logs for the local timber industry—particularly in districts where it is impracticable to establish State Forests.

An expansion of forestry on this scale necessarily involves competition with agriculture for land and the problem is frequently seen primarily in terms of securing optimal land use. This competition comes to a head when the Department of Lands and Survey and the Forest Service both wish to develop the same block of land. The present procedure for resolving such conflicts is through the convening of ad hoc land utilisation committees, which are composed of members of the Lands and Survey Department, Forest Service and Department of Agriculture, and which submit their recommendations to the Land Settlement Board. It appears that these committees do not make a detailed economic analysis of specific cases but base their recommendations primarily upon physical considerations, including soil types and stock carrying capacity, with some reference to the valuation of the land. It is suggested that in order to provide a more rational basis for policy decisions of this nature, two things are required; firstly an objective and systematic way of evaluating the comparative value of using land for one productive use rather than another, and, secondly, a broad policy framework of economic development within which specific investment decisions for agriculture and forestry can be reviewed.

The first problem, which is the one which we are concerned with in

[4]N.Z. Forest Service: Report to F.A.O. Asia and Pacific Forestry Commission, 1960.

this study, may be regarded as a problem in evaluating individual investment projects. Though it is frequently discussed in terms of 'optimum land use', especially by those trained in agriculture and related subjects, this is an oversimplification of the problem that can be misleading. Land cannot be used on its own; the very phrase 'land use' implies that labour, capital and management have to be applied to it. Now these also are scarce resources whose use has to be economized; indeed in New Zealand they are relatively more scarce than land. Any comparison between the two forms of development must therefore take into account their relative demands upon all resources which have to be withheld from alternative forms of production. The real cost to the nation of using land to produce wool and meat or timber is the loss of potential output of other products.[5] A land use decision therefore has implications for sections of the economy other than agriculture and forestry.

A second aspect which has to be taken specifically into account is the incidence of time. The calculations of the net output of agriculture or forestry is relatively straightforward when each enterprise is operated as a going concern. In the case of fully developed farms, or forests operated on a sustained yield basis, the value of net output may be calculated directly by deducting annual costs from annual returns; discontinuous capital inputs may be expressed in annual terms in the form of depreciation charges. The position is far more complex in the case of developing bare land, however, because the costs and returns involved have widely different time profiles. Forestry is outstanding in the length of its period of production, even the fast-growing radiata pine taking thirty-five to forty years before it can be felled for timber, while land development for agriculture may require up to twenty or even thirty years before the farms are fully established. It is not possible to make a direct comparison of costs and incomes incurred at different times; the significance of time, and the solution of some of the problems it raises by the use of compound interest techniques, is discussed in the next chapter.

Secondly, land use decisions in particular areas should not be taken in isolation. In order to secure the optimum use of all our scarce resources these decisions must be integrated into a national development programme; only in this way will it be possible to prevent a series of piecemeal decisions which may not only be isolated but may actually be incompatible. It is not the purpose of the present study to go into these broader questions; some of the problems involved have been discussed in an earlier paper,[6] while it is suggested that others should be explored in complementary studies related both to agriculture and forestry. However, a brief reference to some of them may help to encourage later discussions while also serving to define the limits of the present study.

In policy decisions on the location of forests in competition with

[5]It may be noted that during a period of unemployment some supplies of labour and capital have no alternative use and hence no real cost. This was the case during the depression of the inter-war years when large areas of exotic forest were established in New Zealand at little real cost to the nation.

[6]J. T. Ward, 'The Systematic Evaluation of Development Projects', Proceedings of the 1964 Conference of the New Zealand Association of Economists, Wellington.

agriculture it is not sufficient to consider the relative net productivity of resources in these two uses in any one particular area. A general planning approach should be conducted on the basis of comparative advantage within the country. Detailed analysis might show that agriculture had an economic advantage over forestry in one particular area, but it might have an even greater advantage in another. If there were only the two areas to be considered the principle of comparative advantage would favour developing the second area for agriculture and the first for forestry, assuming it is agreed both of these industries must be expanded. Where there are more than two areas to be considered, as is obviously the case in practice, the ideal solution to which area should go to each of the competing uses should still be determined on the basis of comparative advantage and could be resolved in practice by the application of planning techniques.

In considering this problem of location, a major factor which has to be taken into account is the comparatively greater incidence of transport costs incurred by forestry, so that distance of plantations from a processing centre and from a port becomes a critical factor in siting. A knowledge of forestry transport costs makes it possible to define the radius from such centres within which it will be profitable to establish plantations. This factor is less critical for farm products due to their higher value in relation to physical weight. A generalised conclusion that may be drawn from this is that it may be the reverse of economic wisdom to relegate forestry to the more inaccessible distant lands that are thought to be unsuitable for farming.

Other facts which have to be considered in locating forests are the distinction between local supply forests to serve the urban centres and the so-called industrial forests established primarily for exporting timber or other forest products. Clearly siting again is a critical factor; the former should be located near the cities while the latter must have good access to the ports. Once again the need to integrate forestry planting policy with planning the development of ports, cities and transport facilities is evident.

A further broad economic issue which needs detailed research is the secondary and tertiary effects of large-scale development for agriculture or forestry but in order to undertake an empirical analysis on these lines it would be necessary to carry the study beyond the stage covered in the present report. In this study the basis of evaluating returns has been values at the 'farm gate' for farming and on 'forest ride' for forestry and the costs and benefits of processing the products have not been investigated.

With regard to forestry products the 'forest ride' valuation is subject to a double criticism. In the first place, the value added by processing is far greater for forest products than for farm products, because in general a greater amount of processing is necessary before the forest product is in its final form. (The major exception amongst the agricultural products is wool which similarly requires a large amount of processing although much New Zealand wool is sold 'greasy'.) Secondly, the price used for forestry products has been based on the internal price in New Zealand as the great majority of our forest products are consumed internally. In the case of farm products, a large proportion of our total production is exported and we felt quite confident in valuing output at export prices, which are primarily determined on the London market. Internal timber prices on the other hand have been subject to price control for nearly thirty years and it is a common complaint amongst those engaged in the forest industry that stumpage values are far too low in relation to real costs of production. The question of the effects of price control upon the total production and consumption of forest products and upon the structure of output and use is a further topic which warrants a major economic study.

A comprehensive development programme for agriculture and for forestry requires a great deal of further research and the setting up of a macroeconomic planning apparatus which is far beyond anything New Zealand has established at the moment. Even if such a programme and machinery were established they would have to be complemented by 'economic engineering' studies designed to evaluate the results of using resources for particular purposes in particular areas. It is the purpose of the present report to outline the basis on which a study of the latter type could be made and to apply it to a specific case study.

Chapter 2

THE ANALYSIS OF LARGE-SCALE DEVELOPMENT

THE selection of any development project means that the economy is committed to investing scarce resources—labour, land and materials—for the purpose of building up a productive asset over a period of time. The purpose of the investment is to increase the future flow of goods or services while the real cost to the community of building up the asset is the loss of output of other goods and services which *could* have been produced if the resources had been used in alternative lines of production.

In order to maximise social welfare it is necessary for any specific project to fulfil two conditions:

(1) the increase in production in the future must be sufficient to compensate the community for forgoing a higher level of consumption at the present time in the form of goods which could have been produced with the same resources;

(2) the increase in production in the future must be at least as great as could have been achieved from the use of the same resources in any other investment project not actually undertaken.

The basic problem in making a rational choice between investment projects is therefore seen to be one of comparing flows of benefits and costs differing in composition and time profile. Uncertainty of the future makes the prediction of these future flows difficult and it would be foolish to pretend that precise or accurate forecasts can be made, especially where the asset under consideration is one with a long productive life, as is the case with land development. It would, however, be even more foolish to assume that because the outcome of any particular development proposal cannot be forecast with certainty there is no point in making forecasts. The future may prove a particular projection wrong but investment decisions as a whole are surely more likely to be right if they are analysed systematically than if no attempt at all is made to predict the outcome of alternative investments.

The major problem in a projection analysis is that the results of the development are unlikely to be exactly as planned. The pace of development, the physical results and the relationship between product prices and costs are all unknown, subject to the uncertainty imposed by climatic, economic and human factors. Experience with development budgeting suggests that the main danger lies in making predictions which are too optimistic, particularly with regard to the speed of development; on the other hand, new scientific and technological advances may bring about revolutionary changes in production in the future so that results turn out better than predicted. The impact of cobaltised superphosphate on the pumice lands of the central North Island and of DDT in controlling grassgrub on the light land of the Canterbury Plains illustrate this point.

It may be suggested that since the future is obscure while the past is known, comparison between projects should be based on an analysis of those already completed. An historical study can lay claim to being more scientific than future estimates. Evidence of the past records the physical and economic effects that have occurred when a development programme has been put into operation. Unexpected crop failures, unaccountable losses of stock, the vagaries of the weather and the market and the frailty of management are all embodied in historical records. Or rather they should be. Survey work for the present study and for similar investigations brings home to the research worker the paucity of both financial and physical records and an uneasy suspicion that historical facts are sometimes almost as much a matter for conjecture as future estimates.

A number of particular difficulties arise when the purpose of historical analysis is to evaluate a development programme. First, there are accounting problems. It is extremely difficult to extract from the usual set of farm profit-and-loss accounts, even when supplemented with balance sheets, the physical details of development expenditure. This is particularly true of items such as fertiliser usage and fencing which are major elements in land development.

A second difficulty in analysing historical records is that the financial ones, which are the primary source of information, are subject to the problem that the unit of account changes with depreciation in the value of money. Expenditure of £1,000 on fencing ten years ago is not comparable with an expenditure of the same amount today. In order to measure the true profitability of development it is therefore necessary to express costs and returns in constant real terms. One method of doing this is to deflate the time series by applying appropriate indices for costs and products, but this in turn raises further difficulties because changes in costs and product prices are seldom uniform between different types of farming, so that several indices will be required and their suitability and reliability varies with source and construction. An alternative approach, which in theory is more satisfactory, is to record historical changes in physical inputs and outputs and then value these at constant prices. Here, however, we come up against the fact that physical records tend to be even more incomplete and unreliable than financial ones. It seems probable that the only really satisfactory way of securing physical data of this kind is to record a development programme fully while it is in operation rather than rely upon searching through miscellaneous records after it has been completed.

Historical studies, in themselves, must always remain academic because the investment decisions with which they are directly concerned were made in the past and no matter what the results of analysis now those initial decisions can not be altered. As a basis for reaching decisions on comparable projects they are subject to the difficulty that few projects, particularly those concerned with developing natural resources, are free from some unique characteristic, while many of them will have no historical counterpart at all.

We arrive, therefore, at the conclusion that since any decisions taken now can only affect future events rather than past ones it is desirable to base our analysis on projections for specific projects rather than historical case studies. The projections must, however, incorporate estimates of physical input/output relationships and of trends in technology and in market forces which will themselves be based upon a knowledge of recent events; indeed, we have no other basis for judging future prospects.

It is suggested that a projection analysis of this type should take the following outline:

(1) The construction of a technical development programme, setting out the estimated input of real resources and the probable physical output of the project.

(2) The transformation of this technical programme into a monetary development budget over time, by the application of costs and product prices.

(3) The evaluation of the monetary budget in terms of an acceptable economic criterion.

THE TECHNICAL DEVELOPMENT PROGRAMME

Construction of the technical development programme will require a detailed knowledge of the assset which may have been acquired at first hand by the person making the study, or alternatively may be sought through the co-operation of others experienced in this field. It is here that there is the greatest scope for co-operation between the economist and the technical expert—agriculturalist, forester, engineer, etc.—because this phase of the work must form the basis of an 'engineering' study of this type. Unfortunately, it has been badly neglected in the past, both by the economist who has generally remained too aloof from practical problems, and by the technical man who has failed to see the need for an economic evaluation of his proposals.

The technical programme should be drawn up in terms of detailed requirements for developing and operating the asset and estimates of its future output. A comprehensive knowledge of input/output coefficients is required but experience in studies of land development and related fields has shown that some of these (for example, responses of pastures to varying dressings of fertilisers in some areas) are frequently not known. In such cases the requirements for an economic study can frequently promote a technical one; indeed the two should, wherever possible, go hand in hand. It is an unfortunate, though popular, fallacy to assume that economics should be concerned largely with measuring the costs and returns of a particular process after it has already been established.

THE CHOICE OF INPUT AND OUTPUT PRICES

The uncertainty of the future raises the question of what monetary values should be placed upon anticipated future returns and costs. Three possible procedures may be considered:

1. Present values, or an average of recent historical values, may be projected into the future.

2. The values used in the study may be based upon forecasts of future values. Where these are based on econometric research the studies will require, amongst other things, analyses of recent price trends, of income and price elasticities and of the rate of technical change in specific industries.

3. Instead of working with single valued expectations a series of analyses can be made using a range of values. This procedure throws light on the stability of the result and its sensitivity to changes in critical variables but at the expense of giving a wide range of results which may inhibit a final decision.

Both the first and third approaches have been used in the present report.

THE ECONOMIC CRITERION

The conventional method of evaluation used in accountancy procedure has been to make an assessment of a project by expressing its annual net return, i.e. the gross value of annual output minus operating costs, as a percentage return on the initial capital investment. For example, if a piece of equipment cost £1,000 to install and yields a gross revenue of £200 with operating costs of £100 then the net yield (before allowing for capital replacement) is said to be £200 − 100/£1,000 = 10%. Though this method is superficially attractive and is widely used in commerce, its validity rests upon three assumptions which are seldom justified in practice. They are as follows:

1. That the capital cost of the asset is incurred at one moment of time. This may be appropriate in the case of a firm purchasing a piece of equipment on a given date but it is not correct for an asset whose construction may take years; it is particularly unsuitable for land development for agriculture or forestry.

2. That the annual net return is uniform. If the net return from the machine costing £1,000 is £100 in one year, £200 in another and only £50 in a third it is not possible to determine any relevant rate of return. Here again, agriculture and forestry are industries where annual net returns vary widely because of fluctuations in physical yield and product prices.

3. That the income stream continues in perpetuity. This assumption may be realistic in the case of agriculture and forestry in that given appropriate management both can be conducted on a sustained yield basis. In the case of short-lived assets the wasting of the capital involved invalidates the usual rate of return concept, although it is possible to allow for this by introducing suitable depreciation allowances.

Land development for agriculture and forestry takes a considerable time. Forestry is outstanding in the length of its period of production; some native timber trees in New Zealand take several centuries to reach maturity while even the fast-growing *Pinus radiata* requires thirty-five to forty years for the production of saw timber. Most of the costs of establishing a rotation forest are incurred early in the rotation while the major yield is only secured at the end so that the establishment of commercial forests involves locking up large amounts of scarce resources of capital, land and labour in a productive process which will not reach fruition for several decades. While the long period of production in forestry is well understood it is not so widely recognised that land development for agriculture also takes a long time. It is true that some output will be achieved within a few years of clearing native scrub but on at least some types of country farms are unlikely to achieve their full potential in less than fifteen to twenty years.

It is not possible to make a direct comparison of the costs incurred in one year with returns received twenty or forty years later. A return of £100 in forty years' time is not worth as much as £100 here and now. Similarly an investment of £100 today which secured a return of £110 in a year's time could be regarded as a sound business venture whereas an investment of £100 today to secure £110 in forty years' time would not; the first investment yields ten per cent whereas the second yields only one-quarter per cent. The use of compound interest techniques does in fact provide the means to bridge the time gap between costs and returns. With their aid we are able to compound present costs or discount future returns so that they are placed on a comparable basis. The basic relationship between a single value at the present time and its future value may be expressed by the formula:

$$S = P(1+i)^n$$

where

S = future value of the investment
P = present value of the investment
i = market rate of interest
n = number of years over which the investment is contemplated

An alternative way of comparing a future return with a present cost is by *discounting* the former to its present worth. In this case we have to calculate what is the present sum which would accumulate to the given future value at a certain rate of interest. By simple rearrangement of the first equation we have:

$$P = \frac{S}{(1+i)^n}$$

and we say that P is the discounted value of S, while $\frac{1}{(1+i)^n}$ is defined as the present worth factor. Applying this concept to a simple example we could say that a sum of £127 10s offered in five years' time has a present worth of £100 if it is discounted at five per cent.

This simple example illustrates the case of 'single-input/single-output' which is useful in practice when the comparison to be made is between a single cost incurred in purchasing an asset in a given year with its anticipated realisation price some years later, for example in purchasing a block of land for subsequent resale. In the case of developing land for agriculture or forestry, however, we have to handle not single values but streams of anticipated costs and returns. This may be done by using more sophisticated techniques and for the present study a modified form of discounted cash flow has been used.

The form of analysis suggested as the most appropriate for large-scale land development embodies compound interest 'cash flow' techniques to determine the 'supply price' and 'demand price' of the projects. The 'supply price' is defined as the total net cost of developing the land up to a certain point in time and the 'demand price' as the value of the asset at that time. For agriculture the point of time has been taken as the year(s) in which the farms are likely to achieve a given level of productivity while for forestry it has been taken as the year in which a sustained yield forest is established.

A simple criterion to judge whether the development is worthwhile is a direct comparison of these two values. If the 'demand price' or future capital worth of the asset exceeds the 'supply price' or total net cost of development, including interest charges compounded over the period of development, then the investment can be regarded as economically worthwhile. An extension of this criterion is provided by expressing the difference between the total net cost of the project and its future worth in terms of its discounted value; this is known as the 'present worth' of the project. Where the 'present worth' is positive the project is economically worthwhile, where it is negative it is not.

In order to provide a theoretical framework for the empirical development budgets which are constructed for agriculture and forestry in later chapters these relationships are set out in a symbolic form. It is assumed initially that all costs and returns occur at the end of the year but a modification to allow for the spacing of costs and returns over the year is given in Appendices 2:1 and 2:3.

AGRICULTURE

As explained in Chapters 4 and 5, agricultural development may be analysed in two phases, large-scale primary development by the Department of Lands and Survey and secondary development by individual farmers on their own properties after settlement. The major items of development, grassing, boundary fencing and main subdivision, provision of roads, buildings and water supply occur during the primary phase.

Let,

C =	capital development costs	to Lands and Survey.
G =	annual costs	} to large scale farming
R =	annual gross returns	} by Lands and Survey.
X =	aggregate annual returns	} to individual farmers
A =	aggregate annual costs	} after settlement.

n = number of years of primary development.
m = number of years after settlement before properties become fully established.
i = rate of interest.

(A will include some items such as additional subdivision, stocking, etc., which should properly be regarded as capital costs. They are, however, less distinctive in nature than the primary development costs and may in practice be incorporated with the annual operating costs of individual farmers.)

The net cost of development over the primary phase of development to the year of settlement will be:

$$[C_1 + (G_1 - R_1)]\ (1+i)^{n-1} + [C_2 + (G_2 - R_2)]\ (1+i)^{n-2} + \ldots + [C_n + (G_n - R_n)]$$

This may be expressed in the form:

$$\sum_{j=1}^{n} \left[C_j + (G_j - R_j) \right] (1+i)^{n-j}$$

Compounding this cost forward to the year m when the properties become fully established we have:

$$\left\{ \sum_{j=1}^{n} [C_j + (G_j - R_j)]\ (1+i)^{n-j} \right\} (1+i)^{m-n}$$

The net cost of development over the secondary phase will be:

$$(A_{n+1} - X_{n+1})\ (1+i)^{m-(n+1)} + (A_{n+2} - X_{n+2})\ (1+i)^{m-(n+2)} + \ldots + (A_m - X_m)$$

which may be expressed in the form:

$$\sum_{j=n+1}^{m} (A_j - X_j)\ (1+i)^{m-j}$$

Therefore the total net cost of development to the end of the year m when the properties have reached a given level of productivity will be:

$$\left\{ \sum_{j=1}^{n} [C_j + (G_j - R_j)]\ (1+i)^{n-j} \right\} (1+i)^{m-n} + \sum_{j=n+1}^{m} (A_j - X_j)\ (1+i)^{m-j}$$

We may designate this total cost of development as $\bar{c}$

When the land development project is completed in year m the block will yield annually an aggregate gross output X, which will be sustained by aggregate annual costs A. If we let X′ represent the net annual output X - A the net income stream may be expressed as:

$$X'_{m+1} + X'_{m+2} + \ldots + X'_p$$

where $X'_{m+1} = X'_{m+2} = \ldots = X'_p$ and

where p is the number of years the uniform income stream is expected to continue.

The present worth, V_m of this income stream at the beginning of year m+1 may be obtained by summing the discounted value of the series:

$$\frac{X'_{m+1}}{(1+i)} + \frac{X'_{m+2}}{(1+i)^2} + \ldots + \frac{X'_p}{(1+i)^{p-m}}$$

so that we have:

$$V_m = \frac{X'}{i}\left[1 - \frac{1}{(1+i)^{p-m}}\right]$$

When, as with most cases of development, it is anticipated that the increase in the annual income can be maintained in perpetuity we have the limiting case of the traditional valuation formula:

$$V_m = \frac{X'}{i}$$

since $\left[1 - \frac{1}{(1+i)^{p-m}}\right]$ tends to 1 as p approaches infinity.

We have now obtained symbolically, the total cost, $\bar{c}$ of developing the block to the end of the year m and its capitalized value V_m at the same point in time. Our criterion of profitability requires that $V_m > \bar{c}$ if the development is to be economically worthwhile. In addition, we may say that $V_m - \bar{c}$ measures the future net worth of the project while $\frac{V_m - \bar{c}}{(1+i)^m}$ measures its present net worth.

A SUSTAINED YIELD FOREST

The algebraic form of the cost of building up a sustained yield forest is set out below. It is assumed that the length of rotation is n years and that $^1/n$th of the forest is planted each year while the forest is being built up. All costs and returns are assumed to accrue at the end of each year.

Let,

C = annual cost of establishing $^1/n$th of the forest
e = annual cost of maintenance of $^1/n$th of the forest
aj = year of commencement of jth pruning, j = 1, 2, ... d
P_{aj} = cost of jth pruning on $^1/n$th of the forest
bj = year of commencement of jth thinning, j = 1, 2, ... h
T_{bj} = net value of jth thinning from $^1/n$th of the forest
Y = stumpage value of $^1/n$th of the forest
n = length of rotation
i = rate of interest

The total cost of establishment over the rotation will be:

$$C(1+i)^{n-1} + C(1+i)^{n-2} + C(1+i)^{n-3} + \ldots + C$$

$$= C\left[\frac{(1+i)^n - 1}{i}\right]$$

Using a similar approach for each item of cost and for the returns from thinning which are deducted from costs, we have the total cost of development or supply price of the sustained yield forest, S_f

$$S_f = C\left[\frac{(1+i)^n - 1}{i}\right] + \sum_{j=1}^{a} P_{aj}\left[\frac{(1+i)^{n-aj} - 1}{i}\right]$$

$$- \sum_{j=1}^{h} T_{bj}\left[\frac{(1+i)^{n-bj} - 1}{i}\right] + e\left[\frac{(1+i)^n - 1}{i^2} - \frac{n}{i}\right]$$

THE ANNUAL NET INCOME OF THE FOREST

The annual net income of the forest when operated on a sustained yield basis after year n will be:

$$Y + \Sigma T - C - \Sigma P - ne$$

and the capitalized value of this income, or the demand price of the sustained yield forest, D_f, will be:

$$\frac{Y + \Sigma T - C - \Sigma P - ne}{i}$$

The criterion of whether the development prospect is worthwhile will be:

$$D_f > S_f$$

while the future net worth of the forest will be:

$$D_f - S_f$$

and the present net worth:

$$\frac{D_f - S_f}{(1+i)^n}$$

The rate of interest used for compounding costs, capitalizing net incomes and discounting future values to their present worth can have a marked bearing on the results of the study. A project which is economically worth while at low rates of interest may not be so at higher rates, while a comparison of two projects with different time patterns will be influenced by the rate selected. The profitability of projects with a long period of investment, such as land development for agriculture or forestry, is peculiarly susceptible to the rate of interest used. Much of the cost of establishing a rotation forest, for example, takes the form of interest charges and it is sometimes suggested that while these may be realistic costs for a private firm carrying out commercial forestry they are no more than a book-keeping exercise for a state department establishing national forests. Such a suggestion indicates a failure to appreciate that the accumulation of interest is the monetary expression of the real cost of tying up resources over long periods of time when they could have been used in other lines of production. The role of the rate of interest is to act as a rationing mechanism for allocating scarce resources to those projects which will make the best use of them in terms of their contribution to national output.

The rate of interest used in assessing development projects should ideally be equal to the marginal rate of return on investment capital. In practice, however, it is impossible to say what this rate is and we therefore have to settle for some arbitrary rate; we may select the rate of return on government development bonds on the assumption that this indicates the social rate of time preference.

A second factor which has to be taken into account in evaluating development projects is the length of the planning period, or investment horizon. Clearly, the present worth of an investment will be greater if its net benefits are capitalized over a period of forty years rather than twenty, although, due to the effect of discounting, the discrepancy is less than might superficially be supposed. The major point at issue is whether the time period taken into account should relate to the anticipated working life of the asset or to some arbitrary planning period. Although there has been much inconclusive discussion on this point the former appears more logical, especially when projects with a long period of production are under consideration. For example, a twenty-year planning period would rule out forestry plantation for timber production, while even a ten-year period would discriminate against agricultural land development, conservation, river basin development, etc. For practical purposes it seems advantageous to equate the investment horizon to the first productive cycle of the asset with the longest period of production.

A final point which has to be considered in relation to land development is the element of risk. Apart from the uncertainty of future prices, which is common to all forms of investment, the degree of risk that the physical outcome may not be what is anticipated will vary from one project to another. This risk will generally be greater for projects dependent upon physical processes of growth, such as land development for forestry or agriculture, than for those of an engineering nature. Forestry faces serious physical risks through fire, wind-throw and, especially where a single species is predominant as in many of the exotic planations in New Zealand, of disease. Agriculture, too, faces physical risks not only of disease to stock but also of soil erosion, which may be a serious hazard especially where, as in many areas of New Zealand, the original cover was bush. It is difficult to determine how best to take account of risk in a development analysis. Approaches that might be considered are to adjust the anticipated returns from the projects to a conservative figure, or to use differential interest premiums above the general planning rate. From the point of view of operational simplicity the first of these appears the more desirable and this is the procedure which has been adopted in the present study.

Finally, we have to consider the point of view from which this analysis is to be made. Although large-scale commercial plantings are made by private companies in this country the great bulk of afforestation is carried out by the Forest Service. Similarly, the breaking in of large areas of land for farming, as distinct from improving existing properties, is concentrated in the hands of the Department of Lands and Survey.

In making a comparison of large-scale development for agriculture and forestry it is therefore natural to consider the analysis from the national point of view. This has been virtually self-evident for the forestry study because all operations have been carried out by the Forest Service up to the point of sale of the timber and pulpwood which, owing to the site of the block selected, it has been assumed are sold to a public company.

In the case of agriculture early development is in the hands of the Department of Lands and Survey, but secondary development and subsequent operation are carried out by private farmers, though in the early stages they are subject to supervision, formerly by the State Advances Corporation and more recently by Lands and Survey. In order to restrict the analysis to the national point of view and avoid welfare problems involved in land values and taxation we have assumed that all farming operations are carried out by the Department of Lands and Survey and that the individual property owners are employed by that Department on a salary in exactly the same way as block managers. Admittedly, this raises another welfare problem in that while the State intervenes in, or directly controls, many aspects of economic life in New Zealand the country as a whole still adheres to the philosophy of the individual property-owner in farming. Indeed, it has sometimes appeared that the turning out of properties for settlement has been regarded as a more important social (or political) consideration than the economic viability of those properties or the profitability of their development to the country as a whole.

Although the analysis has been made from the national point of view we have restricted it to the primary benefits and costs of development and have made no attempt to assess the secondary aspects—linkage effects upon other sections of the economy, impact upon overseas markets and earning of foreign currency, etc. As mentioned at the end of the last chapter this is primarily an 'engineering' study.

THE INTERNAL RATE OF RETURN

Although it was considered that the best criterion to use for assessing the profitability of development was the present net worth of the project, there are certain drawbacks to this. While it provides an answer to the question: 'Is this particular development programme worthwhile when the borrowing rate of interest is (say) five per cent?', it does not give an answer to the more general question: 'What is the rate of return yielded by this particular programme?'.

It was pointed out earlier in this chapter that the conventional method of calculating rate of return on investment was invalid because of its inadequate treatment of the dimension of time, but this may be overcome by using appropriate compound interest techniques. The correct rate of return, or 'internal rate of return' as it is frequently known, may be defined as the rate of interest which would make the cost of development just equal to the capitalized value of the asset as a going concern. The concept of a break-even rate of interest ('mean annual forest per cent') has been used in forestry economics for many years but it has not formerly, as far as is known, been applied to agricultural development.

The application of the internal rate of return is subject to a number of conceptual and computational difficulties, which have led many authorities in this field to discard it in favour of the 'present worth' concept based upon a market rate of interest. One of the mathematical objections to using the internal rate of return as a criterion is that the equations derived from the development budgets take the form of polynomial functions which will have up to as many roots as there are years in the development programme; in other words there may be a number of 'break-even' rates of interest rather than a unique one. In practice, the incidence of multiple real positive solutions appears to depend upon the nature of the equation and, in particular, the number of changes of sign. We did not want to enter into a theoretical controversy which has ranged widely elsewhere, but we thought it important to see whether a single real solution could be found for the type of equation that was likely to arise from an empirical development study, as distinct from the hypothetical examples which have been presented in the economic journals.[1] In fact each of the equations derived from the agricultural development budgets which are drawn up later in this study was found to have only one real solution. This may be due to the fact that the normal form for the development programme was a series of net costs in the early years succeeeded by a series of positive returns in later years.

It was shown earlier in this chapter that the future net worth of developing the Maraetai block for agricultural use could be symbolised in the form:

$$\frac{X'}{i}\left[1-\frac{1}{(1+i)^{p-m}}\right]-\left\{\sum_{j=1}^{n}\left[C_j+(G_j-R_j)\right](1+i)^{n-j}\right\}(1+i)^{m-n}$$
$$-\sum_{j=n+1}^{m}(A_j-X_j)\,(1+i)^{m-j}$$

where i is the rate of discount assumed appropriate for this type of investment. Now replacing i by r, the unknown internal rate of return, and setting the equation to zero we can solve for r:

$$\frac{X'}{r}\left[1-\frac{1}{(1+r)^{p-m}}\right]-\left\{\sum_{j=1}^{n}\left[C_j+(G_j-R_j)\right](1+r)^{n-j}\right\}(1+r)^{m-n}$$
$$-\sum_{j=n+1}^{m}(A_j-X_j)\,(1+r)^{m-j}=O$$

[1]For the general review of investment criteria see F. A. and V. Lutz, *The Theory of Investment of the Firm,* Princeton, New York, 1951; also E. L. Grant and W. G. Ireson, *Principles of Engineering Economy,* Ronald Press, New York, 1960. For more specific references see M. J. Bailey, 'Formal Criteria for Investment Decisions', *Journal of Political Economy,* Vol. LXVII, No. 5, 1959; G. Mills, 'Marginal Efficiency of Capital and the Present Value Rule', *Yorkshire Bulletin of Economic and Social Research,* Vol. 12, No. 1, 1960; P. H. Karmel, 'The Marginal Efficiency of Capital', *The Economic Record,* Vol. XXXV, No. 72, Dec. 1959, and many related articles.

The basic forestry equation may be solved for the internal rate of return in exactly the same way:

$$\left[\frac{Y + \Sigma T - C - \Sigma P - ne}{r}\right] - C\left[\frac{(1 + r)^n - 1}{r}\right]$$

$$- \sum_{j=1}^{d} P_{aj}\left[\frac{(1 + r)^{n-aj} - 1}{r}\right] + \sum_{j=1}^{h} T_{bj}\left[\frac{(1 + r)^{n-bj} - 1}{r}\right]$$

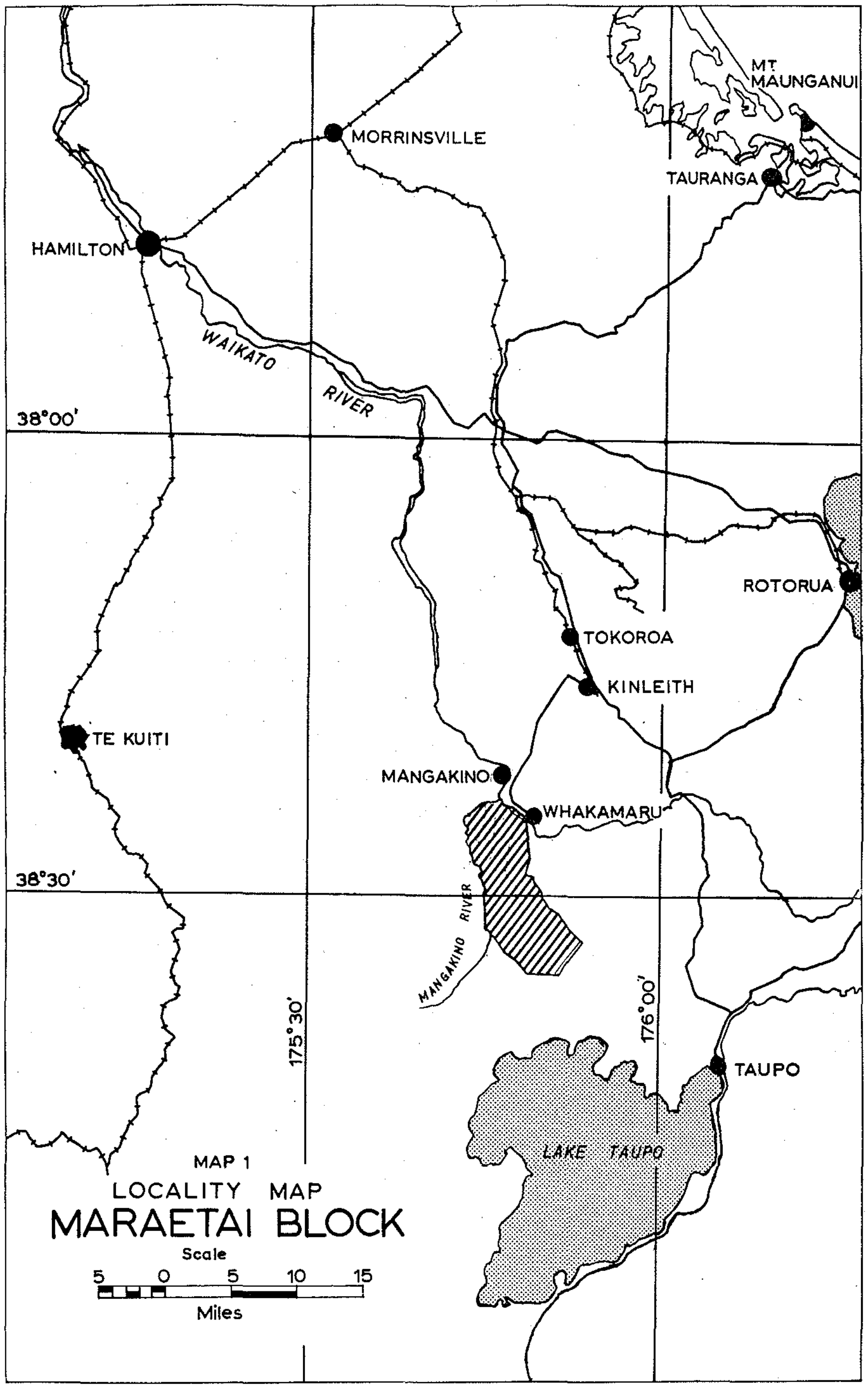
$$- e\left[\frac{(1 + r)^n - 1}{r^2} - \frac{n}{r}\right] = O$$

Equations of this nature may be solved with the aid of a desk calculator by a process of successive approximation. The procedure consists of obtaining approximate values for r and then interpolating graphically or by Newton's law of proportionate parts to obtain the final answer. A more accurate solution may be obtained, with less tedious work if a number of equations have to be solved, by using a computer programme. Such a programme was written to solve the parametric development budgets for the agricultural projection, whereas the solution for the forestry development budget was obtained by graphical interpolation.

It has been argued elsewhere that the internal rate of return is not a suitable criterion for evaluating farm improvement programmes on private properties[2]. It applies to negative values as well as positive values in the development budget which implies that the farmer borrows at the same rate of interest as is yielded by the asset. Obviously this is not in fact the case; in a year when costs exceed returns the farmer must borrow to cover the net cost, and he will in fact borrow at the rate of interest charged by his trading bank or stock firm. There is no reason at all why this borrowing rate should coincide with the yield on his investment and clearly it would only do so as a special case.

In analysing long-term development by the nation, however, the same qualification does not apply. Interest payments on loan money raised internally are simply transfer payments which should not influence social investment decisions, in the way that bank charges influence private investment decisions. The nation may therefore consider the internal rate of return as one of the criteria that should be taken into account in selecting amongst alternative investment decisions.

[2]J. T. Ward, 'Investment Analysis for Farm Improvement', Agricultural Economics Research Unit, Lincoln College, Publication No. 9, 1964.


MT MAUNGANUI
MORRINSVILLE
TAURANGA
HAMILTON
WAIKATO RIVER
38°00'
ROTORUA
TOKOROA
KINLEITH
TE KUITI
MANGAKINO
WHAKAMARU
38°30'
MANGAKINO RIVER
176°00'
175°30'
TAUPO
LAKE TAUPO
MAP 1
LOCALITY MAP
MARAETAI BLOCK
Scale
5 0 5 10 15
Miles

Chapter 3

THE MARAETAI BLOCK

IN selecting a case study for analysis it was decided that the most suitable area would be on the Taupo-Rotorua pumice lands which are being extensively developed for both agriculture and forestry. By agreement with the Department of Lands and Survey and the Forest Service, the Maraetai block was selected as being typical of many of the large development blocks on this type of country. The block is an area of twenty-five thousand acres lying south of Mangakino, and bounded on the north by the Waikato River. Its location is shown on page 32. It was developed by the Department of Lands and Survey over the period 1949 to 1961 and settled to dairy and sheep farms, while a neighbouring block of land, now known as the Kahu block, is still in the process of development. As the block had recently been settled it was thought that detailed accounts of development, settlement and current farming operations would be available; unfortunately this expectation was not fulfilled, but in retrospect it appears that the paucity of development data would have posed a problem on any block and the Maraetai block remains a reasonably satisfactory choice.

The pumice lands of the central North Island, of which the Maraetai block is typical, were virtually unused forty years ago but have since witnessed the spread of a vast acreage of exotic forests upon which rapidly expanding timber and pulp and paper industries are based. The discovery in the late 'thirties that 'bush-sickness', for which this country was notorious, could be combated by the use of cobalt and that pastures responded well to potassic superphosphate has also led to a spectacular large-scale development for agriculture since the Second World War. This development has been carried out by the Department of Lands and Survey and several thousand ex-servicemen have been settled by the State Advances Corporation on sheep and dairy farms in this region during the last twenty years.

The majority of soils on the block are described in the North Island Soil Survey of 1953 as follows: 'Taupo silty soil, parent material Taupo ash. Original cover, manuka scrub, fern, tussock, etc. Profile, 3 inches dark grey sand, 3 inches yellowish brown sand, 9 inches pale yellow brown sand or yellowish grey pumiceous gravelly sand. Natural fertility low, response to phosphate good.'[1]

The practical field description would be more as follows: An undulating landscape, formed from igneous rock, was covered by the Tirau ash

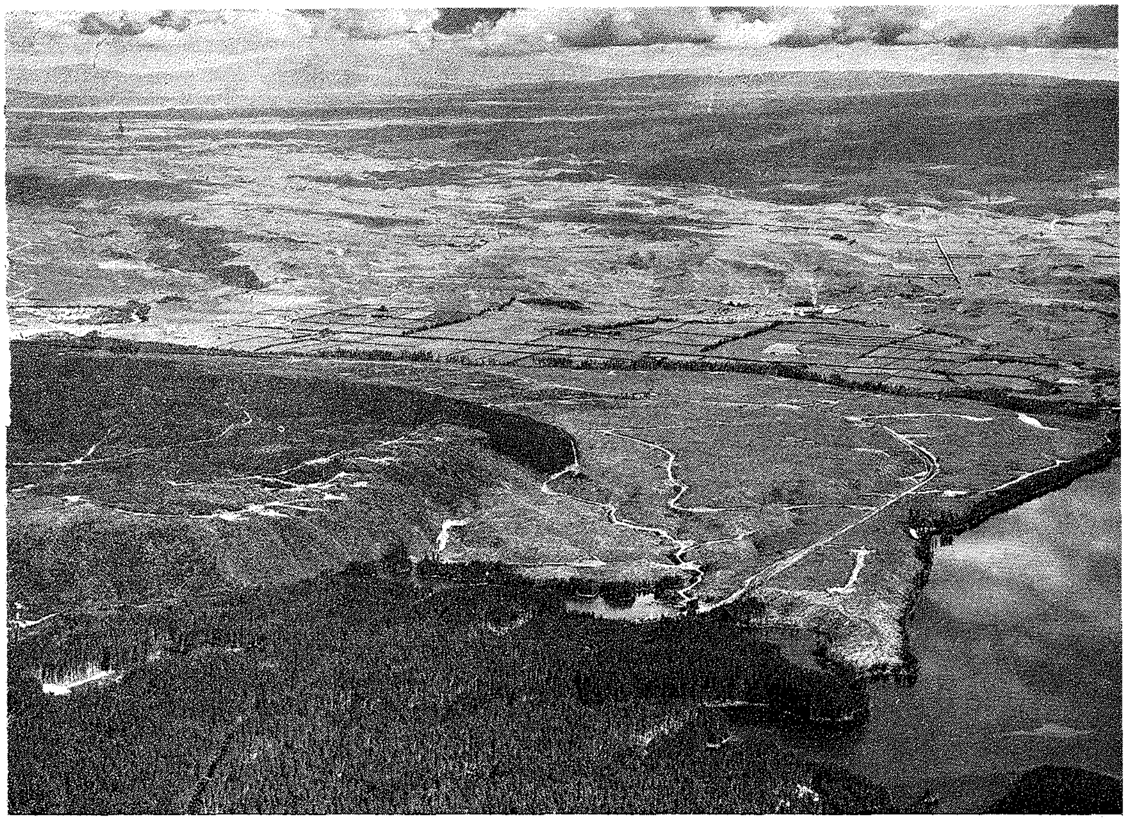
[1]Grouped in the 'Yellow Brown Pumice Soils' Taupo suite, N.Z. D.S.I.R. Soil Bureau Bulletin No. 5, 'General Survey of the Soils of North Island, New Zealand', 1954, p.78.

MARAETAI AND MANGAKINO

A view looking north from halfway down the farming block. The more broken sheep-country with the steep gorge of the Mangakino stream can be seen in the foreground. The easier country now under dairy farms slopes gently down to the Waikato River. Mangakino township is on the left of Maraetai lake with the N.Z. Forest Products plantation in the background.

shower, which has not only a reasonably high natural fertility but also a good water-holding capacity. Subsequently it was covered again by the Taupo shower which is generally a very light infertile material. Erosion of the Taupo ash has tended to wash it from the hills and leave it on the flats with the result that some of the hills have a higher natural fertility and are capable of more vigorous and sustained pasture growth than the flats. The productivity of any single farm in the block is therefore partly dependent upon the proportion of hills to flats.

A physical characteristic of the soils of the area is that they are porous and free-draining with the advantage that the land does not become poached during wet weather so that the wintering of stock is not such a problem as in many other dairying areas in New Zealand. On the other hand, consolidation is an important factor in establishing and maintaining pasture production, while the dangers of soil erosion have become apparent in some parts of the area.



FORESTRY AND FARMING

A general view of the Maraetai block, looking south. Whakamaru dam is on the extreme left and Maraetai lake on the right. N.Z. Forest Products plantations—clearfelled, regenerated and mature crops—can be seen in the foreground, while the farming block curves to the left, back from the river. The National Park mountains are visible in the distance.

The rolling and hummocky topography of the block is typical of much of the pumice country; in places where the rock protrudes there are bluffs and steep slopes but interspersed amongst them are flats of varying shape and contour. Because of the broken nature of the ground there is no predominant aspect. The northern part of the block lies between 800 and 1,000 feet and is described as easy rolling to rolling, with some flatter areas and some steeper sidings and gullies. The southern part of the block rises to 1,750 feet on the more prominent knobs and is moderately steep, broken country, with interspersed flat areas. There are virtually no natural water-courses on the block so that water for stock has to be obtained by pumping from bores.

The apparent homogeneity of the area, in terms of topography and aspect, is a striking physical characteristic, but differences in the proportion of hill to flats do, to some extent, influence the productivity and management of individual properties. On individual farms differences in elevation seldom exceed 150-200 feet but some of the bluffs and steep slopes constitute a stock hazard. The broken ground, together with row shelter belts and barberry hedges, provide some shelter for stock but this is generally inadequate.

In a normal season the area receives between forty and sixty inches of rain, which is fairly well distributed. A hot dry spell lasting thirty to forty days is, however, frequently experienced during the summer, resulting in an acute shortage of feed, a situation which is typical of the Waikato. There is a ninety-day winter when little growth is recorded and at least thirty days during mid-winter when there is no growth at all.

Under appropriate systems of development and post-settlement management the northern part of the block is suited to dairy farming and the southern, higher country to sheep farming. Average production figures of eighty Jersey cows producing over 20,000 lbs of butterfat from 160 acres (125 lbs per acre) have been achieved from the dairy block while the sheep farms of 350 acres carry a thousand Romney ewes with their replacements, supplemented by fifty to seventy breeding cows (three ewe equivalents per acre). Potential outputs are thought to be considerably higher; experience on similar land developed earlier suggests that 200 lbs butterfat and four-plus ewes to the acre might be achieved after fifteen to twenty years' farming, or even earlier under 'good average management'.

Geographically the area is also well suited to the establishment of exotic forests. Rapid growth, particularly of *Pinus radiata,* is achieved on this type of country, as is evident from the large plantations which surround the block. Most of the land is suitable for planting and the rolling terrain presents no major problems for tending or felling, while the location of the block within easy haulage distance of the N.Z. Forest Products Company's timber and pulp mills at Kinleith facilitates marketing.

Chapter 4

AGRICULTURAL DEVELOPMENT OF THE MARAETAI BLOCK

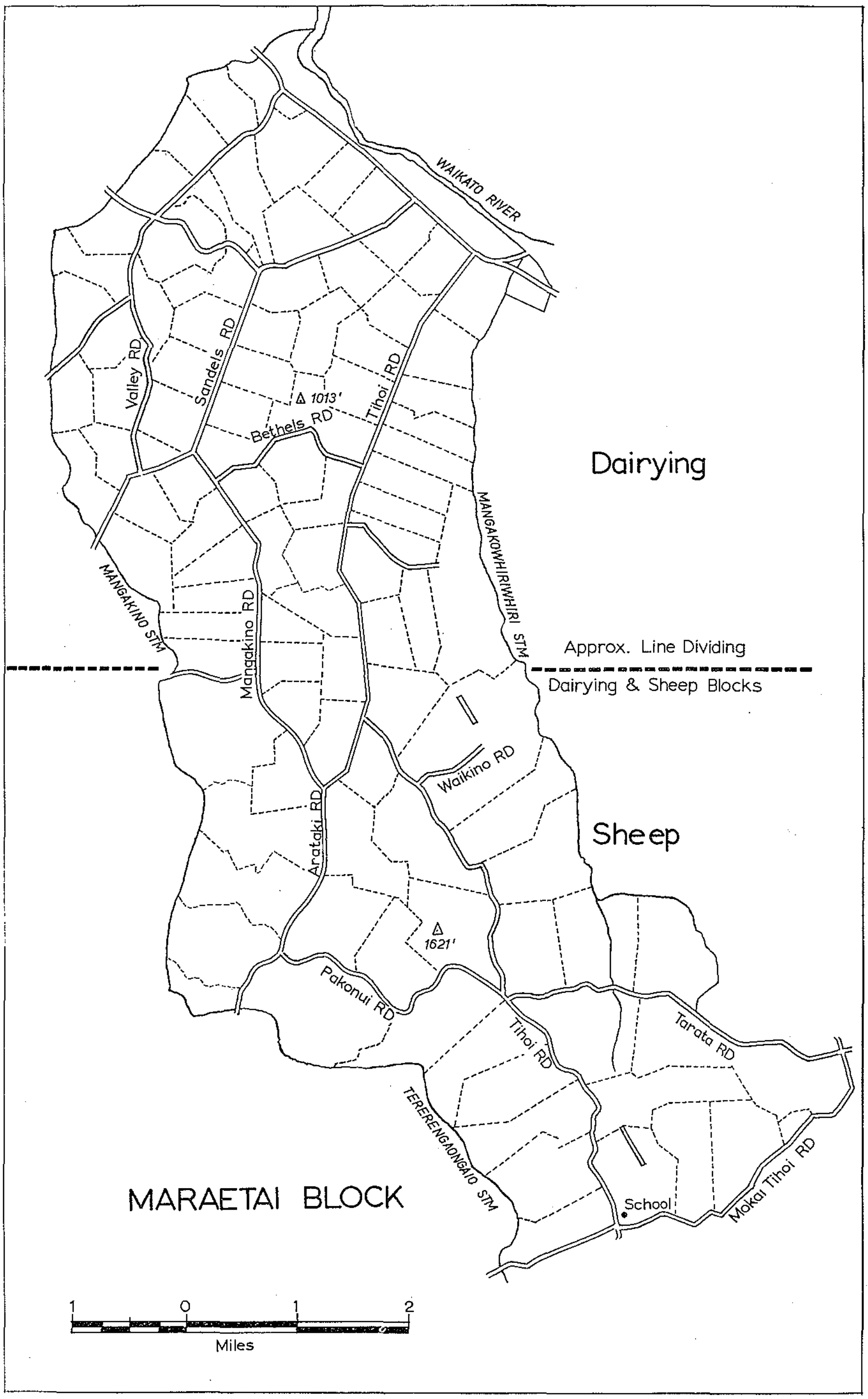
As the Maraetai block was developed for farming the only method of analysis available for its development for forestry was a projection study. A hypothetical case study for the development and operation under a sustained yield forestry regime was therefore drawn up. For agriculture, however, an alternative approach existed in an historical case study based on the actual costs and returns observed during initial development and after settlement. It was originally intended to make both an historical study and a projection study for agriculture as it was felt that a comparison of the results obtained from the one would serve as a valuable check upon the results of the other.

The historical analyses presented most of the difficulties discussed earlier in Chapter 2. As the purpose of the study was to relate inputs of real resources and real outputs over time it was thought necessary to correct historical values of costs and returns for changes in the value of money. The case records of the Department of Lands and Survey are, however, kept on a conventional accountancy basis with no allowance for inflation. The final analyses made for each block, when the development is finished and the books closed, shows whether a financial loss or profit was made from the development, but it does not show the true economic situation in real terms because of the effect of inflation.

The original intention in this study was to record the physical inputs and outputs over the whole period of development and to revalue these at constant prices. To this end a search was made of Lands & Survey Department files and a field survey was made to record physical improvements on sheep and dairy farms.[1]

The results of both were disappointing. The Lands and Survey files were not adequate to record physical quantities for primary development, while farm records were also insufficient for recording post settlement development even when supplemented by detailed analysis of farm accounts and balance sheets. The Lands and Survey files were inadequate even for a financial analysis due largely to administrative changes which occurred while this particular block was being developed. After considerable time had been spent on this part of the study it was decided that it would not be possible to make a reliable historical study and that a projection analysis would have to be undertaken instead. The historical surveys were not wasted, however, in that the findings and

[1]Mr D. G. Keeley undertook the field work for the dairy farms and Mr B. C. Withell that for the sheep farms.



WAIKATO RIVER
Valley RD
Sandels RD
Tihoi RD
Δ 1013'
Bethels RD
Dairying
MANGAKOWHIRIWHIRI STM
MANGAKINO STM
Mangakino RD
Approx. Line Dividing
Dairying & Sheep Blocks
Waikino RD
Sheep
Arataki RD
Δ 1621'
Pakonui RD
Tihoi RD
Tarata RD
TERERENGAONGAIO STM
MARAETAI BLOCK
School
Mokai Tihoi RD
1 0 1 2
Miles

experience gained from them were used to ensure a realistic basis for the projection study.

A general review of the historical development of the block is contained in the remainder of this chapter, together with some comments on the potential of the block and some of the problems that have to be faced in this particular area. It is presented to summarise how development of this type of country is actually carried out and also to provide a technical background for the projection study which follows.

PRIMARY DEVELOPMENT

The Maraetai block was purchased by the Department of Lands and Survey in 1946 and developed over the period 1949 to 1961. During this time returned servicemen with approved farming experience were settled on sixty-eight dairy farms and forty-two sheep farms under the Returned Servicemen's Rehabilitation Scheme. Special provisions of this scheme allowed the State Advances Corporation to finance the purchase of land improvements, buildings, stock and chattels on the basis of a deposit which varied from £1,000 to £3,000.[2] The policy adopted by the Corporation provided for a 'budget' system of control under which its officers supervised both the technical and financial management of the properties for a number of years, allowing the farmers to assume full control of their farms as they gained in experience and managerial ability. Most of the farms were originally settled on a leasehold basis but several of the settlers have since exercised the right to buy their freeholds.

Development of the Maraetai block followed the pattern now well established in New Zealand over large tracts of country. The primary phase of development is carried out by the Department of Lands and Survey followed by a secondary phase of development after settlement. The division between the two phases is demarcated by the legal and physical process of settling properties on individual farmers but the actual stage of development at which this occurs may vary. In the early years, when pressure to turn out farms was greatest, properties were settled in a raw state requiring a great deal of further development by the farmer himself, but recently the policy of farming the land to a higher stage of development before settling has found more favour. This enables the Department of Lands and Survey to recoup more of the initial costs of development from the profits of its farming operations and it also ensures that individual farmers have a greater chance of success.

The techniques of primary development for pumice country have been evolved over a number of years. The first stage of clearing is to crush the manuka scrub which covers much of this country and break the stems by the use of large flanged rollers towed behind crawler tractors. The debris is left to dry for three or four months before being burned in controlled blocks and after the burn the land is disced with

[2]Since 1963 post-settlement supervision has remained with the Department of Lands and Survey.

giant discs, followed up by heavy harrows to crush and level the discing and clear unburnt sticks and stumps. Finally, the whole cultivated area is rolled twice to level it and to compact the seed bed in order to prevent excess loss of moisture and soil blowing. Country too steep to work with tractors is burnt by hand.

When ground conditions are suitable the land is sown from the air with a seed mixture of 30 lbs and a dressing of 3 cwt of cobaltised superphosphate per acre. The seed mixture generally used is 15 lbs perennial ryegrass, 5 lbs H1 ryegrass, 4 lbs cocksfoot, 1 lb dogstail, 2 lbs white clover and 3 lbs red clover. During the first twelve months two further dressings of cobaltised superphosphate are applied at the rate of 3 cwt per acre. To give a better spread of work for contractors, pastures are sown down in spring and autumn; this enables crushing and cultivation to be carried out over most of the year under suitable weather conditions.

Fencing contracts are let soon after the burn-off is completed on lines usually cleared by a bulldozer prior to burning. Some 480 chains of seven-wire fencing (approximately 1.2 chains per acre) are erected for every four hundred acres of developed area, to allow five paddocks of about eighty acres in size. Treated wooden posts are used and all fences are battened. Where, as is generally the case, a good natural source of water is not available, deep-well bores and high-pressure pump units are provided. Reticulation is by half-inch or three-quarter-inch polythene piping, some sixty chains being required for each four hundred acres watered.

The control of weeds and second growth in newly-established pastures is effected through the use of high stocking rates of Aberdeen Angus steers and Romney wethers which are grazed in large mobs giving a 'lawnmower' effect on all vegetation present. Stock losses at this stage can be very high, particularly if poisonous plants such as tutu and ragwort are present, but a measure of control is achieved by spraying either by hand or by helicopter, whichever method is the cheaper. Until recently DDT superphosphate was applied every three years to control grassgrub and porina infestations but, as a result of the recent changes in the regulations for the use of pasture insecticides, control in the future will probably be by DDT prills.

Young pastures on pumice country tend to be red clover dominant so that a major aim of grazing management must be to maintain the balance between pasture species. In order to prevent the red clover eliminating ryegrass and white clover species, pastures are grazed frequently in the early stages under mob stocking. When they have been consolidated and weed control or scrub regeneration is no longer a problem, breeding stock are brought on to the block. Two-tooth Romney ewes and two-year Aberdeen Angus heifers are purchased either from adjoining blocks or from the Gisborne area, but sufficient numbers of wethers and steers are kept to control regrowth of scrub and weeds on newly developed areas. Wethers and steers that have fulfilled their useful working life in this way are moved to better pastures and fattened.

Buildings required for development are, whenever possible, built and sited for settlement. Three-bedroom houses of a thousand to eleven hundred square feet, of standard design, are provided for staff working on the block and subsequently used for settlement. Implement sheds are constructed near the houses and haybarns to hold a thousand bales are built as required on sites with good access for storing winter feed supplies. Woolsheds built for development farming have three shearing stands and shearers' quarters compared with the two-stand sheds normally built for settlement.

Airstrips are an essential part of development and must be centrally located and provided with good access. Allowing for a maximum flight length of three miles from the strip, one airstrip gives economic coverage for up to sixteen thousand acres and two such strips were established on the Maraetai block. Bulk storage bins are provided and make possible the accumulation of sufficient fertiliser to allow rapid top-dressing of a large area.

All access roads are surveyed and constructed by the Ministry of Works. Roads that join existing roads (through-roads) are financed from the Ministry of Works' vote but the cost of no-exit roads is shared equally between that Ministry and the Department of Lands and Survey. At settlement all roads are transferred to local county councils for maintenance.

SECONDARY DEVELOPMENT

At settlement farms are provided with the basic necessities to allow the new settler to run his property efficiently. All properties are now provided with a three-bedroom house of eleven hundred square feet, implement shed, haybarn, water-supply from a high-pressure pump and deep-well bore, nine paddocks fenced and watered and materials for sub-dividing two more. Sheep farms also have a two-stand woolshed erected and sheep and cattle yards in kitset form, while dairy farms have a cowshed and yard erected and piggeries and calf house in kitset form. Historically the level of development of the earlier properties settled on the block was much lower than this. The first dairy farms were settled on pastures of eighteen months to three years of age, with half a house, a dairy shed, sometimes without yards and from three to six paddocks fenced and watered.

When initial building is completed on the dairy farms and the farming routine has settled down it is soon realised that further development is necessary to raise both production and net income. Increased subdivision is essential to ensure good pasture management and grazing control and some nine paddocks are added to give a total of twenty of approximately eight acres in size. In order to control ragwort most dairy farms purchase in-lamb five-year-old ewes, which necessitates sheep-proofing the three-wire fences provided on settlement. Shelter from cold winter and early spring winds is essential for stock protection at calving and approximately seventy chains are planted and fenced. Further dressings of fertiliser are essential and 3 cwt per acre of cobaltised superphosphate are usually provided each year, while increasing use is being made of potassic superphosphate to supply earlier, more nutritious growth of pastures.

Herd size can be increased only slowly because of the hard grazing of sheep necessary to control ragwort, but production per cow rises steadily as herds settle down to a more evenly balanced age composition. As the output of butterfat rises the pig enterprise is enlarged to consume the increasing supplies of skim milk and it becomes necessary to enlarge the piggery. Other buildings are constructed as finance permits. These generally take the form of an enlargement of the haybarn to take an additional four hundred bales, a manure shed for storing phosphate and seed and a garage near the house to give more storage room in the implement shed.

Good pasture management is even more important on the sheep farms than on dairy farms but is usually harder to achieve because steeper ground hampers fodder conservation. To improve grazing control additional fencing is required and, on average, another five paddocks are fenced and supplied with water, giving a total of sixteen paddocks of approximately twenty-two acres. Increases in flock and breeding herd numbers necessitate increased supplies of hay and an extension of the haybarn.

An average of eighty chains of shelter is fenced and planted on each farm, over a number of years, around the farm buildings and to give protection to the flock at lambing time. Further planting is required to control erosion in gullies carrying increasing quantities of runoff water. To improve access into paddocks and sheds ten chains of tracking is completed and, as on the dairy farms, a garage is built near the house to give more storage space in the implement shed. During this period of development any rough corners still in scrub or poor pasture are tackled. Scrub is cut and burned and the area, usually less than ten acres in extent, is oversown and top-dressed.

SETTLEMENT

When sufficient farms are available for settlement advertisements are issued inviting suitable applicants to apply to the Commissioner of Crown Lands for entry into the ballot for a farm. Prospective applicants must furnish details of previous farming experience and financial situation and each applicant is interviewed by the Land Settlement Board before entry is allowed into the ballot. Applicants who fulfil the requirements of the Board are required to inspect the properties beforehand and must state their personal preferences for the properties available. Priorities for candidates are given in the following order:

First: Eligible and graded World War II ex-servicemen.
Second: Eligible and graded Emergency Force ex-servicemen.
Third: All other applicants.

Ballots are open to the public and take place as soon after interviews of applicants by Land Settlement Board as practical while settlement is arranged to give incoming farmers adequate time to settle in before the productive season begins.

(i) *Dairy farms*

With the exception of two units now engaged in liquid milk production to supply the town of Mangakino, the dairy farmers on the 10,655 acre section of the Maraetai block produce cream for butter-making under the conventional seasonal supply system. The main enterprise is a Jersey or Jersey-cross herd of about eighty milking cows, with a subsidiary pig production enterprise to utilise the skim milk. Until recently, herd wastages of as high as twenty-five to thirty per cent per annum were common, attributable largely to the effects of copper and cobalt deficiencies and to bloat and ragwort poisoning. These effects are diminishing today, mainly as a result of increased technical knowledge, but the wastage level is still currently of the order of twenty per cent.

The cows are mated to calve in mid to late July, a month prior to the start of the spring growth flush. Half the farmers run their own bull with the herd while the other half make use of the artificial breeding scheme for the main herd, retaining a bull calf for following up and also to run with the yearlings. One-third of the farmers are herd testing as part of the conventional herd improvement plan while approximately half of the herds have been T.B. tested and the incidence of the disease has been shown to be remarkably low, possibly a beneficial property of new lands. Replacements are bred on almost all the properties, the heifer calves from the top cows being retained whilst surplus calves are disposed of as bobbies.

Although the dairy enterprise is of the seasonal type some form of cropping is necessary to provide supplementary winter feed, over and above the amount of grass consumed as hay or silage, because the winter is more rigorous than in the majority of dairying areas in the Waikato. It is usual to put five to six per cent of the total area under cultivation, generally by ploughing old grass to swedes and turnips followed by new grass, thus providing a means of pasture renovation. In early summer thirty to forty per cent of the farm is shut for hay and silage to provide about fifteen bales of hay per cow and some 150 tons of silage.

Sheep play an important part in the early post-settlement period when they are used to control ragwort on the more difficult areas, and at the time this problem is most evident, usually three to four years after settlement, there will be approximately 150 ewes on each dairy farm. After this, sheep numbers decline and will be negligible within another three to four years.

The pig enterprise is usually based on a breeding herd of eight to ten sows at the conventional ratio of one sow to seven or eight cows. Type cannot be clearly defined and all breeds of pigs and their crosses appear to be present. Early litters are taken through to baconer weights to consume the spring flush of surplus milk while later litters are disposed of as porkers. Dry conditions underfoot, not normally encountered in dairying areas, make it possible to carry a small number of store pigs through the winter, mainly on grass and small quantities of meal, to help utilise the peak of lactation skim-milk production, but few store pigs are bought in for fattening. As there is no tanker collection of whole milk in the area all the farmers send away cream and retain the skim-milk. The traditional association of pigs with the dairy farm has disappeared from many other dairying areas in New Zealand with the advent of the milk tanker so that this remains one of the last areas in the country with a high level of pig production, with the result that buyers visit the district in considerable numbers and most pigs are sold in the sty.[3]

(ii) *Sheep farms*

The system of farming generally practised on sheep farms throughout the block, similar to that found on the great majority of easier and improved North Island hill-country areas, is based on the production of wool and fat lambs, predominantly from Romney flocks, with a complementary enterprise of run cattle, generally Aberdeen Angus in type, producing weaners. The main sheep enterprise is a flock of 950-1,000 mixed-age Romney ewes with a replacement flock of 300 ewe hoggets and 25 rams and killers. Wool production averages 9½ lbs per ewe and 6 lbs per hogget while lambing averages a hundred per cent and deaths five per cent for ewes and two per cent for hoggets. Replacements are bred by mating all but the old ewes to the Romney ram. Weaning is usually late and no large drafts of fat-off-mother lambs are made; instead the lambs are fattened off grass and are generally drafted late in the export season when weights of 32-4 lbs are obtained. The old ewes are usually mated to Down-type rams and the cross lambs are generally drafted fat-off-mother early in the New Year while, when poor conditions for lamb fattening are experienced, the tail-end lambs are usually sold as stores rather than carried through the winter.

Because of physical and climatic conditions it is not a usual practice to grow special feed for fattening lambs but a supplementary winter feed crop of swedes and chou is grown to augment hay for carrying the breeding stock through the winter. As on the dairy farms this practice also provides a means of pasture renewal of the arable areas by rotation of old grass to swedes and chou to new grass. Between 1,000-1,500 bales of hay are either made or bought in to provide the bulk of winter feed for the run cattle and also to give a measure of insurance against crop failure. The majority of farmers in the block practise the proven grassland technique of autumn saved pasture for lambing down. Most improvements in feed supply made after settlement stem more from increased subdivision and improved pasture management than from increasing fertiliser or seed above the normal maintenance requirements.

The sheep farms on the block run between sixty and eighty Aberdeen Angus or A.A.-cross breeding cows, rearing calves for sale as weaners in the autumn sales. Until recently it could be said that the great majority of farmers reared their own replacements, but there is now in

[3]Farms in this area are now (1965) going on to tanker collection.

progress a swing towards buying in replacement heifers. Cattle management, in general, is to run the cattle in conjunction with the sheep in order to control seasonal flushes of growth and to clear up pasture roughage.

THE AGRICULTURAL POTENTIAL OF THE MARAETAI BLOCK

The average production recorded on the dairy farms for 1961/2 was 21,345 lbs of butterfat per farm, a figure which represented a steady but continuous increase over recent years. *(See Table 3:1.)* Comparable data are not available for the sheep block which was developed later. In the opinion of men who have been concerned with the block since first settlement and have had experience of dairy farming on similar areas, this average should reach 30,000 lbs of butterfat (approximately 200 lbs per acre) with the top farmers producing 40,000 lbs, within the next ten to twelve years. This is expected to result from improved pastures as the land becomes settled and fertility is worked up, improved shelter for stock as shelter belts and hedges grow, herd improvements through the use of A.B. and herd testing and better stock-management, resulting in better feed conversion, reduced herd wastage and a higher proportion of productive stock.

Improvement in management is obviously a key factor in assessing the potential of the dairy farms. Several of the farmers are already highly skilled and efficiency overall is increasing as farmers gain experience in managing their own properties while a further factor is the replacement of the poorer farmer by a more efficient man. An indication of this is the recent example of two incoming farmers who had previous sharemilking experience and who each raised production on his farm by 10,000 lbs of butterfat within two years. It is envisaged on the block that there will very likely be a turnover of owners in the next ten years and that incoming farmers will probably have been sharemilking previously.

It is more difficult to assess the economic potential of the sheep block. During the field survey each farmer was asked what he considered the economic potential of his property to be, bearing in mind the problems and difficulties involved, and officers of government departments who have considerable experience both with development and settlement were also asked for their opinions. A fairly wide diversity of views was apparent but the following general pattern emerged.

The block has been developed for less than ten years and individual farms settled for only four to six years. In the early years of development there was a considerable early burst of pasture production with a resultant high carrying capacity which was generally attributed to the effects of burning scrub and fern and to the high rates of top-dressing applied during development. This early phase of prolific growth, predominantly of red clover and cocksfoot, was partly utilised by heavy stocking by the Department of Lands and Survey during the final stage of development and partly by the farmer in the early years of settlement. After two or three years however, this flush fell away and carrying

TABLE 3:1 DAIRY BLOCK: SETTLEMENT AND ANNUAL PRODUCTION

Season	Settlers No.	Area Acres	Av. size Acres	Cows milked No.	Av. Cows per farm No.	Butterfat Production Total lbs	Butterfat Production Av./farm lbs	Butterfat Production Av./acre lbs	Farms No.	Ewes No.	Lambs fattened No.	Seasonal conditions
1950/1	8	1196	149	480	60	93925	11740	79	0	0	0	Dry
1951/2	18	2851	158	1080	60	209286	11627	73	2	25	160	Dry
1952/3	29	4589	158	1760	61	403281	13906	87	8	600	1400	Good
1953/4	42	6320	151	2470	59	579237	13791	90	27	3000	3750	Good
1954/5	58	8890	153	3480	60	739502	13750	83	28	4000	7000	Hot/Dry
1955/6	60	9291	155	3605	60	787335	13,122	85	28	4000	7000	Fair
1956/7	60	9291	155	3513	59	949873	15831	102	32	4000	6000	Good
1957/8	63	9777	155	3870	61	1069079	16968	109	30	3500	5800	Good
1958/9	68	10481	154	4090	62	1242130	18265	119	27	3250	5200	Good
1959/60	66	10091	153	4661	71	1331601	20175	132	20	2000	2000	Good
1960/1	66	10157	154	5051	76	1352950	20501	133	12	1400	1200	Hot/Dry
1961/2	64*	9869	154	5113	80	1366051	21345	138	10	1070	1000	Hot/Dry

*Excluding two 'Town Supply' dairy tarms.

capacity declined. The following figures are given as the typical carrying capacity of a 330 acre property at the different stages:

(*a*) at settlement— 850 ewes plus replacements.
70 head cattle and replacements.

(*b*) 2-3 years after settlement—1,050 ewes plus replacements.
80 head cattle and replacements.

(*c*) 5-7 years after settlement— 950-1,000 ewes plus replacements.
70 head cattle and replacements.

The setback after five years or so appears to occur when the land is going through a transitional stage and a further rise in production is anticipated when the land has settled down, a pattern which has been observed on blocks developed earlier. It was estimated that within fifteen to twenty years the average farm would be carrying some 1,200 ewes with their replacements plus a breeding herd of 120 cows. The transitional stage is characterised by a change from red clover/cocksfoot to white clover/ryegrass and there is visual evidence of an ingress of fog and other low-yielding species and of Scotch thistles. The effect is generally to reduce carrying capacity by some ten per cent since to carry 1,050 ewes plus cattle is to incur lower wool weights and more difficulty in fattening lambs. On some of the pumice country this transitional stage has been marked by matting of the pastures which has increased management problems and has probably accentuated faster 'run off' and so contributed to the problems of erosion which are discussed below.

There was some physical evidence of a similar transitional phase on the dairy farms although it was far less marked than on the sheep farms. This was generally attributed to the fact that the dairy farmers practise higher stocking from the start and that the easier country enables them to conserve any surplus feed as hay or silage. Heavy mob stocking is part of the technique of development by the Department of Lands and Survey, but after settlement the sheep farmers generally have insufficient stock to maintain this practice with the result that the sward is not grazed tightly enough during the period of red clover dominance and tends to open up and become less productive when this phase is over. Stock thrift and numbers rise again when a tight, highly productive sward has been re-established.

SOME PROBLEMS OF THE MARAETAI BLOCK

Although there has been a considerable rise in production on the Maraetai block, the rate of progress has been impeded by a number of factors. On the dairy farms ragwort has been one of the major problems and even in recent years its control has necessitated a considerable amount of work and expense. The good energetic farmer has always managed to keep on top of this problem at an annual cost of around £60 to £70 on sprays, but where the effort is not so great the effects have been serious.

There is an acute labour problem in the area and this may well become a limiting factor towards increased production. The availability of work at sawmills and high wages in local public works makes farm work appear unattractive in comparison, so that little or no labour can be attracted on to dairy farms in the area at the rates the farmers are prepared to pay. The main source of labour is thus the family unit which is augmented with the services of contractors and occasionally a farm labour scheme, a number of which are in operation.

Due to the general inaccessibiilty of the area and in particular the distance from the freezing works, transport charges make large inroads into profit margins. Typical charges are: manure £3 a ton, lambs 4s a head and weaners 6s a head (to Tokoroa).

Due partly to the high freight charges and partly to the basic infertility of so much of the soils the annual cost of top-dressing is also high, amounting to 19s per ewe on a number of farms surveyed. Sporadic deficiencies of potash are showing up and treatment would add considerably to the manure expenditure. Some farmers substitute some of the more costly potash superphosphate for straight superphosphate in an attempt to remedy the deficiency, but the net result, probably because of the reduced phosphate dressing, appears to be the same. It appears that there should be an overall application of potassic-super in addition to the straight superphosphate but at the present level of prices this is not possible. There is, moreover, a lack of precise knowledge of the actual top-dressing requirements, as there are no field trials being carried out in the area. Recommendations are based on trials carried out twenty or thirty miles away but if the area is to be farmed satisfactorily in the future, field trials on the block will be essential.

Limited wheel-tractor country on most blocks necessitates contract cultivation because few of the farmers have the necessary crawler-tractor and plant. At £4 to £5 per hour, the annual crop of swedes and regrassing of fifteen to twenty acres creates a considerable item of expenditure. Some farmers in the area are now trying to winter on grass with reduced stock numbers in order to reduce this expenditure and their experience is that the saving in expenditure more than compensates them for the loss of income through reduced stocking.

A major problem which has been encountered on some blocks on the pumice country, but not to any marked extent on the Maraetai block, is that of soil erosion. This has been spectacular in some areas and undoubtedly could present a major threat to land development. Erosion on this type of country is the result of a number of physical forces; the removal of the scrub cover has exposed the light ash soils to the intense rainstorms which are characteristic of the area. The rate of 'runoff' has been increased markedly and there is growing evidence of gully erosion, of the build-up of underground water-courses and of the accumulation of debris in the main water-courses. The potential seriousness of this problem is now being recognised and advice on soil conservation is being sought at early stages of development as well as for 'salvage operations' in some areas already seriously affected. Fencing off water-courses, a reduction in stocking rates, and the retention of cover in critical areas are some of the practices which are now being followed. Their implication for the present study is that the costs of development and of operating farms on the pumice country are increased by the incidence or threat of erosion, while their carrying capacity may be reduced.[4]

[4]For a review of this problem see A. N. Glass, 'Pumice Land Conservation Problems'. Paper to 11th N.Z. Science Congress, Auckland, 1965.

Chapter 5

THE COST OF AGRICULTURAL DEVELOPMENT

THE BASIS OF THE PROJECTION

THE development programme set out and evaluated in this chapter is based on a projected plan for settling the Maraetai block to sheep and dairy farms. The plan was drawn up in Rotorua by Mr E. Parkes of Lincoln College in co-operation with Mr G. Palmer, District Field Officer of the Department of Lands and Survey. The projection was based on the experience of developing the Maraetai block itself over the period 1949/61.

Detailed title surveys of the block have not yet been completed but it was decided to work on the total area of 25,565 acres recorded for the block in the 1962 Annual Report of the Department of Lands and Survey. The projection is based on the same number of farms as were actually settled, 68 dairy farms and 42 sheep farms, but the settlement plan and the size distribution of farms were modified in the light of experience on the block. The units selected for settlement may be summarised as follows:

	Number	*Average size* (acres)	*Total area* (acres)
Dairy farms	68	157	10,655
Sheep farms	42	355	14,910
			25,565

The typical farm budgets presented later in this chapter are related to farms of these average sizes. It was assumed that, by settling with more careful attention to topography than was actually the case, the average dairy farm would have ninety per cent of its land cultivable while seventy per cent of the average sheep farms would be cultivable. The remainder of the land would be of moderate or steep slope.

It was originally decided to base the projection programme on three phases, primary development by Lands and Survey, secondary development by individual farmers after settlement, and the post-development period when the farm could be treated as a going concern. Field surveys of the Maraetai and similar blocks however showed that it was very difficult to define a stage when a farm had stabilised as a going concern as, while tangible development in the form of subdivision, fencing, extra building, etc., ceased after a number of years, carrying capacity and output were likely to go on increasing long after this due to consolidation of the land and improvements in management. The final analysis, therefore, contains two levels of production: one likely to be reached a few years after settlement and the second taken some time later to allow for some further realisation of the potential of the block. In the development budget these phases have been located at twenty-three years and thirty years after the beginning of primary development. The levels of output assumed correspond respectively to that achieved on the block at the time of survey and the potential production envisaged some seven years later by field officers of the State Advances Corporation and the Department of Lands and Survey, on the basis of experience on similar blocks.

COSTS AND PRODUCT PRICES

Before analysing each phase of development it is necessary to discuss the costs and products prices used to transform the physical development programme into development budgets. The basic development costs, and also the annual operating costs incurred by the Department of Lands and Survey and by the individual farmers after settlement, were expressed in constant values with no allowance for future changes in the general level of prices which may be attributable to inflation. This means that costs are expressed in real terms throughout the development programme. The costs used were based on prices ruling in the Rotorua area in the 1962/3 season. Their selection was simplified by the fact that each district office of the Department of Lands and Survey has to draw up a schedule of costs for submission to Head Office in Wellington in support of its work programme and appropriation for the coming year. Details of the costs used are shown in Appendix 1:1.

The selection of product prices for expressing annual output in terms of revenue raised larger issues. In accordance with the theoretical considerations outlined in Chapter 2 it was thought that the projection should be based on anticipated future prices but it is impossible to select a set of product prices without some reference to those ruling in the recent past. The wide range of possibilities is evident from a review of overseas prices realised for New Zealand's primary products over the last three years which are illustrated in terms of index numbers in Table 7:1 in Chapter 7, page 82.

The 1961/2 season was a particularly bad one with the overall level of export prices at a lower ebb than for several years. There was a marked recovery in 1962/3 which strengthened into boom conditions in 1963/4 when export prices for wool were higher than they had been since the Korean war, while prices for lamb, beef and dairy products were also strong. Wide price fluctuations of this nature have an even greater effect upon farm profits which are the residual of gross farm income minus costs. To have incorporated 1961/2 prices in the development budget would have given an unduly depressed picture for agriculture whereas to have used 1963/4 prices would have given the opposite impression of a high gross output, high profits and a spuriously high return to land development for agriculture.

As part of the development study the projection was programmed for a range of prices which were classed as 'pessimistic', 'moderate' and 'optimistic' and correspond approximately to the general level of product prices recorded for the three years discussed above. Although it was found possible to handle this range of values by means of computer programmes, the wide variations in results made it difficult to interpret results, especially for comparison between agriculture and forestry. Indeed to some extent the range of results made such a comparison almost meaningless. It was decided therefore to restrict this parametric budgeting to an exercise which is shown in Chapter 7 to illustrate the broad effects of variation in product prices, and to use a single set of prices for the major analysis. For this purpose 1962/3 prices were used as these appeared to avoid the extremes of either the previous year or the following one. They may be thought of as a moderate set of prices which it is reasonable to anticipate might be secured for our primary exports for some years into the future.

Other points supporting the choice of 1962/3 prices were:

(1) These were the prices selected by the Targets Committee of the Agricultural Development Conference after consultation with the Producer Boards.[1] This meant that our analysis of land development could be tied in with the broader approach of the Development Conference.

(2) The base period for the projection had already been selected as 1962/3 and throughout the study all development and annual costs were in terms of 1962/3 prices.

(3) The New Zealand Forest Service had also agreed to use 1962/3 as a base year for the projection. During lengthy discussions the members of the Forest Service engaged in the study mentioned that it would be unrealistic to include a range of prices in their analysis as timber is sold largely on the domestic market, subject to price control, so that no range of prices comparable to that recorded for agriculture is available.

A. THE PRIMARY PHASE OF DEVELOPMENT

The length of the initial phase of development was taken to be longer than that actually recorded on the block. Early settlement in particular was subject to the policy of turning out farms for resettlement as rapidly as possible with little regard for determining the optimum period of development either from the point of view of the Department or of the settler. A longer period of development would enable settlement to be made on to less raw properties with a greater degree of subdivision and pasture consolidation, so that the farmer would be faced with a less severe problem initially. The longer period of development would also enable the Department to carry on farming operations for longer periods and the farming profits gained in these later years could be used to offset some of the initial costs of development. The projection phasing adopted would therefore enable farms to be settled at lower prices or, put another way, would make the process of primary development more

[1]Report of the Targets Committee of the Agricultural Development Conference, March 1964, pp5-8.

profitable. The correct phasing of settlement can have a marked influence upon both the technical and economic outcome of land development and it is thought that more careful attention to this aspect of development is warranted.

For the purpose of the study it was assumed that dairy farms would in general be farmed for five years, and sheep farms for seven years, before settlement. On the basis of this assumption, it was possible to draw up a combined development and settlement plan which is given in Table 5:1. This was then used to calculate the area which would be developed and farmed by the Department each year, so providing the basis for the primary phase of the development budget and for settlement.

TABLE 5:1 PHASING OF SETTLEMENT

Year	Number of farms settled	
	Dairy farms	Sheep farms
5	12	
6	13	
7	13	
8	9	
9	8	
10		2
11	8	5
12		5
13	5	5
14		5
15		6
16		6
17		8

The primary phase of development was itself divided into three aspects of budgeting.

(1) basic capital development—clearing and breaking in new land, erection of buildings and other improvements.

(2) social costs of development—housing and roading,

(3) farming operations by Lands and Survey.

BASIC CAPITAL DEVELOPMENT

The year of settlement indicates the year in which the Department of Lands and Survey are involved with the physical requirements of settlement. The first full effective year of farming for the incoming settler is the year after the one shown in the above table. His first year's accounts are therefore likely to cover a period of twelve to sixteen months.

The budget for the primary phase of development was drawn up in detail in physical terms; the physical inputs required for land development and for housing and roading were based primarily on the Maraetai block supplemented by the records of three similar blocks in the Bay of Plenty, i.e. Waikite, Rotomahana and Waiotapu.

(i) *Land development and stock requirements*

The basic development programme assumes that the breaking in of new ground would continue for ten years while the primary phase of

TABLE 5:3 PRIMARY DEVELOPMENT PHASE: BASIC DEVELOPMENT COSTS (£s)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Shearing sheds	1850			1850			1850			2900	5250	5250	5250	4200	5250	5250	7350
Shearers' quarters	1430			1430			1430			1430							
Implement sheds	720	360	720	1080		4680	4680	5400	3960	3960	1800	4680	1440	2880	1080	1080	1080
Haybarns	195	390	195	975		3120	3315	2535	1755	1950	950	1950	780	975	780	585	585
Calf & pig houses						3600	3965	3965	2745	2440		2440		1525			
Milking sheds						11640	12480	12480	8640	7680		7680		4800			
Sheep yards	360		360				400			730	1650	1650	1650	1320	1650	1650	2310
Cattle yards	600							600									
Fencing	26100	21750	21000	21000	21000	26330	26452	26452	24774	26102	2982	6335	2982	5015	3577	3577	4767
Tracking	700	525	700	800	800	1700	1925	1925	1475	1150	375	2175	300	1350	225	225	225
Water supply	7778	6482	6482	6482	6482	16370	17202	17202	13902	14385	2840	9430	2840	6960	3408	3408	4540
Crushing	4725	3937	3948	3558	3558	3756	3692	3688	3640	3590							
Cultivation	14883	12403	11688	10628	10628	10517	10337	10326	10300	10050							
Seed & sowing	14250	11875	11875	11875	11875	11875	11875	11875	11875	12200							
Fertiliser	20700	17250	17250	17250	17250	17250	17250	17250	17250	17700							
Power installation	650	450	600	750	500	2600	2650	2950	2250	2250	800	2200	650	1400	500	500	500
Airstrips	1500					2000											
Administration	3927	3927	4389	4739	4528	7134	7360	8035	8372	8484	8484	8710	8710	8934	7777	6402	5089
Total outlay	100368	79349	79207	82417	77521	122572	126863	124683	110838	117002	25131	52500	24602	39449	24247	22677	26446

TABLE 5:4 PRIMARY DEVELOPMENT PHASE: SOCIAL COSTS (£s)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Housing	6350	3175	6350	9525	600	41275	41275	47600	34925	34925	15875	41275	12700	25400	9525	9525	9525
Through-roads	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824	18824
Access-roads	8000			8000			8000			8000							
Total outlay	33174	21999	25174	36349	19424	60099	68099	66424	53749	61749	34699	60099	31524	44224	28349	28349	28349
Combined totals	133542	101348	104381	118766	96945	182671	194962	191107	164587	178751	59830	112599	56126	83673	52596	51026	54795

development would cover in all seventeen years. Allowing for an even spread of work by contractors (including provision for land development in spring as well as autumn), some 3,000 acres would be broken in during the first year and approximately 2,500 acres in each of the following nine years. Given these acreages the following stocking standards were assumed to calculate stock requirements:

TABLE 5:2 CARRYING CAPACITIES

	Sheep per acre	Cattle per acre
New grass	1	1/6
1-year-old pasture	1½	¼
2 " " "	1½	¼
3 " " "	2	¼
4 " " "	2½	⅓
5 " " "	2½	⅓
6 " " "	3	½

Stock reconciliations were calculated year by year to fit into the total carrying capacity of the farming area. From these reconcilations were calculated stock sales and purchases, wool weights, shearing and crutching costs, requirements for labour, stock health, farm stores, winter crops and hay feed and dipping costs.

(ii) *Fertiliser treatment*

Initial fertiliser dressings of 9 cwt per acre of cobaltised superphosphate were applied in the first twelve to fifteen months. The annual dressing on all land to allow fertility build up over the initial farming period was 3 cwt/acre with DDT being allowed for every third year to control grassgrub.

(iii) *Fencing*

The development phase under Lands and Survey Department farming operations requires 1.2 chains of seven-wire fences per acre while settlement planning requires an additional 0.24 chains per acre for sheep farms and 0.64 chains per acre of three-wire fences for dairy farms.

(iv) *Water-supply*

Development areas require one pump and bore, 60 chains of piping and five troughs per 400 acres for Lands and Survey farming. At settlement an additional 80 chains of piping and eight troughs per 400 acres are required on sheep farms, and an additional 137 chains of piping and twenty-four troughs per 400 acres on dairy farms.

(v) *Labour requirements*

The shepherd requirements for the development phase is based on one man to between 1,500 and 2,000 ewes. One manager is able to oversee and control up to 12,000 ewes (20,000 sheep) but after this level is reached the block would be split into two for convenience of working.

(vi) *Airstrips*

Length of flight in any direction has to be not more than 2½ miles for economic application costs, therefore one airstrip covers up to 16,000 acres economically, requiring two airstrips on the block.

TABLE 5:5 PRIMARY DEVELOPMENT PHASE: STOCK NUMBERS

Stock on hand at the end of year

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Area farmed	3000	5500	8000	10500	13000	13620	14082	14544	15634	16236	14461	11433	9658	7100	4970	2840
SHEEP																
Lambs			720	2000	3500	4900	5400	6300	6500	7950	7500	8000	6995	5795	4400	2015
Breeding ewes		1980	5280	8555	11800	12820	15026	15560	18500	17390	18600	17800	16700	13025	9370	6570
Wethers	4500	4500	4500	4500	4430	4340	4310	4400	4500	4540	4000	2000				
Rams			155	200	360	410	450	465	550	580	467	450	417	324	260	150
Wether lambs								190	450	600	600	445	300	245		
CATTLE																
Heifer calves				182	384	400	420	515	550	690	640	650	600	500	400	170
„ yearlings					176	370	380	404	495	490	362	515	525	456	360	264
Cows			480	1000	1066	1200	1505	1700	1710	1700	1630	1548	1320	1056	775	445
Steer calves				175	260	280	420	465	500	600	600	450	100	100		
„ yearlings					950	830	670	404	447	480	576	576	432	96	384	
„ 2-year	500	195	520	1250	1310	1682	1630	1655	1588	1300	1400	870	800	620	260	530
„ adult		360				250				200						
Bulls				28	30	35	46	52	56	51	49	45	40	30	23	13

Having drawn up the primary development programme in physical terms the next stage in its evaluation was to transpose it into financial terms by applying prices to the physical inputs and outputs. As mentioned earlier in this chapter the prices used were those ruling in the Rotorua area in 1962/3. The primary development costs incurred each year over the seventeen years of development are shown in Table 5:3.

SOCIAL COSTS

Separate estimates were made of costs of housing and roading in order to make final results available in a dual form with and without social costs. It might be argued that the development of the block necessitates roads and houses so that their provision must be regarded as a necessary charge against the agricultural asset that is created. An alternative viewpoint however is that roading—especially through-roading—provides social advantages in opening up the block itself and also neighbouring country, which are largely intangible in nature and are not taken into account in assessing the benefits of the development. Further, the people who eventually farm the properties would have to be housed somewhere; if they were not put into farm houses they would require houses somewhere else so that the real cost to the nation of housing on the block is zero. The isolation of these social costs has a further advantage in that it makes possible a comparison of the provision of roading and housing required for agriculture and for forestry.

A house of eleven hundred square feet was provided for each property at an average cost of £3,175. Forty-four miles of through roads were provided on the block and an additional four miles of no-exit access roads. In the accountancy procedure adopted by Lands and Survey the full cost of all through-roads is borne by the Ministry of Works while that Ministry and the Department of Lands and Survey each pay half of the cost of access-roads. For the purpose of the present study all capital costs of roading were grouped together and included under social costs. Estimated social costs are shown in Table 5:4.

FARMING OPERATIONS

The basic feature of the farming operations carried out by the Department is heavy stocking by large mobs of dry stock, wethers and steers, in the early years to control regrowth and consolidate pastures. The 'lawnmower' effect of these large mobs is remarkably effective in establishing cocksfoot/red-clover pastures. Once the dry stock have fulfilled their useful working life (two years for wethers and three years for steers), they are moved to other pastures, fattened and sold. As pastures consolidate two-tooth Romney ewes and two-to-three-year Aberdeen Angus cows are purchased and breeding herds established. Most of the stock come from the Gisborne area but when sufficient numbers are available some may be transferred from other blocks. To minimise purchases in the early years all female stock bred are retained, as are most of the steer calves, but the wether lambs are fattened and sold.

As development proceeds the breeding stock increase to a peak, during Years 9-11, of almost 19,000 ewes and 1,700 cows, while wether

TABLE 5:6 PRIMARY DEVELOPMENT PHASE: DEPARTMENT OF LANDS AND SURVEY, FARMING ACCOUNT (£s)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
(a) FARM COSTS																	
Stock purchases	23125	17575	46402	67330	66075	51987	39650	31236	37935	32977	27007	14082	10450	6118	9708		
Plant & machinery	2180	1355	50	1980	1700	1900	480	1000	1300	1680	850		150		—250	—50	—1000
Farm expenses	2538	11917	22385	35916	46899	56067	62335	17744	72647	75359	76094	68101	60474	48851	37777	23794	16713
Total cost	27843	30847	68837	105226	114674	109954	102465	99980	111882	110016	103951	82183	71074	54969	47235	23744	15713
(b) FARM INCOME																	
Wool sales	2980	6716	8834	16268	24437	32711	36692	41554	43975	50110	49761	50792	45985	42025	33475	24650	12330
Stock sales		9830	28723	31271	69544	85852	110486	92457	99623	109713	112011	112813	106509	98126	88593	66340	75894
Gross income	2980	16546	37557	47539	93981	118563	147178	134011	143598	159823	161772	163605	152494	140151	122068	90990	88224
Net profit						8609	44713	34031	41716	49807	57821	81422	81420	85182	74833	67246	72511
Net loss	24863	14301	31280	57687	20693												

TABLE 5:7 PRIMARY DEVELOPMENT PHASE: SUMMARY DEVELOPMENT ACCOUNT (£s)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
(a) EXCLUDING SOCIAL COSTS																	
Basic development costs	100368	79349	79207	82417	77521	122572	126863	124683	110838	117002	25131	52500	24602	39449	24247	22677	26446
Net farm income																	
Profit						8609	44713	34031	41716	49807	57821	81422	81420	85182	74833	67246	72511
Loss	24863	14301	31280	57687	20693												
Net outlay	−125231	−93650	−110487	−140104	−98214	−113963	−82150	−90652	−69122	−67195	32690	28922	56818	45733	50586	44669	46065
(b) INCLUDING SOCIAL COSTS																	
Basic development costs	100368	79349	79207	82417	77521	122572	126863	124683	110838	117002	25131	52500	24602	39449	24247	22677	26446
Social costs	33174	21999	25174	36349	19424	60099	68099	66424	53749	61749	34699	60099	31524	44224	28349	28349	28349
Total development	133542	101348	104381	118766	96945	182671	194962	191107	164587	178751	59830	112599	56126	83673	52596	51026	54795
Net farm outlay																	
Profit						8609	44713	34031	41716	49807	57821	81442	81420	85182	74833	67426	72511
Loss	24863	14301	31280	57687	20693												
Net outlay	−158405	−115649	−135661	−176453	−117638	−174062	−150249	−157076	−122871	−128944	−2009	−31177	25294	1509	22237	16220	17716

and steer numbers decline. As settlement takes place the area farmed by the Department falls and stock numbers decline, until the end of Year 16 when the last farms are settled and the remaining stock are sold or transferred to other blocks. In the final years the Department endeavours to make breeding stock available from the block for the incoming sheep farmers but all the dairy stock are purchased from the Waikato area.

The annual build-up of stock in the hands of the Department on the block is shown in Table 5:5. These numbers were used as the basis for calculating stock purchases and sales and also for preparing itemised details of inputs and output which were based on records held by the Department of Lands and Survey. By applying 1962/3 prices it was possible to draw up annual farming budgets to represent the farming operations carried out by the Department of Lands and Survey. The summary results of these operations are shown in Table 5:6. It will be seen that the Department incurred net losses during the first five years but that from Year 6 onwards they made a profit from their farming operations on the block. In order to integrate this aspect of development with the basic development operations all farming losses were added to the outstanding figure for capital development for the year in which they occurred, while the profits of later years were deducted from the accumulated net costs of development. The results of this procedure are summarised in Table 5:7.

B. THE SECONDARY PHASE OF DEVELOPMENT

The secondary phase of development was that carried out by farmers on their own properties after settlement and before they had reached the stage of a 'going concern'. As part of the initial intention to conduct an historical analysis of the development of the block, field surveys were made of the dairy farms and of the sheep farms, with the intention of obtaining physical and financial records of development by individual farmers. These surveys were carried out by temporary research assistants of the Department of Agricultural Economics at Lincoln College, each of whom was based at the Hamilton office of the State Advances Corporation for a number of weeks and was given unstinted assistance by the District Appraiser and members of his staff.

The detailed surveys were based on a sample of farms from each block which were selected from detailed records of all farms held by the State Advances Corporation in order to secure a number of 'typical' farms at each stage of development. Selection was based primarily on the date of settlement, the area and nature of the property and the level of production. Within these limits much reliance was placed upon the personal advice of the Senior Field Officer of the Corporation, Mr Jack Hepburn, who had an unrivalled personal experience of settlement on the Maraetai block.

It was found that the farmers themselves did not keep good records of their development so a physical account was made of the major improvements on each farm, such as buildings, fencing, water-supply, etc., and these observations were then checked against financial records which farmers kindly made available to us through their accountants. When it was decided not to continue with an historical analysis but to concentrate on a projection study most of the financial data recorded after the field surveys became superfluous. The physical data remained of considerable value, however, as it was used extensively in drawing up post-settlement development budgets for typical dairy farms and sheep farms. Some modifications to the recorded data were made to allow for the assumption made in the projection that the farms would be settled at a more developed state than was historically the case for most of them. These modified records were used to draw up development budgets for a typical dairy farm and a typical sheep farm. The initial levels of production assumed on settlement and the final level taken after six years of secondary development are based on production levels experienced on the block. Details of this phase of development are set out in the tables below.

DAIRY FARMS: Physical requirements

(i) *Stock numbers and machinery requirements*

Table 5: 8 shows the initial settlement requirement for stock and for machinery while Table 5:9 shows the build-up of stock numbers during the six years of secondary development.

TABLE 5:8 INITIAL SETTLEMENT REQUIREMENTS

(a) Stock	Number		Price	Total cost
Dairy Cows	70	@	£28	1960
Heifers	20	@	£15	300
Bulls	2	@	£30	60
Breeding sows	6	@	£25	150
Boar	1	@	£25	25
Store pigs	10	@	£2.10.0	25
				£2520
(b) Machinery				
Light tractor (second hand)				400
Grass harrow				20
Mower				110
Siderake				55
Trailer				50
Buckrake (second hand)				20
Milking plant				400
Tools and Sundries				75
				£1130

TABLE 5:9

STOCK NUMBERS AT BEGINNING OF YEAR FROM SETTLEMENT

Year	1	2	3	4	5	6	P.V.
Cows	70	74	72	74	78	84	85
Heifers	20	18	14	18	22	20	20
Calves		16	20	24	22	22	22
Sheep		100	200	150	75		
Sows	6	6	6	6	7	8	8
Boar	1	1	1	1	1	1	1

(ii) *Fertiliser*

This item has been considered very important in view of the declining carrying capacities which appear to result from a change in pasture composition after settlement. Three hundredweight of superphosphate per acre per annum has been allowed in the development budgets.

(iii) *Fencing and water-supply*

An allowance is made for an increase in subdivision from eleven paddocks at settlement (nine erected and materials supplied for two more) to twenty paddocks, while sheep-proofing of existing three-wire fences is carried out to enable sheep to be used in the control of ragwort. Additional water-supply has to be provided for the new paddocks. This involves 95 chains of new fencing, 100 chains of sheep-proofing, nine new troughs and 30 chains of additional piping for the typical dairy farm.

(iv) *Shelter*

The block is exposed to southerly winds, and in order to provide some protection 80 chains of shelter are allowed for in the development budgets. Some of the expenditure on this item would be used for judicious siting of protective blocks of trees to control and prevent gully erosion.

(v) *Buildings*

Additions are required to the storage space in the haybarn, piggeries and implement shed. A car-shed and manure shed are built to provide additional space for implements and fertiliser storage.

The phasing of development costs, estimated on the basis of the physical requirements for development, are set out in Table 5:10. With the exception of Year 2 when a substantial sum is spent on sheep-proofing the original fences, the level of development expenditure runs to approximately £300 a year for six years.

TABLE 5:10 PHASING OF DEVELOPMENT COSTS (£s)

Year	1	2	3	4	5	6	Total
Fencing	200	150	100	67			517
Water-supply	100	100	97				297
Shelter		50	43	128	155	120	496
Sheep-proofing		240	60				300
Haybarn extension			60				60
Piggeries				105	45		150
Manure shed					100		100
Garage						150	150
Total	300	540	360	300	300	270	2070

The annual expenditure on development as well as operating costs are incorporated in the yearly budgets which have been drawn up for this secondary phase and are shown in Table 5:11. As with the analysis of the primary stage of development, capital items have been entered at full cost rather than in the form of annual depreciation charges in order to provide a true picture of the cash flow over the whole period of development. An item of £900 has been entered as the annual cost for management on each property. This is based on the standard farm management procedure of calculating wages of management as a basic wage and adding an additional amount calculated as a percentage of the total capital invested in the property. Calculations for both dairy and sheep farms came to within a few pounds of £900 a year; it was decided to maintain the cost of management at this level, rather than adjust it with the increasing value of the enterprises, and so allow residual income to appear in the annual profit or loss.

In drawing up the development budgets for the projection it was originally decided to take them only as far as the general level of production that had been reached on typical farms on the Maraetai block, which for dairy farms represented an output of around 140 lbs butterfat per acre. Actual records of production on the Maraetai block *(see Table 4:1)* showed clearly however that the average level of production had

TABLE 5:11 TYPICAL DAIRY FARM DEVELOPMENT BUDGETS (£s)

Year	1	2	3	4	5	6	Stable
EXPENSES							
Plant and machinery	1130						
Stock purchases	2520				25	25	
Standing charges	126	126	126	126	126	126	126
Administration expenses	51	51	51	51	51	51	51
Working expenses:							
Wages	90	90	90	90	90	90	90
Animal health	99	106	104	106	112	122	123
Artificial breeding		74	72	74	78	84	85
Cultivation	47	101	108	108	108	114	121
Shed expenses	32	34	33	35	36	40	40
Electricity	64	69	67	69	73	79	80
Freight	15	22	24	22	22	22	20
Hay and feed	75	82	82	82	90	97	98
Fertiliser	384	384	384	384	384	384	384
Seed	2	23	26	26	26	26	29
Weed and pest control	3		20	30	40	60	70
Stock selling	8	16	16	20	12	12	23
General	20	26	29	31	32	36	37
Vehicle	153	169	173	178	184	189	192
Repairs and maintenance	200	205	205	205	205	215	227
Development	300	540	360	300	300	270	
Total cash	5319	2118	1970	1937	1994	2051	1796
Management	900	900	900	900	900	900	900
Total expenses	6219	3018	2870	2837	2894	2951	2696
INCOME							
Milk	1552	1816	1903	2103	2427	2791	2949
Pigs	273	273	286	316	365	419	445
Stock Sales							
Calves	100	96	82	91	103	117	117
Cull cows	128	192	192	236	142	249	249
Sheep		240	480	360	180		
Total income	2053	2617	2943	3106	3217	3576	3760
Total expenses	6219	3018	2870	2837	2894	2951	2696
NET PROFIT			73	269	323	625	1064
NET LOSS	4166	401					

These development budgets are based on 1962/3 season prices in the Taupo district.

increased steadily over the years after settlement and experience on other blocks suggested that it would continue to increase for some years ahead. To 'stabilise' production in the projection at the early stage would give an incorrect impression of the true profitability of developing land for agriculture; some allowance must be made for reaching nearer to the potential of the land. It was assumed this could be done after a further seven years' farming; making a minimum of thirteen years' farming after settlement for each individual farm. In the summary development budget these points are taken at Year 23 and Year 30 respectively. The figures quoted for the potential level of production of 200 lbs butterfat per acre which it is assumed could be reached after this further period, and for the changes in annual costs and returns up to that stage, were based on estimates made by field officers of government departments who had been closely associated with developing this type of country over a considerable number of years. Table 5:12 shows the estimated numbers of stock at Year 23 and Year 30 while Table 5:13 gives the estimated trend of income and costs over this period.

TABLE 5:12

ESTIMATED STOCK NUMBERS AT YEAR 23 AND YEAR 30

	Year 23	Year 30	Additional numbers	Price	Increased cost
Sows	8	11	3	£25	75
Milking cows	85	110	25	£28	700
Yearling heifers	22	30	11	£20	220
					£995

TABLE 5:13

ESTIMATES OF INCOME AND COSTS FROM YEAR 23 TO YEAR 30 (£s)

Year	24	25	26	27	28	29	30
Gross income	3868	4118	4369	4619	4870	5120	5370
Total costs	2835	2975	3115	3254	3378	3534	3674
Net income	1033	1143	1254	1365	1462	1586	1696

The final phase in development is when the farms are established as going concerns so that no further development is entailed and annual income and expenditure have been stabilised. For the purpose of the projection it was decided to draw up two budgets of this nature, one based on the average level of production reached on the Maraetai block (Year 23) and the second based on the potential level of production which it is thought could be reached on the block after a further seven years' farming (Year 30). The former is based on a stocking capacity of 85 milking cows plus followers on an average dairy farm of 157 acres with a production of 138 lbs butterfat per acre; the latter assumed 120 cows plus followers with an output of 200 lbs butterfat.[2] Details of these annual budgets are shown in Table 5:14.

[2]Experience of the last two years 1963/4 and 1964/5 with good growing conditions throughout the season suggests that the potential level assumed may be conservative.

TABLE 5:14

ANNUAL BUDGETS FOR A TYPICAL DAIRY FARM AS A GOING CONCERN (£s)

	Year 23	Year 30
EXPENSES		
Plant and machinery		
Stock purchases		
Standing charges	126	126
Administration expenses	51	51
Working expenses:		
Wages	90	734
Animal health	123	167
Artificial breeding	85	110
Cultivation	121	162
Shed expenses	40	53
Electricity	80	105
Freight	20	25
Hay and feed	98	150
Fertiliser	384	450
Seed	29	43
Weed and pest control	70	70
Stock selling	23	30
General	37	55
Vehicle	192	200
Repairs and maintenance	227	230
Total cash	1796	2761
Depreciation	237	250
Management	900	900
Total expenses	2933	3911
INCOME		
Milk	2949	4336
Pigs	445	654
Stock sales:		
Calves	117	149
Cull cows	249	374
Sheep		
Total income	3760	5513
Total expenses	2933	3911
NET PROFIT	827	1602

A comparison of the budgets for the two years shows the marked effect upon total income and net profit of the increased level of production assumed to result from the additional seven years of consolidation.

SHEEP FARMS: Physical requirements

The projection of the secondary stage of development and the 'going concern' stage was carried out for the sheep farms on exactly the same basis as for the dairy farms. Tables showing physical requirements and financial estimates of costs and returns are given below.

(i) *Stock numbers*

Table 5:15 shows the initial stock numbers and machinery required on the sheep farms at settlement, while Table 5:16 illustrates the build-up of stock numbers in the six years after settlement.

A car is allowed for on a mileage basis and not accounted for as a farm requisite.

TABLE 5:15 INITIAL SETTLEMENT REQUIREMENTS

Stock	Number		Price	Total cost
Ewe hoggets	250	@	31/-	387
2-th ewes	450	@	53/-	1193
4 & 5-yr ewes	400	@	33/-	660
Rams	24	@	£10	240
2-yr heifers	20	@	£18	360
Breeding cows	70	@	£28	1960
Bulls	2	@	£150	300
				£5100
Machinery				
Light reconditioned tractor				400
Mower				110
Siderake				55
Trailer				50
Shearing plant				320
Tools and sundries				75
				£1010

TABLE 5:16 STOCK NUMBERS AFTER SETTLEMENT

Year	1	2	3	4	5	6	Stable
Breeding ewes	850	950	1050	1050	1020	1000	1000
Hoggets	250	282	282	300	300	305	305
Rams	24	26	26	26	25	25	25
Breeding cows	70	72	72	73	74	75	75
Heifers	10	9	14	16	16	15	15
Calves	10	15	16	18	16	16	16

(ii) *Fertiliser*

A level of 3 cwt superphosphate per acre per annum has been allowed for during the development budgets to counter the drop in carrying capacities that usually occur after three or four years' farming.

(iii) *Fencing*

Additional subdivision for a further four paddocks, which is required after settlement to raise the total number to sixteen, involves an additional 85 chains of fencing.

(iv) *Shelter*

This item is also quite important especially on the higher altitude parts of the block and some 80 chains have been allowed for at a total cost which includes fencing and planting.

(v) *Water-supply*

Additional paddocks require five new troughs and twenty chains of reticulation.

(vi) *Oversowing and top-dressing*

An allowance is made for oversowing and top-dressing some five acres of the property that would normally have been missed up to this stage.

(vii) *Roading and tracks*

To give good access to the newly subdivided paddocks ten chains of roading have been provided.

(viii) *Buildings*

Extensions to the haybarn soon become essential as stock numbers build up and the construction of a garage provides more room for implements in the implement shed.

The phasing of development costs is shown in Table 5:17 and the annual budgets over the first six years of farming after settlement in Table 5:18.

TABLE 5:17 PHASING OF DEVELOPMENT COSTS (£s)

Year	1	2	3	4	5	6	Total
Fencing	250	200	146				596
Water-supply	50	75	70				195
Shelter		25	35	170	150	220	600
Oversowing			49				49
Roading				60			60
Haybarn				70			70
Garage					150		150
Annual total	300	300	300	300	300	220	1720

TABLE 5:18 TYPICAL SHEEP FARM DEVELOPMENT BUDGETS (£s)

Year	1	2	3	4	5	6	Stable
EXPENSES							
Plant and machinery	1010						
Stock purchases	5099	100	215	215	215	215	205
Standing charges	148	151	153	154	156	158	159
Administration expenses	55	55	55	55	55	55	55
Working expenses:							
Wages	62	94	100	99	96	98	101
Animal health	145	150	171	177	174	172	180
Cultivation contracts	78	175	208	229	223	209	202
Electricity	17	19	22	21	21	20	20
Freight	30	30	30	28	27	25	25
Hay and feed	50	90	150	135	115	105	100
Fertiliser	939	939	939	939	939	939	939
Seed	3	37	44	52	52	49	46
Weed and pest control			5	12	20	12	10
Stock selling	166	182	225	229	218	228	218
General	39	43	48	52	50	48	49
Vehicle	113	127	152	152	148	144	146
Repairs and maintenance	220	229	239	257	258	254	248
Development	300	300	300	300	300	220	
Total cash	8474	2721	3056	3106	3067	2951	2703
Management	900	900	900	900	900	900	900
Total expenses	9374	3621	3956	4006	3967	3851	3603
INCOME							
Stock sales							
Lambs	1172	1363	1487	1487	1421	1378	1361
Ewes	144	193	253	495	430	405	408
Cattle	732	754	786	883	904	893	908
Wool	1843	2034	2242	2304	2235	2167	2175
Skins and hides	5	8	10	14	15	15	15
Total income	3896	4352	4776	5183	5005	4858	4867
Total expenses	9374	3621	3956	4006	3967	3851	3603
NET PROFIT		745	820	1177	1038	1007	1264
NET LOSS	5478						

These development budgets are based on 1962/3 season prices in the Taupo district.

TABLE 5:19 ASSUMED LEVEL OF STOCKING IN YEAR 23 AND YEAR 30

	Year 23	Year 30	Increased cost				
Ewes	1000	1200	200	@	53/-	=	530
Hoggets	305	370	65	@	32/-	=	104
Cows	76	120	44	@	£23	=	1012
Heifers	15	23	8	@	£28	=	224
Calves	16	24	8	@	£18	=	144
							£1114

POTENTIAL LEVEL OF PRODUCTION

Estimates of the potential carrying capacities of the sheep farms on the block were made by field officers of the State Advances Corporation who had long field experience on similar blocks. The levels of stocking assumed for the average sheep farm of 355 acres is 1,000 ewes plus followers, with 75 breeding cows and followers in Year 23, rising to 1,200 ewes plus followers, with 120 cows and followers in the Year 30.[3] The assumed increase in stock numbers is shown in Table 5:19, while estimates of income and expenditure on a typical sheep farm are shown in Table 5:20.

TABLE 5:20

ESTIMATES OF INCOME AND EXPENDITURE FROM YEAR 23 TO YEAR 30 (£s)

Year	24	25	26	27	28	29	30
Gross income	4888	5069	5249	5430	5610	5791	5972
Total expenditure	3626	3650	3673	3697	3720	3744	3768
Net income	1262	1419	1576	1733	1890	2047	2204

The annual budgets for a typical sheep farm stabilised as a going concern at Year 23 and at Year 30 are shown in Table 5:21. The effects of assuming higher physical standards of production, principally through better management are clearly shown. The estimated value of production has been increased by over £1,200, from £4,867 to £6,131 while costs are estimated to rise by under £200. As a result net profit is doubled, rising from £976 to £2,068.

C. THE SUMMARY DEVELOPMENT BUDGET

Having drawn up development budgets for the primary and secondary phases of development and operating budgets for the block for the 'going concern' stages it is necessary to integrate them. This has been done by bringing together all costs and returns incurred during the overall development of the block into a summary development budget. This is constructed on the overdraft principle; that is all costs are accumulated at compound interest while revenue received is used to reduce the amount outstanding. This process enables us to draw up a capital profile for the whole development period and also to show the overall cost of developing the Maraetai block. It is then possible to compare

[3]Experience of the last year or so (1964/5) suggests that the stocking rates assumed for Year 30 may be rather optimistic unless some of the management problems referred to in Chapter 4 can be overcome.

TABLE 5:21

ANNUAL BUDGETS FOR A TYPICAL SHEEP FARM AS A GOING CONCERN (£s)

	Year 23	Year 30
EXPENSES		
Plant and machinery		
Stock purchases	205	255
Standing charges	159	159
Administration expenses	55	55
Working expenses:		
Wages	101	102
Animal health	180	217
Cultivation contracts	202	216
Electricity	20	25
Freight	25	25
Hay and feed	100	110
Fertiliser	939	939
Seed	46	60
Weed and pest control	10	10
Stock selling	218	239
General	49	61
Vehicle	146	150
Repairs and Maintenance	248	250
Total cash	2703	2873
Depreciation	288	290
Management	900	900
Total expenses	3891	4063
INCOME		
Stock sales		
Lambs	1361	1553
Ewes	408	466
Cattle	908	1720
Wool	2175	2578
Skins and hides	15	15
Total income	4867	6131
Total expenses	3891	4063
NET PROFIT	976	2068

this cost with the capitalised value of the block as a going concern and so to judge whether the development is economically worthwhile.

(i) *Primary Development Phase*

All basic development costs were recorded as they were incurred and compounded forward at interest. Similarly, losses on farming operations by the Department of Lands and Survey were regarded as part of the costs of development and added to direct development costs, while profits made by the Department in later years were deducted from the accumulated development costs.

Two aspects of the method of accounting used require some comment; the first relates to the treatment of stock as an annual input while the second covers the time lag of annual costs and returns. Initially end of year balances were calculated by the taxation accounting procedure, at present in use by the Department of Lands and Survey, of a stock reconciliation at book values at the end of each year. The stock reconciliation

TABLE 5:22 SUMMARY DEVELOPMENT BUDGET, ASSUMING 5% RATE OF INTEREST (£s)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Primary devel'nt costs*	−125231	−93650	−110487	−140104	−98214	−113963	−82150	−90652	−69122	−67195	32690	28922	56818	45733	50586
Secondary costs†															
Dairy farms						−49992	−58970	−58486	−38530	−28615	12645	−5321	36576	28395	55155
Sheep farms											−10956	−25928	−22095	−17281	−11674
Total costs (excluding social costs)	−125231	−93650	−110487	−140104	−98214	−163955	−141120	−149138	−107652	−95810	34379	−2327	71299	56847	94067
+ ½ year interest	−128362	−95991	−113249	−143607	−100669	−168054	−144648	−152866	−110343	−98205	35238	−2385	73081	58268	96418
Compounded at 5%		−230771	−355559	−516944	−643460	−843687	−1030519	−1234911	−1407000	−1575555	−1619095	−1702435	−1714476	−1741932	−1732611
Social costs	−33174	−21999	−25174	−36349	−19424	−60099	−68099	−66424	−53749	−61749	−34699	−60099	−31524	−44224	−28349
Total costs (including social costs)	−158405	−115649	−135661	−176453	−117638	−224054	−209219	−215562	−161401	−157559	−320	−62426	39775	12623	65718
+ ½ year interest	−162365	−118540	−139053	−180864	−120579	−229655	−214449	−220951	−165436	−161498	−369	−63987	40769	12939	67361
Compounded at 5%		−289023	−442527	−645517	−798372	−1067946	−1335792	−1623533	−1870146	−2125151	−2231737	−2407311	−2486908	−2598314	−2660869

TABLE 5:22 SUMMARY DEVELOPMENT BUDGET, ASSUMING 5% RATE OF INTEREST (£s) continued

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Primary devel'nt costs*	44569	46065													
Secondary costs†															
Dairy farms	61469	64865	66203	67817	70116	70221	71049	71263	69155	76635	84183	91731	100367	106759	114239
Sheep farms	−12024	−5744	−11070	41778	44992	48177	48933	50359	52331	58925	65519	72113	78707	85301	91895
Total costs (excluding social costs)	94014	105186	55133	109595	115108	118398	119982	121622	121486	135560	149702	163844	179074	192060	206134
+ ½ year interest	96364	107816	56511	112335	117986	121358	122982	124663	124523	138949	153445	167940	183551	196862	211287
Compounded at 5%	−1722878	−1701206	−1729755	−1703908	−1671117	−1633315	−1591999	−1546936	−1499760	−1435799	−1354144	−1253911	−1133056	−992847	−831202
Social costs	−28349	−28349													
Total costs (including social costs)	65665	76837	55133	109595	115108	118398	119982	121622	121486	135560	149702	163844	179074	192060	206134
+ ½ year interest	67307	78758	56511	112335	117986	121358	122982	124663	124523	138949	153445	167940	183551	196862	211287
Compounded at 5%	−2726605	−2784177	−2866875	−2897864	−2924771	−2949652	−2974153	−2998198	−3023585	−3035815	−3034161	−3017929	−2985274	−2937676	−2873273

Costs shown as negative figures, revenue as positive figures. *Including farming operations by Department of Lands and Survey. †Including farming operations on individual properties.

account consists basically of adding stock purchases to stock on hand at the beginning of the year and then comparing this total with stock sales plus stock on hand at the end of the year. In doing this it is standard accounting practice to write stock down to book values, below the market prices at which they were bought in. This procedure reduces the tax liability of a farmer while he is building up his flock but at the expense of understating his real income when he disposes of it. For the purpose of drawing up a development budget relating input and outputs in real terms this procedure is inappropriate as buying in stock to build up the flock numbers involves the community in a real cost, because the stock could have been used for alternative productive purposes elsewhere, which is best measured by the market price. Similarly, the contribution of these stock to production is only recorded when they, or their progeny, are sold off the farms so that any reconciliation before this stage is reached is simply a book transfer and does not represent real output. The normal accounting procedure was therefore not used in this study for which we adopted a cash flow approach.

Secondly, in calculating the annual flow of costs and of returns we considered the times at which these were likely to be incurred. In the early years of development it was thought that physical inputs would be distributed widely over the year, particularly as the Department adopted the practice of sowing down pastures in spring and autumn. It was therefore decided to charge interest, at the given rate, on half of each year's investment to the end of that year, while for each subsequent year interest was compounded on the full amount outstanding. The same procedure was followed in dealing with farming operations in subsequent years in that half a year's interest was charged on the net return at the end of the year. Where this was negative it increased the cost of development but where it was positive it reduced the cost. This practice corresponds to that followed by the Department of Lands and Survey in assessing its costs and returns on development.

(ii) *Secondary Development Phase*

Having built up the cost of development over the primary phase it is necessary to adopt a procedure for incorporating into the overall budget the returns from settling individual farms. The approach adopted by the Department of Lands and Survey is to deduct the capital value of each farm at settlement which is determined by the Land Settlement Board, from the cost of development. This procedure gives a correct picture of the overdraft position of the Department at the end of Year 17 when the last farm is settled but it does not give an accurate picture from the national point of view because as each farm comes into settlement it contributes its annual net output (negative or positive) and not its capital value. In other words, it will take many years before the net returns from the settled property pay off the cost of development. The use of capital values is a book procedure, valid financially from the point of view of the Department (subject to the criticism about inflation made earlier) but not economically from the national point of view.

The approach adopted for the present study was to bring the typical development budget for the typical farm into the summary budget as each farm was settled. For example, in Year 6 the aggregate net losses on twelve dairy farms in their first year of operation, which amounted to £49,992, was added to the deficit outstanding on primary development at the end of that year. In the following year these twelve farms incurred a loss of £4,812 while the thirteen new dairy farms settled incurred a first-year loss of £54,158, so both these items were added to the total development cost at the end of Year 7. This process was repeated throughout the whole development programme until all farms had been introduced into the summary budget. When, as in the first years of settlement, they incurred farming losses, this added to the total cost of development; where, as in later years, they secured farming profits, this reduced the total development 'overdraft'. This procedure made it possible to build up the overall cost of development to Year 23 (and subsequently Year 30) to compare with the capital value of the block at this stage.

The summary development budget is shown in Table 5:22. Primary development costs, secondary costs after settlement and social costs are shown for each year in which they were incurred. In order to show the build up of a capital profile over the whole period of development, interest on half the sum incurred in each year has been added (to allow for the spread of costs and returns over the year), then the total sum has been compounded forward to the following year. This process has been continued throughout the whole period. For this particular table the capital profile has been worked through manually at a rate of interest of 5% in order to illustrate the procedure. Final results for Year 23 and Year 30 at different rates of interest (and in Chapter 7 for different price assumptions) have been processed by means of a computer programme. The range of results given by this analysis are discussed in later chapters.

Chapter 6

THE FUTURE VALUE AND PRESENT WORTH OF THE MARAETAI BLOCK UNDER FARMING

In the last chapter we were concerned with estimating the cost of developing the Maraetai block to the stage where farms on it could be classed as 'going concerns' with stabilised levels of outputs and costs. We must now turn to a consideration of what value the block would have to the nation when it had reached that position. The first stage in assessing this must be an estimate of the gross physical output of the block which will, of course, depend upon the level of productivity reached. Estimates of gross output at the two levels of productivity assumed are given in Table 6:1.

TABLE 6:1

ESTIMATED GROSS PHYSICAL OUTPUT FROM THE MARAETAI BLOCK IN YEAR 23 AND YEAR 30

	Year 23	Year 30
DAIRY BLOCK		
Butterfat (lbs)	1451460	2133840
Bobby calves	3332	4216
Cull cows and heifers	1088	1632
Pigs	5440	8030
SHEEP BLOCK		
Wool (lbs)	609000	721980
Fat lambs	21000	25200
Store lambs	5670	4872
Cull ewes	7560	9996
2-th ewes	2520	2100
Cull cows	462	714
Weaners	2016	3360

The total volume of output consists of a number of heterogeneous products, wool, lambs, butterfat, pigs, weaners, etc., which cannot be added together in any physical sense. The only common unit in which aggregate output can be expressed in terms of a single figure is monetary value. Here again we are faced with the question of what prices to use in valuing the physical quantities and as in drawing up the development budgets 1962/3 prices have been used. The estimated gross value of total output from the block in Year 23 and Year 30 is shown in Table 6:2.

Gross output gives a measure of the total production from the block but it is not sufficient in itself to indicate the real contribution made by the area to the economy as it does not allow for the annual working costs required to sustain that volume of output. For this reason, estimates of total annual costs are given in Table 6:3, which is calculated from the

TABLE: 6:2

ANTICIPATED GROSS REVENUE FROM THE MARAETAI BLOCK IN YEAR 23 AND YEAR 30

	Year 23 (£s)	Year 30 (£s)
DAIRY FARMS		
Butterfat	200500	294900
Bobby calves	8000	10100
Cull cows and heifers	16900	25400
Pigs	30300	44500
Total	255700	374900
SHEEP FARMS		
Wool and skins	92000	108900
Fat lambs	47300	56700
Store sheep	9900	8600
Cull ewes	8900	12700
2-th ewes	8200	6800
Cull cows	9200	15800
Weaners	28900	48000
Total	204400	257500
Total block	460100	632400

grossed up value of costs shown in the typical farm budgets for dairy and sheep farms in Table 5:14 and Table 5:21. By deducting annual costs, or inputs, from gross output the value of net output in Year 23 and Year 30 has been calculated as shown in Table 6:3.

TABLE 6:3

ESTIMATED AGGREGATE GROSS OUTPUT, ANNUAL COSTS AND NET OUTPUT IN YEAR 23 AND YEAR 30

	Year 23 (£s)	Year 30 (£s)
DAIRY FARMS		
Gross output	255680	374884
Costs	200601	267037
Net output	55079	107847
SHEEP FARMS		
Gross output	204414	257502
Costs	164095	171319
Net output	40319	86183
MARAETAI BLOCK		
Gross output	460094	632386
Costs	364696	438356
Net output	95398	194030

A comparison of the figures for the two different levels of productivity assumed for Year 23 and Year 30 shows an increase of gross output for the whole block from £460,000 to £632,000, a rise of 37%, while costs are shown to rise by 20% to £438,000. As net output is a residual item it is affected in a disproportionate way by these charges rising from £95,000 to £194,000, an increase of over 100%.

It was felt that basing the final analysis on the level of production reached in Year 23 was unduly conservative because there appeared no reason to believe that farmers would not continue increasing output from their properties after they had completed physical development in the form of buildings and other visible improvements, and that less tangible improvements in the form of herd improvement, better pasture management and so on, would be likely to form the basis of increasing production for some years ahead. From the methodological point of view it would have been more correct to take each farm through a post-settlement phase of six years first of all and then alternatively through thirteen years before stabilising it as a going concern. This procedure was not adopted because we wished to have one reference point, Year 23, for which we could tie the assumed levels of production to what was actually recorded in the field. The method adopted, therefore, was to carry all farms through to Year 23 and then assume that on average they developed over the following seven years along the lines set out already in Chapter 5; all reaching the potential level of production in Year 30. This method is likely to underrate the profitability of agricultural development as some farms which were settled early on would have moved into the potential phase of development before Year 23 and would therefore have stabilised at the higher level before Year 30.

TABLE 6:4

ESTIMATED CAPITALIZED VALUE OF THE MARAETAI BLOCK AS A GOING CONCERN IN YEAR 23 AND YEAR 30

		Year 23 (£s)	Year 30 (£s)
Aggregate net output		95000	194000
Capitalized value at	4%	2375000	4850000
	5%	1900000	3880000
	6%	1585000	3230000

At Year 23 (and also at Year 30) the net income of each farm was capitalized in perpetuity. For this purpose, an item of depreciation was introduced into the typical farm budgets to allow for the future replacement of capital inputs which had been entered at their full cost over the development period. The charge for depreciation was based on the capital value of the improvements concerned assessed at the usual rates of depreciation allowed for income tax purposes. The aggregate capitalized values gave the capital worth of the total asset which had been built up over this period. That is to say, it provided the capital value of the stream of annual gross returns minus annual operating costs if these were assumed to flow in perpetuity from the time the farms were stabilised as going concerns. An item of £1,762 was deducted from the annual aggregate net income to cover continuing administrative costs incurred by the State Advances Corporation; this facet of administration was subsequently transferred to the Department of Lands and Survey. The estimated capital value of the block as a going concern is shown in Table

6:4 in which the aggregate net income has been capitalized at three different rates of interest.

Net output has been rounded to the nearest £1,000 and capitalized values to the nearest £5,000.

The estimates of the capital worth of the Maraetai block in Year 23 and Year 30 represent the future value of the total farming asset, land improvements and stock as a going concern. The value for any single set of assumptions represents what we termed in Chapter 2 the 'demand price of the asset', i.e. the present worth at that time of the flow of net incomes into the future.

THE ECONOMIC PROFITABILITY OF THE PROJECT

A comparison of the capital worth of the Maraetai block given above with the cost of developing the asset as set out in the previous chapter provides a basis for determining whether the development was economically worthwhile. Initially, a comparison of this nature was worked out with the aid of a desk calculator using a single rate of interest, 5%. This procedure had the great merit that we were able to consider each calculation as it arose and so iron out the details of the calculation as we worked through the budget, but it also had the serious defect that it was very time-consuming. The problem of handling the analysis with a range of interest rates, two assumptions about the level of production and the inclusion or exclusion of social costs was solved by programming the summary development budget, including the final capitalization, for the IBM 1620 computer of the University of Canterbury.[1] With its aid we were able to run off results for all possible combinations of assumptions as to rates of interest, level of productivity, product prices and including or excluding social costs. The programme was actually carried out for rates of interest ranging from 2% to 8% but in the report results have been limited to those for 4%, 5% and 6% only as this was assumed a realistic range to work with under present and foreseeable conditions.

The outcome of these calculations, which may be regarded as the main results of the study, are shown in Table 6:5, in which estimates of future capital worth and cost of development are shown for Year 23 and Year 30. It will be seen that future capital worth increases from Year 23 to Year 30 due to the assumption that a higher level of productivity will be reached in the latter year without a corresponding increase in operating costs. The cost of developing the block on the other hand is shown to fall over this period, because it is assumed that all costs of development will have been incurred by Year 23 and that the following seven years represent a period of consolidation with increasing production. Aggregate net farm income is positive in these later years and incorporating these annual values into the development budget therefore has the

[1]The programme for this problem was written by Mr W. J. Whiten, formerly a graduate student of the Mathematics Department of the University of Canterbury and now of the University of Brisbane. Since Mr Whiten left the process of seeing the programme through the computer has been undertaken by Miss Mary Matheson of Lincoln College.

effect of reducing the total amount outstanding which is shown as the overall cost of development.

Deducting the cost of development from the anticipated future capital worth of the block gives its future net worth as a going concern and discounting this to its present value, gives the present net worth of the development programme. For example, taking the Year 23 level of development, and the rate of interest at five per cent and excluding social costs, the anticipated future capital worth is £1,908,000 compared with an estimated cost of development of £1,547,000. Deducting one from the other gives a future net worth of £360,000, which discounted over twenty-three years at five per cent has a present worth of £118,000. This final figure represents the present value of the development block under this particular set of assumptions.

TABLE 6:5

ANTICIPATED FUTURE CAPITAL WORTH, COST OF DEVELOPMENT, FUTURE NET WORTH AND PRESENT NET WORTH OF AGRICULTURAL DEVELOPMENT

Rate of Interest		Year 23 Development Excluding social costs (£000s)	Year 23 Development Including social costs (£000s)	Year 30 Development Excluding social costs (£000s)	Year 30 Development Including social costs (£000s)
	Future capital worth	2385	2385	4851	4851
4%	Cost of development	1144	2399	203	1853
	Future net worth	1241	−14	4648	2998
	Present net worth	503	−6	1433	924
	Future capital worth	1908	1908	3881	3881
5%	Cost of development	1547	2998	832	2874
	Future net worth	361	−1090	3049	1007
	Present net worth	118	−355	705	233
	Future capital worth	1590	1590	3234	3234
6%	Cost of development	2033	3712	1667	4195
	Future net worth	−443	−2122	1567	−959
	Present net worth	−116	−556	273	−167

It should be noted that varying the rate of interest affects these comparisons in two ways. Firstly, a higher rate of interest (or capitalization) *lowers* the future capital worth of the asset, as the anticipated future returns from the block are discounted more heavily. Secondly, a higher rate of interest *increases* the cost of developing the asset, as development and operating costs are compounded at the higher rate over the period of development.

SUMMARY RESULTS

Table 6:5 provides in outline the major results of the analysis of the agricultural projection which are summarised below. Assuming the conservative level of productivity indicated by Year 23, the development of the block for agriculture would be economically worthwhile if the rate of interest were five per cent or less and if social costs of roading and housing were excluded from the overall cost of developing the block. If these social costs are regarded as a charge against agriculture then development would cost more than the asset would be worth in Year 23 at any of the rates of interest shown. A more encouraging picture is seen when we turn to the assumption that productivity could reach a higher level as shown at Year 30. In this case the anticipated future value of the block exceeds the estimated cost of development at any of the rates of interest shown if social costs are excluded, and at four per cent and five per cent even when they are included.

LAND EXPECTATION VALUES

The most straightforward criterion for determining whether development is worthwhile is the net worth of the investment, calculated either in terms of its future or present value. In the field of land valuation, however, there is a long tradition of expressing residuals of this nature in terms of land values; in fact, the basic procedure in productive valuation is to deduct costs of co-operating factors from gross revenue and impute the residual as the unimproved annual value of the land, which is then capitalized at an appropriate rate of interest. Productive valuation, as carried out, for example, for a number of years in New Zealand under the Servicemen's Settlement and Land Sales Act, is essentially a static concept in that it is restricted to assessing the capital value of land and improvements at a given state of development. So far as is known the concept of productive valuation has not previously been used in a dynamic sense to determine the present worth of land for development.

A moment's thought will show that the results of the present study can be interpreted in this way. In calculating the cost of developing the Maraetai block no cost was placed on the unimproved land; the costs

TABLE 6:6

LAND EXPECTATION VALUES ACCORDING TO RATE OF INTEREST AND STAGE OF DEVELOPMENT

Rate of Interest	Year 23 development		Year 30 development	
	Excluding social costs	Including social costs	Excluding social costs	Including social costs
	(Land expectation value £s per acre)			
4%	19	0	56	36
5%	4	—14	27	9
6%	—4	—22	10	—1

compounded to the end of Year 23 and Year 30 relate to inputs of all factors other than land, that is they cover improvements to land, buildings, stock, plant, equipment and farming operations. The present worth of the residual value, which has been defined as the present net worth of the development, can therefore be regarded as the 'break-even' value of land; that is to say it represents the price that could be paid for the unimproved land if the cost of development were just to equal the future capital worth of the asset. This price which, following the terminology used for some years in forestry, may be called the 'land expectation value' will vary according to the assumptions made as to state of development, rate of interest and so on. The 'land expectation values' shown in Table 6:6 have been calculated by dividing the relevant present net worths in Table 6:5 by the gross area of the Maraetai block, 25,565 acres. A positive land expectation value indicates that it would be worthwhile to pay that value for the land before development whereas a negative value indicates that a subsidy of that amount would be required on the land if the development were to break even. For example, assuming the level of development actually reached on the Maraetai block in 1961 (Year 23), and taking the rate of interest at five per cent, it would be worthwhile paying £4 an acre for the block for development if the social costs of roading and housing were not charged against agriculture. At a rate of interest of four per cent this value rises to £19 an acre but at six per cent it falls to –£5 an acre.

THE INTERNAL RATE OF RETURN

Finally, the profitability of developing the Maraetai block for farming was analysed in terms of the internal rate of return. It will be recalled from Chapter 2 that this is the rate of interest which the project could pay if the cost of development to the going concern stage were just to equal the capitalized value of the asset at that stage. It may be regarded as a 'break-even' value for capital in the same way as the land expectation value may be regarded as a 'break-even' value for land. A computer programme was written for solving the internal rate of return for the equations based upon the summary development budgets. The results rounded to the nearest quarter per cent are given in Table 6:7 while the precise details are shown in brackets.

TABLE 6:7

INTERNAL RATE OF RETURN ACCORDING TO STAGE OF DEVELOPMENT, WITH AND WITHOUT SOCIAL COSTS

Year 23 development		Year 30 development	
Excluding social costs	Including social costs	Excluding social costs	Including social costs
5½%	4%	7%	5½%
(0.0545)	(0.0399)	(0.0700)	(0.0552)

Chapter 7

THE INFLUENCE OF PRODUCT PRICES UPON THE PROFITABILITY OF AGRICULTURAL DEVELOPMENT

IN the last two chapters we have analysed the projected development of the Maraetai block for agriculture under certain assumptions. While assuming a single level of product prices (1962/3) we have shown that the profitability of development will depend upon the following factors:

(*a*) whether social costs are included or excluded as a charge against development.

(*b*) the level of physical productivity achieved,

(*c*) the rate of interest charged on development and used for discounting future values.

The first of these differs in nature from the other two in that various levels of social costs have not been introduced; we have rather to decide as a matter of judgment whether such costs are or are not a legitimate charge against development for agriculture. For the other two, however, a number of assumptions have been made (two levels of productivity and three rates of interest) and Chapter 6 shows how the results of the development project vary with the assumptions made. This type of analysis is known as a 'sensitivity analysis'; it indicates how far the various assumptions are critical in affecting the results. For example, the results summarised in Table 6:5 show that the assumption that production from the Maraetai block will reach the level postulated for Year 30 is critical. Under that assumption development would be profitable at all rates of interest shown if social costs are excluded and at rates of interest up to six per cent even if they are included. If productivity does not go beyond the Year 23 assumption however the future value of the project would not be sufficient to include social costs at any of the rates of interest given and would only cover the other costs of development at rates below six per cent.

In order to limit the range of results to manageable proportions in the earlier chapters a single valued assumption was made for product prices. It will, however, be evident that the profitability of a land development scheme will in fact be strongly affected by the future prices at which the output can be sold. In order to analyse how critical product prices would be, three different levels of prices were selected and written into the development budget. No changes in costs of production were assumed so that the price asumptions made may be regarded as representing real changes in prices and in the value of net output.

As mentioned on page 51 three sets of prices were used; these were defined as 'pessimistic', 'moderate' and 'optimistic' to correspond to the level of prices for dairy products and for meat and wool products in the seasons 1961/2, 1962/3 and 1963/4. The index numbers used are shown in Table 7:1.

TABLE 7: 1 INDEX NUMBERS OF PRICES OF MAJOR EXPORTS

Year	Dairy products	Meat and wool products	All pastoral and dairy products
1961/2	927	927	927
1962/3	1000	1000	1000
1963/4	1051	1175	1138

Source: N.Z. Abstract of Statistics, 31 September, 1964.
Table 80 converted to 1962/3 base year.

Product prices realised in 1962/3 were used to calculate the value of gross output under moderate prices and the index numbers were then used as weights to calculate gross revenue under 'pessimistic' and 'optimistic' price assumptions. The results are given in Tables 7:2 and 7:3. Assuming the level of productivity reached in Year 23, the value of gross output would amount to £508,906 at 1963/4 prices compared with an estimated £460,094 at 1962/3 prices, and only £426,507 at 1961/2 prices.

While fluctuations in product prices affect the value of gross output they have an even greater effect upon the value of net output which is a residual after the deduction of annual costs from gross output. We have assumed that costs remain constant so that changes in product prices represent real changes, i.e. real profit margins are greater at high prices and less at low prices. The value of net output at the three different price levels is also shown in Tables 7:2 and 7:3. Assuming productivity remained at the level assumed for Year 23 the value of net output would reach £144,210 at optimistic prices compared with £95,398 at moderate

TABLE 7:2

ESTIMATED AGGREGATE GROSS OUTPUT, ANNUAL COSTS AND NET OUTPUT UNDER THREE PRICE ASSUMPTIONS IN YEAR 23 (£s)

	Price assumptions		
	Pessimistic	Moderate	Optimistic
DAIRY FARMS			
Gross output	237015	255680	268720
Costs	200601	200601	200601
Net output	36414	55079	68119
SHEEP FARMS			
Gross output	189492	204414	240186
Costs	164095	164095	164095
Net output	25397	40319	76091
MARAETAI BLOCK			
Gross output	426507	460094	508906
Costs	364696	364696	364696
Net output	61811	95398	144210

TABLE 7:3

ESTIMATED AGGREGATE GROSS OUTPUT, ANNUAL COSTS AND NET OUTPUT UNDER THREE PRICE ASSUMPTIONS IN YEAR 30 (£s)

	Price assumptions		
	Pessimistic	Moderate	Optimistic
DAIRY FARMS			
Gross output	347517	374884	394003
Costs	267037	267037	267037
Net output	80480	107847	126966
SHEEP FARMS			
Gross output	238704	257502	302565
Costs	171319	171319	171319
Net output	67385	86183	131246
MARAETAI BLOCK			
Gross output	586221	632386	696568
Costs	438356	438356	438356
Net output	147865	194030	258212

prices and £61,811 at pessimistic prices. At the higher level of productivity assumed for Year 30 the comparative figures would be £258,212, £194,030 and £147,865.

It has already been shown in Chapter 6 that by capitalizing the value of net output anticipated from the block when it is developed it is possible to make estimates of its future capital worth. The significance of product prices in making these estimates is illustrated in Table 7:4 in which a five per cent rate of interest has been used to capitalize the net outputs assumed for Year 23 and Year 30. For the former the capitalized value of the block is more than twice as high at optimistic compared with pessimistic prices while for Year 30 it would be just under £3 million assuming 1961/2 prices but over £5 million assuming 1963/4 prices.

TABLE 7:4

ESTIMATED CAPITALIZED VALUE OF THE MARAETAI BLOCK AS A GOING CONCERN UNDER THREE PRICE ASSUMPTIONS IN YEAR 23 AND YEAR 30 AT FIVE PER CENT INTEREST RATE (£s rounded to nearest £000)

	Price assumptions		
	Pessimistic	Moderate	Optimistic
YEAR 23			
Aggregate net output	62000	95000	144000
Captalized value at 5 per cent	1235000	1910000	2885000
YEAR 30			
Aggregate net output	148000	194000	258000
Capitalized value at 5 per cent	2960000	3880000	5165000

It is possible to show the full effects of 'parametric budgeting' upon the future and present net worth of development by presenting tables in which all assumptions were shown as variables. Table 7:5 shows results under the level of productivity assumed for Year 23 and Table 7:6 those for the higher productivity assumed for Year 30. Each of the

TABLE 7:5

ANTICIPATED FUTURE CAPITAL WORTH, COST OF DEVELOPMENT, FUTURE NET WORTH AND PRESENT NET WORTH OF AGRICULTURAL DEVELOPMENT UNDER THREE PRICE ASSUMPTIONS, INCLUDING AND EXCLUDING SOCIAL COSTS IN YEAR 23 (£000s)

Rate of interest		Excluding social costs Price assumptions			Excluding social costs Price assumptions		
		Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic
4%	Future capital worth	1545	2385	3605	1545	2385	3605
	Cost of development	1894	1144	12	3148	2399	1266
	Future net worth	—349	1241	3593	—1603	—14	2339
	Present net worth	—142	503	1458	—650	—6	949
5%	Future capital worth	1235	1908	2885	1235	1908	2885
	Cost of development	2366	1547	305	3817	2998	1756
	Future net worth	—1131	361	2580	—2582	—1090	1129
	Present net worth	—368	118	840	—841	—355	367
6%	Future capital worth	1030	1590	2405	1030	1590	2405
	Cost of development	2931	2033	668	4611	3712	2347
	Future net worth	—1901	—443	1737	—3581	—2122	58
	Present net worth	—498	—116	455	—937	—556	15

TABLE 7:6

ANTICIPATED FUTURE CAPITAL WORTH, COST OF DEVELOPMENT, FUTURE NET WORTH AND PRESENT NET WORTH OF AGRICULTURAL DEVELOPMENT UNDER THREE PRICE ASSUMPTIONS, INCLUDING AND EXCLUDING SOCIAL COSTS IN YEAR 30 (£000s)

Rate of interest		Excluding social costs Price assumptions			Including social costs Price assumptions		
		Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic
4%	Future capital worth	3695	4851	6455	3695	4851	6455
	Cost of development	1494	203	—1735	3144	1853	—85
	Future net worth	2201	4648	8190	551	2998	6540
	Present net worth	679	1433	2525	170	924	2016
5%	Future capital worth	2960	3881	5165	2960	3881	5156
	Cost of development	2304	832	—1380	4347	2874	653
	Future net worth	656	3049	6545	—1387	1007	4503
	Present net worth	152	706	1514	—321	233	1042
6%	Future capital worth	2465	3234	4305	2465	3234	4305
	Cost of development	3346	1667	—865	5872	4195	1660
	Future net worth	—881	1567	5170	—3407	—959	2645
	Present net worth	—153	273	900	—593	—167	461

tables shows the future capital worth of the project, its cost of development, its future net worth and present net worth, according to the varying assumptions made about product prices and rates of interest, and whether social costs are included or excluded from the overall cost of development. By reading along the rows of the tables it is possible to see how sensitive the results are to price assumptions and to compare results with and without social costs; by reading down the columns the influence of the rate of interest on the results can be studied; while a comparison between the two tables shows the significance of the level of productivity achieved.

The results of the sensitivity analysis may also be expressed in terms of land expectation values, which, as pointed out in Chapter 6, represent the prices that could be paid for the land in its unimproved state if its development were just to break even. The results of this analysis are shown in Table 7:7. The range of land expectation values given may be something of a surprise to those trained in the traditional valuation philosophy that there is only one price for land. However, it must be borne in mind that we are not seeking here to determine the value of a block of land at the present moment but rather that price which would represent a break-even value under a range of varying assumptions.

TABLE 7:7

LAND EXPECTATION VALUES UNDER THREE PRICE ASSUMPTIONS, THREE RATES OF INTEREST, INCLUDING AND EXCLUDING SOCIAL COSTS AT YEAR 23 AND YEAR 30

(£s per acre)

	Excluding social costs Price assumptions			Including social costs Price assumptions		
YEAR 23	Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic
Rate of interest						
4%	−6	20	57	−25	0	37
5%	−14	5	33	−33	−14	14
6%	−19	−5	18	−37	−22	1
YEAR 30						
Rate of interest						
4%	27	56	99	7	36	79
5%	6	28	59	−13	9	41
6%	−6	11	35	−23	−7	18

There is, in fact, not a unique value of land but a range of values according to the assumptions made. The break-even values have a maximum of £99 an acre if we exclude social costs of housing and roading from the cost of development and assume that the level of productivity reached corresponds to Year 30, that the output is sold at optimistic prices and that the relevant rate of interest is four per cent. At the other extreme there is a negative value of £37 an acre (which means that the development would have to be subsidised to that extent if it were to break even) which would result from charging social costs against agricultural development and an unfortunate coincidence of low productivity (Year 23) low product prices (pessimistic) and a high rate of interest (six per cent).

Finally, it was decided to express the profitability of the development in terms of the internal rate of return. The results of this analysis are given in Table 7:8. They show that development to the stage reached in Year 23 would only be likely to yield 5½% or better under optimistic price assumptions, unless social costs were excluded when moderate prices would be sufficient to secure this yield. If productivity reached the level predicted for Year 30 however, a yield of 5½% or better would be secured under all price assumptions if social costs were excluded and under all but pessimistic prices if they were included.

The purpose of a sensitivity analysis is to show the way the results of the analysis alter with changes in the assumptions made for the variables. If the probability distributions for these variables were known it would be possible to weigh the results according to the probability of the assumptions occurring. We should be in a somewhat similar position to the life insurance companies who relate annual premiums to sums assured on the basis of life expectancy and ruling rates of interest but, unfortunately, the economist cannot predict future prices with the same precision as the actuary calculating his life tables. We therefore come to the conclusion that investment decisions, which have to be made here and now, should be based upon those assumptions which appear to be most likely to eventuate viewed from the present time.

TABLE 7:8

INTERNAL RATE OF RETURN UNDER THREE PRICE ASSUMPTIONS, AT YEAR 23 AND YEAR 30, INCLUDING AND EXCLUDING SOCIAL COSTS

	Excluding social costs Price assumptions			Including social costs Price assumptions		
	Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic
Year 23	3½% (0.0359)	5½% (0.0545)	8¼% (0.0818)	2½% (0.0259)	4% (0.0399)	6% (0.0606)
Year 30	5½% (0.0543)	7% (0.0700)	9¼% (0.0936)	4½% (0.0428)	5½% (0.0552)	7¼% (0.0734)

This broad conclusion may be applied to the range of results shown in Table 7:7. Let us decide in the first place that we are justified in excluding social costs from the costs of developing the Maraetai block for agriculture. Now assuming that:

(i) the long term rate of interest will persist at six per cent,

(ii) product prices, while varying, are more likely to average around the 1962/3 level than that of either 1961/2 or 1963/4 and

(iii) the average level of productivity achieved on this class of country will reach 200 lbs of butterfat per acre on the dairy farms and five ewe equivalents per acre on the sheep farms within thirty years of breaking in the land,

then the results of the development analysis indicate that it would be profitable to develop the block for farming and that the unimproved value of the land would be around £11 an acre. Alternatively it may be said that under these assumptions, excluding a market rate of interest, the development would be profitable and would show a rate of return of seven per cent.

Chapter 8

A PROJECTION FOR LARGE-SCALE FARMING

IN this chapter an alternative agricultural development programme for the Maraetai block is postulated and evaluated. It is assumed that the Department of Lands and Survey break-in the block and then continue to farm it in large units instead of settling it to individual farmers. The purpose of this part of the study is to consider what differences in output, costs and profitability would arise if a practice of large-scale farming were introduced.

The projection programme for large-scale farming is based on the plan constructed for the settlement study and the basic data used are those provided by the Department of Lands and Survey for that study. It was assumed that the block of 25,565 acres was developed at the same rate and had the same requirements for fencing, water-supply, fertilizer and seed mixture as for the settlement plan but it was not, of course, necessary to add the extra fencing and water-supply required for settlement.

For the purpose of comparing the profitability of large-scale farming with development for settlement, only base year prices and costs (1962/3) and one rate of interest (5%) were used initially, so that the comparison was limited to two sets of results, including and excluding the social costs of housing and roading. In order to see whether variations in product price and interest rates had any effect on the comparative profitability of large-scale farming, a sensitivity analysis similar to that described in Chapter 7 was then carried out.

For budgeting purposes the projection was divided into the same three aspects used for the primary phase of the settlement projection, i.e.

(1) capital development costs; clearing and breaking in new land, erection of buildings and improvements,

(2) social costs of development; housing and roading,

(3) net annual costs of farming operations.

THE DEVELOPMENT PROGRAMME

The development programme was drawn up in detailed physical terms based on the coefficients and requirements outlined for the settlement projection. A number of minor alterations which were introduced are outlined below.

(i) *Rate of development, stock numbers build-up, fertilizer and seed requirements*

The rate of development for large-scale farming was assumed to be the same as for the settlement projection outlined in Chapter 5, both taking ten years to complete breaking in the whole area. The stock number build-up was largely based on the area of grazing available and the pasture age coefficients outlined in Table 5:2 but because the large-scale farming operations involved such large numbers of stock under each manager it was thought necessary to restrict the maximum carrying capacity of mature pasture to two-and-a-half sheep per acre rather than the three sheep per acre given in that table. The calculated carrying capacities were then used to derive the annual stock reconcilations including sales and purchases; wool clip; shearing, crutching and labour costs; farm stores and winter feed requirements. The same fertilizer treatment was assumed for both projections.

(ii) *Fencing and water-supply*

Development operations required 1.2 chains per acre of seven-wire treated fence posts, as described previously. Additional subdivision previously required for settlement was disregarded in this projection. Similarly, settlement water-supply was not required, leaving only one pump and bore, sixty chains of plastic piping and five troughs per four hundred acres to be assembled and installed during development.

(iii) *Labour requirements*

Shepherding requirements were based on sheep and cattle numbers, one man to 1,500 ewes and 270 cows being considered sufficient. It was assumed that the block would be run by four managers each of whom would be assisted by one head shepherd, seven shepherds and two general hands, and would be responsible for 16,000 sheep and 3,200 cattle.

(iv) *Airstrips*

It was assumed that the two airstrips constructed for settlement would both be required for large-scale farming.

Having drawn up the development programme in physical terms the next stage in its evaluation was to transpose it into a financial budget by applying prices to the physical inputs and outputs. The costs incurred each year over the sixteen years of development are shown in Table 8:1, all development costs being completed by Year 15 but because of the delay in reaching maximum carrying capacities and stock number build-up, farming operations are not assumed to stabilise until Year 16.

SOCIAL COSTS

As with the settlement projection the costs of housing and roading have been calculated separately from the other costs of development. The amounts involved are considerably reduced from those required for settlement because the total number of houses required for people employed on the block has dropped from one hundred and ten to forty-four, while the amount of access-roading required on the block dropped from 48 miles to 12 miles. Estimated social costs are shown in Table 8:2.

FARMING OPERATIONS

The basic features of farming operations as described in Chapter 5 are assumed to be continued for large-scale farming. Paddock size,

TABLE 8:1 BASIC DEVELOPMENT COSTS (£s)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fencing	26100	21750	21000	21000	21000	21000	21000	21000	21000	21560					
Sheep yards	360		360				400			400					
Cattle yards	600			600			600			600					
Wool sheds	2000			2000			2000			2000					
Shearing quarters	1600			1600			1600			1600					
Implement shed	720	360	720	1080	1800	1080	1440	1440	1440	1800	1440	1080	720	360	360
Haybarns	400	400	400	800	400	800	400	800	1200	800	400	400	400	400	800
Tracking	700	525	700	800	800	1000	1000	1000	1000	1000	800	600	300	150	
Water-supply	7778	6482	6482	6482	6482	6482	6482	6482	6482	6650					
Clearing	4725	3937	3948	3558	3558	3756	3692	3688	3640	3590					
Cultivation	14883	12403	11688	10628	10628	10517	10337	10326	10200	10050					
Seed and sowing	14250	11875	11875	11875	11875	11875	11875	11875	11875	12200					
Manure	20700	17250	17250	17250	17250	17250	17250	17250	17250	17700					
Power installation	650	450	450	800	1100	800	950	950	950	1100	600	450	300	150	150
Airstrip	1500					2000									
Shelter				2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
Total Outlay	96966	75432	74873	80973	77393	79060	81526	77311	77537	83550	5740	5030	4220	3560	3810

TABLE 8:2 SOCIAL COSTS (£s)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Housing	6350	3175	6360	9525	15875	9525	12700	12700	12700	15875	12700	9525	6350	3175	3175
Roading	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000			
Total Outlay	14350	11175	14350	17525	23875	17525	20700	20700	20700	23875	20700	17525	6350	3175	3175
Combined Total	111316	86607	89223	98498	101268	96585	102226	98011	98237	107425	26440	22555	10570	6735	6985

stocking rate and pasture management techniques used at present on development blocks have been used as the farming basis. The stocking policy is the same in the initial years as that described earlier with dry stock being run on the newly-developed areas. As weed regeneration decreases on older, well-managed pastures, the policy of grazing steer cattle and wethers for weed control changes to a fattening and breeding system, with breeding herds and flocks being built up and lambs and two or three-year steers being sold fat for slaughter.

With the completion of development a reappraisal of the system by means of partial budgeting suggested that the cattle policy would be less profitable than a policy of selling all steer calves and any heifer calves not required for herd replacements as weaners, hence cow numbers were increased and steer numbers decreased. This policy, although requiring slightly more intensive shepherding, does mean that the weaner calves are not carried over winter, therefore reducing the demand on winter feed reserves. It is assumed that the weaners would be sold to buyers from the South Auckland area who fatten large numbers of stock for the expanding Auckland beef market; the profitability of selling weaners on such a large scale would, of course, depend on the continued expansion of this market. By the end of Year 16, when pasture carrying capacity levels out it is estimated that the block would carry 49,000 ewes and 8,600 cows.

The annual build-up of stock numbers on the block under the assumed system of management is shown in Table 8:3. These numbers were used as the basis for calculating stock purchases and sales, wool production and farm operation requirements.

By applying base year (1962/3) prices it was possible to draw up annual farming budgets to represent the farming operations carried out and the summary results of these operations are shown in Table 8:4. It will be seen that the farming operations incurred net losses for the first eight years and again in Year 10 but in Year 9 and from Year 11 onwards profits were returned and increased until a stable level of output was reached in Year 16. A summary development budget was then drawn up by integrating the separate budgets, all farming losses being added to the outstanding figure for capital development for the year in which they occurred, while the profits of later years were deducted from the accumulated net costs of development. The result of this procedure is summarised in Table 8:5.

ACCUMULATED CAPITAL PROFILE

Having drawn up the cost of development and farming operations with and without social costs in the form shown in Table 8:5, it was then possible to find the annual capital requirements and total cost of development compounding all costs at an interest rate of five per cent. The accumulated capital profiles are shown in Table 8:6. Half-yearly interest has been charged on the net outlay for each year to approximate the requirements for working capital.

TABLE 8:3 STOCK ON HAND AT THE END OF YEAR

Item Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	P.V.
SHEEP																	
Lambs			720	2000	3500	5000	7000	9500	11000	12000	13000	13000	13000	13000	13000	13000	13000
Ewes		2000	5280	8550	11802	16002	22036	25500	30195	35935	38000	41004	46000	48292	49042	49042	49042
Wethers	4500	4590	4500	4450	4430	4500	4500	4500	4500	4500	4500	4000	2000	400	400	400	400
Rams			155	200	360	480	660	750	930	1080	1140	1230	1320	1470	1470	1470	1470
Total	4500	6590	10655	15205	20092	25982	34196	40250	46925	53515	56640	59234	62320	63162	63912	63912	63912
CATTLE																	
Calves				182	384	420	480	585	780	1100	1470	1600	1717	1717	2281	2281	2281
Yearlings					176	358	384	460	562	740	1056	1412	1536	1648	1648	1648	1648
Cows			480	1000	1066	1202	1433	1951	3000	3600	4087	5181	6583	7930	8168	8593	8593
Steer calves				175	260	280	400	500	600	900	840	420					
" 1-year					250	700	1200	1450	1400	1300	1200	808	400				
Adult steers	500	855	820	1250	1310	1300	1400	1400	1500	1400	1250	1152	768	380			
Bulls				28	30	33	45	60	90	114	126	150	204	228	258	258	258
Total	500	855	1300	2635	3476	4293	5342	6377	7932	9154	10029	10723	11203	11898	12245	12780	12780

TABLE 8:4 FARMING ACCOUNT (£s)

Item	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	P.V.
INCOME																	
Wool Sales	2980	6716	8834	16268	24437	31585	41028	54054	63488	72870	83603	88125	92631	98175	99618	100743	100743
Stock Sales		31938	52090	54274	81079	88117	92461	105200	116851	134595	143148	140613	163796	168665	178370	169137	181127
Total income	2980	38654	60924	70542	105516	110702	133489	159254	180339	207465	226751	237738	256427	266840	277988	269916	281870
EXPENDITURE																	
Administration	3870	3870	4359	4709	4940	5127	5521	5746	5746	5428	4730	4505	3450	3281	3113	2325	2325
Plant & machinery	2750	50	1550	2750	2800	1150	3200	2350	1,350	4000	3450	2400	2200	1200	4200	1200	2120
Stock purchases	22625	39047	59052	71314	58007	55832	65769	49164	70355	51332	26977	31094	36582	30123	21400	15990	15990
Working expenses	2538	13753	24451	37908	52711	64537	79012	94917	110485	126246	140512	147729	152831	155597	158850	160843	170951
Total Expendt're	31783	56720	89412	116681	118458	126646	153502	152177	187936	187006	175669	185728	195063	190201	187563	180358	191386
Net farm LOSS	28803	18066	28488	46139	12942	6944	20013		7598								
PROFIT								7077		20459	51082	52010	61364	76639	90425	89558	90484

TABLE 8:5 SUMMARY DEVELOPMENT ACCOUNT (£s)

Item	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	P.V.
							Excluding Social Costs										
Primary development	−96966	−75432	−74873	−80973	−77393	−79060	−81526	−77311	−77537	−83550	−5740	−5030	−4220	−3560	−3810		
Farm account	−28803	−18066	−28488	−46139	−12942	−6944	−20013	7077	−7597	20459	51082	52010	61364	76639	90425	89558	90484
Net outlay	−125769	−93498	−103361	−137112	−90335	−86004	−101539	−70234	−85134	−63091	45342	46980	57144	73079	86615	89558	90484
							Including Social Costs										
Primary development	−96966	−75432	−74873	−80973	−77393	−79060	−81526	−77311	−77537	−83550	−5740	−5030	−4220	−3560	−3810		
Social costs	−14350	−11175	−14350	−17525	−23875	−17525	−20700	−20700	−20700	−23875	−20700	−17525	−6350	−3175	−3175		
Combined total	−111316	−86607	−89223	−78498	−101268	−96585	−102226	−98011	−98237	−107425	−26440	−22555	−10570	−6735	−6985		
Farm account	−28803	−18066	−28488	−46139	−12942	−6944	−20013	7077	−7597	20459	51082	52010	61364	76639	90425	89558	90484
Net outlay	−140119	−104673	−117711	−144637	−114210	−103529	−122239	−90934	−105834	−86966	24642	29455	50794	69904	83440	89558	90484

TABLE 8:6 ACCUMULATED CAPITAL PROFILE (£s)

Item	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Total exclud. social costs	−125769	−93498	−103361	−137112	−90335	−86004	−101539	−70234	−85134	−63091	45342	46980	57144	73079	86615	89558
Half-yearly inter. at 5%	−128913	−95835	−105945	−140540	−92593	−88154	−104077	−71990	−87262	−64668	46476	48062	58573	74906	88780	91797
Compounded at 5%		−231194	−348699	−506674	−624601	−743985	−885261	−1001514	−1138852	−1260463	−1277010	−1292799	−1298866	−1288903	−1264568	−1235999
Total, includ. social costs	−140119	−104673	−117711	−144637	−114210	−103529	−122259	−90934	−105834	−86966	24642	29455	50794	69904	83440	89558
Half-yearly inter. at 5%	−143622	−107290	−120654	−148253	−117065	−106117	−125295	−93207	−108480	−89140	25258	30191	52064	71651	85526	91797
Compounded at 5%		−258093	−391652	−559488	−704527	−845870	−1013459	−1157339	−1323686	−1479010	−1527703	−1573897	−1600528	−1608903	−1603822	−1592216

THE FUTURE VALUE OF THE MARAETAI BLOCK UNDER LARGE-SCALE FARMING

We now turn to consider what the value of the block would be under large-scale farming when it had reached the going concern stage at the end of Year 16. To do so we must first estimate the gross physical output of the block and then value it at base year prices.

TABLE 8:7

ESTIMATED GROSS PHYSICAL OUTPUT AND GROSS REVENUE AT 1962/3 PRICES AT THE END OF YEAR 16

	Physical output	Revenue (£s)
Wool and skins	671620 lbs	100743
Wether lambs	23385	58462
Ewe ,,	10295	15442
Cull 2-th ewes	1000	2650
,, aged ,,	8276	8751
Weaner calves	4753	59156
Yearling heifers	542	9756
Cull cows	1238	24760
,, bulls	54	2160
		281870

By taking account of the annual inputs required to produce the level of output shown in Table 8:7 we can obtain the net output from the block, and when this is capitalized at a rate of interest of five per cent an estimate of the demand price of the project under the assumptions outlined in the first part of this chapter is obtained.

TABLE 8:8

ESTIMATED AGGREGATE GROSS OUTPUT, ANNUAL COSTS, NET OUTPUT AND CAPITALIZED VALUE AS A GOING CONCERN AT 5% INTEREST RATE IN YEAR 16

	(£s)
Gross output	281870
Annual costs	191386
Net output	90484
Capitalized value at 5%	£1810000

THE ECONOMIC PROFITABILITY OF THE PROJECTION

A comparison between the capital worth of the block given in Table 8:8 with the cost of developing it as set out in Table 8:6 provides a basis for determining the economic worthwhileness of the project. The summary set out in Table 8:9 shows that the capital worth of the project at the end of Year 16 is £1,810,000 which is more than the compounded cost of development, £1,236,000 excluding social costs and £1,592,000 including social costs. Deducting the cost of development from the anticipated future capital worth of the project gives its future net worth as a going concern and discounting this to its present value gives the present net worth of the development programme.

TABLE 8:9

LARGE-SCALE FARMING; ANTICIPATED FUTURE CAPITAL WORTH, COST OF DEVELOPMENT, FUTURE NET WORTH AND PRESENT NET WORTH, AT 5% INTEREST, INCLUDING AND EXCLUDING SOCIAL COSTS (£000s)

	Excluding social costs	Including social costs
Future capital worth	1810	1810
Cost of development	1236	1592
Future net worth	574	218
Present net worth	263	100

A COMPARISON OF LARGE-SCALE FARMING AND SETTLEMENT FARMING

It is now possible to make a comparison of the results of the projection study for large-scale farming with those for settlement farming. For this purpose a single set of produce prices and costs (1962/3) and a single interest rate (five per cent) were used initially and then a sensitivity analysis was carried out. Table 8:10 shows that gross output from large-scale farming would be approximately £280,000 compared with £460,000, at the level of productivity assumed for Year 23, and £630,000, at that for Year 30, under settlement farming. This illustrates the point that settlement farming with its closer supervision and greater intensity of inputs generates a larger volume of physical output. At the same time, however, it involves greater costs of operation; the comparative figures are £191,386 a year under large-scale farming compared with £360,000 (Year 23) and £438,000 (Year 30) under settlement farming.

A major element in the difference in annual costs incurred by large-scale farming and settlement farming is the labour input. It has been assumed that the block could be run as a large-scale unit with 44 full-time men (4 managers, 4 head shepherds, 28 shepherds and 8 general hands). Settlement farming is much more demanding for labour, 110 men are required as owner-managers on the individual properties and, in addition, contract labour is also required, primarily for shearing. At the level of productivity assumed for Year 30 it has been assumed that a further 68 full-time dairy hands would also be required on the dairy farms. The annual cost of total labour inputs may be summarised as £48,000 for large-scale farming compared with £109,000 for settlement farming in Year 23 and £153,000 in Year 30. From the national point of view the most important figure is net output, or gross output minus operating costs. On this basis it appears that large-scale farming with a net output of £90,000 would be slightly behind settlement farming if a level of productivity equivalent to Year 23 were reached (£95,000) and considerably behind if the Year 30 level (£194,000) were attained. These figures, together with comparative figures for net output capitalized at five per cent, are shown in Table 8:10.

In addition to comparing net output we have to take into account the differences in cost of developing the block and the length of time required for development under the two systems. It will be recalled from Chapter 5 that the cost of development is a net figure in that annual farming

TABLE 8:10

COMPARISON OF ANTICIPATED GROSS OUTPUT, COSTS AND NET OUTPUT FOR THE MARAETAI BLOCK FOR LARGE-SCALE FARMING IN YEAR 16 AND SETTLEMENT FARMING IN YEAR 23 AND YEAR 30 UNDER MODERATE PRICE ASSUMPTIONS (£s)

	Large-scale farming	Settlement farming	
	Year 16	Year 23	Year 30
Gross output	281870	460094	632386
Annual costs	191386	364696	438356
Net output	90484	95398	194030
Capitalized net output	1810000	1908000	3881000

profits are deducted from capital costs of development; for this reason the figures given for cost of development in Table 8:11 do not reflect the gross input of real resources which would be relatively greater for Year 23 and greater still for Year 30.

Deducting net costs from future capital worths gives values for future net worth which are given in Table 8:11. They show that large-scale farming compares favourably with settlement farming in Year 23 but unfavourably with settlement farming in Year 30, both when social costs are excluded and also when they are included in total costs of development.

TABLE 8:11

COMPARISON OF ANTICIPATED CAPITAL WORTH, COST OF DEVELOPMENT, FUTURE AND PRESENT NET WORTHS BEWEEN LARGE-SCALE AND SETTLEMENT FARMING YEAR 23 AND YEAR 30 AT 5% INTEREST UNDER MODERATE PRICE ASSUMPTIONS (£000s)

	Large-scale farming	Settlement farming	
		Year 23	Year 30
Excluding social costs			
Future capital worth	1810	1908	3881
Cost of development	1236	1547	732
Future net worth	574	361	3049
Present net worth	263	118	706
Including social costs			
Future capital worth	1810	1908	3881
Cost of development	1598	2998	2873
Future net worth	218	−1090	1008
Present net worth	100	−355	233

The comparison is however complicated by the fact that each of the three systems referred to relates to a different year. The level of output shown under large-scale farming could be achieved within sixteen years whereas the levels of net productivity under settlement farming would not be achieved for twenty-three or thirty years. Allowance for this difference in period of development can be made by discounting each value of future net worth over the appropriate number of years to obtain its present net worth.

If we make the comparison assuming that social costs are to be included as a part of the total cost of development, then the influence of the much smaller level of social cost involved in large-scale farming becomes apparent. The cost of development is much less than for settlement farming and the net worth when discounted over the development period comes to £100,000 compared with a higher figure of £233,000 under settlement farming for Year 30 and a negative value of –£355,000 for Year 23. If social costs are excluded each projection shows up more favourably but the order of ranking remains the same. The present net worth of large-scale farming, £236,000, falls between that of £706,000 under settlement farming for Year 30 and £118,000 for Year 23.

This comparison between the two systems of farming can be expressed in terms of the land expectation values or the price per acre that could be paid for the land under each form of development, and under the various assumptions if the project were just to break even. These land expectation values, which are summarised in Table 8:12, again illustrate the conclusion that if social costs are excluded the profitability of large-scale farming lies between Year 23 and Year 30 of settlement farming, but that if social costs are included it is almost as profitable as Year 30 and very much more profitable than Year 23 of settlement farming.

TABLE 8:12

LAND EXPECTATION VALUES, INCLUDING AND EXCLUDING SOCIAL COSTS, FOR LARGE-SCALE FARMING AND FOR YEAR 23 AND YEAR 30 OF SETTLEMENT FARMING AT 5% INTEREST (£s/Acre)

	Large-scale farming	Settlement farming	
		Year 23	Year 30
Excluding social costs	10	5	28
Including social costs	4	—14	9

Finally, a comparison was made between large-scale and settlement farming at 1962/3 prices, in terms of the internal rate of return, which was carried out by using the computer programme discussed previously in Chapter 6. The budget for large-scale farming was written without a specific interest charge and then solved on the IBM 1620 computer for the break-even rate of interest. The solutions obtained were 6½% when social costs were excluded and 5½% when they were included. Comparisons with the internal rates of return obtained for settlement farming, which are illustrated in Table 8:13 showed that this criterion gave similar results, with one exception, to present net worth, for ranking the various possibilities. Large-scale farming appeared to be a better proposition than Year 23 settlement farming, but while it gave a lower return than Year 30 settlement farming if social costs were excluded it gave fractionally better results (0.0575%) than Year 30 (0.0552%) if social costs were taken into account.

TABLE 8:13

INTERNAL RATE OF RETURN OF LARGE-SCALE FARMING AND SETTLEMENT FARMING YEARS 23 AND 30 INCLUDING AND EXCLUDING SOCIAL COSTS

	Large-scale farming	Settlement farming	
		Year 23	Year 30
Excluding social costs	6¼%	5½%	7%
	(0.0618)	(0.0545)	(0.0700)
Including social costs	5½%	4%	5½%
	(0.0539)	(0.0399)	(0.0552)

So far the comparison between large-scale and settlement farming has been conducted in terms of 1962/3 prices only and at the single interest rate of five per cent. In the last section of this chapter these limiting assumptions are dropped and a sensitivity analysis carried out by varying product prices and interest rates, as in Chapter 7. The purpose is to see whether any of these variables are critical in comparing the alternative forms of development.

Table 8:14 shows the effect of changes in the rate of interest and in product prices, upon the profitability of the projections expressed in terms of present net worth. It can be seen that, when social costs are excluded, large-scale farming shows better results than Year 23, but poorer results than Year 30 settlement farming. If social costs are included in total costs of development a slightly different picture appears. Large-scale farming is still more profitable than Year 23 farming at all interest rates and all levels of prices; in addition, when development is unprofitable for both large-scale farming and for Year 30 settlement farming (at pessimistic prices with a five per cent rate of interest and at pessimistic and moderate prices at a six per cent rate of interest) it is less unprofitable for the former system than the latter. The explanation is that compounding costs of development and discounting future net worth to present value at higher rates of interest has a greater influence upon the longer term of production for settlement farming over thirty years than for large-scale farming over sixteen years. The effect of pessimistic prices, whatever the rate of interest, is to increase the cost of development, which is a net figure, and also to reduce the future capital worth of the asset. Both factors tell more heavily against settlement farming, which relies upon a greater volume of output to bring down its cost of production and to enhance its future capital value.

Finally, it was decided to express the sensitivity analysis of large-scale and settlement farming in terms of the internal rate of return and the results of this analysis are given in Table 8:15. Once again large-scale farming shows better results than Year 23 settlement farming under all

TABLE 8:14

PRESENT NET WORTH OF LARGE-SCALE AND SETTLEMENT FARMING YEARS 23 AND 30 INCLUDING AND EXCLUDING SOCIAL COSTS AT THREE RATES OF INTEREST AND THREE PRICE ASSUMPTIONS (£000s)

	Excluding Social Costs			Including Social Costs		
	Large-scale farming	Settlement farming Year 23	Settlement farming Year 30	Large-scale farming	Settlement farming Year 23	Settlement farming Year 30
4% Interest						
Pessimistic prices	239	−142	679	57	−650	170
Moderate prices	638	503	1433	465	−6	924
Optimistic prices	1613	1458	2525	1430	949	2016
5% Interest						
Pessimistic prices	−39	−368	152	−210	−841	−321
Moderate prices	263	118	706	100	−355	233
Optimistic prices	1003	840	1514	831	367	1042
6% Interest						
Pessimistic prices	−205	−498	−153	−367	−937	−593
Moderate prices	32	−116	273	−121	−556	−167
Optimistic prices	620	455	900	458	15	461

assumptions considered. It also yields a fractionally higher return than Year 30 settlement farming, under optimistic price assumptions, whether social costs are included or not, but not under moderate or pessimistic price assumptions.

It will be noted that the comparison between large-scale farming and Year 30 settlement farming when the internal rate of return is used as a criterion are not completely symmetrical with those given by the present net worth, illustrating the fact that the two criteria do not give entirely the same ranking of projects.

TABLE 8:15

INTERNAL RATE OF RETURN TO LARGE-SCALE FARMING, AND SETTLEMENT FARMING IN YEAR 23 AND YEAR 30 UNDER THREE PRICE ASSUMPTIONS, INCLUDING AND EXCLUDING SOCIAL COSTS

	Large scale	Settlement farming	
	farming	Year 23	Year 30
Excluding social costs			
Pessimistic prices	4¾%	3½%	5½%
	(0.0482)	(0.0359)	(0.0543)
Moderate prices	6%	5½%	7%
	(0.0618)	(0.0545)	(0.0700)
Optimistic prices	9½%	8¼%	9¼%
	(0.0955)	(0.0818)	(0.0936)
Including social costs			
Pessimistic prices	4%	2½%	4¼%
	(0.0417)	(0.0259)	(0.0428)
Moderate prices	5¼%	4%	5½%
	(0.0539)	(0.0399)	(0.0552)
Optimistic prices	8¼%	6%	7¼%
	(0.0829)	(0.0606)	(0.0734)

In the light of these results it appears necessary to look closely at the levels of production achieved on settlement properties after development by the Department of Lands and Survey. If it is unlikely that carrying capacities similar to those outlined for the Year 30 assumptions can be achieved then we should seriously examine our present policy of development for settlement. One aspect that should be considered carefully is the size of unit settled. If properties are too small they will tend to be uneconomic, in that a high level of inputs will be required in relation to the level of output obtained. This factor will be particularly important if pasture and erosion problems mean that stocking rates can not be pushed up to those assumed in Year 30 settlement. The wide divergence in profitability between the Year 23 and Year 30 assumptions indicates the need for more basic research into soil, fertilizer and management problems, and more intensive advisory work to translate the results obtained into farming practice. The results also suggest that the social policy of turning out as many farms as possible might have to be reviewed in terms of settling fewer but better developed and larger properties. They also emphasise that managerial ability should be the major qualification on which settlement farmers should be selected.

Chapter 9

FORESTRY DEVELOPMENT OF THE MARAETAI BLOCK

ESTIMATION OF SITE QUALITY AND CHOICE OF SPECIES

THE description of the agricultural development of the Maraetai block given in Chapter 4 naturally relies on historical evidence; for example, the course of pasture establishment, and the rises in stock carrying capacity were obtained directly from field experience. By contrast, the course of forest development has to remain hypothetical and so greater attention must be given to showing that the projections made are soundly based, as first-hand evidence is lacking. Initially, it may seem difficult to make an accurate assessment of the performance of forest crops on an area now largely used for farming, but fortunately a number of indications can be used to define both the suitability of the site for various species, and also the quantitative performance of the species on the sites.

The striking homogeneity of the topography and aspect of the block has been mentioned in Chapter 3, and from a tree-growing point of view it can be added that the soil types—being almost all Taupo silty sands or their hill phase—are also relatively homogeneous. (The forest projection could still be made if the area were a complex of soil types at differing altitudes and aspects, but this would involve much more work and explanation.) In addition to this homogeneity of soils, the effect of climate, and probably burning regimes on the vegetation present before development occurred, is such that the vegetation itself is an efficient indication of site quality[1]. The texture of the original aerial photographs of the block taken just before land development began, together with the notes on the four-inches-to-the-mile topographical maps, supplemented by local knowledge, provide information on the original vegetation and hence on the site quality. The remaining asset in establishing site potential and growth performance of exotic forest species is that provided directly by a State Forest (Mangakino) of young trees immediately adjoining the block by the Mangakino stream and the older and very extensive areas owned by New Zealand Forest Products Ltd to the north and east. Further, this company originated and maintained an invaluable set of physical yield plots for which results have recently been published[2]. Hence the combination of uniform sites, together with a good idea of the original vegetation can lead to a reliable estimation

[1]J .Ure, 'The Natural Vegetation of the Kaingaroa Plains as an indication of Site Quality for Exotic Conifers', N.Z. Jour. For., Vol. 6, No. 2, 1950: pp112-3.

[2]S. H. Spurr, 'Growth and Mortality of a 1925 planting of *Pinus radiata* on pumice', N.Z. Jour. For., Vol. 8, No. 4, 1962, pp560-9.

of species suitability, which can be corroborated by the performance of neighbouring plantations.

In any given area, the most important decision in afforestation is the choice of species to be used, and the silvicultural regime to be followed. Ecological limits define which species can be grown and how well they can be grown, and within these limits economic considerations define which ones should be grown. In the case of the Maraetai block—which is particularly favourable for exotic afforestation—application of these two restraints does not result in a unique solution as both Douglas fir *(Pseudotsuga taxifolia)* and *Pinus radiata* would most fully satisfy both sets of criteria. The critical question as to final choice was decided in favour of *P. radiata* by the proximity of an integrated pulp and paper mill together with a large exotic sawmilling industry at Kinleith, Tokoroa and Putaruru based almost exclusively on the use of this species. Further, one of the original reasons for the choice of a case study in the Taupo-Rotorua area was to investigate sales of forest produce as pulpwood, for which purpose pine is preferable to fir.

The productivity of *P. radiata* on these sites was estimated to be of Site Index 95[3]—that is, the height of the hundred biggest trees would be 95 ft at twenty years of age. From this estimate of site quality, together with the prescribed silvicultural regime, it is possible to calculate the size and volume of both the final crop and intermediate yield (thinning) trees by application of results from Forest Research Institute yield tables[4].

The topography and climate is such that parts of the area are frost flats, which would initially have to be planted with a hardier species; a coastal strain of *Pinus contorta* should result in good initial yields from such sites. After the first rotation of *Pinus contorta,* all such areas would be converted to *Pinus radiata* by a shelterwood system—leaving 5-15% of the original crop as an overstorey which protects the young trees beneath from climatic extremes. The frost flats are obviously the easiest of all the sites to road, and to tend trees on, and their conversion to a more productive species is one method of raising productivity from a forest regime. The relatively low altitude and good forest soils are such that the site would be of Site Quality I for *Pinus contorta.*

FOREST-MANAGEMENT DIVISIONS

The topography of these blocks effectively decides the basis for forest management. There are three classes of land present from a forestry point of view: frost flats; other relatively easy country capable of being thinned by tracked tractors; and steep country, or country with frequent rocky outcrops. The extent of these actual divisions is given in Table 9:1, and in formal forest-management terms the areas are 'Working Circles' and 'Felling Series', and should be understood as such by

[3]E. R. Lewis, 'Yield of unthinned *Pinus radiata* in New Zealand', N.Z. For. Res. Notes, Vol 1, No. 10, 1954.

[4]J. B. Beekhuis, 'Prediction of yield and increment for thinned *Pinus radiata* in New Zealand', N.Z. Forest Research Institute, Silvicultural Branch, Report 11, 1963.

TABLE 9:1 FOREST-MANAGEMENT DIVISIONS

Topography	Management division (Working circle)	Management sub-division (Felling series)	Gross area (acres)	Net area (acres)
Frost flats	Sawlog division	Shelterwood sub-division	1700	1600*
Relatively easy tractor country—capable of being thinned by tracked tractors	Sawlog division	Sawlog sub-division	20500	17000
Sub-total			22200	18600
Steep country, or country with frequent rocky outcrops	Pulpwood division	Pulpwood division	2800	2200
Total			25000	20800 (20200)

*In practice, 1000 acres

foresters. However, the more general terms of divisions and sub-divisions have been alloted and these are used throughout the forestry chapters.

Only two technical forestry terms are retained: 'normality' and 'rotation', as these are too useful to drop. When a forest is 'normal' or has achieved 'normality' it means that all operations are constant in terms of equivalent area, and in terms of time. At its simplest each year 1,000 acres would be planted, another 1,000 acres of older trees pruned, a further 1,000 acres thinned and 1,000 acres of the oldest trees felled, and this sequence would be maintained indefinitely. The forest would be self-perpetuating and give a sustained yield indefinitely. A 'rotation' is a period of time between establishment (planting or regeneration) and final utilisation felling.

In the forest-management regime of the blocks, it should be noted that the names of the divisions are merely labels and not absolute descriptive terms—e.g., pulpwood as well as sawlogs come from the Sawlog Division. The steepest country—largely corresponding to the uncultivable land of the present sheep farms—is to be managed purely for pulpwood, and not for sawlogs, as the job of extracting thinnings from the major crop would be difficult and, on today's costs, too expensive. To produce good-quality sawlogs requires frequent pruning and some thinning operations, and without the value of intermediate yields these operations may be too expensive on the hill country.

The end-product requirements determine the silvicultural regimes which should be used in the two forestry divisions. These are:

Pulpwood Division

The regime is based on obtaining the maximum yield without any pruning or thinning, and this means felling before mortality through crowding becomes too severe. This mortality is an uncertain variable; the untended stands of this site quality on the volcanic plateau suffered considerable mortality in the 1946/8 epidemic of *Sirex noctilio*, but the subsequent patterns of mortality have not been constant, and have generally been lighter. Calculations of the yield have, however, assumed that the epidemic was normal, and therefore allow for some pathological contingencies. The regime would be:

Year	1	Plant by hand 8 x 8 feet apart (about 680 stems per acre, s.p.a.).
	2	Blank (replace losses).
	1 & 2	Release cut if necessary.
	23	Clearfell by hauler systems.

Yield figures[5] show a total potential live yield of 9,420 cu. ft per acre from 378 s.p.a. in Year 22 (and a further 652 cu. ft on the 21 s.p.a. that died that year—a number of which could be utilised). A net yield of 8,500 cu. ft per acre has therefore been assumed. Second and later rotations would be 45% naturally regenerated, 45% direct seeded, and 10% hand planted; an early slasher thinning at age 2-3 could be required, instead of planting, over 90% of the Working Circle.

Sawlog Division

Shelterwood Sub-division: Mortality in dense young *Pinus contorta* stands is very light, and the yield table figures used include an allowance for such mortality.[6] The regime for the first rotation would be:

Year	1	Plant by machine 8 x 8 feet apart (680 s.p.a.). No blanking or release cutting is required for this species on these sites.
Year	30-1	Fell 90% of the standing crop. The net yield would be 5,000 cu. ft per acre.
Year	33-6	Fell, or salvage, the remaining trees, giving another yield of 1,000 cu. ft per acre of *Pinus contorta*.
Year	30-31	Plant *Pinus radiata* by hand at 8 x 6 spacing; further treatment then follows that of the Sawlog Sub-division, except that at Year 34 of the third and later rotations only 70 s.p.a. are felled, leaving 10 s.p.a. as a shelterwood. These remaining 10 s.p.a. are to be felled, or salvaged 3-4 years later in each rotation.

Sawlog Sub-division: The topography of these areas is such that half could be planted by machine, and all could be thinned by tractor. The overall regime at forest normality would be:

Year	1	Plant at 8 x 6 ft (about 910 s.p.a.).
	2	Blank (replace losses).
	2	Release cut if necessary (less release cutting is required, as fern growth on the easy country is likely to be less vigorous than on the hillsides).
	5	Prune 300 s.p.a. to half height.

[5]S. H. Spurr, ibid.

[6]G. Duff, 'Yield Tables for fully-stocked unthinned stands of the "green" varieties of *Pinus contorta*', N.Z.F.S. unpublished report, 1959.

7	Prune 180 s.p.a. to half height.
9	,, 180 ,, ,, 20ft.
11	,, 60-80 ,, ,, 28ft.
	Thin to 180 s.p.a. to waste, preferably by poison; as this allows access for the remaining pruning operations.
12	Prune 60 s.p.a. to 36 ft.
19-23	Thin to 80 s.p.a., extracting 100 s.p.a. to give a net yield of 2,300 cu. ft per acre.
37	Clearfell 80 s.p.a., producing 9,000 cu. ft per acre net.

In subsequent rotations 45% of the area is assumed to regenerate naturally, 45% to be direct seeded and 10% to be hand-planted. The pattern of forest establishment and utilisation would be:

(i) Year 1—planting of all the frost flats (Shelterwood Sub-division) which require no ground clearing and little further attention in the first rotation.

(ii) Year 1—the major activity, and one common to the Pulpwood Division and to the Sawlog Sub-division, is an overall clearing plan in which much of the block is burnt off. Clearing continues steadily for seventeen years.

(iii) Year 2-6—afforestation of the Pulpwood Division is completed by planting 440 acres per year for five years, with its subsequent blanking and releasing operations.

(iv) Year 2-19—afforestation of the Sawlog Sub-division is completed by planting 1,000 acres per year for seventeen years, with subsequent blanking and release cutting.

(v) The intensive pruning operations are applied to half of the area (500 acres) planted each year in the Sawlog Sub-division for the first rotation.

(vi) Utilisation for pulpwood begins in the 19th year after planting on the entire forest began and rapidly reaches a maximum within 26 years after planting. Sawlogs are first utilised 37 years after the beginning of forest activity.

(vii) Absolute normality is not achieved for almost 60 years, but a practicable level of 'normality' is achieved in 39 years.

The technical prescriptions whereby this unevenly developed forest achieves normality is given in the full forest account (N.Z.F.S. 1965) and only the outlines are repeated here. These include both the shortening and lengthening of the given twenty-two years rotation in the Pulpwood Division, and utilisation of half of the Sawlog Sub-division for pulpwood in the first rotation. Broad outlines of these proposals are given in Table 9:2, and details of the yield are in Table 9:3. The forest regime is prescribed in detail for purposes of academic thoroughness in showing how the result can be achieved; in practice exotic forestry in New Zealand does not follow the niceties of management given, but at least aims towards them.

TABLE 9:2 DEVELOPMENT OF NORMALITY-FORESTS ON MARAETAI BLOCK

Year	Pulpwood division	Sawlog division: Sheltered sub-division	Sawlog division: Sawlog subdivision
1		All planted, and this rotation is felled over 6 years, 29-34 years later.	
2	Planted in 5 yrs, and this rotation is felled over 10 yrs, 18 to 23 yrs later. (years 2–7)		Planted in 17 years; half of this annual planting receives the intensive tending outlined. (Call these B.) The other half is clear-felled 20 years later over 17 years for pulpwood. (Call these C.) (years 2–17)
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20	Second rotation clearfelled over 22 yrs, 18 to 30 yrs later. (years 20–29)		
21			The 500 acres per year felled is replaced by a series of age classes that follows those of A. These areas are now all fully tended.
22			
23			
24			
25			
26			
27			
28			
29			
30		2-300 acres felled for 6 years. Second rotation is of P. radiata for pulpwood and is felled over 2 yrs, 20-25 yrs later. (Call these 2 yrs 'A') (years 30–33)	
31			
32			
33			
34		Standards felled over 5 years. (34–38)	
35	In strict normality from 59 yrs from first development in practical normality from year 38.		
36			
37			
38		38 Third rotation is normal, and fits in gap of Sawlog Sub-division. These stands are now fully tended.	Year 38 tended sawlogs come from the first planting—B. Sequence of felling at normality then follow B/A/C.

At normality, the annual pattern of work is:

Pulpwood
Division Area felled 100 acres

45	,,	naturally regenerate
45	,,	are direct seeded
10	,,	,, hand planted
100	,,	,, blanked at age 1
100	,,	,, release cut and thinned for the first time at age 1
100	,,	,, release cut and thinned for the second time at age 2

Sawlog Sub-division 34 years out of 36

Sawlog Division	Area felled 500 acres		
	225 ,,	naturally regenerate	
	225 ,,	are direct seeded	
	50 ,,	,,	hand planted
	500 ,,	,,	blanked
	500 ,,	,,	release cut and thinned by slasher at age 1-2
	500 ,,	,,	pruned to half height at age 4-5-6 etc
	500 ,,	,,	thinned to waste at age 10
	500 ,,	,,	production thinned at age 18

Shelterwood Sub-division 2 years out of 36

As for the Sawlog Sub-division, except that in fact the annual acreages are between 500 and 800. In practice, with development of the young crop under a shelterwood the work would be more spread out in time than in the Sawlog Sub-division. In the actual costing of the forest regime only 500 acres per year are allowed here, and the net area of forest is reduced by a further 600 acres.

If it could be demonstrated that the costs of thinnings were lower and their efficiency in carrying out a prescribed operation higher, then the whole basis of forest management would undoubtedly be changed and probably rendered more profitable through earlier yields, but the data used in the study are for things as they are, not as they could be.

ACTUAL METHODS OF FOREST WORKING

Forestry techniques are basically simple and straightforward and the austere outlines of forest-management given above can be filled out with some details. The first step in forest development, as in agriculture, is to clear the site and a clearing schedule is prescribed. In practice the amount of clearing would be less than in agriculture, but as the result of clearing some 500 acres of bush (which is left uncleared in the agricultural development); of taking conservative assumptions; and of recurrent firing, the actual costs of forest clearing are higher than those for agriculture. It can be assumed that the clearing is thorough, and that subsequent release cutting costs are lowered. A series of fires is then run through the block with the aim first to convert to, and then to weaken, bracken. The frost flats receive no preparation and can be planted directly through the dragonwood *(Dracophyllum spp.)* cover.

Six-month-old *P. radiata* stock is suitable for planting on the block, and use of these young trees saves higher nursery costs. Machine planting usually gives better strikes than hand planting, and a D6 tractor pulling two Lowther planters in parallel could be used on this country—

TABLE 9:3 FOREST YIELDS IN MILLION CUBIC FEET

	Pulpw'd Division	Sawlog Division						Totals
		Shelterw'd Sub-div.		Sawlog Sub-division				
Year	Pulpw'd Clear-fellings	Shelterw'd	Standards	Pulpw'd Clear-fellings	Pulp'wd from 18-22-yr Thinnings	Pulpw'd from Top Logs	Tended Sawlogs	Pulpw'd
1979	1.43							1.43
80	1.49			3.75				5.24
81	1.49			"				5.24
82	1.65			"	1.15 in perpetuity			6.55
83	1.65			"	"			6.55
84	1.80			"	"			6.70
85	1.80			"	"			6.70
86	1.87			"	"			6.77
87	1.87			"	"			6.77
88	1.87			"	"			6.77
89		1.0		"	"			5.90
90		1.5		"	"			6.40
91		1.5		"	"			6.40
92		1.5		"	"			6.40
93		1.5	0.2	"	"			6.60
94		1.0	0.3	"	"			6.20
95			0.3	"	"			5.20
96			0.3	"	"			5.20
97	0.65		0.3	Cease	"	1.35 in perpetuity	3.15 in perpet'y	3.45
98	0.68		0.2		"	"	"	3.38
99	0.69	(In years 54 and 55, at			"	"	"	3.19
2000	0.75	34 year cycles there-			"	"	"	3.25
01	0.78	after the yield would			"	"	"	3.28
02	0.82	rise as the larger			"	"	"	3.32
03	0.84	shelterwood annual			"	"	"	3.34
2004	0.85 in perpet'y	coupes are cut)			"	"	"	3.35 in perpet'y

the machines plant in the track of the tractor, and the trees benefit from this additional scrub crushing. Hand-planting is generally by spade. All planting is done in the winter following the last burn, and during the following summer the establishment rate is assessed; if the strike is below 85%, the dead trees are replaced during the next winter. If necessary the young trees are release cut from fern and other vegetation in the summer following planting. The trees on steep hillsides have two release cuttings, as fern growth is often more vigorous on these sites. Surplus trees from regeneration are cut out at this stage. No fertiliser is necessary for tree growth in the Maraetai area.

Pruning is carried out with a variety of hand secateurs and saws, and for lifts above eighteen feet, specially-designed ladders are used. The five steps of pruning necessary to reach thirty-six feet are expensive, and direct costs amount, without interest, to about £42 per acre.

Thinning for extraction of intermediate yields is a difficult job and small tracked-tractors (HD6) are used for hauls of up to 300 yards in dragging logs to a cleared central loading point or 'square'. Usually straight extraction tracks can be made by felling one row of trees in every seven to ten rows. Loading is usually by a mobile crane—almost always called a 'loader'. Crews are small and their exact jobs in an expensive operation such as thinning are laid down on the basis of work study assessment. Work-study methods have resulted in considerable savings and rationalisation of the use of machines.

Clearfelling, although involving expensive machines, is again a relatively straightforward operation. Tracked tractors, with winches and logging arches collect the logs and, as for thinning, drag to a loading point. For steep areas, cable systems run by diesel haulers are used, with only slightly greater cost than tractor operations on easier country. Power saws are used for all thinning and clearfelling operations. As much of the work as possible is paid for by incentive or 'bonus' schemes, which serve both to attract workers by paying at above award wages and to reduce direct costs.

In the second rotation, natural regeneration is adequate to restock areas felled in the summer months, but seed-eating birds usually eat almost all of the smaller quantity of seed available from winter clearfellings. (Hot sun is required to open the hard cones of *P. radiata).* Seed treated with bird repellent is applied directly from the air by helicopter to winter-felled areas.

All permanent Forest Service housing is of a State Housing standard with woodshed, fences, concrete paths, etc., and each house costs £4,200. Single men's huts now cost £450 each. Provision for a settlement water-supply, roads and other services is usually made early on in forest development. All roads are made by the Forest Service and maintained by them. Often, of course, phases of road construction are let out on contract.

In many countries, the role of forestry in reducing rural depopulation by employing more labour than agriculture is often stressed, but this would be an inappropriate question in New Zealand, where in both agriculture and forestry, the problem is to attract labour to the countryside, rather than to prevent depopulation. When camp attendants, clerks, mechanics and other non-direct labour and staff are included, a total of 125 men are required to work the Maraetai block in perpetuity on the regime given. This rate of labour employment results in production of 52,000 cubic feet of wood/man-year—about half of which is pulpwood and half high-quality large sawlogs.

There are very great differences between a system of land development for forestry and for agriculture as both are practised in New Zealand. In forestry, the number of decision-makers are few, and the structure of management simple and monolithic. The schedules laid down, and the operations prescribed each year are all necessary, and production plantation forestry is not subject to the variations in management such as would be found amongst the 110 farmers on the block. Whereas overall output from farming can, and does, increase steadily as improved techniques adapted from the advisory services or from innovating farmers become the practice of the majority, changes in forestry are likely to be more sudden. For example, development of specialised machinery to extract thinnings may be made elsewhere, and can then be applied throughout a particular area. The results of tree breeding by production of selected strains, instead of the wholly wild plants grown at present, could completely alter the course of management on the block.

Again, apart from increases in quality, it seems unlikely that overall gross production of a given species can be increased much from the afforested areas; although *net* yield can be increased markedly by utilising the intermediate crops which at present are wasted by being left to die. Because forestry is a highly centralised and capitalized business it is possible to apply such techniques as work study to operations; similarly results of research or changes in technique can be applied fairly readily as there are relatively few men to be persuaded to change from older methods.

Chapter 10

THE COST OF FOREST DEVELOPMENT AND VALUATION OF THE FOREST OUTPUT

THE projected plan for forest development has been given in Chapter 9; it is now necessary to apply appropriate costs and prices to the regime in order to draw up a development budget for forestry on the Maraetai block. Naturally, the basis for these costs rests primarily on internal costs of the N.Z. Forest Service; and full details are given in the contemporaneous report.[1] The forest budget falls into only two direct phases—the accumulation of compounded costs and of compounded returns until the forest is at a normal stage; and an annual budget once the forest has reached normality. Changes in the value of output from the forest can only result from either changes in silvicultural techniques—notably in extracting thinnings—or changes in prices when an increase in, say, pulpwood prices would make more thinning operations worthwhile. The silvicultural regime prescribed, containing as it does only one extraction thinning, is a safeguard against over-optimistic results from afforestation. Changes in technique or prices are not assured at present, so the forestry budget has been prepared for only one level of output at conservatively high estimates of cost.

FORESTRY COSTS

(i) *General*

Costs are mostly based on data from the Rotorua conservancy, or, in some cases, North Island or New Zealand averages of the Forest Service for the year 1962. The costing of this forest could vary somewhat, depending on whether it was regarded as an extension of the large resources of N.Z. Forest Products Ltd, or, alternatively, as an independent State or company forest. In the former case, amalgamation would lead to some economy in overhead and other charges due to scale of operations. However, it is unlikely that the block (being originally Crown land) would have been alienated had it been given over to forestry, hence the project has been set up as a State forest. It has been further assumed that State control would cease with the delivery and sale of logs loaded on trucks at forest ride ready for transport to private utilisation plants.

Difficulties occurred in drawing costs directly from Forest Service financial records, as unit costs vary with any given forest environment and with physical performance. For example, current utilisation costs

[1]N.Z. Forest Service, Forest Research Institute, Silvicultural Branch Report No. 31, 1965.

for all clearfelling and most thinning operations are based on completely untended stands, and cannot be applied (without adjustment) to the tended Sawlog Division at Maraetai. The technique used was to take the most representative data available and then systematically to equate the several cost elements to the circumstances of the problem. In the case of tending operations such as pruning and thinning to waste, the basic approach was by man-hour performance data because so far in the Forest Service no system has been brought into operation whereby unit silvicultural costs can be identified with physical performance and forest environment. Data derived from work study records and from the personal observations and experience of technical, supervisory, and research staff provided the man-day performance standards which have subsequently been translated into unit costs by adding wage and machine hire rates, travelling time, and appropriate indirect charges. Contemporary forest policy is to employ incentive schemes based on piece rate, contract, or bonus payments, although some jobs must remain on wages because they cannot readily be placed on an incentive basis. An example of the type of cost calculation made is given for planting rates in Table 10:1, based on an analysis of incentive planting over a large area in Kaingaroa Forest in 1962.

(ii) *Direct costs*

Table 10:2 gives abbreviated details of the direct costs used in successive operations in Maraetai Forest for clearing, planting, tending and utilisation; while Table 10:3 covers haulage costs. Costs of annual maintenance of roads, bridges and buildings; general repairs and maintenance; staff salaries; supervisory vehicles; and general administration are shown in Appendix 3:1.

TABLE 10:1 PLANTING COSTS

1. Hand planting

Labour costs have been based on the overall unit cost of planting at Kaingaroa for 1962 when approximately 1,600 acres were planted under a bonus system. The rate of planting was 1,000 trees for a 7½-hour working day based on a recorded overall average rate of 138 trees planted per man hour. Cost details were as follows:

	per acre	per acre
Wages plus bonus	£3.6	
Travelling time	0.3	
Wet time	0.1	
	—	£4.00
Add 12% for compensation and holiday pay		0.48
Total labour cost		£4.48
Cost of trees at 1962 Kaingaroa cost 900 per acre @ £3.6 per 1000		£3.24
Vehicle hire		0.50
Distribution of trees and 'contingencies allowance' to cover unforseen costs (but excluding supervision, etc.)		1.78
Total		£10.00

2. Machine planting

The labour cost has been set at 200 man days per 1000 acres for a tractor and 5-man team:

	per acre
Hence labour (on bonus)	£0.76
Plus travel time	0.03
12% compensation and holiday pay	0.09
Plant hire @ £6 per day	0.24
Cost of trees @ £3.6 per 1000	3.24
Distribution of trees and contingencies, etc.	0.64
Total	£5.00

3. Re-stocking

From 1980 onwards the mode of re-stocking the cut-over area will be as follows:

	per acre
45% Regeneration at no cost	
45% Aerial sowing @ £5 per acre	£2.25
10% Hand planting @ £10 per acre	1.00
Total cost	£3.25

TABLE 10:2 DIRECT COSTS OF PRIMARY FOREST OPERATIONS

1. Land clearing

	per acre
Cutting heavy scrub	£8
Scrub crushing	£2
Overall burning (2 annual burns)	£0.25
Felling of bush	£13
Burning of bush	£0.5
Bulldozing bush slash	£7
Fencing	£800 (per mile)

2. Establishment and tending

	per acre
Hand planting	£10
Machine planting	£5
Blanking	£2
Release cutting (each operation)	£3
Pruning: age 4-5	£8
6	£9
8	£9
10	£9
12	£9
Thinning: age 10—power saws	£13

3. Utilisation costs (loaded on truck at forest ride)

Thinning, age 18-22 — 9d per cu. ft (£86 per acre)

Clearfelling—Pulpwood

		per cu. ft
(a)	ex Pulpwood Division (Steep hills) younger stands	5.4d (7000 cu. ft/acre
	″ ″ ″ ″ ″ older ″	4.5d (8000 cu. ft/acre)
(b)	ex Sawlog Division (Tractor, untended stands)	4.5d
(c)	″ ″ ″ ″ ″ shelterwood	5.1d
	″ ″ ″ ″ ″ standards	7.1d
	Clearfelling—Sawlogs and Pulpwood toplogs	3.6d

TABLE 10:3 HAULAGE COSTS (based on current contract rates)

	per cu. ft
Log cartage (Sawmill at Tokoroa)	4.4d
Slabwood (approximately 5 miles)	1.75d

Details of administrative and general vehicle requirements are given in Table 10:4 The initial capital cost of the original unit is included in each case because interest must run on the full sum from the date of purchase; hence to rely only on the depreciation element (which is included in machine and vehicle hire rates) would result in under-costing these items. But, after the initial cost has been charged in, the cost of replacing the particular unit is taken care of by an annual depreciation charge which is incorporated in the cost of individual forest operations. The net effect is to slightly overcharge the cost of plant and vehicles.

TABLE 10:4 FOREST ADMINISTRATION AND GENERAL VEHICLES

1960	10 cwt pick-up truck for O.I.C.	£950	
	1 tip-truck and 2 gang trucks @ £1800	£5400	£6350
1965	Fire engine	£4000	
	Vanguard truck for 2.I.C.	£750	
	Grader and H.D.6 tractor @ £4500 each	£9000	£13750
1970	1 Supervision vehicle	£750	
	1 tip-truck	£1800	£2550
1980	1 10 cwt pick-up truck for O.I.C. logging	£950	
	2 Supervision vehicles	£1500	
	2 tip-trucks	£3600	£6050

Logging equipment is very expensive, compared with any individual item used in agriculture, and details of the equipment required are given in Table 10:5. Although revenue is earned from the Year 19 (and logging equipment is, of course, required then) no debit is shown in the budget at that time for either logging plant or the cost of logging. The

TABLE 10:5 FOREST LOGGING EQUIPMENT

1. Hauler operation 1979-88—Pulpwood			
	2 haulers @ £9000	£18000	
	1 mobile loader	13000	
	1 D7 tractor	12500	
	2 gang trucks @ £2000	4000	
	10 power saws @ £60	600	£48100
2. Hauler operation, 1997 onwards—Pulpwood			
	1 hauler	£9000	
	1 D7 tractor*	12500	
	1 gang truck	2000	
	5 power saws	300	£23800
	*In practice an older tractor could be used.		
3. Tractor country—clearfell untended Sawlog Division areas 1980-96—Pulpwood			
	3 D7 tractors	£37500	
	3 logging arches	6750	
	3 mobile loaders	39000	
	3 gang trucks	6000	
	18 power saws	1080	
	Miscellaneous	1000	£91330
Plus:			
	1 Field service unit	£2250	
	2 spare D7 tractors	25000	
	1 spare loader	13000	
	1 spare logging arch	2250	£45000
			£133,830

4. Tractor country—Shelterwood 1989-94 }
" " " —standards 1993-98 } Pulpwood

1	D7 tractor	£12500	
1	logging arch	2250	
1	gang truck	2000	
5	power saws	300	
	Miscellaneous	500	£17550

(No loader is specified, as the operation can be serviced by a mobile loader from the untended Sawlog Division areas in conjunction with the spare loader.)

5. Clearfell tended Sawlog Division area—$\frac{2}{3}$ of plant sawlogs } 1997 onwards
$\frac{1}{3}$ pulpwood }

3	D7 tractors	£37500	
3	logging arches	6750	
3	gang trucks	6000	
3	track loaders	33000	
18	power saws	1080	
	Miscellaneous	2000	£86,330
Plus:			
1	Field service unit	£2250	
2	spare D7 tractors	25000	
1	spare loader	13000	
1	spare logging arch	2250	£42500
			£128830

6. Thinning—Sawlog Division area. Pulpwood 1982 onwards

5	H.D.6 tractors @ £4500	22500	
5	logging arches @ £400	2000	
1	mobile loader	13000	
1	gang truck	2000	
12	power saws	720	
	Miscellaneous	500	40720

relevant debits are not brought to charge until the 37th year, when the clearfelling of the tended sawlog working division begins. The reason is that because of the lack of a market price for pulpwood it is necessary to use a net stumpage value (i.e. after charging all costs and also after crediting interest on logging capital) instead of a 'pulpmill value', as in the case of sawlogs.

(iii) *Social costs*

Accommodation and roading costs have both been included initially (Table 10:15) as they are normal elements of forest costing, but they are also shown separately elsewhere. Provision has been made for a complete settlement at the northern boundary of the forest—presumably as part of the N.Z. Electricity Department's village at Whakamaru Dam—but in practice there might well be more profitable alternatives for forestry. For instance, with the cessation of hydro-electric construction work on the Waikato at Maraetai, Whakamaru and Atiamuri dams, much of Mangakino's accommodation has become redundant, with consequent devaluation or loss of the social capital of hospital, schools, shops, cinema and churches. If the Maraetai block had been allocated to forestry, say in 1950, the Ministry of Works housing at Mangakino could have been constructed to a better standard and subsequently made available for forest development. Then again the comparative cost, as well as the obvious social advantage, of recruiting forest labour in Tokoroa and transporting the men daily to the forest would be at least worthy of investigation. Full social costs have, however, been calculated for purposes of comparison, with some allowance for recruiting local labour. The houses and single men's accommodation needed are shown in Table 10:6. No allowance has been made for housing logging-truck drivers as the delivery of the logs would be the responsibility of the purchaser and their homes would logically be in Tokoroa.

TABLE 10:6 FOREST ACCOMMODATION REQUIREMENTS

5-year period	Manpower required per annum	Available locally*	Total to be housed on the forest	Accommodation required: Houses	Accommodation required: One-man huts†
1960-4	20	10	10	4	6
1965-9	36	"	26	13	13
1970-4	55	"	45	22	23
1975-9	61	"	51	25	26
1980-4	124	"	114	57	57
1985-9	131	"	121	57	64
1990-4	132	"	122	57	65
1995-9	125	"	115	57	58(2)

*This is a somewhat arbitrary estimate of the number of men who could be drawn from Mangakino permanently, and to allow for some houses 'producing' more than one worker.

†Surplus huts could replace earlier ones, or be transferred to other forests.

(iv) *Fire-protection costs*

The spread of expenditure on fire equipment is shown in Table 10:7, while other forest-protection costs are shown in Table 10:8. This fire equipment consists of 1 water tanker, 2 fire pumps, plus miscellaneous equipment and stores. The fire engine is listed separately in Table 10:4.

It is likely that the cost of constructing and maintaining the main north and south fire breaks under the national grid lines could be shared with the Electricity Department, but no attempt has been made to allow any credits—the cost being £2 per acre of discing.

TABLE 10:7 SPREAD OF EXPENDITURE ON FOREST FIRE EQUIPMENT

Period	Amount	Years	4%	5%	6%
1960-4	2000	37	£8540	£12160	£17270
1965-9	4000	32	14030	19060	25810
1970-4	3000	27	8650	11200	14470
1975-9	1000	22	2370	2920	3600
			33590	45340	61150
Plus interest for ½ year			670	1130	1830
			£34260	£46470	£62980

TABLE 10:8 SPREAD OF OTHER FOREST PROTECTION COSTS

5 year period	Average acres	per acre	Total
1960-64	3700	£0.35	£1300
65-69	10100	0.23	2300
70-74	15300	0.21	3200
75-79	19300	0.20	3800
1980 onwards	20800	0.20	4200

The data given in Table 10:9 show how the cost of capital works other than social costs would be distributed over the period during which the forest is being established, while Table 10:10 gives a similar breakdown for social costs. Unit costs for buildings, etc., are based on those of the Rotorua conservancy in 1962, and are inclusive of services such as fencing, paths, sheds, sewerage, etc.

(v) *External overheads and indirect costs*

In Table 10:15 each operational heading covers only the direct cost of the operation, i.e. wages, equipment, vehicles, stores, roading (if relevant) and the twelve per cent loading for Workers' Compensation and holiday pay. All indirect costs, such as salaried supervision, administration costs, and general forest overheads have been excluded from the 'job cost' and instead have been aggregated under 'indirect costs' as shown in Table 10:11. This should be borne in mind when comparing the level of costs shown for Maraetai with those of comparable operations elsewhere. The derivation of these internal indirect costs (or 'forest overheads') is shown in Appendix 3:1. Basically they include costs incurred on the forest itself but not those costs normally debited against State forests by Conservancy and Head Office. The latter overheads have been kept entirely separate (Table 10:12) in order to show their effect on the forest investment. As soon as the establishment phase is complete and the forest is placed on an annual profit-and-loss basis in its 41st year, depreciation must be brought to charge in the annual cost of buildings. To cover this cost the indirect costs amounting to £33,100 in Table 10:11 for the year 1999 are increased by £8,000 for the year 2000 and each year thereafter.

The question of expenditure which originates in Forest Service head office and Conservancy offices, and subsequently finds its way into the annual costs of each State exotic forest by way of an 'overhead', must also be considered in relation to Maraetai. To a considerable extent the service rendered by the Forest Service to the community is directly comparable to that rendered by the Department of Agriculture to farmers. Hence, in the annual accounts of the Forest Service only about 35% of the General Administration Account is recovered against the commercial forest estate by way of 'overhead' charges. The accountancy method of disposing of these overheads is largely a matter of administrative convenience rather than a precise evaluation of cost and benefit. From the Departmental accounts we were able to derive a flat rate per acre of productive forest, which is a function of the total sums charged out and the forest areas covered thereby. To check if this figure was of a reasonable order, and not too low, a comparison was made between the private enterprise equivalent of these external overheads and those in the Forest Service; the former estimate worked out at 7.8 shillings per acre compared with 7.2 shillings for State forests in the Rotorua conservancy. In this study the higher figure has been used because it has been built up systematically and is possibly more reliable; but in any case there is close agreement between the two figures. It can therefore

TABLE 10:9 CAPITAL WORKS PROGRAMME FOR MARAETAI FOREST—EXCLUDING SOCIAL COSTS

(Costs by 5-year periods)

No.	Description	Total cost (£s)	Spread of expenditure (£s) 1960/4	1965/9	1970/4	1975/9	1980/4	1985/9
1	Firebreaks: North/South grid lines @ £120/mile*	900	300	300	300			
	13 miles standard break @ £80/mile	1000	350	350	300			
2	Fire lookout	2500	2500					
3	Office-store	7000	3500				3500	
4	Fencing: 4 miles @ £800/mile (half cost)†	1650	1650					
5	Telephone lines: 3½ miles @ £350/mile	1250	1250					
6	Petrol and oil compound	1500	1500					
7	Fire garage-store	2000		2000				
8	Garage-workshop	15000	8000				7000	
9	Water-supply	5500	5500					
10	Miscellaneous	6700	1250	1250	1250	1250	1700	
	Total development costs	45000	25800	3900	1850	1250	12200	

*Allow 7.5 miles @ 7.5 chains width (i.e. 50% wider than standard breaks)

†Allow £50 for 2 gates and 2 cattle-stops

TABLE 10:10 CAPITAL WORKS PROGRAMME FOR MARAETAI FOREST—INCLUDING SOCIAL COSTS

(Costs by 5-year periods)

No.	Description	Total cost (£s)	Spread of expenditure (£s) 1960/4	1965/9	1970/4	1975/9	1980/4	1985/9
1	Roading: Formation of main access roads	18000	7500	7500	3000			
	Metalling ready for logging	25000				10400	14600	
2	Houses: 57 @ £4250, complete with facilities	242250	17000	38250	38250	12750	136000	
3	Huts: 65 @ £450	29250	2700	3150	4500	1350	13950	3600
4	Cookhouse	12500	5000			7500		
5	Camp ablution blocks	4000	2000			2000		
6	Caterer's quarters	3000	3000					
7	Preparation of camp site	1000	1000					
	Total social costs	335000	38200	48900	45750	34000	164550	3600
	Primary development costs (from Table 10:9)	45000	25800	3900	1850	1250	12200	
	Total costs	380000	64000	52800	47600	35250	176750	3600

Note: Only main access roads are a capital charge and included here. Logging shunts are charged as a cost of logging.

TABLE 10:11 ANNUAL INDIRECT COSTS FOR MARAETAI FOREST (£s)

(For 25000 acres gross area)

Cost Item	1960-4	1965-9	1970-4	1975-9	1980-4	1985-9	1990-4	1995-9
(Av'age net planted area)	3700	10100	15300	19300	20800	20800	20800	20800
Forest protection	1300	2300	3200	3800	4200	4200	4200	4200
R. and M. buildings	400	900	1300	1500	3300	3300	3300	3300
R. ,, M. roads	200	600	800	1000	1000	1000	1000	1000
R. ,, M. services	400	700	800	1000	1000	1000	1000	1000
R. ,, M. general	900	1300	1500	1900	2100	2100	2100	2100
Salaries	3400	6000	7300	7300	15000	15900	15900	15900
Single men's camp	1000	1100	1500	1600	3400	3800	3800	3400
Administration: Vehicles	600	1200	1800	1800	3600	3600	3600	3600
General	1800	2400	2600	2800	2900	2900	2900	2900
Total	10000	16500	20800	22700	36600	37900	37900	37500
Less house rentals	300	1000	1700	1900	4400	4400	4400	4400
Net indirect forest costs	9700	15500	19100	20800	32200	33500	33500	33100

Note: From and including the year 2000 the annual indirect costs shown for 1995-9 are increased by £8000 for depreciation, and also by £800 'overhead' costs.

be accepted that as far as these so-called external overheads are concerned, the Maraetai forest can be regarded as either a State forest or a company-owned forest without in any way affecting the validity of the analysis. The cumulative cost of these overheads at normality (forty years) amounts to £549,000 when compounded at five per cent: Details are shown in Table 10:12.

Table 10:12 is based on estimates of the additional salaries and administration costs that would be incurred by any wood-processing

TABLE 10:12 EXTERNAL OVERHEAD COSTS

	General Administration Costs		Compounded Sum (£s)		
Period	Amount for 5 years (£s)	No. of years	4%	5%	6%
1960-4	7500	37	32100	45600	64800
1965-9	13200	32	46300	62800	85200
1970-4	16000	27	46100	59700	77000
1975-9	16000	22	37900	46700	57600
1980-4	33000	17	64300	75600	88800
1985-9	35000	12	56000	63000	70300
1990-4	35000	7	46200	49300	52500
1995-9	35000	2	37800	38500	39300
Administration vehicles:					
	Capital expenditure		70000	86000	107000
	Operating costs		6500	8500	11000
			443200	535700	653500
	Plus interest for ½-year		8900	13400	19600
Total cost after 40 years			452100	549100	673100

company which proceeded to establish a forest similar in all respects to Maraetai forest. The costs charged against the two additional administration vehicles assume that each vehicle would run 12,000 miles per year at an all-inclusive cost of one shilling per mile, giving a total annual cost of £600 per vehicle. Total external overhead costs have been transferred to Table 10:15 and appear at the foot of the forestry budget. From the year 2000 onwards when the forest operates as a 'going concern' these external overheads have to be accounted for as an annual cost—the relevant figure being £8000. Thus in Table 10:15 the column headed *Indirect Costs* increases the sum charged against the year 2000 by a total of £16,000 (£8000 for depreciation on buildings and £8000 also for external overheads). Table 10:13 summarises both internal and external overhead costs on an annual basis per acre of productive forest.

(vi) *Sawmilling costs*

The type of sawmill to be built, its location, the conversion factor (which is the amount of sawn timber recovered from round logs) and the grade outturn are discussed fully in the Forest Service report. Considering the standard of tending planned for the sawlog working division the extraction of peeler logs for rotary veneer production would be profitable, and could doubtless play a useful part in the operation of the forest. However, this market has been ignored and the three lowest logs

TABLE 10:13 INTERNAL AND EXTERNAL OVERHEAD COSTS

(£s per acre)

Period	Internal overheads	External overheads	Total overhead costs
1960-4	£2.62	£0.57	£3.19
1965-9	1.54	0.32	1.86
1970-4	1.25	0.25	1.50
1975-9	1.08	0.20	1.28
1980-4	1.55	0.37	1.92
1985-9	1.61	0.39	2.00
1990-4	1.61	0.39	2.00
1995-9	1.59	0.39	1.98
Annually thereafter:	1.97	0.38	2.35

have been reserved *in toto* for the production of sawn timber. The net effect on overall forest stumpage value has not been assessed, but peeler logs of radiata pine currenly command a price of 40d per cu. ft on rail at Rotorua, and these logs are not equal to the quality envisaged from Maraetai; so net sales realisation could probably be improved by selecting peelers. A similar conservative assumption has been made in ignoring the possibility of utilising minor forest produce, particularly fencing material, although the market for this produce has in fact been strong in recent years. The effect of this potential early revenue yield on forest profitability—by turning the thinning-to-waste at a cost of £13 per acre into a profit of 7d/cu. ft or over £40 per acre @ 1,500 cu. ft/acre—could be considerable; and its omission in this study is another 'safety factor' built into the forest budget.

The type and location of the sawmill have a direct bearing on the cost of production, and hence on the ultimate stumpage revenue accruing from the sawlogs. It was decided to locate the hypothetical mill at Tokoroa; to assume a one-shift/five-day-week production; and to have a bandsaw-headed sawmill. The conversion factor was calculated to be 6.45 as the only logs sawn will be three lower logs from tended, final crop trees; and the annual cut would be around 20 million board feet per year. The sale of sawmill slabs to the pulpmill is considered later, but a total of 690,000 cubic feet of slabwood would be available. The indirect benefits of sawing the bark-free logs are not assessed in financial terms, but 'waste disposal' costs, which are frequently fairly high, would be reduced, and bark-free logs mean lower saw maintenance and lower mill 'house-keeping' costs. The cost of sawmilling is discussed in Appendix 3:2.

It is desirable to specify where the sawn output would be marketed as this affects any freight differential, which in turn influences (though admittedly only to a very minor degree) the stumpage value of the sawlog supply. Growth of population will result in a big expansion in the demand for sawn timber throughout the Waikato region towards the end of this century; hence the utilisation programme assumes that the sawmilling unit (located at Tokoroa) would be integrated with its own retailing and processing organization in Hamilton. This 'vertical' integration is a common feature of the timber industry today; in fact it appears to be generally accepted that sawmilling no longer offers any inducement to the investor unless it can be effectively integrated with processing, retailing and/or end-use activities.

The value of sawlogs loaded on truck at forest ride was determined by standard Forest Service timber sales procedure and is summarised in Appendix 3:3. Unlike the derivation of pulpwood value, the value of sawn timber can be reduced to a 'log value' as opposed to a 'stumpage value'; hence appropriate debits have been fully included in the financial analysis commensurate with the capital investment in logging equipment and also the unit operating cost for this phase of forest activity. The appendix shows that, before adding in the credit for slabs sold to the pulpmill, sawlogs would command a price of 28.5d per cubic foot loaded on truck at forest ride. Subtracting the *direct* cost of logging (3.6d per cu. ft) leaves a net stumpage value of 24.9d per cu. ft for sawlogs before charging interest on logging capital; but the effect of selling slabwood increases this to 26.2d. The cost of debarking sawlogs (to yield bark-free slabs for subsequent chip production for pulp) is dealt with in Appendix 3:4, which shows a net profit of 1.3d per cu. ft of log throughput.

FOREST REVENUE

There is no open market for pulpwood in New Zealand; hence for the purposes of this study we sought the opinion of N.Z. Forest Products Ltd. The company advised that Maraetai pulpwood would have a stumpage value of approximately 4.5d per cubic foot. Appendix 3:5 discusses this figure and shows that it seems a fair reflection of the value of pulpwood stumpage under *competitive* conditions. It would of course be more satisfactory to work backwards from a definite all-inclusive pulpwood value delivered at pulpmill, which would enable due credit to be taken for the low unit cost of producing pulpwood from the upper logs of clear-fellings from the tended Sawlog Division. However, no market value is available at mill skids or on ride; and to this extent the study is not completely satisfactory, since it does not allow the net effect of all relevant debits and credits to be evaluated. The available evidence suggests that if pulpwood could be costed in detail, forest revenue would rise significantly; moreover as pulpwood production begins in the 19th year after establishment, the effect could be to reduce the net sum shown in the development budget after forty years.

The derivation of the sawlog stumpage value has been given in Appendix 3:3; stumpage for pulpwood is 4.5d; and the credit for pulpwood slabs is worth 6d per cu. ft of slabwood (equal to 1.3d per cu. ft on the 3,150,000 cu. ft of sawlogs produced annually). These three items are the only sources of income from the forest, as peeler logs and roundwood for fencing and other uses have been excluded. Credits for the sale of slabwood are constant at £17,200 annually from 1997 and this sum has been added to total revenue in Table 10:14, which provides a summary of forest earnings. It will be noted that total revenue does not stabilise until the year 2004 when it finally reaches £454,000 but for computation there is some convenience in regarding it as constant at £452,000 from the year 2000; the degree of understatement is slight.

TABLE 10:15 DEVELOPMENT BUDGET FOR MARAETAI FOREST TO THE STAGE OF CONSTANT RETURN

(All data in £000s)

Year	Land preparation	Capital works	Establishment: Planting	Establishment: Blanking	Establishment: Releasing	Silviculture: Pruning	Silviculture: Thinning (to waste)	Plant and Vehicles: Logging	Plant and Vehicles: Other	Logging costs	Indirect costs	Total exp'ture	Annual balance: Total revenue	Annual balance: Net investm't	Years	Value at compound interest: 4%	Value at compound interest: 5%	Value at compound interest: 6%
1960	33.0	12.8	7.2						6.4		9.7	69.1		69.1	39	319.0	463.3	670.5
61		12.8	9.4								9.7	31.9		31.9	38	141.6	203.7	292.0
62		12.8	9.4	1.9	4.3						9.7	38.1		38.1	37	162.6	231.7	329.0
63	5.0	12.8	9.4	1.9	5.6						9.7	44.4		44.4	36	182.2	257.2	361.7
64		12.8	9.4	1.9	5.6						9.7	39.4		39.4	35	155.5	217.3	302.8
1965		10.6	9.4	1.9	5.6	4.0			13.7		15.5	60.7		60.7	34	230.3	318.9	440.1
66	0.2	10.6	5.0	1.9	5.6	8.5					15.5	47.3		47.3	33	172.6	236.7	323.6
67	0.3	10.6	5.0	1.0	4.3	8.5					15.5	45.2		45.2	32	158.6	215.4	291.7
68	0.2	10.5	5.0	1.0	3.0	13.0					15.5	48.2		48.2	31	162.6	218.7	293.4
69	0.3	10.5	5.0	1.0	3.0	13.0					15.5	48.3		48.3	30	156.7	208.7	277.4
1970	0.2	9.6	5.0	1.0	3.0	17.5	6.5		2.6		19.1	64.5		64.5	29	201.2	265.5	349.5
71	8.3	9.5	10.0	1.0	3.0	17.5	6.5				19.1	74.9		74.9	28	224.6	293.6	382.9
72	0.2	9.5	10.0	1.0	3.0	22.0	6.5				19.1	71.3		71.3	27	205.6	266.2	343.8
73		9.5	10.0	1.0	3.0	22.0	6.5				19.1	71.1		71.1	26	197.1	252.8	323.5
74	0.3	9.5	10.0	1.0	3.0	22.0	6.5				19.1	71.4		71.4	25	190.3	241.8	306.4
1975	2.0	7.1	10.0	1.0	3.0	22.0	6.5				20.8	72.4		72.4	24	185.6	233.5	293.1
76	2.0	7.1	10.0	1.0	3.0	22.0	6.5				20.8	72.4		72.4	23	178.4	222.4	276.5
77		7.0	10.0	1.0	3.0	22.0	6.5				20.8	70.3		70.3	22	166.6	205.6	253.3
78		7.0		1.0	3.0	22.0	6.5		2.0		20.8	62.3		62.3	21	142.0	173.6	211.8
79		7.0				22.0	6.5		2.0		20.8	58.3	26.8	31.5	20	69.0	83.6	101.0
1980		35.4	0.7			22.0	6.5		6.0		32.2	102.8	98.3	4.5	19	9.5	11.4	13.6
1981		35.4	2.3	0.4	0.7	22.0	6.5				32.2	99.5	98.3	1.2	18	2.4	2.9	3.4
82		35.4	2.3	1.4	2.8	18.0	6.5				32.2	98.6	122.8	Cr. 24.2	17	Cr. 47.1	Cr. 55.5	Cr. 65.2
83		35.3	2.3	1.4	2.8	13.5	6.5				32.2	94.0	122.8	Cr. 28.8	16	Cr. 53.9	Cr. 62.8	Cr. 73.2
84		35.3	2.3	1.4	2.8	13.5	6.5				32.2	94.0	125.7	Cr. 31.7	15	Cr. 57.1	Cr. 65.9	Cr. 76.0
1985		0.8	2.3	1.4	2.8	13.0	6.5				33.5	60.3	125.7	Cr. 65.4	14	Cr. 113.2	Cr. 129.5	Cr. 147.9

(Continued next page)

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(All data in £000s)

Year	Land preparation	Capital works	Establishment: Planting	Blanking	Releasing	Silviculture: Pruning	Thinning (to waste)	Plant and Vehicles: Logging	Other	Logging costs	Indirect costs	Total exp'ture	Annual balance: Total revenue	Net investm't	Years	Value at compound interest: 4%	5%	6%
86		0.7	2.3	1.4	2.8	17.5	6.5				33.5	64.7	127.0	Cr. 62.3	13	Cr. 103.7	Cr. 117.5	Cr. 132.9
87		0.7	2.3	1.4	2.8	13.0	6.5				33.5	60.2	127.0	Cr. 66.8	12	Cr. 106.9	Cr. 120.0	Cr. 134.4
88		0.7	2.3	1.4	2.8	17.5	6.5				33.5	64.7	127.0	Cr. 62.3	11	Cr. 95.9	Cr. 106.6	Cr. 118.3
89		0.7	3.0	1.4	2.8	13.0	6.5				33.5	60.9	110.7	Cr. 49.8	10	Cr. 73.7	Cr. 81.1	Cr. 89.2
1990			2.6	1.8	3.4	17.5	6.5				33.5	65.3	120.0	Cr. 54.7	9	Cr. 77.9	Cr. 84.9	Cr. 92.4
91			2.6	1.6	3.1	17.5	6.5				33.5	64.8	120.0	Cr. 55.2	8	Cr. 75.5	Cr. 81.6	Cr. 88.0
92			2.6	1.6	2.4	22.0	6.5				33.5	68.6	120.0	Cr. 51.4	7	Cr. 67.6	Cr. 72.3	Cr. 77.3
93			2.6	1.6	2.4	22.0	6.5				33.5	68.6	123.8	Cr. 55.2	6	Cr. 69.8	Cr. 74.0	Cr. 78.3
94			2.3	1.6	2.4	22.0	6.5				33.5	68.3	116.4	Cr. 48.1	5	Cr. 58.5	Cr. 61.4	Cr. 64.4
1995			1.6	1.4	2.1	22.0	6.5				33.1	66.7	97.5	Cr. 30.8	4	Cr. 36.0	Cr. 37.4	Cr. 38.9
96			1.6	1.0	1.5	22.0	6.5				33.1	65.7	97.5	Cr. 31.8	3	Cr. 35.8	Cr. 36.8	Cr. 37.9
97			2.0	1.0	1.5	22.0	6.5	86.0†		47.3	33.1	199.4	455.9	Cr. 256.5	2	Cr. 277.4	Cr. 282.8	Cr. 288.2
98			2.0	1.0	1.8	22.0	6.5			47.3	33.1	113.7	454.5	Cr. 340.8	1	Cr. 354.4	Cr. 357.8	Cr. 361.2
99			2.0	1.0	1.8	22.0	6.5			47.3	33.1	113.7	450.9	Cr. 337.2	0	Cr. 337.2	Cr. 337.2	Cr. 337.2
2000			2.0	1.0	1.8	22.0	6.5			47.3	49.1	129.7	452.1	Cr. 322.4				

	4%	5%	6%
Total for 39 years	Dr. 1572.4	Dr. 2659.4	Dr. 4140.1
Plus interest for ½-year	31.4	66.5	124.2
Total forest costs	£1603.8	2725.9	4264.3
Fire and radio equipment	34.0	46.0	63.0
External overhead costs	452.0	549.0	673.0
Contingencies allowance*	93.0	117.0	150.0
Working capital	50.0	50.0	50.0
TOTAL: (a) Including social costs	2232.8	3487.9	5200.3
(b) Excluding ,, ,,	1119.0	2067.0	3378.0

*Appendix 3:6.

†Owing to the use of net stumpage as the return from pulpwood, no logging plant is debited against capital charges until 1997 when sawlogs are produced. The sum then debited is one-third less than the total logging investment of £129,000 to compensate for the fact that one-third of the Sawlog Working Circle's yield is pulpwood which carries only a net stumpage.

TABLE 10:14 SUMMARY OF FOREST REVENUE

Year	Pulpwood: value on a net stumpage basis			Sawlogs: total value on truck at forest ride			Total
	Million cu. ft	Stumpage (pence per cu. ft)	Total value (£s)	Million cu. ft	Value in pence per cu. ft	Total value (£s)	Revenue (£s)*
1979	1.43	4.5	26800				
1980	5.24	,,	98300				
81	,,	,,	,,				
82	6.55	,,	122800				
83	,,	,,	,,				
84	6.70	,,	125700				
1985	,,	,,	,,				
86	6.77	,,	127000				
87	,,	,,	,,				
88	,,	,,	,,				
89	5.90	,,	110700				
1990	6.40	,,	120000				
91	,,	,,	,,				
92	,,	,,	,,				
93	6.60	,,	123800				
94	6.20	,,	116400				
1995	5.20	,,	97500				
96	,,	,,	,,				
97	3.45	,,	64700	3.15	28.5	374000	455900
98	3.38	,,	63300	,,	,,	,,	454500
99	3.18	,,	59700	,,	,,	,,	450900
2000	3.25	,,	60900	,,	,,	,,	452100
01	,,	,,	,,	,,	,,	,,	452100
02	3.32	,,	62200	,,	,,	,,	453400
03	,,	,,	,,	,,	,,	,,	453400
04	3.35	,,	62800	,,	,,	,,	454000

*Includes slabwood sale: £17,200

DEVELOPMENT BUDGET FOR MARAETAI FOREST

Table 10:15 sets out the expenditure and returns which would be incurred over a period of approximately forty years to establish and tend an area of 25,000 acres gross (20,800 net) to the point where the forest functions as a normal forest earning a constant net annual income. The column showing 'Net Investment' is the sum of all expenditure for the year, less annual revenue as the forest begins to earn income. The final three columns give the net value of the investment at three rates of compound interest at the end of forty years. Expenditure and income are both deemed to be centred at the mid-point of the year to which they belong; and the total compounding period to the end of Year 40 is therefore 39½ years. The budget demonstrates the spread of forest expenditure and shows in particular the extent to which land preparation and capital works influence the financial outlay in the early years of the forest.

Chapter 11

THE FUTURE VALUE AND PRESENT WORTH OF THE MARAETAI BLOCK UNDER FORESTRY

THE preceding chapter has traced the cost of developing the Maraetai block up to the point where, at the end of forty years, capital expenditure is complete and the 25,000-acre forest of radiata pine can be classed as a single large-scale 'going concern' of normal forest, with (ideally) stable physical output and stable costs. Estimated annual output is given in Table 11:1.

TABLE 11:1

ESTIMATED GROSS PHYSICAL OUTPUT IN YEAR 41

Sawlogs	3150000 cu. ft
Pulpwood	3250000
Slabwood	690000
Total	6400000

The slabwood (for pulping) is a by-product of the sawlogs and therefore is included in the latter for purposes of addition. But because it represents the salvage of waste wood and thereby adds to forest revenue it is shown as a separate item even though it does not add to the volume of wood extracted. To be rather more precise, the annual output of wood finally stabilises at 6,500,000 cu. ft some years later, but for convenience we have ignored this further increase so as to show the forest as a stable going concern after forty years.

Valuation of the physical output has been partially discussed already in Chapter 10, and nothing further needs to be said about the pricing of either pulpwood or slabwood. Sawn wood, however, calls for some comment because it has been under rigid price control for nearly thirty years. As a result prices do not fluctuate (as they do in the case of farm products) because, being under severe official restraint, their only movement is the periodic slight increase sanctioned by the Price Control Division when general wage increases are granted, or the timber industry can effectively establish that the cost of equipment and supplies has increased. It is worthy of note that stumpage is not recognised by the price control authority as an item of cost that will justify any increase in the price of the sawn product, and in consequence sawlog stumpages have for the exotic pines tended to be held at relatively low levels. Looked at realistically, we believe the scope for future price movements in sawn wood can only be upward.

In contradistinction to the cost-free indigenous resources which the exotic forests are replacing, the cost of growing, managing and protecting the latter must eventually be adequately recognised if private forestry is to play an effective part in the national wood economy. So far the price control authority has declined to take any account of the cost of exotic forest management when fixing saw wood prices. A comment regarding the possible future movement of sawn wood prices is given elsewhere in some detail[1]; but in this study we confine ourselves to the 1962 official price level even though it has the disadvantage of not necessarily reflecting the true market value.

New Zealand wholesale prices for sawn wood are standardised on a 'price point' basis; and the common source of reference in the North Island is the approved price list issued by the Dominion Sawmillers' Federation, which fixes prices by species, size and grade 'free on rail' at specific price points (with provision for freight differentials for other loading points). The price list introduced at the beginning of April 1962 operated until December and therefore has been used in this study because it covers the bulk of the year 1962/3. Prices have risen in the course of several approved increases since that date and are expected to maintain this upward movement. We therefore feel that the 1962 price level for sawn wood provides a very conservative basis for the valuation of the Maraetai sawlogs. Table 11:2 summarises the forest revenue.

TABLE 11:2

ANTICIPATED GROSS REVENUE FROM THE MARAETAI BLOCK IN YEAR 41 (£s)

Sawlogs	374000
Pulpwood	60900
Slabwood	17200
Total	452100

Gross forest output is of course only seen in correct perspective when set against the annual expenditure required to keep the forest functioning as a going concern. The many elements of cost have been traversed in detail in Chapter 10; and from the several tables and appendices we can select those costs which relate specifically to the normal forest operating at a stabilised level of output. Table 11:3 sums up and deducts these costs so as to present the net value of the annual forest output in perpetuity.

TABLE 11:3

ESTIMATED AGGREGATE GROSS OUTPUT, ANNUAL COSTS, AND NET OUTPUT IN YEAR 41 (£s)

	Excluding social costs	Including social costs
Gross output	452100	452100
Annual costs	119200	129700
Net output	332900	322400

[1]N.Z.F.S. 1965 Forest Research Institute, Silvicultural Branch Report 31.

No attempt has been made to postulate two different levels of forest production based on the adoption of more intensive management techniques subsequent to Year 41 and aimed at increasing the annual output of usable wood. It seems very likely that the conservative yields estimated for Maraetai could be considerably improved; but in New Zealand forestry is young compared with agriculture, and development of techniques to deal with intensive silviculture began only ten to fifteen years ago. We could perhaps have examined the prospects for a higher level of output, say by Year 40; but the picture did not seem clear enough for useful conclusions to be drawn with any confidence. But, weighing the estimated level of physical output in conjunction with the unit values which have been applied, we are satisfied that the net output of £333,000 annually (exclusive of social costs) is a conservative assessment of the potential value of the Maraetai block to the nation. Considering that not only is the price of sawn wood under rigid control but that in addition the price control formula actually does not recognise the cost of producing mature timber trees for the sawmiller, it would be difficult to reach any other conclusion.

The net annual forest income shown in Table 11:3 is assumed to continue in perpetuity; hence it can be capitalized to give the capital value of the normal forest as an income-producing investment at the end of Year 40. The procedure parallels that adopted in the agricultural analysis in Chapter 6 and therefore incorporates similar allowances for depreciation on buildings and (in the case where social costs are included) accommodation. All the other indirect and overhead costs have been fully dealt with in Chapter 10 and hence are correctly reflected in the net income which is now capitalized. The estimated capital value of the Maraetai block as a going concern forest is shown in Table 11:4 for three rates of interest, with and without social costs.

TABLE 11:4

ESTIMATED CAPITALIZED VALUE OF THE MARAETAI BLOCK AS A GOING CONCERN IN YEAR 41 (£s)

	Excluding social costs	Including social costs
Aggregate net output	333000	322000
Capitalized value at 4%	8325000	8050000
5%	6660000	6440000
6%	5550000	5365000

Net output has been rounded to the nearest £1,000 and capitalized values to the nearest £5,000. These estimates of capital worth in Year 41 represent the future value of the entire Maraetai block as a fully stocked productive forest at constant levels of output. That is to say, the table shows, for any particular set of assumptions, what the forest is worth in Year 41 as an income-producing asset.

THE ECONOMIC PROFITABILITY OF THE PROJECT

We can now compare the capital worth of the Maraetai forest in Year 41 with the cost of developing the asset to this stage as described in Chapter 10—and so estimate the profitability of the forestry project. Table 10:15, which sets out the total cost of the forest development inclusive of interest, also includes the social costs normally associated with forest development (roading, accommodation, water-supply, telephone and power reticulation). Table 10:10 lists the capital cost of these social items; but substantial revenue items (both expenditure and income) must also be allowed for when calculating the reduced cost of development if social items are excluded. Full details of the social costs involved are set out elsewhere[2]. Deducting the cost of development from the anticipated future capital worth of the project gives the future net worth of the forest as a going concern in Year 41; discounting this future value back to its present value in Year 1 gives the present net worth of the entire development programme. Thus, taking the rate of interest at 5%, and excluding social costs, the anticipated future capital worth is £6,660,000 compared with an estimated cost of development of £2,067,000. Deducting one from the other gives a net worth of £4,593,000 in Year 41; and discounting this value over forty years at 5% gives a present net worth (in Year 1) of £652,000. This final figure then represents the value of the Maraetai block as a forestry project at the beginning of Year 1 under this particular set of assumptions. As pointed out in the discussion of the agricultural results in Chapter 6, the rate of interest exercises a profound influence on the results which are set out in Table 11:5.

TABLE 11:5

ANTICIPATED FUTURE CAPITAL WORTH, COST OF DEVELOPMENT, FUTURE NET WORTH, AND PRESENT NET WORTH OF DEVELOPMENT FOR FORESTRY

Rate of interest		Excluding social costs (£000s)	Including social costs (£000s)
4%	Future capital worth	8325	8050
	Cost of development	1119	2233
	Future net worth	7206	5817
	Present net worth	1499	1210
5%	Future capital worth	6660	6440
	Cost of development	2067	3488
	Future net worth	4593	2952
	Present net worth	652	419
6%	Future capital worth	5550	5365
	Cost of development	3378	5200
	Future net worth	2172	165
	Present net worth	210	16

Table 11:5 shows that the development of the Maraetai block for forestry would be economically worthwhile at all three rates of interest and regardless of whether social costs of roading and housing are included or not. It will be seen, however, that when these social costs are included the venture really does little better than 'break-even' if the interest rate is 6%; hence from a practical viewpoint 6% can be regarded as the critical rate for forestry on the Maraetai block if social costs are regarded as a legitimate charge.

[2]N.Z.F.S., ibid.

LAND EXPECTATION VALUES

In this type of exercise in forest economics the derivation of a land expectation value has long been regarded as a convenient and useful method of approach. The adoption of this technique is, of course, merely tantamount to expressing in slightly different language the conclusions already reached in the guise of present net worth; but because land expectation value is traditionally the more popular approach in forestry it should at least find a place in this study as an alternative to the 'present net worth' approach. The relationship between the two methods is more or less self-evident; but in any case it is elaborated in Chapter 6 and therefore calls for little comment here. The forestry development budget is based on a rounded gross land area of 25,000 acres which reduces to a net 20,800 acres of productive forest. For the agricultural

TABLE 11:6

LAND EXPECTATION VALUES ACCORDING TO RATE OF INTEREST

Rate of interest	Excluding social costs (£ per acre)	Including social costs (£ per acre)
4%	60	48
5%	26	17
6%	8	1

section of the study a gross area of 25,565 acres has been used; but this does not affect the use of a slightly lesser area for the forestry section since forest income would have to be proportionately increased if the larger area were applied. By the simple process of dividing present net worth in Table 11:5 by 25,000 the land expectation value for the several alternative assumptions is presented in Table 11:6. The effect is to show what a 'break-even' price per acre could be paid for the Maraetai block in order to develop it for forestry. For example, if the costs of roading and housing are not to be charged against the project we could offer £60 per acre if the rate of interest were 4%; but only £8 per acre if the interest rate were raised to 6%.

THE INTERNAL RATE OF RETURN

Following the application of the internal rate of return to agriculture as discussed in Chapter 6, the same criterion was also adopted for the forestry analysis as a further alternative to the two already discussed. The forestry analysis had already been extended to the point where it registered a negative result, and the internal rate of return was then interpolated by graphing the results for the several rates of interest.

TABLE 11:7 INTERNAL RATE OF RETURN

(rounded to nearest $\frac{1}{4}$ per cent)

Excluding social costs	$6\frac{3}{4}$%
Including social costs	6%

Although such a method lacks finesse it is accurate enough provided we are not looking beyond the nearest quarter per cent. This concept of the internal rate of return is frequently encountered in forestry in the form of the 'forest per cent'. It expresses the rate of interest which the investment would earn if the land itself were free of cost; and it correctly accounts for the diverse manner in which the forest investment is built up by the expenditure of widely varying annual sums of money over a period of forty years. The results of this further analysis are given in Table 11:7.

FUTURE PRICE LEVELS

As stated earlier, the valuation of forest output has been based on the price levels ruling in 1962 and no attempt has been made to introduce other possibilities. Desirable as it might be to present a range of price possibilities to parallel the treatment applied to the analysis of agricultural development we have not been able to find a satisfactory basis for useful estimates. The crux of the problem is, of course, the continuance of price-control on sawn wood.[3] Not only is the upward movement of timber prices in general strictly controlled but in addition the rigid nature of the price-control formula prevents the ready adjustment of grade differentials within the approved price structure in accordance with the strength of demand. As a result the lowest grades tend to be over-priced and the top grades under-priced, the overall effect being that the price structure for exotic timbers has become compressed within a very narrow range. Thus we are confronted with an extremely rigid and highly artificial price situation which does not seem to contain any of the elements of variability which are found for agricultural products.

Even export markets do not provide a useful guide to possible price variations, mainly for two reasons. In the first place the volume of sawn timber exports has long been very small; indeed, during recent years only about five per cent of the total sawn output has gone to overseas markets. Secondly, and more significantly, New Zealand produces a surplus of low grade timber, for which the market is very weak, but has no surplus of the best grades which are in good demand for export. Under present conditions it is impossible to produce the required quantity of framing and finishing grades for the home market without also producing more than the required quantity of low-grade wood; a situation resulting directly from the complete lack of silviculture in the exotic forests now being harvested. Hence although we have planned a vastly different forest regime for Maraetai, with adequate silviculture to ensure a high percentage of good-quality sawn wood, we cannot as yet refer to a well-developed export market for a realistic range of timber prices. A higher yield of high grade wood automatically enhances the average timber value, but this essentially represents an upward movement of grades not prices. The weighted price naturally rises as the ratio of higher grades increases, but there is no effect on individual timber prices *per se*. It would make this comparative land use study much more useful if we were able to relate our timber prices realistically to free market conditions, but unfortunately we cannot do so. Thirty years of price-control have left us without any evidence as to how the price level might vary under a free market.

[3]Price-control on timber has been removed since this report went to press (i.e. 23 December 1965).

Chapter 12

A COMPARISON OF DEVELOPMENT FOR AGRICULTURE AND FORESTRY

IN this final chapter the main results of the analyses which have been carried out in the preceding sections of the study are brought together in order to make a broad comparison of the relative profitability of developing the Maraetai block for agriculture or forestry. The success of development for either form of land use, as with any other type of development, will, of course, largely depend upon the level of prices ruling when the output from the block comes on to the market and, in an attempt to make some allowance for the uncertainty involved, agricultural output has been valued at prices ranging from pessimistic to optimistic, by standards ruling in 1964. It is impossible to foretell which of the assumptions made for the prices of agricultural products is likely to be nearest the truth. Much will depend upon whether New Zealand is able to maintain the favourable treatment she at present enjoys in the British market, a factor which will be brought to the fore when our present marketing agreements with the United Kingdom expire in 1967. The results of new negotiations are in turn likely to depend upon Britain's own relationship with the European Economic Community. In addition, overseas earnings for our farm products will be dependent on our success in developing and extending new markets, especially in Japan and other Asian countries, and in North America.

In the case of forest products there is only a single set of price assumptions because sawn timber is sold almost entirely on the internal market where it has now been subject to price-control for nearly thirty years. Moreover, it is not only the fact of price-control but also the basis on which control was first instituted that impinges on the comparability of forestry and agriculture. It is probably not widely known that sawn timber was placed under price-control in 1936 (that is, about two years before general price-control was introduced in New Zealand) before timber prices had fully recovered from the depression and when utilisation of the commercial exotic forests had barely commenced. At that time the timber industry was based on cost-free indigenous forests carrying very low stumpage values, with a small supplementary supply of logs coming from farm shelter belts. Under the circumstances it is not really surprising that the price-control formula made no provision for the cost of establishing and managing the exotic forests that were progressively to replace the vanishing indigenous forests. What is surprising is that in 1965 we not only still have price-control on sawn timber but in addition are bound by a price-fixing formula which still ignores the cost of producing the mature timber trees.

The significance of price-control when comparing forestry with agriculture lies in the fact that the stumpage value of the standing trees is a residual value which is reached by progressively deducting from the approved wholesale price of sawn timber the cost of sawmilling, transport, logging, etc. What is left is the direct forest revenue. In the case of the projection for the Maraetai forest at least eighty per cent of the net stumpage revenue is accounted for by the sale of saw logs; that is to say, eighty per cent of the annual forest income has its upper limit fixed by an edict of the State, not by the operation of a free market.

In effect, the forestry analysis is limited by circumstances to a single set of price assumptions which cannot be accurately labelled in terms of the pessimistic-moderate-optimistic classification adopted for agriculture. This is, of course, a serious drawback because it limits our ability to make valid comparisons and to draw unequivocal conclusions. By its very nature price-control necessarily implies at least a somewhat lower price level than would normally apply under free market conditions, and this suggests that in adopting the controlled 1962 prices for sawn wood we are using values which are less than representative of the true market. Hence it might reasonably be argued that the level of forestry prices used in this analysis could, at best, be compared with the 'moderate' series in agriculture and that it would be quite unrealistic to compare the forestry results given here with those based on optimistic agricultural prices.[1]

The difference in the approach to product prices for the two projections, together with the fact that two different levels of productivity were analysed for agriculture in comparison with a single one for forestry, raised difficult questions in making the final comparison between agriculture and forestry. To compare a single result for forestry with a range of results for agriculture would make it difficult to draw any final conclusion especially if, as proved to be the case in this study, the agricultural results straddled the forestry result. It was therefore decided to make the final comparison on two different bases: first, using 'most likely' assumptions for agriculture to get a single comparison and, second, using the results of the parametric analysis for agriculture to show the effect that changes in assumptions made about the level of productivity in farming and the level of farm prices, have upon the comparison.

A COMPARISON BASED ON 'MOST LIKELY' ASSUMPTIONS

Although settlement farming is the only type of agricultural development envisaged in the land-use controversy between forestry and agriculture, the results from the large-scale farming projection carried out in Chapter 8 have been included for comparative purposes. The 'most likely' assumptions for agriculture have been taken to be moderate prices (falling between the extremes realised in 1961/2 and 1963/4) and the level of productivity assumed for Year 30, which in broad terms

[1]There is some evidence that on a long-term basis latent forces will drive the price of sawn wood upwards in terms of 1962 values.

implies five sheep plus beef stock to the acre on the sheep farms and 200 lbs of butterfat on the dairy farms. There are now indications from similar blocks that the latter figure would be relatively easy to achieve and might be regarded as conservative whereas the former might prove more elusive, especially if problems of pasture matting and erosion become more serious. However, there is a widespread consensus of opinion amongst agriculturalists experienced on this class of country, that the figures represent a reasonable level of productivity for thirty years after initial development.

To simplify this comparison further it has been restricted to one rate of interest, five per cent, on the assumption that this is the 'most likely' rate for long term development capital over the period envisaged. Two other rates, four per cent and six per cent, are included in the sensitivity analysis.

A starting point for comparing the two alternative forms of development is to consider the gross output of the block under each of them. When the development has reached the going concern stage there is no method by which the physical volume of output of wool and butterfat may be compared with that of timber and pulpwood so that the only logical basis of comparison is in terms of value. The estimated value of gross output for agriculture and forestry is shown in Table 12:1. The production forest when established on a rotation basis after forty years would have an annual output estimated at £452,000, compared with £632,000 from agriculture. Turning to the operating costs required to sustain these levels of output, however, it is evident that forestry requires a much smaller annual input of resources, £119,000, than agriculture, £438,000. A detailed comparison of these annual costs has not been made because of differences in the accounting procedure; annual costs in farming are expressed in terms of inputs, i.e. labour, fertilizer, power, contract services, etc., whereas in forestry they are expressed in terms of operations, establishment, silviculture, logging, etc. However, a broad comparison shows that forestry requires fewer inputs from other sectors of the economy as well as a smaller labour force.

The annual input for forestry is smaller than that for agriculture not only in absolute terms but also in relation to the value of gross output. This is reflected in the value of net output which is considerably greater for forestry at £333,000 than for farming at £194,000. This comparison

TABLE 12:1

A COMPARISON OF SUSTAINED YIELD VALUES FOR AGRICULTURE AND FORESTRY

Sustained yield values	Agriculture £	Forestry £
Annual gross output	632000	452000
Annual costs	438000	119000*
Annual net output	194000	333000
Capitalized value†	3880000	6660000

*Excluding £11,000 annual social costs depreciation on roads and houses. This item was not estimated for agriculture.

†Net output capitalized in perpetuity at 5%.

may also be made in terms of the future capital value of the block as a going concern; the capitalized value under forestry, £6,660,000, is considerably greater than its value under farming, £3,880,000.

Although the preceding section shows that forestry has a marked advantage over agriculture in terms of the value of net output when the sustained yield stage is reached, the relative profitability of the two alternative types of development depends not only upon the level of net output but also upon the cost of development necessary to achieve that output. Details of these costs for agriculture and forestry have been shown in earlier sections of this study where they have been related to the value of development by deducting the net cost of development from the capitalized value of the project to give future net worth. Comparative figures for future net worth for agriculture and forestry are shown in Table 12:2. They indicate that, if social costs of development are excluded, the future net worth of the block under forestry, £4,593,000, would be greater than under agriculture, £3,049,000, and that if social costs are included forestry, £2,952,000, compares even more favourably with farming, £1,007,000.

In the comparison of development for agriculture and forestry so far no account has been taken of the period of production required before the sustained yield stage is reached, which occurs later in forestry, forty years after initial development, than for agriculture. Moreover, the build-up of output during the development period also occurs less rapidly in forestry; it is nineteen years before an annual output is expected from the forest (although this would be reduced if the forestry projection did not preclude the sale of roundwood for posts) and a further three years before annual revenue begins to exceed annual costs. In agriculture, on the other hand, some output (wool sales) is anticipated from the very first year of development, while the annual profit on farming account exceeds the yearly capital cost of development by the 11th year if social costs are excluded and the 13th year if they are included. These differences in the period of time needed to create the asset have to be taken into account in making a comparison of the two forms of development, and this has been done by discounting the future net worth of development over the period of development to determine its present value or the present net worth. If social costs are excluded the present net worth of agricultural development, £706,000, exceeds that for forestry, £652,000. If social costs are included, however, the position is reversed, the present net worth of agriculture falling to £233,000 compared with £419,000 for forestry.

TABLE 12:2

COMPARISONS OF THE PROFITABILITY OF DEVELOPMENT FOR AGRICULTURE AND FORESTRY

	Excluding social costs		Including social costs	
	Agriculture	Forestry	Agriculture	Forestry
Future net worth (£000s)	3049	4593	1007	2952
Present net worth (£000s)	706	652	233	419
Land expectation value (£s)	28	26	9	17
Internal rate of return (%)	7	$6\frac{3}{4}$	$5\frac{1}{2}$	6

As discussed in earlier chapters, present net worth divided by the acreage of the block gives a value per acre which has been termed the land expectation value, the price that could be paid for the land before development began if that development were just to break even. The comparative positions are, of course, exactly the same as for present net worth but their expression in terms of land value may justify some discussion. In general terms, if social costs are excluded, the amount that could be paid for land to be developed for agriculture, £28 an acre, is very close to its value for forestry, £26 an acre. If social costs are included as a charge against development however, the land expectation values become £9 an acre for agriculture compared with £17 an acre for forestry.

Finally, the alternative ways of developing the block were analysed in terms of the internal rate of return. If social costs are excluded, the internal rate of return on development for agriculture is fractionally higher at 7% than for forestry at 6¾%, but if social costs are included the yield on forestry at 6% exceeds that on agriculture which falls to 5½%.

In summary, the value of annual gross output that could be anticipated from the Maraetai block thirty years after settlement for farming would be considerably greater than the value of output from the same land under forestry. On the other hand, the annual costs of managing the forest on a sustained-yield basis would be absolutely and proportionally lower than for agriculture, so that a comparison of annual net output is more favourable to forestry. But against this we have to consider the length of time involved before each type of development reaches the sustained-yield stage, and as has been pointed out the full development period is ten years shorter for agriculture, while the volume of output from agriculture also builds up much more rapidly during development. This poses one of the critical problems which has to be faced in making investment decisions, the comparison of a greater net output at a later stage with a smaller net output at an earlier stage. A number of criteria have been employed to make a valid comparison; all give the same result. If social costs are excluded, development for agriculture is more profitable, although the margin appears to be small, but if they are included the position is reversed and forestry appears the more profitable; this illustrates the significance of the higher social costs of housing and roading which is required for the denser settlement for farming on the traditional pattern.

The final conclusion as far as the present section of the study is concerned therefore turns upon whether social costs should be included as a charge against development. If it is agreed that houses for the farm families settled on the block would have to be found elsewhere in the country if the land went to forestry, and that the through roads have a social value in opening up the country over and above their value for agricultural production, then social costs should not be charged against agricultural development. In this case development would appear to be slightly more profitable for agriculture than for forestry.

TABLE 12:3 GROSS OUTPUT, ANNUAL OPERATING COSTS, AND NET OUTPUT FROM THE BLOCK, UNDER AGRICULTURE AND FORESTRY (£000s)

	AGRICULTURE									FORESTRY
	Settlement farming						Large-scale farming			
	Year 23			Year 30						
Price assumption:	Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic	
1. Gross output	427	460	509	586	632	696	261	282	331	452
2. Annual operating costs	365	365	365	438	438	438	191	191	191	119†
3. Net output	62	95	144	148	194	258	70	90	140	333
4. Capitalized value*	1235	1910	2885	2960	3880	5165	1400	1810	2800	6660

†Excluding £11,000 annual social costs—depreciation roads and houses. This item was not included for agriculture.

*Net output capitalized at 5%.

A COMPARISON BASED ON THE SENSITIVITY ANALYSIS

Having compared the relative profitability of development for agriculture and forestry on the basis of 'most likely' assumptions, we have now to compare the range of results for agriculture under different assumptions for productivity, prices and interest rates with those recorded for forestry for which the only variable was the rate of interest. Although a comparison of this nature is complex and may seem to confuse rather than clarify the issues involved, it does serve two important purposes. Firstly, it draws attention to those assumptions that are critical in the comparison, and, secondly, it emphasises the fact that in making investment decisions we are concerned with events that lie in the future and that can not be known with any certainty. The apparently definitive nature of the comparison based on 'most probable' assumptions can be deceptive and for this reason a sensitivity analysis is a valuable complementary study to the narrower one just carried out. In making such an analysis there will inevitably be some repetition as the results for Year 30 settlement farming, at moderate prices, and for forestry, both at a five per cent rate of interest, have already been considered.

The estimated value of gross output under the various price assumptions is shown in Table 12:3. The production forest when established on a rotation basis after forty years would have an annual output estimated at £452,000. This is less than could be expected from the most intensive system of farming, under any of the price levels assumed, but very close to the output, valued at moderate prices, which would be achieved if agricultural productivity did not rise beyond the level assumed for Year 23. It is considerably greater than the output estimated for large scale farming, under any of the price assumptions.

When the operating costs required to sustain these levels of output are considered, it is evident that forestry requires a much smaller annual input of resources than for any system of agriculture. The comparative figures for annual costs are £119,000 for forestry as against £438,000 and £365,000 for settlement farming at Year 30 and Year 23 respectively and £191,000 for large-scale farming. Turning to net output, Table 12:3 illustrates that the annual net output expected from forestry, £333,000, is considerably greater than that from any system of farming even under optimistic prices. The highest level of net output under agriculture is estimated to be £258,000 assuming a high level of productivity and high product prices. Similarly, the capitalized value of the block under forestry at £6,660,000 is considerably greater than under farming for which the most favourable estimate is £5,165,000.

Comparative figures for future net worth for agriculture and forestry are shown in Table 12:4. The results indicate that if social costs of development are excluded the future net worth of the block under forestry would be greater than under agriculture at any of the three rates of interest shown, except under the most favourable combination of high productivity (Year 30 settlement farming) and optimistic prices. Almost identical results are found if social costs are included in the

TABLE 12:4 FUTURE NET WORTH OF DEVELOPMENT FOR AGRICULTURE AND FORESTRY (£000s)

		Excluding social costs				Including social costs			
		AGRICULTURE			FORESTRY	AGRICULTURE			FORESTRY
		Settlement farming		Large-scale		Settlement farming		Large-scale	
Rate of interest	Price assumptions	Year 23	Year 30	farming		Year 23	Year 30	farming	
	Pessimistic	—349	2201	447		—1603	551	107	
4%	Moderate	1241	4648	1195	7206	—14	2998	872	5817
	Optimistic	3593	8190	3020		2339	6540	2680	
	Pessimistic	—1131	656	85		—2582	—1387	—458	
5%	Moderate	361	3049	574	4593	—1090	1007	218	2952
	Optimistic	2580	6545	2184		1129	4503	1800	
	Pessimistic	—1901	—881	—520		—3581	—3407	—932	
6%	Moderate	443	1567	81	2172	—2122	—959	—307	165
	Optimistic	1737	5170	1575		58	2645	1162	

TABLE 12:5 PRESENT NET WORTH OF DEVELOPMENT FOR AGRICULTURE AND FORESTRY (£000s)

		Excluding social costs				Including social costs			
		AGRICULTURE			FORESTRY	AGRICULTURE			FORESTRY
		Settlement farming		Large-scale		Settlement farming		Large-scale	
Rate of interest	Price assumptions	Year 23	Year 30	farming		Year 23	Year 30	farming	
	Pessimistic	—142	679	239		—650	170	57	
4%	Moderate	503	1433	638	1499	—6	924	465	1210
	Optimistic	1458	2525	1613		949	2016	1430	
	Pessimistic	—368	152	—39		—841	—321	—210	
5%	Moderate	118	706	263	652	—355	233	100	419
	Optimistic	840	1514	1003		367	1042	831	
	Pessimistic	—498	—153	—205		—937	—593	—367	
6%	Moderate	—116	273	32	210	—556	—167	—121	16
	Optimistic	455	900	620		15	461	458	

TABLE 12:6 LAND EXPECTATION VALUES FOR AGRICULTURE AND FORESTRY (£s per acre)

		Excluding social costs				Including social costs			
		AGRICULTURE			FORESTRY	AGRICULTURE			FORESTRY
		Settlement farming		Large-scale farming		Settlement farming		Large-scale farming	
Rate of interest	Price assumptions	Year 23	Year 30			Year 23	Year 30		
4%	Pessimistic	−6	27	9		−25	7	2	
	Moderate	20	56	25	60	0	36	18	48
	Optimistic	57	99	63		37	79	56	
5%	Pessimistic	−14	6	−1		−33	−13	−8	
	Moderate	5	28	10	26	−14	9	4	17
	Optimistic	33	59	39		14	41	33	
6%	Pessimistic	−19	−6	−8		−37	−23	−14	
	Moderate	−5	11	1	8	−22	7	−5	1
	Optimistic	18	35	24		1	18	18	

TABLE 12:7 INTERNAL RATE OF RETURN TO DEVELOPMENT FOR AGRICULTURE AND FORESTRY

	Excluding social costs				Including social costs			
	AGRICULTURE			FORESTRY	AGRICULTURE			FORESTRY
	Settlement farming		Large-scale farming		Settlement farming		Large-scale farming	
Price assumptions	Year 23	Year 30			Year 23	Year 30		
Pessimistic	3½%	5½%	5¼%		2½%	4¼%	4½%	
Moderate	5½%	7%	6½%	6¾%	4%	5½%	5¾%	6%
Optimistic	8¼%	9¼%	9¾%		6%	7¼%	8½%	

capital cost of development, the sole difference being that large-scale farming, under optimistic price assumptions at a six per cent rate of interest, would also have a higher future net worth than forestry.

When allowance is made for the length of time necessary for development and for revenue during the development period, by expressing the relationship between costs and revenue in terms of present net worth, the comparison changes. The results given in Table 12:5 show that if social costs are excluded the present net worth of development for forestry is less than that for agriculture when farm products are valued at optimistic prices, but greater when pessimistic prices are used. With moderate prices only settlement farming, Year 30, compares favourably with forestry and in fact the closeness of these particular results is one of the features of the table. If social costs are included, the comparison becomes more favourable to forestry. Its present net worth is greater than for settlement farming Year 23 under all assumptions and greater than that for Year 30, and also for large-scale farming, under all assumptions but optimistic prices. The higher the rate of interest the less favourable does the comparison become for forestry, due to its longer period of production, under all assumptions.

It has already been shown that the comparative positions shown by present net worth are exactly the same as for land expectation values. The main interest in Table 12:6 is therefore that it expresses the relative profitability of development for agriculture or forestry in terms of land values, which some readers may find a more intelligible concept than present net worth. As a knowledge of valuation would suggest, the land expectation values vary directly with the state of productivity and the level of prices assumed, and inversely with the rate of interest.

If social costs are excluded the amount that could be paid for land to be developed for forestry is very close to its value for agriculture assuming a Year 30 level of productivity and moderate product prices, but higher than for Year 23 settlement farming and also for large-scale farming, except under favourable price assumptions. If social costs are included, the land expectation values are affected proportionally more for agriculture than for forestry reflecting the higher incidence of social costs in agriculture and the comparative position is also affected. Under none of the assumptions made could agriculture pay more for the land than forestry if productivity only reached the level assumed for Year 23. Moreover, at the higher level of productivity assumed for Year 30 the land expectation values for agriculture would still be lower than for forestry except under optimistic price assumptions, and for moderate prices at six per cent rate of interest.

Finally, the alternative ways of developing the block were analysed in terms of the internal rate of return and the results are shown in Table 12:7. If social costs are excluded, the internal rate of return on development for forestry is fractionally lower at 6¾% than that on Year 30 settlement farming, 7%, although higher than for Year 23 farming, 5½%, if moderate prices are assumed for agriculture. At higher prices for farm products the yield on agricultural development would exceed that on forestry while at lower prices it would fall short whatever the system of farming. If social costs are included the yield on forestry at six per cent exceeds that on any form of development for agriculture except under optimistic price assumptions.

The parametric analysis carried out in this study has made it possible to compare the profitability of development for agriculture or forestry, including or excluding social costs and under various assumptions as to product prices, rates of interest and level of productivity. This makes it possible to determine which variables are critical for the major comparison we wish to make. The broad results of the analysis suggest that the level of productivity achieved in settlement farming is one such critical factor and that the level of prices at which the agricultural products are sold is also highly significant. The rate of interest used in assessing development in terms of net worth is less critical.

The forestry projection has assumed a certain level of productivity, and its results are based on the assumption of good silvicultural management designed to ensure a higher proportion of good grades of timber than has been attained in the past. Because of the larger scale of operation, management is an even more important factor in forestry than in farming. The scope for increased productivity is also probably greater; the use of fertilizers on tree crops and of selected strains of trees for planting are still only in the experimental stage, while optimum planting, thinning and pruning regimes have still to be determined. A technical advance in any of these lines could lead to substantial gains in productivity, although the cost of management might also increase in some instances.

Although a range of results makes it possible to draw conclusions of this nature, unfortunately it also makes the major comparison more complex. If the results indicated that development for agriculture was always more profitable than for forestry whatever the assumptions made then we should have reached an unequivocal conclusion. However, this is not the case; it is not possible to say that one form of development is economically better than the other without specifying the price assumptions at which the products will be sold and the level of productivity which will be reached in agriculture. Although such a result will no doubt seem inconclusive and even irritating to those who prefer clear-cut answers, it is in itself a conclusion of some importance. There has long been an implicit assumption, amounting almost to a social philosophy, underlying discussions of land-use in this country, that if land is capable of development for farming it should not be used for forestry. The results of this study suggest that this attitude is an oversimplification and that in certain areas at least, forestry can compete successfully with agriculture for land which has quite a high potential under farming. It should be borne in mind, however, that for this particular study the forestry results relate to an integrated sawlog and pulpwood project favourably located in relation to both pulp mill and sawn-timber market. The circumstances at Maraetai are more favourable to forestry than would be the case in many other locations, and it is not implied that the results for this projection could be applied generally to other areas throughout New Zealand. Location in relation to mills, urban centres and ports is a more critical factor for forestry than for agriculture and should be one of the major factors taken into account in planning the use of land for agriculture and forestry.

In considering the comparisons which have been made in this chapter it is necessary to recall the qualification made in Chapter 1 concerning the use of 'farm gate' and 'forest ride' prices in evaluating development for agriculture and forestry. By using prices at these stages in the process of production we have restricted the analysis to one sector only, the primary stage of production and have ignored the processing and marketing stages which are linked vertically with it. Such a procedure would be applicable to a single farm, or a small commercial plantation, whose output would have virtually no effect upon the processing or servicing industries. This is not the case, however, when the development contemplated is on a large scale covering many thousands of acres of land and involving large inputs and outputs which affect the servicing and processing industries. In this case a complete comparison of agriculture and forestry as alternative land uses requires a broader emphasis than has been attempted in this study.

Large-scale development of the nature envisaged for agriculture or forestry, development involving between one and two million acres of land for each use, is bound to have major repercussions upon the economy as a whole because of the interrelationship between these industries and other sectors of the economy. A full study of these implications would require an input/output analysis based on sector accounts. The Agricultural Economics Research Unit at Lincoln College is now making a study of the farming sector account, and it is highly desirable that a similar analysis should be made for forestry. It is essential that the development plans drawn up by the Departments of Agriculture and of Lands and Survey and by the Forest Service should be reviewed jointly and as far as possible integrated to avoid incompatability. To be successful this will require land-use planning and it will also require a measure of general economic planning because land development involves the use of resources which are in demand from other sectors of the economy.

Appendix 1

COSTS AND PRICES USED IN THE AGRICULTURAL DEVELOPMENT BUDGETS

(Based on 1962/3 season)

(1:1) COSTS OF CAPITAL DEVELOPMENT ITEMS

(i) *Cultivation*

	No. of operations	Costs per acre
Super giant disc	1	3 0 0
Heavy harrows	1	17 6
Tandem disc	½	8 9
Roll	2	1 5 0
		£5 11 3

(ii) *Grass seed*

30 lbs mixture per acre	4 0 0
Application	15 0
	£4 15 0

(iii) *Scrub-crushing*

Price depends on topography—35s to £2 per acre

(iv) *Scrub-cutting* £6 0 0

(v) *Fertiliser* (costs per ton)

	Cobaltised superphosphates	DDT superphosphates
Ex-works	8 17 0	12 12 0
Cartage	3 5 2	3 5 2
Application	3 4 6	3 4 6
	£15 6 8	£19 1 8

(vi) *Fencing*

Seven-wire fences £7 to £7 5s per chain

Three-wire fences £4 5s per chain

Costs per acre:	SHEEP SECTIONS	DAIRY SECTIONS
Development phase	8 8 0	8 8 0
Settlement phase	1 13 8	1 7 0
Total outlay	£10 1 8	£9 15 0

(vii) *Water-supply*

	£
Bore	360
Pump	295
Troughs with ballcocks	13
Piping (polythene, per ch. laid)	5.75

Total cost per acre:	SHEEP SECTION	DAIRY SECTION
Development phase	2.625	2.625
Settlement phase	1.6	5.26
	£4.225	£7.885

(viii) *Buildings*

	£
House	3175
Implement shed	360
Woolshed development	1850
Shearers' quarters development	1430
Shearing shed settlement	1050
Haybarn	195

(ix) *Yards and tracks*

Sheep yards (development)	360
Cattle yards ,,	600
Airstrip ,,	1400-1900

(x) *Stock purchases*

In lamb 2-th ewes	70s
2-th ewes	65s
2-th wethers	45s
Rams	£18
In-calf heifers	£27
2-yr ,,	£25
Yearling steers	£18
2-yr ,,	£26
2-yr/3-yr ,,	£30
Bulls	£150

(1:2) SEASONAL EXPENDITURE COSTS

(i) *Farm stores*

2-th ewes and all wethers	1s 0d each
Breeding ewes	2s 6d
Cattle	2s 0d

(ii) *Hay*

Purchased hay	5s 0d a bale
Hay making	2s 6d

(iii) *Shearing*

£9 5s per 100 sheep shorn

(iv) *Crutching*

Ewes, lambs and 2-ths	£2 per 100
Adult ewes	£4 per 100

(v) *Dipping* £1 per 100

(vi) *Repairs and maintenance*

Vehicles—Landrovers 1s a mile, trucks 2s a mile.
Fences and capital items 1% of total capital involved.

(vii) *Tractor costs,* 7s 6d per hour.

(viii) *Winter crop*

Cultivation	£6	10	0	per acre
Borated super (3 cwt)	£13	10	0	
Swede seed		4	0	
Resowing crop to pasture	£6	18	0	

(ix) *Wages*

Manager	£19-£23 per week
Head shepherd	£17-£18
Shepherds	£14-£16
General hands	£14-£15

(x) *Freight and cartage*

Comparison with blocks of similar location were made and estimations made to correct for differences in size.

(xi) *Grant in lieu of rates*

Similar methods as used in (x).

(xii) *Administration charges*

These are based on estimates of labour required to supervise the block at current wage rates.

(1:3) PRIMARY DEVELOPMENT PHASE, PRODUCT PRICES USED IN BUDGET

(i) *Sheep prices* (sales) per head

	1962/3
Ewe lambs	30s
Ewes 2-th	53s
,, 4-th	50s
,, 6-th	40s
,, 4-yr	33s
,, 5-yr	20s
Wether lambs prime	50s
,, ,, stores	35s
,, 2-th	55s
,, 4-th	50s
,, 6-th	45s

(ii) *Wool prices*

Prices per lb net of shearing and selling	3s

(iii) *Cattle prices* (sales) per head

	1962/3
Weaner heifers	£8
18-mth ,,	£18
2-yr ,,	£28
3-yr ,,	£23
Cull cows	£20
Weaner steers	£14
Yearling ,,	£18
18-mth/2-yr steers	£26
3-yr steers	£48
Bulls	£40

Appendix 2

AGRICULTURAL DEVELOPMENT SUMMARY EQUATIONS

(2:1) Equations which were drawn up from the summary development budget, and solved for future net worth, and present net worth, at various rates of interest, and also for internal rate of return.

Equation No. 1. Year 23 development, excluding social costs.

$$FNW = (1+\tfrac{1}{2}i)\,[-125231(1+i)^{22} - 93650(1+i)^{21} - 110487(1+i)^{20} - 140104(1+i)^{19} - 98214(1+i)^{18} - 163955(1+i)^{17} - 141120(1+i)^{16} - 149138(1+i)^{15} - 107652(1+i)^{14} - 95810(1+i)^{13} + 34379(1+i)^{12} - 2327(1+i)^{11} + 71299(1+i)^{10} + 56847(1+i)^{9} + 94067(1+i)^{8} + 94014(1+i)^{7} + 105186(1+i)^{6} + 55133(1+i)^{5} + 109595(1+i)^{4} + 115108(1+i)^{3} + 118398(1+i)^{2} + 119982(1+i) + 121622] + \frac{93598}{i}$$

Equation No. 2. Year 23 development, including social costs.

$$FNW = (1+\tfrac{1}{2}i)\,[-158405(1+i)^{22} - 115649(1+i)^{21} - 135661(1+i)^{20} - 176453(1+i)^{19} - 117638(1+i)^{18} - 224054(1+i)^{17} - 209219(1+i)^{16} - 215562(1+i)^{15} - 161401(1+i)^{14} - 157559(1+i)^{13} - 320(1+i)^{12} - 62426(1+i)^{11} + 39775(1+i)^{10} + 12623(1+i)^{9} + 65718(1+i)^{8} + 65665(1+i)^{7} + 76837(1+i)^{6} + 55133(1+i)^{5} + 109595(1+i)^{4} + 115108(1+i)^{3} + 118398(1+i)^{2} + 119982(1+i) + 121622] + \frac{95398}{i}$$

Equation No. 3. Year 30 development, excluding social cost.

$$FNW = (1+\tfrac{1}{2}i)\,[-125231(1+i)^{29} - 93650(1+i)^{28} - 110487(1+i)^{27} - 140104(1+i)^{26} - 98214(1+i)^{25} - 163955(1+i)^{24} - 141120(1+i)^{23} - 149138(1+i)^{22} - 107652(1+i)^{21} - 95810(1+i)^{20} + 34379(1+i)^{19} - 2327(1+i)^{18} + 71299(1+i)^{17} + 56847(1+i)^{16} + 94067(1+i)^{15} + 94014(1+i)^{14} + 105186(1+i)^{13} + 55133(1+i)^{12} + 109595(1+i)^{11} + 115108(1+i)^{10} + 118398(1+i)^{9} + 119982(1+i)^{8} + 121622(1+i)^{7} + 121486(1+i)^{6} + 135560(1+i)^{5} + 149702(1+i)^{4} + 163844(1+i)^{3} + 179074(1+i)^{2} + 192060(1+i) + 206134] + \frac{194030}{i}$$

Equation No. 4. Year 30 development, including social costs.

$$FNW = (1+\tfrac{1}{2}i)\,[-158405(1+i)^{29} - 115649(1+i)^{28} - 135661(1+i)^{27} - 176453(1+i)^{26} - 117638(1+i)^{25} - 224054(1+i)^{24} - 209219(1+i)^{23} - 215562(1+i)^{22} - 161401(1+i)^{21} - 157559(1+i)^{20} - 320(1+i)^{19} - 62426(1+i)^{18} + 39775(1+i)^{17} + 12623(1+i)^{16} + 65718(1+i)^{15} + 65665(1+i)^{14} + 76837(1+i)^{13} + 55133(1+i)^{12} + 109595(1+i)^{11} + 115108(1+i)^{10} + 118398(1+i)^{9} + 119982(1+i)^{8} + 121622(1+i)^{7} + 121486(1+i)^{6} + 135560(1+i)^{5} + 149702(1+i)^{4} + 163844(1+i)^{3} + 179074(1+i)^{2} + 192060(1+i) + 206134] + \frac{194030}{i}$$

All these equations are based on moderate prices and included a charge for working capital, based on one-half of the cost incurred each year.

(2:2) The present net worth of the development project was calculated by multiplying the future net worth by the single payment present worth factor $\left[\frac{1}{(1+i)^n}\right]$

(2:3) The internal rate of return for each of the above equations was determined by setting each equation to zero and solving for i.

NOTES

(i) The last term in each equation represents the future capital worth of the Maraetai block as a going concern; it is obtained by capitalizing the aggregate net output of the block at the rate of interest, i.

(ii) The initial term $(1+\tfrac{1}{2}i)$ which represents the interest charged (or accrued) on half of each year's net cost (or revenue) was derived as follows. Charging interest on half the amount expended or received each year may be expressed as

$$\left[a_1 + \frac{a_1}{2}i\right](1+i)^{n-1} + \left[a_2 + \frac{a_2}{2}i\right](1+i)^{n-2} + \ldots + \left[a_n + \frac{a_n}{2}i\right]$$

Simplifying we have

$$(1+\tfrac{1}{2}i)\,[a_1(1+i)^{n-1} + a_2(1+i)^{n-2} + \ldots + a_n]$$

The term was introduced to allow for the fact that neither cost nor revenue occur exactly at the beginning or end of each year but, on average, approximately half way through the year.

Appendix 3

COSTS AND PRICES USED IN THE FORESTRY DEVELOPMENT BUDGET

(3:1) INTERNAL INDIRECT COSTS

1. *Annual maintenance—roads and bridges*

Any road required for utilisation has been fully allowed for in the unit cost of logging and extraction. Construction of all specific logging roads (which double the total length of road present on the block) are likewise provided for as an item under 'logging cost'. These roads, as distinct from forest roads proper, do not appear in the schedule of capital works since they are written off immediately as an item of direct cost against the produce extracted. A total of 48 miles of primary road is required, and the annual maintenance is costed at £0.05 per acre of forest. On the advice of the Forest Service Engineering Division the cost of roading was estimated at 25% *above* Kaingaroa costs as a safeguard against under-costing.

2. *Repairs and maintenance—services and general*

These cover water-supply, sewerage, communications, grounds, etc, and are based on overall North Island costs which show a reduction with size of forest.

	per acre
Up to 3,000 acres of forest	£0.35
3-8,000 ,, ,, ,,	0.25
8-13,000 ,, ,, ,,	0.13
13-30,000 ,, ,, ,,	0.10

3. *Repairs and maintenance—buildings*

Each building has been charged into the forest budget at full capital value, and depreciation has been omitted until the forest begins to function on a normal profit and loss basis, when 2½% of the capital value is charged annually for depreciation. Repairs are charged at the actual rate on Forest Service buildings of 1¼% annually. House rentals at 30s per week have been allowed as credits (where social costs are included) and rounded downwards to compensate for loss of rentals during short-term vacancies.

4. *Staffing salaries*

Forest Service rates were used, and a progressively larger staff was employed as the project expanded. Near normality (1982) these amounted per annum to:

O.I.C.	Forester	Station clerk	General clerks	Stores clerk
£1450	£1250	£1100	£1800(2)	£1000
Rangers	Foremen	Logging O.I.C.	Logging rangers	Logging foremen
£2100(2)	£1900(2)	£1300	£2100(2)	£1900(2)
			Total:	£15,900

The build-up of annual salaries would be:

1960-64	£3,400
65-69	6,000
70-74	7,300
75-79	7,300
80-84	15,000
1985-	15,900

5. *Administration—general*

General expenditure on administration decreases on North Island forests as the forest area increases. Net figures are:

Area in acres	Approximate cost per acre
4,000	£0.48
10,000	.24
15,000	.17
19,000	.145
21,000	.11

6. *Supervisory and administrative vehicles*

Average annual mileage was taken to be 12,000 per vehicle, and costs @ 1s per mile. Rounded costs per year are:

1960-4	£600
1965-9	1,200
1970-4	1,800
1975-9	1,800
1980-	£3,600

(3.2) COST OF SAWMILLING

1. The annual yield of sawlogs from Maraetai forest is 3.15 million cubic feet, which, at a coversion factor of 6.45, indicates a sawn output of 20 million board feet per annum or 84,000 board feet per day. The sawing pattern envisages that two out of every three logs will be sawn to high quality one-inch boards and the third log mainly to framing. The effect of this prescription is that 75% of the log volume is sawn to boards and only 25% to larger sizes.

2. For detailed cost data covering a sawmill of sufficient capacity to absorb the entire log supply at Maraetai the Waipa band mill is our only available source of reference. The capacity of this mill is rated at 80,000 bd ft per shift; moreover, since a horizontal bandsaw is incorporated in the main production line there is no bottleneck at the band head-rig when the sawing emphasis is on one-inch boards. The total log yield

from Maraetai will give a daily sawn output of 84,000 bd ft but this quantity could be handled by the Waipa band-mill without difficulty. However, Waipa costs cannot be applied as they stand because a gang-frame mill is operated in conjunction with the band-mill; hence the cost of log sorting, and also the cost of sorting and handling the sawn product, are combined costs for both mills. At the sawn timber end of the mill there would be no significant difference in sorting and handling costs for the Waipa and Maraetai mills; but there would be a very material difference in log-sorting costs because the elaborate Waipa log-sorting installation would not be required for the Maraetai logs. For the relatively simple form of handling Maraetai logs through an appropriate log yard it is certain that the Waipa cost could be reduced by approximately two-thirds. However, the only obvious saving in the sawmill itself lies in the utilisation of all slab-wood for pulping, so that waste disposal is a negligible item of cost and in fact is partially allowed for (as far as bark is concerned) in the costing of the debarking section. The derivation of a comparative cost for the Maraetai sawmill is as follows:

	Actual Waipa band-mill costs in 1962 (Shgs per 100)	*Estimated Maraetai costs* (Shgs per 100)
Log yard	2.8	1.0 (maximum)
Band-mill	8.0	8.0
Sorting and recutting	3.5	3.5
Grading and branding	3.0	3.0
Recording and yard handling	3.3	3.3
Waste disposal	0.5	0.2
	21.1	19.0

3. *Allowance for profit*

A detailed analysis of the assets employed in the sawmill equated to 1962 replacement values, gives the following orthodox assessment of profit to be allowed to the sawmiller:

Sawmill buildings and equipment	£219,000
Accommodation and services	94,000
Annual profit allowance:	
15% on £219,000	32,850
5% on £94,000	4,700
	£37,550

Profit per day (based on 240 working days): £156.5
Hence profit per 100 bd ft (based on 50,000): 6.25 shillings

(3:3) VALUATION OF SAWN OUTPUT AND DERIVATION OF NET LOG VALUE AT FOREST

1. Three factors in particular have a pronounced bearing on the average 'cut-of-log' price realised for the sawn product. These are:

(*a*) The percentage grade yield.
(*b*) The premium for clear timber.
(*c*) The proportion of 'wides'.

2. The following analysis shows how the average value f.o.r. Tokoroa has been computed (based on the assumption that, given the grade of log in question, sawing patterns would be designed to yield the maximum quantity of high-grade timber in one-inch boards):

Grade	*Percentage*	*Size*	*Price basis (April, 1962)*	*Value in shillings*
Clears	30	Up to 6″ wide	15% @ 96s	14.4
		10″ average	15% @ 110s	16.5
Dressing and factory	30	4 and 5 x 1	15% @ 64s 6d	9.7
		10 x 1	15% @ 90s	13.5
Merchantable	10	8 x 1	10% @ 51s	5.1
Framing 1	10	4 x 2	5% @ 64s 6d	3.2
		Other to 6″ wide	5% @ 67s	3.4
Framing 2	5	4 x 2	5% @ 51s	2.5
Box	15	6 x 1	8% @ 41s 6d	3.3
		9 x 1	7% @ 44s 6d	3.1
	100			74.7
Less trade discounts				7.5
Net sales value f.o.r. per 100 bd ft @ 1962 prices:				67.2

The premium for clears is 20s per 100 bd ft above dressing and factory grade.

3. *Derivation of log value* (*Shillings per 100*)

Net sawn value f.o.r. Mamaku	67.2	
Plus d.i.f. Tokoroa-Hamilton	0.6	
		67.8
Cost of sawmilling	19.0	
Allowance for profit	6.3	
		25.3
Log value at mill		42.5

Converting log value per 100 bd ft of sawn output into unit value per cubic foot of logs sawn @ 6.45 c.f. we have:

	per cu. ft
Equivalent log value at mill	32.9d
Less cartage to Tokoroa	4.4d
Value (loaded) 'on forest ride':	28.5d

(3:4) COSTS AND RETURNS

1. *Operating costs*

The annual cost of operating the de-barker is assessed as follows:

Depreciation at 10%	£6,500
Maintenance and repairs	4,000
Electric power	1,500
Labour (1 man)	1,000
Waste disposal and contingencies	1,000
	£14,000

The above schedule of costs is based on information supplied by Whakatane Board Mills Ltd; but the cost of power has been deliberately overstated in order to give a well-rounded total and a conservative overall cost.

2. *Cost of debarking*

It has been assumed that the Maraetai sawlog supply might yield 0.69 million cubic feet of wood in slab form for pulping. Hence the actual cost of debarking this material would be:

$$\frac{£14,000}{690,000} = 4.87\text{d/cu. ft of slabwood.}$$

It is assumed that the maximum distance between the sawmill at Tokoroa and the pulpmill would be five miles; hence the cost of transport is at most 1.75d per cu. ft (see Table 10:3). The only other item to be charged against the operation is the usual allowance of fifteen per cent by way of profit on the capital invested in debarking equipment. This works out at 3.1d per cubic foot of slabwood. The overall costs is as follows:

	per cu. ft
Cost of debarking	4.87d
Cartage to pulp mill	1.75d
Allowance for profit	3.10d
Total	9.72d

3. *Net value of slabs*

Because there is no recognised market value for pulpwood it is necessary to assess the net value of the slabs by comparing the cost of production with the corresponding cost of producing and delivering a normal run of forest pulpwood. Logging and extraction costs are given in Table 10:2, and logging capital employed on pulpwood production can be readily computed from Table 10:5. The theoretical cost of pulpwood landed at the pulp-mill works out as follows:

	Pence per cu. ft
Cost of 3.35 million cu. ft (£80,000	5.75
Transport to pulp-mill	4.40
Profit allowance at 15% on £100,000	1.07
Stumpage as per N.Z.F.P. advice	4.50
Theoretical value at Kinleith	15.72
Less cost of debarking slabs	9.72
Value of slabs (net)	6.00

Hence net annual value of revenue from sale of slabwood is:

690,000 cu. ft @ 6d = £17,250

4. It should be noted in paragraph 4 above that the cost of ordinary pulpwood delivered at the mill door would be subsequently increased by the cost of debarking (though of course only by a fraction of the unit cost shown against slabwood where the cost of debarking the entire sawlog is charged against the salvaged slabwood). As a conservative assessment we have merely assumed that a common price for all categories of pulpwood would operate at the pulp mill door—which means that the resultant *net* value of 6d per cubic foot probably under-estimates the true worth of the slabs for pulping.

(3:5) VALUATION OF PULPWOOD AT MARAETAI

1. *Valuation by N.Z. Forest Products Ltd*

This company has placed on record its opinion that pulpwood from Maraetai would command a stumpage value of 4.5d per cubic foot. No further details are given; hence we logically assume that this figure is based on the current operations of the Kinleith plant, the output of which goes mainly to the New Zealand market. Since this is a net stumpage after paying expenses and providing for the usual profit on capital employed in logging and extraction, it follows that all costs relating to the production of pulpwood must be deleted from the financial analysis. The stumpage moreover is a weighted average value for the entire forest and for all categories of pulpwood; for in practice costs tend to vary significantly between the eight distinct phases of pulpwood production prescribed for this forest.

2. *Value under effective competition*

Since there is virtually no effective competition on the New Zealand market, it might appear *prime facie* that 4.5d represents an inflated stumpage value; hence the desirability of relating this value to the stumpage paid by the Tasman Pulp & Paper Co. (which, by the very nature of its operations, has to compete against long established overseas suppliers). The following calculation demonstrates that this 4.5d does not include any margin arising from monopoly conditions or import control policy, but does in fact fairly reflect the competitive value of pulpwood at Maraetai. However, it must be pointed out that this makes no allowance for the prospective lower logging cost at Maraetai for all pulpwood extracted during the course of clearfelling operations in the sawlog working division—a factor which could considerably improve the stumpage value.

	per cu. ft
Stumpage payable by Tasman	3.0d
Plus transport to Murapara	3.9d
Freight Murupara to Kawerau	2.6d
	9.5d
Less cartage Maraetai to Kinleith	4.4d
Equivalent Maraetai stumpage	5.1d

'Transport to Murupara' is based on the average road trip of 35 miles for the entire Tasman working circle and includes loading on rail at Murupara. Of the Kinleith output of pulp it is understood that approximately 30% goes to export; hence the above stumpage gives the following weighted value for Maraetai stumpage based on current operations at Kinleith.

	per cu. ft
70% @ 5d as above	3.5d
30% @ 3.5d as hereunder	1.0d
Average value	4.5d

(3:6) ALLOWANCE FOR CONTINGENCIES

1. The costing of a complete hypothetical forest in detail is a complex operation because of the vast array of expenditure items. Despite the greatest care in assembling schedules of annual and periodic expenditure it is almost inevitable that some items of expenditure will be missed. By the same token, of course, it is possible for omissions to be balanced by excessive estimates for other items—particularly in cases where, because of the absence of accurate data, costing must include a margin for safety. Nevertheless, it seems prudent to introduce a small annual allowance into the financial analysis to cover contingencies and unavoidable omissions.

2. The question as to what is an appropriate allowance is far from easy, and the decision becomes largely arbitrary. It is proposed (as a matter of convenience) to adopt the very simple expedient of a flat sum of £1,000 each year throughout the 40-year capitalization period. Obviously this has no mathematical basis, but in view of the attention given to the cost analysis of the forest it is believed that this figure will provide all the margin necessary to ensure that the project is not undercosted.

3. The value of such an annual 'rental' of £1,000 for a period of 39½ years at compound interest is as follows:

Rate of interest	*Total forest*
4%	£93,000
5%	£117,000
6%	£150,000

PUBLICATIONS

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